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THE JOURNAL

OF THE

111
Society of Chemical Industry.

VOL. XXXVI.--1917.

373667
11 12 39

LONDON:
VACHER & SONS, LTD.,
GREAT SMITH STREET, WESTMINSTER, S.W.1.—56520.

The Society of Chemical Industry.

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23,280	294	17,670	126	101,295	1047	102,881	210	103,873	370	104,718	501	105,647	583
29,310	886	17,672	123	101,339	135	102,891	212	103,877	385	104,734	548	105,654	611
		17,743	142	101,406	936	102,892	211	103,881	402	104,743	500	105,687	585
		17,814	288	101,408	647	102,897	222	103,885	379	104,758	498	105,690	654
		17,822	357	101,412	1016	102,903	206	103,890	254	104,766	494	105,719	615
		17,846	544	101,475	1232	102,918	205	103,892	404	104,775	535	105,722	615
		17,862	139	101,536	465	102,928	1048	103,893	379	104,822	497	105,729	607
		17,891	25	101,539	588	102,933	1279	103,917	389	104,863	1054	105,703	995
1275	43	17,902	88	101,541	955	102,959	967	103,953	388	104,866	976	105,772	654
8134	123	17,920	162	101,549	930	102,966	1025	103,963	376	104,880	980	105,775	633
8899	231	18,023	160	101,620	137	102,974	602	103,989	1188	104,887	558	105,788	636
10,087	721	18,028	164	101,624	589	102,983	206	103,996	1277	104,890	497	105,789	640
10,879	1052	18,047	222	101,636	1064	102,986	298	104,012	383	104,899	563	105,810	654
12,719	653	18,059	214	101,649	77	103,046	305	104,015	404	104,919	561	105,817	636
12,987	504	18,069	162	101,703	1124	103,029	295	104,023	379	104,923	512	105,826	640
17,348	131	18,081	129	101,708	1063	103,023	287	104,025	389	104,936	535	105,830	640
20,192	906	18,092	127	101,709	1176	103,031	205	104,032	383	104,939	536	105,831	659
22,644	33	18,114	58	101,724	1061	103,048	222	104,034	385	104,942	497	105,835	636
24,646	1053	18,115	143	101,702	1131	103,057	288	104,045	542	104,952	544	105,840	665
		18,174	93	101,802	388	103,062	221	104,048	283	104,953	541	105,853	647
		18,221	215	101,804	563	103,079	296	104,061	460	104,961	503	105,861	659
1483	958			101,860	32	103,083	212	104,065	281	104,969	537	105,870	633
1490	959			101,870	1177	103,097	200	104,066	281	104,986	544	105,875	653
2941	229			101,959	557	103,107	476	104,067	380	104,999	565	105,884	586
6195	534			101,961	203	103,112	1101	104,083	383	105,015	514	105,902	1277
7010	343			101,962	1262	103,118	215	104,108	384	105,026	558	105,906	1093
7295	99			101,967	1174	103,132	261	104,115	386	105,033	541	105,929	637
7260	1008			101,973	705	103,142	229	104,121	380	105,041	501	105,935	645
8592	1218			101,975	1065	103,168	206	104,127	380	105,047	497	105,949	668
8706	48			101,978	962	103,169	205	104,128	389	105,054	501	105,953	656
9485	238			101,979	1272	103,196	201	104,132	379	105,055	868	105,962	659
9547	164			102,080	444	103,204	508	104,136	387	105,057	860	105,971	654
9049	233			102,081	41	103,205	294	104,139	376	105,075	1239	105,993	647
10,055	1185			102,089	31	103,228	203	104,145	396	105,086	611	105,995	648
11,332	26			102,092	37	103,230	205	104,154	383	105,096	537	106,036	637
11,820	507			102,138	138	103,232	200	104,155	548	105,105	611	106,042	637
12,205	25			102,141	1000	103,233	218	104,163	1170	105,106	548	106,050	655
12,441	97			102,142	887	103,239	212	104,181	1111	105,118	542	106,067	636
12,463	101			102,168	47	103,243	205	104,187	471	105,119	542	106,071	670
12,932	382			102,174	37	103,251	210	104,232	451	105,127	584	106,077	633
13,067	200			102,205	38	103,288	968	104,213	462	105,135	602	106,081	979
13,168	507			102,216	78	103,294	1148	104,214	451	105,137	514	106,113	707
13,452	32			102,234	37	103,310	653	104,220	382	105,138	558	106,120	721
13,753	139			102,237	38	103,312	1262	104,225	593	105,146	555	106,121	704
13,796	205			102,240	28	103,321	285	104,230	448	105,162	542	106,152	722
14,055	547			102,242	36	103,324	286	104,231	467	105,174	556	106,165	698
14,602	31			102,243	36	103,343	302	104,261	445	105,190	583	106,167	708
14,663	31			102,251	979	103,376	288	104,294	445	105,198	542	106,184	721
14,800	286			102,278	37	103,415	291	104,293	465	105,202	552	106,187	886
15,005	1030			102,284	74	103,431	289	104,327	445	105,204	521	106,189	704
15,248	395			102,291	80	103,432	289	104,339	1041	105,209	545	106,196	886
15,249	395			102,294	38	103,433	302	104,352	499	105,255	600	106,197	723
15,442	85			102,310	80	103,445	289	104,353	500	105,256	540	106,228	708
15,467	379			102,313	28	103,448	299	104,361	519	105,282	608	106,232	721
15,887	36			102,318	74	103,458	303	104,366	507	105,285	551	106,247	712
15,933	76			102,331	80	103,493	349	104,367	508	105,296	551	106,248	703
16,087	450			102,359	83	103,521	329	104,368	448	105,323	536	106,249	703
16,096	42			102,377	1182	103,529	332	104,369	448	105,319	594	106,270	1141
16,110	36			102,386	86	103,555	346	104,409	511	105,353	594	106,302	732
16,203	78			102,388	205	103,541	353	104,429	463	105,354	600	106,313	887
16,309	36			102,394	79	103,553	344	104,456	445	105,357	584	106,324	733
16,315	29			102,407	375	103,561	332	104,461	502	105,380	615	106,336	727
16,336	49			102,411	38	103,569	313	104,465	447	105,395	590	106,351	698
16,410	161			102,422	76	103,572	285	104,472	458	105,396	588	106,375	736
16,416	25			102,453	41	103,593	329	104,485	494	105,431	600	106,376	887
16,511	74			102,460	98	103,621	329	104,496	506	105,444	593	106,378	704
16,531	43			102,470	97	103,634	351	104,497	907	105,445	594	106,393	718
16,543	138			102,493	1272	103,638	641	104,510	1013	105,449	588	106,400	887
16,612	313			102,522	86	103,641	1227	104,512	1088	105,463	593	106,406	704
16,642	95			102,527	201	103,647	1232	104,516	598	105,466	614	106,423	724
16,658	47			102,539	159	103,668	1111	104,521	451	105,478	611	106,427	738
16,708	132			102,595	112	103,682	394	104,561	461	105,490	588	106,428	712
16,742	93			102,597	125	103,689	385	104,578	450	105,508	544	106,430	913
16,805	25			102,608	589	103,691	376	104,583	509	105,525	611	106,433	734
16,830	344			102,631	123	103,696	385	104,591	518	105,548	1277	106,439	728
16,867	314			102,635	159	103,698	401	104,595	458	105,556	1269	106,448	728
16,888	78			102,645	127	103,710	333	104,600	461	105,571	1013	106,460	1047
16,916	510			102,660	113	103,716	344	104,601	447	105,578	607	106,503	959
16,981	82			102,685	159	103,720	333	104,609	520	105,582	600	106,512	904
16,985	80			102,692	161	103,722	560	104,633	461	105,606	637	106,513	802
17,002	163			102,751	159	103,729	447	104,636	499	105,611	614	106,514	905
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17,202	93			102,784	139	103,772	335	104,652	520	105,613	614	106,519	700
17,232	83			102,802	151	103,775	340	104,657	507	105,614	584	106,531	903
17,281	96			102,813	226	103,776	376	104,658	470	105,617	653	106,546	857
17,463	160			102,815	232	103,818	457	104,661	465	105,626	583	106,547	870
17,567	123			102,826	218	103,820	905	104,670	967	105,627	654	106,549	858
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107,324	962	108,132	996	108,755	1048	109,323	1124	109,905	1185	110,430	1248	107,325	954
107,332	955	108,146	1025	108,759	1086	109,328	1134	109,915	1170	110,443	1240	107,333	953
107,344	956	108,164	969	108,773	1047	109,329	1086	109,926	1171	110,448	1231	107,345	952
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107,418	919	108,339	1001	108,826	1051	109,422	1107	110,015	1189	110,601	1263	107,426	962
107,426	962	108,340	1045	108,869	1086	109,458	1127	110,023	1173	110,621	1286	107,433	967
107,433	967	108,343	1000	108,875	1139	109,465	1183	110,025	1171	110,631	1266	107,443	995
107,443	995	108,358	996	108,884	1086	109,468	1148	110,035	1227	110,636	1268	107,446	956
107,446	956	108,363	1014	108,889	1117	109,471	1170	110,036	1184	110,637	1271	107,454	957
107,454	957	108,368	1001	108,892	1102	109,471	1170	110,036	1184	110,637	1271	107,465	969
107,465	969	108,372	1007	108,897	1086	109,471	1170	110,036	1184	110,637	1271	107,468	967
107,468	967	108,376	1044	108,802	1054	109,511	1128	110,042	1174	110,649	1274	107,474	968
107,474	968	108,412	1013	108,915	1087	109,519	1191	110,050	1174	110,650	1232	107,483	965
107,483	965	108,434	1045	108,916	1100	109,522	1170	110,053	1266	110,652	1241	107,502	922
107,502	922	108,437	1041	108,918	1094	109,523	1125	110,059	1185	110,653	1241	107,525	957
107,525	957	108,441	1004	108,920	1048	109,528	1137	110,066	1174	110,661	1243	107,532	968
107,532	968	108,448	1001	108,921	1087	109,530	1141	110,080	1195	110,717	1277	107,538	976
107,538	976	108,450	1087	108,938	1031	109,541	1129	110,132	1173	110,724	1263	107,549	1009
107,549	1009	108,477	1241	108,955	1080	109,560	1134	110,175	1231	110,737	1264	107,556	969
107,556	969	108,496	999	108,986	1094	109,572	1125	110,178	1243	110,774	1263	107,557	965
107,557	965	108,498	1013	108,990	1093	109,575	1143	110,180	1227	110,776	1272	107,561	957
107,561	957	108,503	998	109,013	1087	109,584	1144	110,183	1227	110,787	1290	107,567	957
107,567	957	108,504	996	109,018	1065	109,584	1144	110,183	1227	110,787	1290	107,605	960
107,605	960	108,508	1001	109,036	1053	109,586	1136	110,188	1237	110,803	1262	107,606	962
107,606	962	108,509	1000	109,037	1053	109,594	1174	110,194	1237	110,816	1262	107,613	965
107,613	965	108,520	996	109,038	1087	109,595	1170	110,197	1247	110,819	1272	107,640	962
107,640	962	108,543	1021	109,063	1123	109,596	1155	110,214	1239	110,821	1262	107,644	967
107,644	967	108,545	1054	109,074	1088	109,634	1129	110,215	1238	110,837	1271	107,678	963
107,678	963	108,555	995	109,077	1089	109,638	1191	110,217	1230	110,860	1278	107,769	1280
107,685	980	108,566	996	109,079	1106	109,648	1171	110,219	1238	110,872	1256	107,778	977
107,769	1280	108,573	1013	109,084	1107	109,652	1135	110,221	1232	110,897	1256	107,807	962
107,778	977	108,576	1007	109,105	1094	109,657	1139	110,235	1238	110,918	1275	107,811	980
107,807	962	108,579	998	109,106	1102	109,686	1174	110,237	1248	110,921	1262	107,820	960
107,811	980	108,590	1039	109,149	1092	109,686	1174	110,248	1239	110,926	1267	107,821	955
107,820	960	108,596	1000	109,152	1125	109,691	1174	110,258	1237	110,936	1281	107,824	958
107,821	955	108,602	998	109,176	1134	109,709	1126	110,260	1228	110,937	1277	107,866	963
107,824	958	108,604	1019	109,178	1134	109,710	1124	110,269	1228	110,939	1267	107,876	955
107,866	963	108,613	1043	109,179	1108	109,711	1129	110,275	1228	110,939	1267	107,879	956
107,876	955	108,615	1014	109,194	1121	109,715	1122	110,283	1239	110,946	1278	107,911	958
107,879	956	108,616	1061	109,195	1124	109,742	1171	110,293	1246	110,948	1277	107,921	961
107,911	958	108,619	1049	109,196	1121	109,746	1137	110,318	1232	110,960	1266	107,937	977
107,921	961	108,626	1009	109,196	1121	109,749	1135	110,324	1242	110,970	1278	107,951	965
107,937	977	108,684	1092	109,200	1092	109,752	1124	110,338	1244	110,983	1263	107,967	1147
107,951	965	108,688	1100	109,205	1103	109,753	1150	110,379	1227	110,993	1290	107,982	1000
107,967	1147	108,692	1047	109,213	1122	109,755	1135	110,380	1220	110,994	1266	108,004	1001
107,982	1000	108,693	1048	109,230	1100	109,766	1136	110,381	1227	111,007	1263		
107,982	1000	108,693	1048	109,238	1145	109,817	1181	110,382	1227	111,026	1278		
108,004	1001	108,701	1086	109,248	1145	109,836	1173	110,383	1230	111,051	1290		
				109,297	1103	109,838	1171	110,384	1227	111,061	1263		
						109,843	1177	110,385	1228				

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(Note.—“R” indicates that a re-issue of the Patent is referred to.)

1,819R	239	1,204,700	32	1,205,619	24	1,206,156	77	1,206,708	84	1,207,284	163	1,207,858	124
1,724R	340	1,204,869	42	1,205,659	83	1,206,177	85	1,206,821	126	1,207,312	89	1,207,881	144
1,840R	590	1,204,960	38	1,205,694	40	1,206,188	89	1,206,827	164	1,207,347	90	1,207,910	143
1,546R	604	1,204,907	37	1,205,698	76	1,206,189	81	1,206,828	164	1,207,381	126	1,207,967	89
1,566R	504	1,204,926	38	1,205,704	102	1,206,190	81	1,206,833	142	1,207,414	133	1,207,968	84
1,567R	601	1,204,927	37	1,205,723	82	1,206,220	89	1,206,834	142	1,207,416	83	1,207,978	132
1,857R	1004	1,205,002	26	1,205,724	83	1,206,222	100	1,206,861	142	1,207,503	143	1,207,981	78
1,934R	91	1,205,144	91	1,205,735	33	1,206,223	101	1,206,874	84	1,207,527	163	1,207,982	78
1,950R	91	1,205,207	88	1,205,822	101	1,206,232	78	1,206,902	142	1,207,567	83	1,208,014	75
1,746R	47	1,205,264	77	1,205,829	96	1,206,283	80	1,206,954	159	1,207,621	161	1,208,134	77
1,971R	1268	1,205,267	91	1,205,837	96	1,206,297	75	1,206,962	129	1,207,694	127	1,208,159	124
1,985R	31	1,205,268	91	1,205,838	96	1,206,383	77	1,206,963	146	1,207,706	84	1,208,185	144
1,032R	89	1,205,269	91	1,205,924	45	1,206,397	223	1,206,965	146	1,207,707	84	1,208,199	96
1,049R	32	1,205,325	102	1,205,926	80	1,206,456	48	1,206,983	146	1,207,708	84	1,208,214	126
1,073R	31	1,205,326	201	1,205,944	89	1,206,495	97	1,207,014	157	1,207,723	76	1,208,237	144
1,087R	32	1,205,327	201	1,205,957	91	1,206,545	88	1,207,042	163	1,207,724	76	1,208,242	83
1,126R	32	1,205,377	77	1,205,964	77	1,206,546	86	1,207,177	156	1,207,762	131	1,208,246	112
1,135R	155	1,205,477	84	1,205,998	222	1,206,547	86	1,207,178	201	1,207,782	84	1,208,247	112
1,162R	162	1,205,478	81	1,206,000	101	1,206,603	90	1,207,180	76	1,207,784	81	1,208,248	112
1,193R	155	1,205,493	32	1,206,056	86	1,206,605	75	1,207,207	80	1,207,798	129	1,208,249	112
1,197R	217	1,205,503	77	1,206,057	90	1,206,685	75	1,207,209	123	1,207,800	78	1,208,250	112
1,343R	92	1,205,509	83	1,206,062	83	1,206,704	223	1,207,218	89	1,207,802	78	1,208,255	75
1,400R	92	1,205,516	101	1,206,063	83	1,206,771	86	1,207,230	123	1,207,826	161	1,208,257	75
1,417R	42	1,205,531	74	1,206,075	222	1,206,777	80	1,207,261	143	1,207,840	155	1,208,330	85
1,469R	42	1,205,578	26	1,206,077	222	1,206,796	84	1,207,261	143	1,207,843	123	1,208,331	89
1,469R	32	1,205,611	88	1,206,155	83	1,206,797	84	1,207,273	84	1,207,848	144	1,208,378	126

No. of Patent.	Page.	No. of Patent.	Page.	No. of Patent.	Page.	No. of Patent.	Page.	No. of Patent.	Page.	No. of Patent.	Page.	No. of Patent.	Page.	No. of Patent.	Page.
1,208,400	132	1,210,726	208	1,212,579	381	1,214,209	329	1,216,174	382	1,218,052	450	1,220,111	401	1,222,130	536
1,208,411	101	1,210,751	211	1,212,612	382	1,214,346	349	1,216,187	456	1,218,058	510	1,220,131	536	1,222,131	537
1,208,416	89	1,210,756	218	1,212,611	401	1,214,414	317	1,216,265	461	1,218,151	510	1,220,194	537	1,222,194	537
1,208,453	77	1,210,759	233	1,212,620	380	1,214,518	399	1,216,266	461	1,218,156	463	1,220,248	499	1,222,248	500
1,208,507	89	1,210,792	214	1,212,638	375	1,214,520	445	1,216,306	507	1,218,161	463	1,220,253	504	1,222,253	504
1,208,534	136	1,210,808	131	1,212,643	334	1,214,539	390	1,216,334	463	1,218,177	509	1,220,262	511	1,222,262	511
1,208,596	142	1,210,852	145	1,212,648	402	1,214,593	330	1,216,338	386	1,218,190	516	1,220,292	504	1,222,292	504
1,208,597	128	1,210,880	223	1,212,656	399	1,214,611	317	1,216,371	457	1,218,209	473	1,220,293	504	1,222,293	504
1,208,629	128	1,210,916	121	1,212,702	339	1,214,630	390	1,216,390	418	1,218,232	419	1,220,349	507	1,222,349	507
1,208,658	77	1,210,918	211	1,212,722	401	1,214,712	331	1,216,404	461	1,218,261	465	1,220,391	558	1,222,391	558
1,208,670	121	1,210,948	238	1,212,738	396	1,214,725	311	1,216,450	461	1,218,332	465	1,220,401	504	1,222,401	504
1,208,689	77	1,210,949	238	1,212,770	403	1,214,726	401	1,216,451	461	1,218,350	451	1,220,411	547	1,222,411	547
1,208,717	143	1,210,965	202	1,212,818	395	1,214,729	400	1,216,452	386	1,218,354	495	1,220,416	555	1,222,416	555
1,208,722	116	1,210,968	226	1,212,825	341	1,214,730	400	1,216,462	383	1,218,400	508	1,220,429	564	1,222,429	564
1,208,739	164	1,210,982	225	1,212,881	375	1,214,753	332	1,216,493	396	1,218,412	509	1,220,444	509	1,222,444	509
1,208,781	127	1,211,065	133	1,212,844	377	1,214,760	445	1,216,515	396	1,218,470	417	1,220,504	498	1,222,504	498
1,208,797	215	1,211,061	206	1,212,816	340	1,214,763	389	1,216,516	468	1,218,472	473	1,220,513	500	1,222,513	500
1,208,798	223	1,211,092	206	1,212,847	340	1,214,764	389	1,216,554	408	1,218,544	416	1,220,557	550	1,222,557	550
1,208,799	223	1,211,093	223	1,212,865	379	1,214,765	404	1,216,555	447	1,218,568	462	1,220,575	504	1,222,575	504
1,208,817	224	1,211,125	215	1,212,869	379	1,214,766	784	1,216,558	450	1,218,573	450	1,220,651	498	1,222,651	498
1,208,821	201	1,211,137	223	1,212,894	380	1,214,770	390	1,216,581	396	1,218,575	447	1,220,735	504	1,222,735	504
1,208,830	233	1,211,181	138	1,212,928	382	1,214,775	391	1,216,613	507	1,218,582	510	1,220,746	521	1,222,746	521
1,208,833	208	1,211,218	222	1,212,929	390	1,214,791	330	1,216,643	509	1,218,584	510	1,220,752	547	1,222,752	547
1,208,877	138	1,211,227	151	1,212,932	377	1,214,792	330	1,216,667	470	1,218,588	456	1,220,778	538	1,222,778	538
1,209,132	233	1,211,252	152	1,212,933	377	1,214,808	344	1,216,671	401	1,218,599	451	1,220,789	537	1,222,789	537
1,209,133	132	1,211,252	152	1,212,991	376	1,214,817	390	1,216,675	401	1,218,601	446	1,220,815	538	1,222,815	538
1,209,135	218	1,211,258	132	1,212,996R	996	1,214,841	390	1,216,675	380	1,218,638	451	1,220,820	569	1,222,820	569
1,209,154	211	1,211,301	127	1,213,042	330	1,214,842	390	1,216,677	396	1,218,678	467	1,220,821	554	1,222,821	554
1,209,163	211	1,211,325	225	1,213,045	335	1,214,844	391	1,216,728	450	1,218,713	465	1,220,839	555	1,222,839	555
1,209,165	225	1,211,346	225	1,213,075	334	1,214,910	341	1,216,729	382	1,218,772	461	1,220,843	507	1,222,843	507
1,209,201	138	1,211,351	297	1,213,082	377	1,214,919	403	1,216,760	382	1,218,817	462	1,220,973	558	1,222,973	558
1,209,212	211	1,211,361	202	1,213,115	334	1,214,924	353	1,216,812	382	1,218,840	495	1,220,980	503	1,222,980	503
1,209,219	218	1,211,388	295	1,213,118	335	1,214,931	353	1,216,813	384	1,218,850	407	1,220,999	519	1,222,999	519
1,209,220	218	1,211,393	215	1,213,142	382	1,214,934	391	1,216,847	445	1,218,915	495	1,221,002	561	1,222,002	561
1,209,221	212	1,211,394	215	1,213,143	382	1,214,940	403	1,216,880	382	1,218,916	508	1,221,024	563	1,222,024	563
1,209,222	212	1,211,395	205	1,213,180	343	1,214,972	341	1,216,921	403	1,218,954	450	1,221,039	580	1,222,039	580
1,209,253	218	1,211,413	211	1,213,182	391	1,214,991	386	1,216,931	391	1,218,976	473	1,221,045	556	1,222,045	556
1,209,245	215	1,211,438R	1126	1,213,210	401	1,215,006	390	1,216,961	447	1,218,982	451	1,221,046	556	1,222,046	556
1,209,246	215	1,211,450	238	1,213,261	403	1,215,007	390	1,216,971	463	1,218,996	509	1,221,055	540	1,222,055	540
1,209,247	128	1,211,481	303	1,213,330	395	1,215,022	195	1,216,980	403	1,219,010	511	1,221,058	561	1,222,058	561
1,209,258	202	1,211,502	205	1,213,346	390	1,215,034	334	1,216,981	383	1,219,021	495	1,221,061	602	1,222,061	602
1,209,262	223	1,211,503	205	1,213,347	390	1,215,041	377	1,217,027	383	1,219,074	462	1,221,062	602	1,222,062	602
1,209,321	201	1,211,526	226	1,213,357	401	1,215,055	389	1,217,028	383	1,219,081	495	1,221,077	499	1,222,077	499
1,209,324	103	1,211,545	223	1,213,367	404	1,215,072	396	1,217,032	450	1,219,089	508	1,221,120	536	1,222,120	536
1,209,327	103	1,211,564	215	1,213,368	377	1,215,075	376	1,217,076	446	1,219,130	470	1,221,139	558	1,222,139	558
1,209,337	225	1,211,588	288	1,213,369	404	1,215,077	334	1,217,100	463	1,219,155	447	1,221,144	496	1,222,144	496
1,209,365	202	1,211,594	214	1,213,375	385	1,215,138	391	1,217,115	463	1,219,166	500	1,221,206	602	1,222,206	602
1,209,369	232	1,211,635	294	1,213,403	335	1,215,140	377	1,217,118	366	1,219,178	447	1,221,241	490	1,222,241	490
1,209,399	133	1,211,687	295	1,213,414	334	1,215,182	377	1,217,123	494	1,219,193	508	1,221,259	540	1,222,259	540
1,209,400	147	1,211,691	303	1,213,415	334	1,215,222	351	1,217,156	512	1,219,194	508	1,221,357	610	1,222,357	610
1,209,490	124	1,211,704	225	1,213,429	385	1,215,243	380	1,217,157	494	1,219,226	473	1,221,382	521	1,222,382	521
1,209,512	224	1,211,713	215	1,213,486	403	1,215,246	334	1,217,165	503	1,219,240	509	1,221,383	551	1,222,383	551
1,209,539	160	1,211,715	294	1,213,487	403	1,215,293	395	1,217,218	419	1,219,277	457	1,221,397	558	1,222,397	558
1,209,546	212	1,211,721	206	1,213,545	401	1,215,300	332	1,217,238	503	1,219,291	517	1,221,412	536	1,222,412	536
1,209,580	131	1,211,729	294	1,213,549	383	1,215,334	473	1,217,247	510	1,219,315	458	1,221,441	556	1,222,441	556
1,209,588	145	1,211,739	233	1,213,555	341	1,215,335	473	1,217,306	507	1,219,333	518	1,221,442	556	1,222,442	556
1,209,613	297	1,211,761	238	1,213,566	376	1,215,337	378	1,217,340	459	1,219,358	507	1,221,450	551	1,222,450	551
1,209,644	297	1,211,806	294	1,213,608	334	1,215,340	376	1,217,367	455	1,219,349	450	1,221,505	538	1,222,505	538
1,209,657	124	1,211,826	294	1,213,627	401	1,215,351	386	1,217,388	455	1,219,388	458	1,221,553	607	1,222,553	607
1,209,692	116	1,211,828	223	1,213,659	377	1,215,359	382	1,217,389	455	1,219,406	495	1,221,554	507	1,222,554	507
1,209,710	116	1,211,837	219	1,213,724	386	1,215,385	377	1,217,390	518	1,219,413	463	1,221,571	504	1,222,571	504
1,209,723	218	1,211,856	233	1,213,726	301	1,215,396	378	1,217,397	493	1,219,438	495	1,221,618	552	1,222,618	552
1,209,784	221	1,211,923	208	1,213,740	353	1,215,424	378	1,217,425	455	1,219,451	500	1,221,627	541	1,222,627	541
1,209,785	221	1,211,943	295	1,213,763	379	1,215,432	387	1,217,432	509	1,219,485	511	1,221,636	810	1,222,636	810
1,209,835	145	1,211,947	203	1,213,795	380	1,215,433	387	1,217,437	473	1,219,486	463	1,221,667	569	1,222,667	569
1,209,841	145	1,211,959	238	1,213,796	380	1,215,463	460	1,217,446	503	1,219,499	537	1,221,698	541	1,222,698	541
1,209,871	201	1,212,007	302	1,213,806	343	1,215,517	455	1,217,447	500	1,219,500	537	1,221,735	556	1,222,735	556
1,209,914	239	1,212,014	212												

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1,222,305	538	1,224,485	608	1,226,471	722	1,228,609	822	1,230,648	940	1,232,451	1021	1,234,862	999
1,222,340	537	1,224,578	616	1,226,496	699	1,228,622	815	1,230,667	935	1,232,494	1048	1,234,870	998
1,222,345	570	1,224,641	636	1,226,520	704	1,228,680	907	1,230,722	853	1,232,495	1049	1,234,880	999
1,222,422	541	1,224,668	724	1,226,535	718	1,228,712	905	1,230,681	858	1,232,551	1003	1,234,905	1008
1,222,422	544	1,224,703	668	1,226,542	637	1,228,818	863	1,230,751	905	1,232,552	1003	1,234,921	1044
1,222,433	542	1,224,787	637	1,226,555	637	1,228,855	859	1,230,754	908	1,232,553	1021	1,234,946	1053
1,222,519	537	1,224,788	637	1,226,611	699	1,228,879	862	1,230,782	892	1,232,620	1019	1,234,947	1016
1,222,511	538	1,224,869	668	1,226,620	723	1,228,888	853	1,230,803	891	1,232,625	1017	1,234,973	1017
1,222,503	616	1,224,910	665	1,226,735	708	1,228,910	900	1,230,820	894	1,232,653	1045	1,234,993	1039
1,222,608	603	1,224,913	665	1,226,738	719	1,228,916	903	1,230,869	921	1,232,702	1065	1,235,003	1052
1,222,636	609	1,224,917	655	1,226,739	888	1,228,917	903	1,230,899	922	1,232,772	1061	1,235,025	1021
1,222,637	611	1,224,941	655	1,226,750	718	1,228,925	889	1,230,921	922	1,232,805	1039	1,235,030	996
1,222,640	535	1,224,943	658	1,226,760	894	1,228,926	867	1,230,955	922	1,232,839	1039	1,235,061	1056
1,222,660	603	1,224,951	607	1,226,764	831	1,228,930	839	1,230,990	944	1,232,843	1017	1,235,063	1017
1,222,690	585	1,224,978	618	1,226,811	712	1,228,950	870	1,231,007	946	1,232,873	1053	1,235,081	1020
1,222,691	583	1,224,984	669	1,226,812	736	1,228,956	869	1,231,045	880	1,232,904	1053	1,235,071	1004
1,222,751	585	1,225,044	601	1,226,833	733	1,228,983	869	1,231,083	890	1,232,913	1054	1,235,083	1011
1,222,780	654	1,225,048	636	1,226,852	733	1,228,987	869	1,231,141	929	1,232,977	1008	1,235,161	1061
1,222,793	655	1,225,052	632	1,226,884	894	1,228,988	869	1,231,141	940	1,232,989	1031	1,235,193	996
1,222,801	586	1,225,061	633	1,226,889	721	1,229,037	889	1,231,153	923	1,233,118	1012	1,235,202	1068
1,222,809	602	1,225,118	665	1,226,892	718	1,229,042	862	1,231,123	929	1,233,177	1031	1,235,220	1044
1,222,830	610	1,225,120	649	1,226,893	700	1,229,052	904	1,231,123	943	1,233,273	1008	1,235,253	1943
1,222,861	583	1,225,146	615	1,226,901	719	1,229,053	904	1,231,123	943	1,233,333	1029	1,235,258	1044
1,222,861	605	1,225,147	618	1,226,923	888	1,229,101	870	1,231,143	924	1,233,334	1004	1,235,278	1064
1,222,922	655	1,225,175	656	1,226,925	863	1,229,132	893	1,231,153	923	1,233,371	978	1,235,285	1062
1,222,928	588	1,225,211	640	1,226,934	894	1,229,139	862	1,231,176	929	1,233,374	1004	1,235,291	1039
1,222,960	646	1,225,226	633	1,226,941	700	1,229,159	896	1,231,172	918	1,233,384	1012	1,235,325	1049
1,222,967	503	1,225,237	638	1,226,983	733	1,229,189	862	1,231,176	929	1,233,398	1014	1,235,339	1953
1,222,979	596	1,225,262	669	1,226,990	704	1,229,203	860	1,231,226	926	1,233,415	1017	1,235,342	1047
1,222,980	603	1,225,263	595	1,227,027	733	1,229,247	891	1,231,239	926	1,233,436	1025	1,235,354	999
1,222,999	602	1,225,264	595	1,227,047	711	1,229,305	905	1,231,247	959	1,233,446	1025	1,235,395	999
1,223,001	601	1,225,296	655	1,227,049	712	1,229,316	872	1,231,259	928	1,233,449	1004	1,235,426	1015
1,223,002	611	1,225,318	648	1,227,050	887	1,229,324	879	1,231,260	928	1,233,490	1010	1,235,449	1015
1,223,030	653	1,225,321	670	1,227,060	704	1,229,337	894	1,231,285	929	1,233,496	1009	1,235,450	1015
1,223,121	608	1,225,348	633	1,227,067	891	1,229,338	862	1,231,349	943	1,233,555	996	1,235,507	1019
1,223,123	603	1,225,374	647	1,227,068	891	1,229,422	923	1,231,351	943	1,233,561	1007	1,235,523	1000
1,223,153	586	1,225,396	636	1,227,071	894	1,229,439	889	1,231,409	917	1,233,566	979	1,235,543	1056
1,223,158	593	1,225,405	637	1,227,127	888	1,229,456	869	1,231,411	917	1,233,580	1014	1,235,552	1047
1,223,239	597	1,225,407	615	1,227,148	705	1,229,487	869	1,231,410	917	1,233,606	957	1,235,598	1046
1,223,242	632	1,225,414	593	1,227,174	888	1,229,494	869	1,231,411	917	1,233,611	957	1,235,608	1045
1,223,245	584	1,225,470	555	1,227,184	733	1,229,509	872	1,231,471	925	1,233,633	1015	1,235,620	1053
1,223,248	588	1,225,469	588	1,227,194	723	1,229,524	918	1,231,476	925	1,233,652	969	1,235,630	1053
1,223,249	588	1,225,574	634	1,227,232	705	1,229,587	903	1,231,478	918	1,233,700	957	1,235,638	1047
1,223,278	601	1,225,634	586	1,227,259	863	1,229,593	863	1,231,488	921	1,233,713	1009	1,235,655	1015
1,223,322	601	1,225,664	658	1,227,367	738	1,229,612	872	1,231,492	870	1,233,730	1020	1,235,666	1025
1,223,330	586	1,225,722	647	1,227,361	709	1,229,612	870	1,231,494	863	1,233,771	999	1,235,672	1049
1,223,356	650	1,225,749	724	1,227,374	732	1,229,681	803	1,231,499	918	1,233,803	1016	1,235,698	1062
1,223,357	659	1,225,750	724	1,227,400	709	1,229,684	803	1,231,509	921	1,233,807	1017	1,235,698	1042
1,223,358	659	1,225,755	721	1,227,407	706	1,229,685	858	1,231,519	927	1,233,808	1017	1,235,716	1056
1,223,377	655	1,225,764	647	1,227,453	711	1,229,689	859	1,231,554	927	1,233,843	1031	1,235,721	1019
1,223,406	607	1,225,768	888	1,227,454	734	1,229,693	859	1,231,617	930	1,233,862	1012	1,235,723	1016
1,223,427	611	1,225,798	733	1,227,465	894	1,229,698	863	1,231,684	926	1,233,906	969	1,235,724	1016
1,223,440	596	1,225,825	730	1,227,491	888	1,229,919	904	1,231,687	929	1,233,919	1023	1,235,738	1044
1,223,451	654	1,225,832	712	1,227,518	704	1,229,949	870	1,231,695	921	1,233,925	962	1,235,766	1010
1,223,475	654	1,225,872	712	1,227,525	732	1,229,960	889	1,231,707	929	1,233,926	963	1,235,777	998
1,223,480	593	1,225,877	733	1,227,534	704	1,229,978	918	1,231,709	913	1,233,930	1018	1,235,777	998
1,223,567	655	1,225,889	698	1,227,559	704	1,229,978	918	1,231,709	913	1,233,977	1008	1,235,791	1025
1,223,612	585	1,225,889	698	1,227,560	704	1,229,978	918	1,231,709	913	1,233,986	1002	1,235,815	1062
1,223,650	637	1,225,954	721	1,227,569	888	1,229,981	886	1,231,818	918	1,233,986	1002	1,235,850	1055
1,223,650	637	1,225,956	721	1,227,573	888	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,223,660	637	1,225,956	721	1,227,573	888	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,223,732	585	1,226,022	718	1,227,624	905	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,223,738	601	1,226,032	698	1,227,703	907	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,223,745	604	1,226,041	637	1,227,781	872	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,223,790	610	1,226,052	731	1,227,891	866	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,223,809	596	1,226,062	721	1,227,903	880	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,223,810	596	1,226,062	721	1,227,903	880	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,223,834	597	1,226,082	699	1,227,963	859	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,223,953	616	1,226,088	722	1,228,017	889	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,223,959	596	1,226,103	634	1,228,089	867	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,223,986	602	1,226,108	634	1,228,119	883	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,224,013	646	1,226,108	634	1,228,119	883	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,224,014	646	1,226,121	722	1,228,169	891	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,224,057	655	1,226,122	722	1,228,183	886	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,224,071	593	1,226,165	699	1,228,184	889	1,229,981	886	1,231,818	918	1,234,015	1004	1,235,852	1056
1,224,095	607	1,226,178	707	1,228,194	889	1,229,981	886	1,231,818	918	1			

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1,236,213	1008	1,237,192	1002	1,238,307	1127	1,239,630	1191	1,240,607	1137	1,242,168	1275	1,243,111	1279
1,236,236	1015	1,237,193	1002	1,238,331	1090	1,239,734	1089	1,240,609	1122	1,242,188	1231	1,243,149	1248
1,236,267	1019	1,237,197	1018	1,238,339	1090	1,239,766	1145	1,240,628	1173	1,242,189	1243	1,243,170	1241
1,236,370	1045	1,237,210	1088	1,238,359	1126	1,239,768	1127	1,240,675	1126	1,242,208	1248	1,243,171	1231
1,236,382	1061	1,237,220	1101	1,238,371	1145	1,239,776	1126	1,240,694	1118	1,242,236	1275	1,243,190	1245
1,236,383	1016	1,237,221	1101	1,238,372	1145	1,239,785	1137	1,240,700	1173	1,242,264	1235	1,243,191	1287
1,236,384	1016	1,237,222	1088	1,238,373	1145	1,239,787	1127	1,240,737	1128	1,242,275	1279	1,243,231	1290
1,236,395	1016	1,237,267	1045	1,238,394	1130	1,239,810	1126	1,240,766	1127	1,242,292	1266	1,243,244	1287
1,236,416	1087	1,237,280	1045	1,238,409	1131	1,239,822	1126	1,240,792	1125	1,242,327	1232	1,243,274	1239
1,236,447	1052	1,237,282	1129	1,238,469	1122	1,239,854	1137	1,240,816	1191	1,242,337	1240	1,243,275	1286
1,236,460	1092	1,237,283	1129	1,238,489	1143	1,239,867	1108	1,240,824	1182	1,242,339	1240	1,243,312	1242
1,236,461	1092	1,237,368	1139	1,238,528	1141	1,239,885	1137	1,240,869	1185	1,242,340	1240	1,243,323	1287
1,236,468	1020	1,237,383	1040	1,238,574	1122	1,239,912	1095	1,240,875	1186	1,242,341	1240	1,243,351	1290
1,236,501	1052	1,237,425	1145	1,238,577	1144	1,239,969	1090	1,240,894	1188	1,242,355	1227	1,243,382	1235
1,236,501	1052	1,237,485	1093	1,238,589	1126	1,239,984	1128	1,240,904	1171	1,242,368	1227	1,243,416	1239
1,236,557	1041	1,237,488	1094	1,238,600	1127	1,239,992	1128	1,240,920	1174	1,242,396	1286	1,243,440	1285
1,236,570	1048	1,237,520	1094	1,238,604	1102	1,240,016	1144	1,240,950	1177	1,242,421	1237	1,243,489	1232
1,236,578	1092	1,237,521	1094	1,238,644	1099	1,240,020	1107	1,241,017	1149	1,242,422	1237	1,243,505	1241
1,236,579	1092	1,237,551	1065	1,238,660	1138	1,240,027	1149	1,241,020	1177	1,242,423	1223	1,243,524	1272
1,236,581	1052	1,237,554	1140	1,238,734	1139	1,240,054	1134	1,241,013	1185	1,242,434	1235	1,243,623	1243
1,236,655	1055	1,237,579	1045	1,238,774	1139	1,240,055	1134	1,241,044	1185	1,242,435	1241	1,243,681	1243
1,236,662	1047	1,237,587	1106	1,238,873	1126	1,240,056	1134	1,241,067	1185	1,242,442	1238	1,243,742	1263
1,236,693	1102	1,237,652	1108	1,238,916	1127	1,240,081	1122	1,241,112	1181	1,242,444	1236	1,243,762	1280
1,236,706	1065	1,237,653	1090	1,238,930	1105	1,240,116	1105	1,241,113	1181	1,242,445	1228	1,243,776	1266
1,236,719	1087	1,237,691	1091	1,238,932	1091	1,240,148	1131	1,241,153	1126	1,242,455	1240	1,243,777	1274
1,236,721	1016	1,237,704	1140	1,238,951	1136	1,240,154	1126	1,241,211	1178	1,242,464	1239	1,243,783	1275
1,236,723	1092	1,237,723	1143	1,239,012	1136	1,240,165	1146	1,241,229	1177	1,242,518	1227	1,243,798	1278
1,236,727	1000	1,237,724	1143	1,239,080	1103	1,240,185	1129	1,241,299	1122	1,242,532	1240	1,243,822	1266
1,236,737	1053	1,237,745	1088	1,239,099	1125	1,240,220	1124	1,241,351	1138	1,242,536	1231	1,243,855	1287
1,236,788	1045	1,237,765	1099	1,239,100	1125	1,240,252	1131	1,241,397	1137	1,242,537	1275	1,243,878	1263
1,236,806	1020	1,237,767	1089	1,239,112	1130	1,240,253	1131	1,241,499	1184	1,242,586	1243	1,243,890	1277
1,236,812	1058	1,237,815	1094	1,239,125	1127	1,240,272	1149	1,241,531	1237	1,242,592	1242	1,243,976	1278
1,236,825	1088	1,237,828	1042	1,239,157	1136	1,240,274	1171	1,241,574	1184	1,242,593	1242	1,243,977	1278
1,236,833	1048	1,237,840	1094	1,239,178	1136	1,240,290	1121	1,241,648	1173	1,242,624	1241	1,244,007	1263
1,236,856	1052	1,237,848	1088	1,239,179	1136	1,240,305	1171	1,241,655	1184	1,242,676	1232	1,244,032	1271
1,236,857	1052	1,237,852	1095	1,239,180	1130	1,240,341	1148	1,241,738	1185	1,242,728	1287	1,244,033	1280
1,236,868	1046	1,237,864	1092	1,239,202	1108	1,240,345	1174	1,241,749	1172	1,242,783	1232	1,244,058	1280
1,236,875	1050	1,237,874	1115	1,239,214	1138	1,240,368	1125	1,241,750	1182	1,242,795	1267	1,244,082	1278
1,236,881	1041	1,237,881	1091	1,239,215	1138	1,240,385	1122	1,241,789	1173	1,242,796	1267	1,244,107	1269
1,236,885	1041	1,237,920	1050	1,239,221	1122	1,240,386	1122	1,241,791	1234	1,242,833	1240	1,244,108	1269
1,236,903	1048	1,237,921	1050	1,239,256	1130	1,240,397	1125	1,241,796	1235	1,242,866	1227	1,244,216	1267
1,236,917	1042	1,237,961	1101	1,239,282	1137	1,240,405	1140	1,241,834	1235	1,242,883	1286	1,244,217	1267
1,236,933	1016	1,237,962	1088	1,239,368	1149	1,240,460	1183	1,241,899	1182	1,242,884	1286	1,244,275	1275
1,236,934	1016	1,238,020	1095	1,239,403	1147	1,240,490	1130	1,241,900	1182	1,242,886	1243	1,244,280	1275
1,236,948	1092	1,238,022	1101	1,239,423	1125	1,240,491	1130	1,241,905	1171	1,242,900	1290	1,244,296	1275
1,236,959	1092	1,238,084	1103	1,239,443	1136	1,240,549	1149	1,241,909	1182	1,242,953	1234	1,244,347	1269
1,236,978	1098	1,238,085	1122	1,239,465	1137	1,240,565	1138	1,241,919	1195	1,242,954	1247	1,244,348	1269
1,236,996	1049	1,238,097	1100	1,239,471	1145	1,240,566	1138	1,241,920	1195	1,242,955	1247	1,244,349	1269
1,237,036	1049	1,238,101	1090	1,239,510	1128	1,240,567	1138	1,241,926	1184	1,242,986	1287	1,244,358	1269
1,237,076	1065	1,238,137	1103	1,239,517	1124	1,240,569	1129	1,241,950	1186	1,242,987	1234	1,244,359	1267
1,237,078	1010	1,238,147	1127	1,239,526	1093	1,240,570	1128	1,241,966	1182	1,242,988	1234	1,244,380	1271
1,237,094	1001	1,238,202	1095	1,239,530	1138	1,240,571	1128	1,241,967	1184	1,243,009	1269	1,244,414	1278
1,237,110	996	1,238,236	1105	1,239,555	1145	1,240,572	1128	1,241,971	1182	1,243,042	1231	1,244,421	1272
1,237,128	1008	1,238,242	1101	1,239,579	1151	1,240,591	1122	1,241,979	1173	1,243,062	1241	1,244,580	1272
1,237,129	1052	1,238,256	1122	1,239,616	1131	1,240,597	1137	1,241,995	1174	1,243,098	1239	1,244,903	1272
1,237,141	1052	1,238,279	1101	1,239,618	1125	1,240,598	1137	1,242,030	1174				
1,237,183	1002	1,238,298	1135	1,239,629	1139	1,240,599	1137	1,242,161	1242				

FRENCH PATENTS.

(Note.—“A” indicates that an addition to the Patent is referred to.)

468,642A	133	479,998	27	480,230	132	480,376	121	480,509	41	480,726	121	480,939	151
472,744A	143	480,002	27	480,232	137	480,397	133	480,533	25	480,736	132	480,975	159
477,812	163	480,014	137	480,236	12	480,398	133	480,534	126	480,764	133	480,998	40
477,835	132	480,020	138	480,247	136	480,402	39	480,535	126	480,772	40	481,001	39
478,779A	144	480,034	24	480,249	127	480,408	161	480,536	126	480,774	138	481,050	127
479,493	32	480,061	163	480,259	48	480,412	132	480,542	139	480,802	39	481,056	144
479,467	38	480,079	152	480,271	33	480,416	124	480,558	157	480,803	146	481,062	145
479,909	25	480,082	137	480,285	139	480,431	24	480,563	144	480,809	40	481,066	127
479,901	25	480,087	44	480,286	26	480,433	80	480,569	152	480,819	144	481,074	128
479,902	28	480,106	116	480,289	39	480,451	32	480,597	45	480,846	151	481,079	143
479,908	40	480,127	116	480,293	23	480,453	25	480,601	158	480,847	151	481,093	39
479,912	26	480,129	26	480,294	137	480,456	151	480,606	131	480,848	138	481,095	126
479,921	48	480,147	127	480,295	27	480,462	27	480,620	137	480,861	121	481,099	130
479,960	151	480,150	137	480,300	146	480,467	28	480,633	145	480,869	26	481,106	138
479,962	147	480,151	129	480,302	146	480,487	25	480,636	145	480,904	39	481,131	136
479,965	33	480,196	151	480,338	139	480,491	139	480,637	131	480,909	92	481,134	127
479,970	144	480,197	114	480,343	39	480,492	30	480,653	127	480,915	138	481,141	24
479,972	23	480,205	215	480,345	138	480,493	137	480,661	166	480,917	40	481,149	164
479,992	32	480,206	133	480,347	126	480,503	27	480,660	24	480,928	144	481,156	189
479,997	126	480,226	45	480,355	152	480,504	144	480,697	152	480,933	28		

GERMAN PATENTS.

No. of Patent.	Page.	No. of Patent.	Page.	No. of Patent.	Page.	No. of Patent.	Page.	No. of Patent.	Page.	No. of Patent.	Page.	No. of Patent.	Page.
292,145	239	294,008	201	295,268	219	295,594	541	296,102	601	296,715	585	297,266	894
292,682	928	294,909	224	295,270	238	295,607	292	296,115	616	296,796	872	297,274	700
293,238	223	294,910	386	295,272	212	295,624	542	296,127	601	296,834	584	297,290	589
293,952	929	294,911	503	295,290	218	295,627	291	296,141	594	296,837	586	297,291	889
294,276	403	294,912	503	295,296	206	295,657	569	296,142	594	296,841	591	297,300	665
294,330	395	294,931	81	295,321	285	295,666	295	296,155	597	296,888	872	297,324	869
294,333	389	294,932	89	295,322	88	295,670	640	296,169	591	296,922	603	297,328	895
294,516	377	294,957	519	295,337	306	295,708	646	296,191	589	296,925	605	297,365	699
294,575	398	294,993	299	295,340	296	295,709	646	296,192	591	296,964	591	297,374	870
294,632	403	295,013	86	295,351	302	295,719	291	296,193	588	296,991	592	297,379	700
294,633	286	295,016	202	295,354	213	295,726	647	296,195	601	297,075	873	297,380	896
294,661	85	295,025	78	295,418	300	295,736	306	296,209	700	297,080	639	297,411	886
294,667	377	295,043	202	295,421	297	295,739	601	296,210	699	297,084	668	297,414	639
294,683	1189	295,044	503	295,436	281	295,747	646	296,228	700	297,101	637	297,431	881
294,701	395	295,053	292	295,463	330	295,767	542	296,245	735	297,111	894	297,432	700
294,724	503	295,070	213	295,489	296	295,794	296	296,285	700	297,115	699	297,440	870
294,730	81	295,072	213	295,490	292	295,799	584	296,361	605	297,138	869	297,509	886
294,754	402	295,074	503	295,491	285	295,800	647	296,394	594	297,178	733	297,515	870
294,755	520	295,104	211	295,492	306	295,801	610	296,395	602	297,185	639	297,569	869
294,776	202	295,142	299	295,495	287	295,817	542	296,405	593	297,186	895	297,859	929
294,780	81	295,164	203	295,502	307	295,831	601	296,457	596	297,187	895	297,873	936
294,781	282	295,178	224	295,507	281	295,859	647	296,466	595	297,188	895	298,149	921
294,798	81	295,183	286	295,509	548	295,906	646	296,501	590	297,189	895	298,207	928
294,799	286	295,202	520	295,517	296	295,921	647	296,537	598	297,203	638	298,223	921
294,814	101	295,203	520	295,518	298	295,933	648	296,539	589	297,210	889	298,342	929
294,824	306	295,209	296	295,547	548	295,976	569	296,559	594	297,211	889	298,387	921
294,830	78	295,221	203	295,548	560	295,987	633	296,591	907	297,225	907	298,687	929
294,833	81	295,236	238	295,549	555	296,009	615	296,596	700	297,243	668		
294,850	75	295,245	203	295,552	291	296,053	593	296,597	700	297,244	888		
294,857	398	295,246	503	295,556	282	296,054	584	296,636	585	297,252	636		
294,858	299	295,253	211	295,557	282	296,065	588	296,677	615	297,258	873		
294,860	90	295,254	211	295,577	347	296,071	605	296,678	615	297,261	638		

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JOURNAL.	ABBREVIATION.	ADDRESS OF PUBLISHER AND PRICE.*
Agricultural Bulletin of the Federated Malay States	Agric. Bull. F.M.S. ..	Dept. of Agriculture, Kuala Lumpur, F.M.S. 1s. 3d.
Agricultural Journal of India ..	Agric. J. India ..	W. Thacker and Co., 2, Creed Lane, London. 3s.
Agricultural Ledger	Agric. Ledger ..	Reporter on Economic Products to the Government of India, Calcutta.
Agricultural Research Institute, Pusa, Report and Bulletins.	Rep. (Bull.) Agric. Res. Inst., Pusa.	Supt. Govt. Printing, Calcutta. Price varies.
Allgemeine Zeitschrift für Bierbrauerei und Malzfabrikation ..	Allgem. Z. Bierbrau. u. Malzfabr.	Michaelerstrasse 25, Vienna XVIII/1. Krono 12 per annum.
American Journal of Pharmacy	Amer. J. Pharm. ..	115, North Tenth Street, Philadelphia, Pa., U.S.A. 30 cents.
American Journal of Science ..	Amer. J. Sci. ..	New Haven, Conn., U.S.A. 50 cents.
Analyst	Analyst	Simpkin, Marshall, Hamilton, Kent, and Co., Ltd., 2, 4, 6, S. Orange Street, London, S.W. 2s.
Annalen der Chemie	Annalen	C. F. Winter'sche Verlagshandlung, Leipzig, Germany. Per annum; M. 28.
Annales de Chimie Analytique ..	Ann. Chim. Analyt. ..	M. Crillon, 20, Boulevard Richard-Lenoir, Paris, 1 fr.
Annales des Falsifications ..	Ann. Falsif. ..	56, Rue Madame, Paris, 6c. 3 fr.
Annali di Chimica Applicata ..	Annali Chim. Appl. ..	Via Panisperna N, 89b, Rome. Lire 34 per annum.
Annali della R. Stazione Chimico Agraria Sperimentale di Roma	Ann. R. Staz. Chim. Agrar. Sperm. Roma	R. Stazione Chimico-Agraria Sperimentale di Roma, Rome.
Apotheker-Zeitung	Apoth.-Zeit. ..	Levetzowstrasse 16b, Berlin, N.W. 87. 25 Pf.
Archiv der Pharmazie	Arch. Pharm. ..	Selbstverlag des Deutschen Apotheker-Vereins, Berlin, Germany. M. 12 per annum.
Atti della Reale Accademia dei Lincei, Roma	Atti R. Accad. dei Lincei, Roma	Tipografia della R. Accademia dei Lincei, Rome. Lire 10 per annum.
Australasian Pharmaceutical Notes and News	Austr. Pharm. Notes and News	Elliott Bros., Ltd., O'Connell St., Sydney, N.S.W. 3d.
Berichte der Deutschen Chemischen Gesellschaft	Ber.	R. Friedländer und Sohn, Karlstrasse 11, Berlin, N.W. 6, Germany. M. 32 per annum.
Berichte der Deutschen Pharmazeutischen Gesellschaft ..	Ber. d.ents. Pharm. Ges.	Verlag von Gebr. Bornträger, Berlin, W. 35, Schöneberger Ufer 12a, Germany. M. 20 per annum.
Berichte des Ohara Instituts für landwirtschaftliche Forschungen	Ber. Ohara Inst. landw. Forsch.	Verlag der Ohara Schiō-ōkai, Kuraschiki, Provinz Okayama. 1 yen.
Biedermann's Zentralblatt für Agrkultur Chemie	Biedermann's Zentr. ...	O. Leiner, Königstrasse 26b, Leipzig, Germany. M. 22 per annum.
Bio-chemical Journal	Bio-chem. J.	Cambridge University Press, Fetter Lane, London, E.C. 7s.
Biochemische Zeitschrift	Biochem. Zeits. ..	Verlag von J. Springer, Berlin, W. 9, Linkstrasse 23/24. M. 14 per volume.
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Bulletin de la Société Chimique de Belgique	Bull. Soc. Chim. Belg.	M. J. Wauters, Palais du Midi (Galerie du Travail, 7), Brussels.
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Chemical Trade Journal	Chem. Trade J. ..	Davis Bros., Danes Inn House, 265, Strand, London, W.C. 6d.
Chemiker-Zeitung	Chem.-Zeit.	Dr. v. Vietinghoff-Scheel, Cöthen, Anhalt, Germany. M. 28 per annum.
Chemisch Weekblad	Chem. Weekblad ..	D. B. Centen, O.Z. Voorburgwal 115, Amsterdam. 10 fr. per annum.
Chemische Industrie	Chem. Ind.	Weidmann'sche Buchhandlung, Zimmerstrasse 94, Berlin, S.W., Germany. M. 20 per annum.
Chemische Revue über die Fett- und Harz-Industrie	Chem. Rev. Fett-Ind.	Dr. L. Allen, Catharinenstrasse 25, Hamburg, Germany. M. 1.75.
Chemisches Zentralblatt	Chem. Zentr.	R. Friedländer und Sohn, Karlstrasse 11, Berlin, N.W. 6, Germany. M. 80 per annum.
Chemist and Druggist *	Chem. and Drug. ..	42, Cannon Street, London, E.C. 6d.
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Comptes-Rendus hebdomadaires des Séances de l'Académie des Sciences	Comptes rend. ..	Imprimerie Gauthier-Villars, Quai des Grands Augustins 55, Paris. 44 fr. per annum.
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Deutsche Zuckerindustrie	Deuts. Zuckerind. ..	Verlag der Gesellschaft, Die Deuts. Zuckerindustrie, Berlin. M. 24 per annum.
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Engineering	Engineering	C. R. Johnson, 35 and 36, Bedford Street, Strand, London, W.C. 9d.
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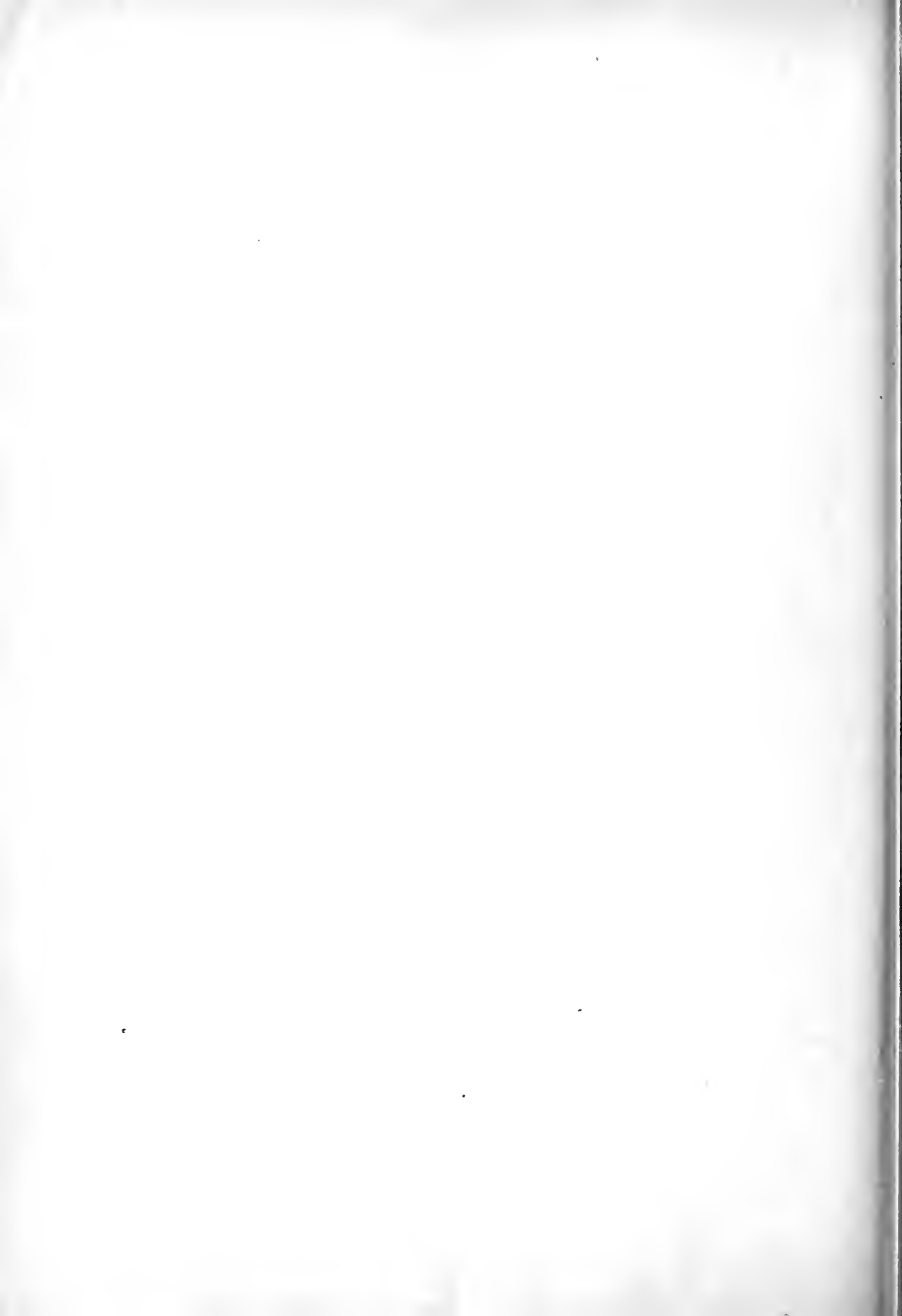
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Kōgyō-Kwagaku-Zasshi (Journal of Chemical Industry, Japan)	Kōgyō-Kwagaku-Zasshi (J. Chem. Ind. Japan)	Kōgyō-Kwagaku-Kwai, Iidamachi, Kojimachi-ku, Tokyo. 5 yen. (10s. 3d.) per annum.
Kolloid-Zeitschrift	Kolloid-Zeits.	T. Steinkopff, Bismarckplatz 16, I., Dresden-A, 14, Germany. M. 3—4.
L'Industria Chimica	L'Ind. Chimica ..	Associazione Chimica Industriale, Via Roma 28 (Galleria Nazionale Scala A), Turin, Italy. Lira 1.
Mededeelingen van het Central Rubberstation	Mededeel. Centr. Rubberstat.	The University, Kyoto, Japan. Price varies.
Memoirs of the College of Science and Engineering, Kyoto Imperial University	Mem. Coll. Sci. and Eng. Kyoto Imp. Univ.	W. Thacker and Co., 2, Creed Lane, London. Price varies.
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Mémoires des Poudres et Salpêtres	Mém. Poudres et Salpêtres	W. Knapp, Mühlweg 19, Halle on Saale, Germany. M. 28 per annum.
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Mittheilungen des k. k. Technischen Versuchsamtes	Mitt. k. k. Techn. Versuchsamtes	Verlag der k. k. Hof- und Staatsdruckerei, Wien, Austria.
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New Zealand Journal of Science and Technology	N.Z.J. Sci. and Technol	The Director, Dominion Museum, Wellington, N.Z. 1s. 6d.
Oesterreichische Zeitschrift für Berg- und Hüttenwesen	Oesterr. Z. Berg- u. Hüttenw.	Kohlmarkt 20, Wien I, Austria. Kr. 28 per annum.
Oil, Paint, and Drug Reporter ..	Oil, Paint, and Drug Rep.	100, William Street, New York City, U.S.A. \$5 per annum, U.S.A., \$6 Canada, \$7 other countries.
Paper Making	Paper Making ..	5, Ludgate Circus Buildings, E.C. 5s. per annum.
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Petroleum	Petroleum	Verlag für Fachliteratur, Motzstrasse 8, Berlin, W. 30. M. 1.50.
Pharmaceutical Journal	Pharm. J. ..	150, Holborn, London, E.C. 6d.
Pharmaceutisch Weekblad ..	Pharm. Weekblad ..	D. B. Centen, O.Z. Voorburgwal 115, Amsterdam. 10 fr. per annum.
Pharmazeutische-Zeitung ..	Pharm.-Zeit. ..	Link-Strasse 23-24, Berlin, W. 9.
Pharmazeutische Zentralhalle ..	Pharm. Zentralh. ..	Dr. A. Schneide, Schandauer Strasse 43, Dresden A, 21.
Philippine Journal of Science ..	Philippine J. Sci. ..	Bureau of Science Manila, Philippine Islands. 50 cents.
Philosophical Magazine and Journal of Science	Phil. Mag.	Taylor and Francis, Red Lion Court, Fleet Street, London, E.C. 2s. 6d.
Photographic Journal	Phot. J.	Harrison and Sons, 45, Pall Mall, London, S.W. 1s.
Proceedings of the American Society of Civil Engineers	Proc. Amer. Soc. Civ. Eng.	220, West 57th Street, New York City, U.S.A. \$8 per annum.
Proceedings of the Australasian Institute of Mining Engineers	Proc. Austral. Inst. Min. Eng.	57-59, Swanston Street, Melbourne, Victoria, Australia.
Proceedings of American Society for Testing Materials	Proc. Amer. Soc. Test-ing Materials	McGraw Hill Book Co., 239 W. 39th Street, New York.
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Schweizerische Chemiker-Zeitung	Schweiz. Chem.-Zeit.	Meyer & Co., Oerlikon-Zürich, Switzerland. 20 fr. per annum.
Science Reports of Tohoku Imperial University	Sci. Reports, Tohoku Imp. Univ.	The Maruzen Co., Ltd., Sendai, Japan. Price varies.
Scientific American	Scient. Amer. ..	233, Broadway, New York City, U.S.A. 10 c.
Scientific Proceedings of the Royal Dublin Society	Scient. Proc. Roy. Dublin Soc.	Leinster House, Dublin. Price varies.
Silikat-Zeitschrift	Silikat-Zeits.	Verlag von Müller und Schmidt, Coburg, Germany. M. 12 per annum.
Sitzungsberichte der Königlich, Preussischen Akademie der Wissenschaften	Sitzungsber. Kgl. Preuss Akad. Wiss. ..	Verlag der Königl. Akademie der Wissenschaften Berlin. M. 12 per annum.
Soil Science	Soil Sci.	Williams & Wilkins Co., 2419-2421, Greenmount Avenue, Baltimore, U.S.A. 50 cents.
South African Journal of Industries	S. African J. Ind. ..	Government Printer, Box 373, Pretoria. 6d

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Sprechsaal	Sprechsaal	Verlag von Müller und Schmidt, Coburg, Germany. M. 14 per annum.
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Teknisk Tidskrift	Tekn. Tidsk.	Jakobsbg. 19, Stockholm, 16, Sweden.
Tonindustrie-Zeitung	Tonind.-Zeit.	Dreysstrasse 4, Berlin, N.W. 21, Germany. M. 20 per annum.
Transactions of the American Ceramic Society	Trans. Amer. Ceram. Soc.	The Secretary, Columbus, Ohio, U.S.A. \$5.50 per annum.
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United States Bureau of Mines, Bulletins and Technical Papers	U.S. Bureau of Mines, Bull. & Tech. Papers	Bureau of Mines, Washington, D.C., U.S.A. Price varies.
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Wasser und Gas	Wasser u. Gas	G. Stalling, Oldenburg i. Gr., Germany.
West Indian Bulletin	West Ind. Bull.	Imperial Dept. of Agriculture, Barbados, W.I. 6d.
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Zeitschrift der analytischen Chemie	Z. anal. Chem.	C. W. Kreidel's Verlag, Wiesbaden, Germany. M. 2.
Zeitschrift für angewandte Chemie	Z. angew. Chem.	Verlag von Otto Spamer, Nürnberger Strasse 48, Leipzig, Germany. M. 36 per annum.
Zeitschrift der anorganischen Chemie	Z. anorg. Chem.	Verlag von L. Voss, Leipzig, Germany. M. 12 per volume.
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Zeitschrift für Zuckerindustrie in Böhmen	Z. Zuckerind. Böhm. . .	Die Administration, Vodickova No. 704 (Palais Lucerna), Prag II Bohemia. M. 17.20 per annum.

LIST OF ERRATA, 1917.

No. of Journal.	Page.	Column.	Line from Top.	Line from Bottom.	Errata.
No. 1—Jan. 15	28	1	..	35	For "Kelvin" read "Kevlin."
" "	32	2	..	37	Insert "F. C. Frary," name of patentee.
" "	34	2	17	..	For "C. H. Guillaume" read "C. E. Guillaume."
No. 2—Jan. 31	93	2	19	..	For "17,702" read "17,202."
No. 4—Feb. 28	202	1	24	..	For "Gessell" read "Gesell."
" "	209	2	..	12	For "van" read "von."
" "	220	1	..	19	For "0-0200c. (0-01045d.)" read "0-2c. (0-1d.)"
" "	233	1	..	4	For "G. P." read "J. P."
No. 5—Mar. 15	271	2	..	23 and 27	For "by the addition of phenol in which the . . . " read "by means of phenol of which the viscosity at different . . ."
" "	272	1	..	18	For "jet was moved" read "pipette was movable."
" "	272	1	..	12	Delete this line
" "	272	1	..	11	Delete "bottom."
" "	272	1	..	11	For "main" read "mean."
" "	272	1	..	7	After "viscosity" add "within the limited range chosen here."
" "	297	2	11	..	For "275,421" read "295,421."
No. 6—Mar. 31	347	2	..	15	For "Rendall" read "Randall."
No. 7—Apr. 16	379	1	11	..	For "1,212,991" read "1,212,291."
" "	382	1	18	..	For "103,709" read "103,739."
No. 8—Apr. 30	447	1	12	..	For "F. G. Lea" read "E. G. Lea."
" "	457	2	26	..	For "1,216,590" read "1,216,390."
" "	474	1	..	18	For "Davies" read "Davis."
No. 9—May 15	590	2	21	..	For "McCulloch" read "McNulloh."
" "	520	2	..	29	For "1,209,575" read "1,219,575."
No. 11—June 15	585	2	..	4	For "Bart" read "Bartl."
" "	615	2	18	..	For "105,350" read "105,380."
No. 13—July 16	736	2	30	..	For "0-1622" read "1-0622."
No. 15—Aug. 15	880	2	..	33	For "H. A. Ashenhurst" read "H. S. Ashenhurst."
" "	888	1	17	..	For "S. W. Lawrie" read "J. W. Lawrie."
No. 16—Aug. 31	925	2	..	5	For "1,231,741" read "1,231,471."
" "	933	2	..	10	For "Toret" read "Joret."
" "	938	1	22	..	For "1,203,364, 1,203,365, and 1,203,366," read "1,230,364 1,230,365, and 1,230,366."
No. 18—Sept. 29	999	2	8	..	For "Born" read "Born."
No. 19—Oct. 15	1051	1	..	19	For "microscopic" read "macroscopic."
No. 20—Oct. 31	1088	2	7	..	For "Mass" read "Moss."
" "	1088	2	..	32	For "Westby" read "Westly."
No. 21—Nov. 15	1137	1	3	..	For "McGraham" read "McGahan."
No. 22—Nov. 30	1171	1	15	..	For "1906" read "1916."
" "	1185	1	2	..	For "J. R." read "G. R."
No. 23—Dec. 15	1216A	1	..	13	For "not" read "now."
" "	1227	2	33	..	For "M. B. Lamb" read "M. R. Lamb."
" "	1228	1	30	..	For "P. Bingham" read "C. Bingham."
" "	1228	1	..	24	For "Wilcox" read "Wilcox."
" "	1232	2	16	..	For "1,243,327" read "1,242,327."
No. 24—Dec. 31	1266	2	26	..	For "Dri fein" read "Dreifin."



Journal of the Society of Chemical Industry.

No. 1, Vol. XXXVI.

JANUARY 15, 1917.

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Official Notices.

CROSS AND BEVAN ESSAY PRIZE OF £20 AND LATHAM RESEARCH GRANT OF £300.

The Council have pleasure in announcing that a gift of £20 has been made by Messrs. Cross and Bevan as a prize for an essay on "The Inter-connection of Economic Botany and Chemical Industry."

A further sum of £300 has also been presented by their friend, Mr. T. P. Latham, of Weybridge, to be paid in three annual instalments to such one of the competing essayists as may be judged to be of conspicuous ability, as a grant towards his expenses, on the condition that he apply himself, during three years, to research of approved character on a subject cognate with that discussed in his essay.

The immediate object of the donors is to promote the study of economic botany with special reference to its bearing on chemical industry, giving the widest possible interpretation of the relationship.

They desire, under the auspices of the Society, to assist in forming public opinion in this direction and to discover and further the career of a student of promise who may wish to devote himself to work in such a field.

The Essay Prize will be open to all members of the Society who are British subjects. The Research Grant will be limited to competitors under 25 years of age at the time of sending in the essay.

Essays are to be submitted to the Council of the Society not later than the close of the year 1917. The awards will be made promptly. Neither the prize nor the first grant will be given unless the essayist or essayists shall be deemed to have real merit. The Latham Research Student will be required to submit a report at the close of each year, to satisfy the Council that he has made and is likely to make proper use of the grant.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY.

The first volume of the Reports of the Progress of Applied Chemistry is now in active preparation, and will, it is hoped, be published shortly. It will cover recent progress to the end of June, 1916. The second volume will deal with the period up to the end of 1917, and subsequently it is proposed to issue the Reports annually.

The Reports will present a critical summary of the progress that has been made in the various branches of chemical industry during the period in question. It has not been found practicable to treat every section of the Journal classification. Agricultural chemistry, the chemistry of foods, and analysis are fully dealt with in the admirable series of Reports issued annually by the Chemical Society, and for the present there will be no sections on general plant and explosives.

The following is a list of the subjects which will be dealt with, together with the names of the experts who are contributing to this volume:—

Fuel—J. W. Cobb,
Gas, destructive distillation, tar products—E. V. Evans.
Mineral oils—A. W. Eastlake,
Colouring matters and dyes—G. T. Morgan.
Fibres, paper, dyeing, printing—Julius Huebner.
Acids, alkalis, salts, etc.—H. A. Auden.
Glass, ceramics, cement, etc.—J. A. Audley.
Metals, metallurgy—W. R. E. Hodgkinson.
Electro-chemistry—J. T. Barker.

Fats, oils, waxes—G. H. Warburton.
Paints, pigments, varnishes, resins—R. S. Morrell.
Indiarubber—H. P. Stevens.
Leather, glue, etc.—J. T. Wood.
Sugar, starches—J. G. Macintosh.
Fermentation—A. R. Ling.
Sanitation, water purification—F. R. O'Shaughnessy.
Fine chemicals, medicinal substances, essential oils—F. L. Pyman.
Photographic materials and processes—B. V. Storr.

The price of issue will be, to members, 2s. 6d. (plus 6d. postage), and non-members, 5s. (plus 6d. postage). As the issue is to be a limited one, those desirous of securing copies are requested to fill in the order form attached to the cover of the Journal, and return it to the Secretary at an early date.

Glasgow Section.

Meeting held at Glasgow on Tuesday, November 28th, 1916.

MR. JAMES MCLEOD IN THE CHAIR.

THE THERMAL DECOMPOSITION OF LOW TEMPERATURE COAL TAR.

BY DAVID TREVOR JONES, M.Sc.

The mechanism of the process by which coal tar is formed in the gas retort has been the subject of much speculation and controversy. The various theories which have been propounded regarding this process resolve themselves into two classes: (1) those which assume that the components of coal tar are formed by the combination of various small molecules, such as acetylene, which are regarded as primary products of the destructive distillation, and (2) those which assume that the coal substance is itself essentially aromatic, and that the benzene and other aromatic distillates are themselves primary products of the breakdown of coal. This second theory has been put forward by Hensler (Ber., 1897, 30, 2744; this J., 1898, 37) as the result of observations made on bituminous coals, brown coals, and lignite. This theory that coal is a mixture of aromatic substances can only be upheld if observations are confined to its distillation products obtained at temperatures of 700° C. and upwards. Coal is certainly not aromatic in the structure of any of its chief components, though it must be admitted that but little is as yet known of its chemical nature. It is formed from decayed vegetable matter which has been subjected to very considerable pressure, and in many cases to such a degree of heat as would suffice to bring it to the stage of incipient distillation, i.e., between 250° C. and 300° C. This was argued on purely chemical grounds by Jones and Wheeler (Chem. Soc. Trans., 1914, 105, 143; this J., 1914, 192), who pointed out that certain English bituminous coals yielded on extraction with solvents the identical paraffin, C₂₇H₅₆, which they yielded in much larger quantity on distillation. They pointed out that a similar conclusion could be drawn from the earlier results of Pictet and Ramseyer (Ber., 1911, 44, 2486; this J., 1911, 1041, 1199), who extracted from a Montrambert coal the readily polymerisable hexahydrofluorene, along with traces of bases and phenols, these two last being primary products of low temperature distillation. More recently Pictet, Ramseyer, and

Kaiser (Comptes rend., 1916, 163, 358; this J., 1916, 1145) have extracted from five tons of coal, 0.25% of tar which is closely identical in many of its components with that obtained in quantity from the same coal on distillation at 450° C.

Coal is therefore to be regarded as a mixture of substances of vegetable origin, which have undergone change as the result of bacterial decay, pressure and heat. The original main components, the cellulose and the sap, have both suffered change as the result of the action of these agencies but not to such an extent as to render impossible their identification and separation. Preliminary loosening of the coal substance with pyridine and a final extraction with chloroform has led to the separation of these two portions, the degraded cellulose being the insoluble component, the sap the soluble one (Clark, Wheeler, and Platt, Chem. Soc. Trans., 1913, 103, 1713; this J., 1913, 969). Separate destructive distillation of these shows that the cellulose portion yields phenols, while the sap yields what is virtually petroleum (Jones and Wheeler, Chem. Soc. Trans., 1915, 107, 1318; this J., 1915, 1013). These combined distillates, as obtained from the unresolved coal by distillation *in vacuo* below 450° C., constituted a tar of low specific gravity (0.967—0.999¹⁵). This tar was 61% of the weight of the coal. That portion of it, about one-half, which distilled below 300° C. at ordinary pressure contained: (1) unsaturated hydrocarbons (40—15%); (2) naphthenes; (3) liquid paraffins—the two last-named being about 40% of the oil, with the naphthenes predominating; (4) phenols, chiefly cresols and xylenols (12—15%); (5) aromatic compounds, which, on account of the stability of their picrates to water, were considered to be homologues of naphthalene; (6) pyridine bases, in traces; and (7) traces of a solid paraffin, C₂₇H₅₆. Benzene and its homologues were absent, as were also naphthalene, anthracene, phenanthrene, and solid aromatic bodies generally. The aqueous distillate was strongly acid, and was found to contain hydrochloric acid, with which traces of ammonia were combined (Jones and Wheeler, Chem. Soc. Trans., 1914, 105, 140; this J., 1914, 192). It seemed a matter of interest to investigate the thermal decomposition of this tar, and, with Dr. Wheeler's concurrence, the author undertook this investigation independently. The first experiment carried out was the decomposition of the tar at 650° C. with the object of obtaining the liquid products of decomposition. The tar taken had specific gravity 0.967¹⁵ and contained carbon 86.32%, hydrogen 9.53% (C+H=95.85). It was allowed to flow over coke packed in a vertical tube of hard glass, which was heated in an electric furnace. The temperature was registered by means of a platinum-platinum-rhodium thermocouple, the junction of which was inserted in the hottest part of the furnace. The length of the heated zone was 30 cm., and the gas capacity of the heated zone of the decomposition tube was 30 c.c. The temperature of decomposition (650° C.) was kept fairly constant within about 6° C. The liquid was run in at the rate of about 5 c.c. per hour. Gas was formed to the extent of 220 c.c. per gram of tar taken. The first receiver, which was air cooled, was fitted vertically below the decomposition tube, so that the heavier liquid products of decomposition ran directly into it. The second receiver was cooled in a mixture of solid carbon dioxide and ether contained in a Dewar vessel. The permanent gases were allowed to escape. The tar collected in the first receiver was 55% of the weight of the original tar. It had specific gravity=1.013¹⁵, carbon 88.51, hydrogen 7.18%. It contained a little water in suspension. It began to boil at 128° C., and distilled 19% at 200°, 37% at 250° C., and 50% at 300° C.

The distillate coming over below 300° C. was washed with caustic soda to remove phenols, and with dilute sulphuric acid to remove bases. The separate fractions had the following characteristics:—

	Fraction I.	Fraction II.	Fraction III.
Range of boiling point	110—180°	180—260°	260—300°
Specific gravity	0.8645	0.9093	1.000
Carbon	90.55	90.63	91.36
Hydrogen	9.04	9.11	7.52
C+H	99.59	99.74	98.88

If these figures be contrasted, so far as is possible, with those given by the original tar oils, the increase in specific gravities and carbon content are at once apparent, even when the fractions from the new tar are of lower boiling range than those from the original.

Low temperature tar oils.

	Fraction I.	Fraction II.	Fraction III.	Fraction IV.
Boiling range	160—200°	200—250°	250—275°	275—300°
Specific gravity	0.8045	0.8556	0.8903	0.9278
Carbon	86.28	87.88	88.13	88.21
Hydrogen	13.11	11.65	11.09	10.36
C+H	99.39	99.53	99.22	98.60

From the observation that oxygen is absent from the neutral oil fractions obtained after decomposition it follows that cumarone, C₉H₆O, and its homologues are also absent. As their absence from low temperature tar has been similarly demonstrated, it must be presumed that this substance is formed at higher temperatures, either synthetically or by direct distillation from the coal.

The increases in specific gravity and in carbon content, alluded to above, are due to two causes: increased aromatic formation, and increased olefinic linkage. The latter was the predominant factor, though it was difficult to distinguish accurately and quantitatively between the two (cf. Egloff and Twomey, Met. and Chem. Eng., 1916, 14, 247; this J., 1916, 411), the difficulty being accentuated by the smallness of the amounts available for examination. A further difficulty was occasioned by the fact that aromatic substances were present in the original tar, and these passed through the heated zone apparently unchanged. A small quantity of aromatic substances of specific gravity 0.89 (determined by flotation) was distilled from a strong sulphuric acid wash of the lower fractions, and the aromatic substances originally present were recovered from the higher boiling portions. No solid aromatic substances such as naphthalene or anthracene could be detected in the tar. A study of the gases formed at various temperatures was therefore begun. The only aromatic substance which could possibly affect the gas analyses in any way was benzene, and that only to a limited extent owing to its low vapour tension, and to its comparative absence at the lower temperatures of decomposition. The gas absorbents used were: (1) Sulphuric acid of 96% strength. This removes olefines containing from 3 to 6 carbon atoms in the molecule, thus discriminating between ethylene and the higher members of the series. (2) Ammoniacal silver chloride for acetylene. (3) Bromine in potassium bromide solution for ethylene. (4) Freshly-prepared ammoniacal cuprous chloride for carbon monoxide. Hydrogen was estimated by removing

it with "burnt" palladium at 96° C. and the remaining methane and ethane were determined by explosion.

Investigation was first made of the gases which were boiled off at a temperature range of -80° C. to +35° C. from the ether-CO₂ cooled receiver which served as the second condenser in the experiment carried out at 650° C. as described above. The gases so obtained were found to contain paraffins 21.1% (C₂H₆ 11.8%, C₃H₈ 10.3%), ethylene 5.3%, higher olefines 72.6%. (Gases absorbed by strong sulphuric acid, consisting of olefines containing more than two carbon atoms, are described throughout this paper as "higher olefines.")

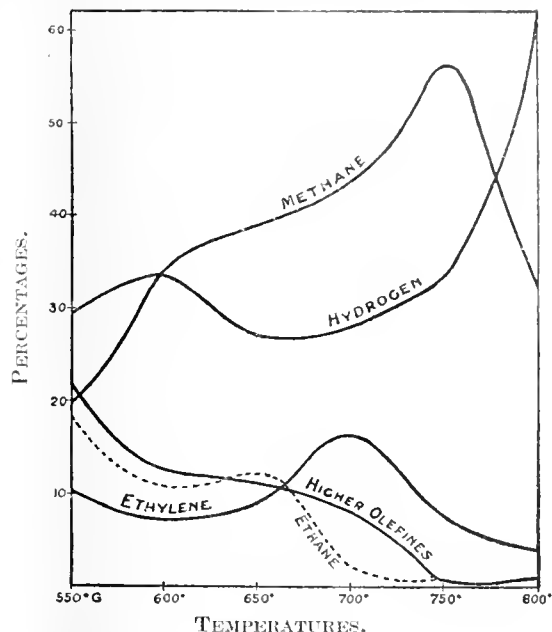
The marked preponderance of the olefines over the saturated hydrocarbons is very noticeable, and is in striking contrast to the corresponding gas fraction obtained direct from coal at 450°, and which was found to contain total olefines 23.5% and paraffins 75.1% (Jones and Wheeler, *loc. cit.*). The higher percentage of olefines at this stage was also observed in the liquid fraction from which they had been distilled (b.pt. 35°—120° C.), which appeared to contain over 60% of olefinic substances.

It was then decided to decompose small quantities of the tar at successive temperature increments of 50° C., beginning at 550° C., the lowest temperature at which such decomposition was rapid enough to be conveniently studied under the same conditions as held at higher temperatures. The method adopted was the simple one of distilling a small quantity of the substance over heated porous porcelain in an atmosphere of carbon dioxide, and finally sweeping out the gaseous products of decomposition with carbon dioxide and collecting them over potash in a nitrometer. About 0.1 grm. of substance was placed in a small porcelain boat, which was inserted in the back end of the hard glass decomposition tube (a quartz tube was used at 800°), heated in an electric furnace 30 cm. long and fixed horizontally. Backward diffusion of vapours was prevented as far as possible by the insertion of a plug of glass wool at the back of the boat. After the boat had been placed in position and all air driven out by carbon dioxide, the current of the latter was shut off, and the nitrometer filled with potash. The tube was then moved along so as to bring the boat into the hot zone of the furnace. The tar was then distilled and decomposed. The results obtained in the form of percentages calculated as "nitrogen-free" are set forth in the following table:—

Temp.	Higher olefines.	C ₂ H ₂ .	C ₂ H ₄ .	H ₂ .	CH ₄ .	C ₂ H ₆ .
(2) 550° C.	21.7	0.7	10.4	29.4	19.6	18.2
(3) 600° C.	12.5	1.3	7.4	33.6	33.9	11.3
(4) 650° C.	11.4	0.9	9.3	27.4	39.0	12.0
(5) 700° C.	8.2	1.3	16.1	28.2	43.8	2.4
(6) 750° C.	0.7	1.2	7.6	33.2	56.1	1.2
(7) 800° C.	1.0	1.3	4.0	60.7	33.0	—

As carbon monoxide is formed as the result of the action of nascent hydrogen on carbon dioxide at the given temperatures, no column is assigned to it in the above table, and it is included in the hydrogen. A separate experiment showed that when the tar was decomposed *in vacuo* at 550° C., only 0.6% of carbon monoxide was found in the resulting gas. Carbon monoxide is found in quantity in coal gas, but it proceeds largely from the insoluble portion of the coal, and to a much less extent from the soluble portion from which the bulk of the tar is derived (Clark and Wheeler, Chem. Soc. Trans., 1913, 103, 1704; this J., 1913, 969). The figures given represent the percentages of the various components in the gas mixture and not the absolute amounts.

No examination was made of the liquids. It was observed, however, that naphthalene was deposited in the front end of the tube at 750° C., though not below this temperature. It will be noticed on studying the curves, that ethylene



increases to a maximum at 700° C., and then falls; acetylene is uniformly low and almost negligible; the higher olefines fall from a maximum at 550° almost to zero at 750° C.; hydrogen averages about 30% till 750° C. is passed, when the curve becomes steep; methane rises rapidly to 750° and then falls.

In order to avoid confusion with the curves for ethylene and the higher olefines, the curve for ethane is indicated by dotted lines. It shows a fairly steady decline.

No simple explanation is vouchsafed for the contour of the ethylene curve. The rise may perhaps be explained in part by the fall in the ethane, and also by the direct formation of ethylene as a primary decomposition product of the various tar components, saturated and unsaturated. Analyses (8), (9), and (10) show that from 20 to 30% of ethylene was present in the gases obtained by rapidly decomposing various oil fractions at 650° C. The low percentages of acetylene call for remark, in view of the important rôle which has been assigned to this compound as a participant in coal tar formation. If, as is still held by some, notably R. Meyer (Ber., 1912, 45, 1609; this J., 1912, 633), acetylene plays a prominent part in coal tar formation, it should be present in much larger quantities than are here indicated. Bone and Coward have shown (Chem. Soc. Trans., 1908, 93, 1197; this J. 1908, 886) that the velocity of polymerisation of this gas when formed by the thermal decomposition of ethylene at 570°—580° is not so rapid as not to allow of its accumulation to the extent of from 6 to 7%, at which value it remained fairly constant after prolonged heating.

The curve for the higher olefines differs considerably from that of ethylene in that it exhibits a steady decline from 550° to 750° C. The higher olefines practically vanish at this latter temperature, and their disappearance synchronises with the appearance of naphthalene, and with the commencement of a marked increase in the

hydrogen. This fall in the curve finds a counterpart in the results of Egloff and Twomey obtained by them when decomposing Pennsylvania petroleum (Met. and Chem. Eng., 1916, 14, 247; this J., 1916, 411). They observed, particularly in the case of the low boiling fractions, that the liquid olefines were at a maximum at 550° C., and that there was a more or less steady fall in the curve from 44% at that temperature to 5% at 800° C. Their curve does not, however, coincide with the gas curve shown here, in that it shows there is still 25% of liquid olefines remaining at 700° C. and 15% at 750° C.

Ordinary coal tar oils, particularly the lower fractions, contain very little olefines. In ordinary crude benzol from coal tar, the olefines present,

cussed below, the process is represented by the simple scheme:—

Low temperature tar → Higher olefines → High temperature tar.
(liquid and gaseous)

The mechanism of the condensation has not yet been investigated. The suggestion that naphthenes are intermediate products in the condensation cannot be upheld in view of the observation made by the author that these substances break down at 500° C. (Chem. Soc. Trans., 1915, 107, 1582; this J., 1915, 1239).

The formation of gaseous olefines is more marked in the case of certain tar-oil fractions than of the tar itself, as can be seen from the following table which gives results obtained at 650° C.

Fraction.		Higher olefines.	C ₃ H ₄ (+ C ₂ H ₂)	H ₂	CH ₄	C ₂ H ₆	Total "unsaturated."
Sp. gr.	R.pt.						
(8) 0.69	38–100° (olefine-free)	29.9	20.6	13.7	19.6	16.2	50.5
(9) 0.784	200–250° (olefine-free)	26.8	23.8	12.6	21.7	9.1	56.6
(10) 0.855	200–250°	24.2	22.6	21.6	25.5	6.1	46.8

which are removed as "acid tar" with strong sulphuric acid, amount to about from 2% to 1% of the whole. A fraction of similar range of boiling obtained from low temperature tar lost over 50% of its volume as "acid tar" on washing with strong sulphuric acid.

The higher olefine curves differ from those of Zanetti (J. Ind. Eng. Chem., 1916, 8, 671; this J., 1916, 957), who observed that a propane-butane mixture yielded a maximum of "unsaturateds" at 750° C. Zanetti, however, makes no distinction between ethylene and other olefines, and the high percentage of "unsaturateds" probably consists very largely of the former. It is to be observed that Zanetti comments on a rapid increase in hydrogen and aromatic substances immediately above 750° C.

Staudinger's work on di-olefines with conjugated double linkings appears to have a distinct bearing on the results already recorded (Staudinger, Endle, and Herold, Ber., 1913, 46, 2466). It was observed that di-olefines of this type yielded aromatic substances in quantity when heated to 800° C. Isoprene first gave aromatic substances in quantity at 750° C. along with unsaturated substances. At 800° C. the aromatic substances had increased, while unsaturated had almost disappeared.

Staudinger further identified butadiene, the simplest di-olefine of this type, in gas distilled from coal *in vacuo*. Its formation from naphthenes has been demonstrated (Engler and Staudinger, Ber., 1913, 46, 2466; Ger. Pat. 241,895), as it has also from many olefines and saturated hydrocarbons (Ostrowski, J. Russ. Phys. Chem. Soc., 1915, 47, 1917–1978; this J., 1916, 380). It also appears prominently in various petroleum vapours as the result of decomposition at 700° C. (Lomax, Dunstan, and Thole, Chem. Trade J., 1916, 59, 458; Engineering, 1916, 102, 511).

These combined results tend to show that in coal tar formation the bulk of the high temperature tar is formed by the decomposition of the low temperature tar into olefines, and the condensation of these at 700° C. and upwards to aromatic substances. It is highly probable that a necessary transition stage is the formation and condensation of olefines containing the stable conjugated double linkage—CH=CH:CH=CH—. Polynuclear aromatic substances are formed at 750° C. and upwards subsequent to the disappearance of the olefines. With certain reservations which are dis-

Certain modifications relating to the phenols, benzenoid substances, and pitch must be made in the above scheme. The phenols of high temperature tar must be regarded as having been formed with certain changes from the phenols of low temperature tar.* Much of the high temperature pitch is formed by partial carbonisation of the low temperature pitch.

Benzenoid substances, in addition to being formed synthetically from olefines, are also formed to a limited extent by the elimination of six hydrogen atoms from the corresponding naphthenes. This change, however, only takes place to a very limited extent. Naphthenes of the cyclohexane series do not break down entirely in this way, but also undergo scission of the ring, with formation of olefines, including butadiene, and paraffins. The author has shown that both these processes of breakdown take place at 550° C. (Chem. Soc. Trans., 1915, 107, 1582). This is also manifest in analysis (9), where the fraction concerned consisted largely of naphthenes. If all the benzene, toluene, and their homologues found in ordinary coal tar were obtained directly from naphthenes by simple elimination of hydrogen, it follows that at temperatures not much above 550° C. coal would yield the maximum possible amounts of these substances. It is well known, however, that when coal is distilled at dull redness only small quantities of benzenoid hydrocarbons are found in the tar.

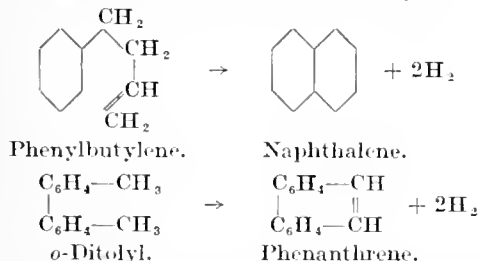
It might be argued that the naphthalene deposited at 750° C. may have been derived from the methylnaphthalenes originally present by a form of decomposition analogous to that by which xylene successively yields toluene and benzene (Rittman, Byron, and Egloff, J. Ind. Eng. Chem., 1915, 7, 1019; Egloff and Twomey, J. Phys. Chem., 1916, 20, 115; this J., 1916, 105, 296). The presence of naphthalene cannot, however, be adequately accounted for in this way. A tar oil fraction from which methylnaphthalenes had been removed with picric acid was thermally decomposed at 750° C. and it was observed that naphthalene was deposited in quantity at the front of the tube. The gas analysis (11), it is to be observed, shows very little higher olefines.

* Pictet and Bouvier (Ber., 1913, 46, 3342) found no phenols in a vacuum tar freshly distilled from certain French coals. On standing, however, phenols were formed, apparently from alcoholic bodies present (Pictet, Rev. Gén. des Sciences, Oct. 30, 1916, 7).

	Higher olefines.	C ₂ H ₄ .	H ₂ .	CH ₄ .
(11)	1.9	10.9	18.3	68.9

An explanation of the formation of hydrogen at intermediate temperatures has been given above in discussing the thermal decomposition of the naphthenes. Some hydrogen may also have been formed to a lesser extent from other hydrocarbons, notably ethane. Its increased formation at temperatures above 750° with the concomitant appearance of polynuclear aromatic substances has not been explained. Similar observations of increased hydrogen formation have been recorded by Zanetti with a propane-butane mixture (*loc. cit.*) and by Burgess and Wheeler with bituminous coal and with anthracite (Chem. Soc. Trans. 1910, 97, 1917; this J., 1910, 1291). In all three cases it was observed that the hydrogen curve became steep above 750° C., and Zanetti also noticed increased aromatic formation at the same temperature.

As very few measurements have been recorded of the conditions of thermal decomposition of individual substances at these temperatures, it is not an easy matter to explain the above coincidences. Smith and Lewcock have observed (Chem. Soc. Trans., 1912, 101, 1453; this J., 1912, 807) that the combination of two molecules of benzene to diphenyl with elimination of hydrogen takes place slowly at 655° C., and rapidly at 720° C. With increased concentration of benzenoid substances some combination of this kind must inevitably occur. Diphenyl is known to be a constituent of coal tar. The observation of Burgess and Wheeler concerning anthracite shows that the increased formation of hydrogen is not dependent upon changes of such a kind as can only take place in the vapour phase. It could not for instance be asserted, if regard is to be had for these coincidences, that the increased hydrogen is due to the prior disappearance of olefines, which may hitherto have combined with and retained it. The change which produces this hydrogen is evidently of such a kind as takes place between large molecules and also intramolecularly. The increased production of hydrogen must probably therefore be attributed to the union of aromatic molecules, and to the intramolecular closing up of side chains and rings of these to form new rings. Simple examples of these changes are the formation of diphenyl from benzene already mentioned, and that of naphthalene from phenylbutylene and of phenanthrene from stilbene and *o*-ditolyl.



The increased hydrogen formation in tar and petroleum fractions is thus necessarily concomitant with the formation of polynuclear aromatic substances, while the similar hydrogen formation in coal marks the beginning of the rapid conversion of the coal to polynuclear molecules of indefinite dimensions, a process which culminates in their coalescence to the aromatic molecule of carbon.

The curves for ethane and methane call for little comment. Bone and Coward (*loc. cit.*) have shown that the former decomposes rapidly at

675° C., and that at 810° C. only 17.9% remained after heating for one minute. The disappearance of ethane with rise of temperature was therefore to be anticipated. It is possible that paraffins higher in the series than ethane are present at lower temperatures. These would appear in the analyses as ethane, and the early rapid fall in the curve may be due in part to their decomposition.

Methane is a general product of most thermal decompositions, even of such substances as carbohydrates where its formation might be least expected. The observed rise in the methane curve is in accordance with this and with its known stability.

SUMMARY.

(1) Ordinary coal tar is formed from coal at high temperatures chiefly as the result of the decomposition of a tar previously formed at low temperatures.

(2) The mechanism of this process consists essentially in the decomposition of the naphthenes, paraffins, and unsaturated hydrocarbons present in the low temperature tar to form olefines of varying carbon content which condense at higher temperatures to aromatic substances.

(3) The higher (gaseous) olefines are at a maximum at 550° C., the curve descending to a minimum at 750° C., when they virtually disappear. Their disappearance at 750° C. synchronises with the appearance of naphthalene, and immediately precedes a rapid increase in the evolution of hydrogen.

(4) Hydrogen is formed at middle temperatures chiefly as the result of the decomposition of naphthenes. The increase at higher temperatures must probably be attributed to the union of aromatic molecules and to intramolecular ring closing.

(5) Phenols are primary products of coal distillation (*cf.*, however, Pietet, *loc. cit.*).

(6) Benzene and its homologues are chiefly formed as the result of olefinic condensation. To some extent they are secondary products of coal distillation, having been formed by the thermal dehydrogenation of the corresponding naphthenes.

(7) Acetylene plays an insignificant part in coal tar formation.

New York Section.

Meeting held at Rumford Hall, Chemists' Building, on Friday, November 24th, 1916.

MR. JEROME ALEXANDER IN THE CHAIR.

THE IMPORTANCE OF "IMPURITIES."

BY JEROME ALEXANDER.

Many of the discoveries and improvements of chemical science have been due to the recognition of the importance of impurities. Although it has long been known that chemical and physical changes can be brought about or influenced by extremely minute quantities of substances which exercise disproportionately great effects, it is only within comparatively recent years that the widespread occurrence and technical importance of these phenomena have been recognized. Thus, for example, a minute quantity of platinum black, one part to a million according to Bredig and von Berneck,* is able to decompose hydrogen peroxide, and as an extreme case, Brode states that one gram-molecule of molybdic acid in 31,000,000 litres has a detectable catalytic effect upon the reaction between hydriodic acid and hydrogen peroxide. The effect of an infusion of straw or

* Z. Physik. Chem., 1899, 31, 353; see also this J., 1901, 376.

similar substances in rendering clay plastic may not have been known as such to the Egyptians; but they certainly knew that bricks could not be made without straw. Coming to more recent times, let us consider a few cases where so-called impurities are of great technical importance.

Auer von Welsbach's experiments to produce a satisfactory incandescence gas mantle had been unsuccessful, when he once more took up the investigation of thoria, which had in his preliminary work given a good though transitory effect. In the attempt to prepare pure thoria the surprising discovery was made that the purer the thoria preparations, the lower their illuminating power, and the identification and use of cerium as the light-giving impurity brought success to the incandescence gas mantle industry.

The importance of impurities is so well recognized in the iron and steel industry, that its products are made according to specifications limiting some of them to the third decimal place. Even the impurities in alloying metals must be considered, for the early attempts to produce a workable nickel steel failed because of such impurities as copper, arsenic, and sulphur which existed in the commercial nickel of that day.

H. A. Bernthsen, in his address on the production of synthetic ammonia by the Haber process*, pointed out that sulphur, selenium, tellurium, phosphorus, arsenic, boron, or the compounds of these elements such as the hydrides, and also many carbon compounds and certain metals of low melting point such as lead, bismuth, and tin, may all act as poisons to the catalyst. Sulphur dioxide is very poisonous. Bernthsen says: "Extremely minute quantities of these bodies, which are almost always present even in the purest commercial products or in so-called pure gases, suffice to render the catalysts absolutely inactive or at least to diminish their action very seriously. Thus iron, for example, prepared from ordinary iron oxide with a content of one per thousand of sodium sulphate is, as a rule, inactive. Iron containing 0.1% of sulphur is generally quite useless, and even with 0.01% is of very little use, although in appearance and when examined with ordinary physical and chemical methods no difference at all can be detected as compared with pure iron.

"The recognition of these facts gave rise to two problems: (A) The preparation of contact masses free from poison or the removal of such poisons from them, and (B) freeing the gases to be acted upon catalytically from all contact poisons. A trace of sulphur, one part per million, in the gas mixture, can under certain conditions be injurious, so that even electrolytically prepared hydrogen must generally be further specially purified.

"A painstaking study, for which we are indebted principally to Dr. A. Mittasch and which involved literally many thousands of experiments, has afforded an insight into the importance of substances of the most varied nature as promoters and poisons, and thus a sure foundation has been prepared for a reliable continuous manufacture with a good yield of ammonia."

The catalytic nickel used in the hydrogenation of oils is so sensitive to impurities that Paul Sabatier in his paper on "Hydrogenation by Catalysis" states that small traces of bromine in the air of the laboratory rendered it impossible to hydrogenate phenol which had stood there in an open flask. Benzol which could not be freed from thiophen, could not be converted into cyclohexane.

With some substances the escape of mere traces must be prevented. Thus, in the manufacture of sulphonal there is produced a mercaptan, the odour of which is described as appalling, and so powerful

that ~~xxxxxxxx~~ mgrm. may be recognised. Obviously not much can be allowed to escape.

An interesting demonstration of the importance and efficiency of apparently negligible traces is given by Dr. W. R. Whitney in his recent Willard Gibbs Medal Address (J. Ind. Eng. Chem., 8, 563), in which he states:—"I remember also that after we had tried to increase the resistance of our early tungsten filaments by introduction of rare oxides and other material which we hoped would remain in the filament when hot, and had seen them distil out at the temperature of operation, someone suggested adding traces of such oxides for the purpose of increasing the life of the filament. It seemed a futile experiment, but the traces served the new purpose, while greater quantities had failed."

Through the kindness of Dr. G. W. Thompson, of the National Lead Company, I am able to show two corroded lead buckles which exhibit the effect of impurities in metallic lead upon the white lead made from it. One was made from lead containing only 0.01% of silver, and shows a very deep pink colour, probably due to silver sulphide. The other was made from lead containing 0.02% of copper, and shows a marked green coloration.

In the case of copper, small amounts of arsenic seriously affect the conductivity. Thus W. Hampe (Ch. m.-Zeit., 1892, 16, 726-728; this J., 1892, 1014) reports that if the conductivity of pure copper be rated at 100, the conductivity of copper containing 0.246% of arsenic falls to 61.05. E. S. Sperry (Trans. Amer. Inst. Min. Eng., Feb., 1898; this J., 1898, 582) has pointed out the injurious effects of antimony and bismuth in copper upon brass made with it. He states that brass containing 0.006% of antimony can be rolled without cracking, but when the percentage reaches 0.02 the fracture indicates the presence of the antimony. Sperry also found bismuth to be very objectionable (Eng. and Min. J., 1898, 66, 519; this J., 1899, 47, because it renders brass hot-short, cold-short, and determines actual or "latent" firecracks. He therefore advises that high brass intended for cold rolling should not contain over 0.01% of bismuth. Cadmium, which frequently occurs as an impurity in zinc, also injuriously affects brass. On the other hand, I am informed that a small percentage of lead in brass makes it machine well. But quite the contrary is the case with gold, which is rendered brittle by 0.05% of lead.

In the refining or deposition of metals by electrolytic methods there are numerous instances published in the technical and patent literature dealing with the beneficial or detrimental effects of small quantities of previously neglected "impurities," some accidentally, but some intentionally added. Sulphates interfere with the electrolysis of magnesium chloride and with the electrolytic production of chlorates. In electroplating with gold, a little copper gives a red shade and a little silver gives a greenish shade. In fact, quite a variety of colours may be produced by the judicious introduction of suitable impurities. The work of Anson Betts has demonstrated the effect of tannin and similar substances which behave like protective colloids, upon the electro-deposition of lead. The effect of protectors can be exhibited by dividing a solution of lead nitrate between two beakers, adding some gum arabic solution to one, and then inserting a strip of zinc into each beaker. A brilliant crystalline lead tree deposits on the strip in the solution without the gum, whereas the other deposit appears blackish and amorphous.

The following are a few scattered instances. In the manufacture of dry batteries, traces of iron in the pyrolusite and of copper in the sal ammoniac have been found to be detrimental. Traces of arsenic in the hydrogen used by lead burners prevent the formation of a proper joint. Nitric acid carboys which had been used in a felt factory

*Eighth Int. Congr. Appl. Chem., New York, 1912; this J., 1912, 982.

to make mercuric nitrate for carroting, retained enough mercury to cause serious trouble when they were refilled and sent to another plant. Traces of copper or iron in tanning materials are inimical to the production of white leather. As little as one part of sulphur per million in coconut oil has a deleterious effect on the soap made from it. Water and air in liquid ammonia may accumulate and cause trouble with the refrigerating machinery. Iodine, fluorine, and arsenic are poisons prohibited in foods; yet physiological chemists state that certain small quantities of these substances which we unwittingly take in our food, are essential to our bodily well-being.

In the brewing industry, many peculiar facts, long known, have been traced to the presence of disregarded impurities; for instance, "Burton water" is supposed to owe its advantageous properties to traces of calcium salts, and patents have been granted for "Burtonizing" brewing water. The outbreak of "beer-poisoning" in Manchester, England, in 1900, was traced to arsenic in the mineral acid used in making brewing sugar. Where would be our present knowledge of radium and radioactivity, had not the Curies traced and isolated the potent impurities of pitch-blende?

The importance of traces of manganese in plant growth has been pointed out by Gabriel Bertrand who found that one part of this metal in ten million exercised a noticeable favourable effect upon the growth of *Aspergillus niger*, both the ash and the weight of the plant being increased. On the other hand, Raulins in 1870, experimenting with the same organism, found that one part of silver nitrate in 1,600,000 prevents growth. When growth was attempted in a silver cup, vegetation did not even begin. Duclaux, commenting upon this, remarked that "it is almost impossible to detect chemically any dissolution of silver into the liquid. But the fungus proves it by dying."

This naturally leads us to a consideration of the influence exerted upon physiological changes by the presence of substances that in the past might have been regarded as unimportant impurities. Take the enzymes for example, the distribution and importance of which are only now being recognised. With the aid of enzymes changes take place with comparative ease, which ordinarily require quite severe treatment with inorganic chemicals. Thus, according to E. F. Armstrong, 2-N hydrochloric acid required about five weeks at 35° C. to produce the same degree of hydrolysis as was produced by a certain preparation of lactase in one hour. Although the preparations of enzymes actually used in experiments contain only small percentages of the active enzymes themselves, some indication of their enormous efficiency may be gained from the statement of O'Sullivan and Tompson that invertase can hydrolyze 200,000 times its weight of sucrose, and the report of Hammarsten that one part of rennet can clot 400,000 times its weight of caseinogen in milk. The great efficiency of the enzymes becomes comprehensible upon ultramicroscopic examination, which reveals the continuous kinetic activity of their multitudinous particles. I have seen the particles of taka-diastase concentrated about a starch granule, probably by adsorption, practically gnaw holes in it. It is difficult to say where physical action ends and chemical action begins, for there is no sharp line of demarcation between the two.

In conclusion, I must deprecate the tendency of some scientifically educated people to dismiss in a cavalier manner observations coming to them from any source, no matter how humble. If we cannot give a scientific reason for a fact, we must work to enlarge our fund of scientific knowledge, not close our eyes to the truth, because it does not fit in with present-day theories. Most of us have smiled at the fetish-like prescriptions of the

Egyptians and Chinese, which include toads, caterpillars, and the like, not knowing that toads had long formed the basis of a folk remedy among Western nations and our own American colonists, and had even been used by the medical profession. Last year, however, Prof. John J. Abel announced in "Science" that he had isolated from the skin of *Bufo aqua*, a tropical toad, considerable quantities of that powerful drug adrenalin or epinephrin, and also a crystalline substance which he calls "bufagin" to which he says the skin owes its curative power in dropsy.

The practical housewife has known for centuries that if the white of an egg is overbeaten it runs to water; but just recently our colloid chemists have talked of the coagulation of colloids by mechanical agitation. Many decades ago, the British explorer, Captain Speke, reported the widespread belief among the African natives that the sleeping sickness was associated with the coming of the tsetse fly, but this was regarded as a superstition rather than a fact. Tardy science has since proved it to be true and has greatly extended our knowledge and control of the tiny insect carriers of disease, heretofore neglected as "unimportant impurities."

Experiment is the basis of all knowledge. But experiment must be accompanied by exact observation and correct deduction if we would find truth. In our search, let us not neglect any source or factor, no matter how lowly or insignificant it may seem, for the very thing we cast aside as unimportant or negligible may be the key to the door we seek to open.

SOME PRESENT-DAY TECHNOCHEMICAL PROBLEMS.

BY DR. RAYMOND F. BACON.*

Theodore N. Vail, the distinguished organizer of the greatest telephone system in the world, has well expressed a recent industrial recognition:

"Research, investigation, experiment, comprehensive and thorough, are now necessary to hold any position in any industrial or utility enterprise."

Mr. Vail attributes the success of his company—the nervous system of our economic and social structure—to the centralised, co-ordinated work of operation with research. Transportation, the circulatory system of the world, owes a similar debt to scientific investigation, for its development has resulted entirely from industrial growth, for which chemical inquiry is so largely responsible. It is now generally conceded that research and progress are synonymous as applied to manufacturing.†

The recent impetus imparted to the investigational activity in American chemical manufacturing has materially altered the traditional policy of industrial secrecy.‡ This change in attitude, the direct product of the appreciation of urgent action in industrial research, has been long desired by our universities, and it will undoubtedly result in the extension of the practice of referring certain of the problems of industry to university laboratories for study. Many of the numerous problems of chemical manufacturing could be advantageously attacked outside of the plants; but some

* On May 14th, 1915, I addressed the Chicago Section of the American Chemical Society on "Some Problems of Chemical Industry," and the discourse was duly published, in condensed form, in *J. Ind. Eng. Chem.*, 7 (1915), 535. However, a number of omissions occurred in that brief report, and, at the request of my colleagues, I have endeavoured to supply, principally for the research workers in our universities, the additions necessitated for completion of the presentation. The present contribution is therefore supplemental to the paper cited.

† On this relation, see Bacon, *Sci. Am. Suppl.*, 1915, No. 2087, 334.

‡ For an illustration, see the reports of the Industrial Conferences at the 53rd Meeting of the American Chemical Society (*J. Ind. Eng. Chem.*, 8 (1916), 947 *et seq.*).

central organisation, similar to the Committee on Research in Educational Institutions of the National Research Council, is needed for securing and properly distributing those problems which are pressing. It is clear, however, that stable relations between the universities and industrialists will be worth while only if some mutual benefits can accrue therefrom. This co-operation can therefore be most satisfactorily promoted by actively demonstrating the advantages of the exchange or interchange of subjects for research, which primarily presupposes a reasonable freedom from the concealment of knowledge which tenaciously adheres to all industrial research.

I shall now pass rapidly over a few of the many important problems of manufacture,* for the most part in the traditional industries—problems that a few years ago were either not given any consideration or were unknown, but which are now the subjects of considerable contemporary inquiry and even anxiety.

Some present-day metallurgical problems.

A metallurgical problem which invites the investment of research with peculiar force, is the concentration of the so-called brown-ore of Virginia, Tennessee, Kentucky, Georgia, Alabama, and Texas. Calined brown-ore carrying more than 50% of iron is readily marketable and it is said that processes of the type of the Goltra method may be profitably applied not only to these deposits but also to brown-ore "banks" which cannot be worked by old methods of preparation. Other iron-ore problems are the economic utilization of the aluminous ores of Tennessee and of the siliceous potash-bearing ores (gray iron ores) which occur in other southern States.

In blast-furnace practice, there is needed some method of increasing the basicity of the slag without increasing its temperature; very little information is available regarding the amount of sulphur which can be expelled with the top gases; the control of manganese is comparatively incomplete; little is known of the general subject of the effects of variations in the carbon contents of the different kinds of iron, and consequently we are unacquainted in detail with methods for the systematic control of carbon; and there is a lack of experimental knowledge relating to the action of a considerable percentage of vanadium in the blast-furnace charge. Reference may also be made here to the problem presented in the production of ferro-vanadium alloys directly from iron ores containing vanadium; this is difficult because vanadium goes into slag very readily.

The following are some of the many other problems in siderurgy: the recovery of manganese as an alloy from slags high in manganese; the extension of the commercial uses of open-hearth and converter slags, particularly a broad study of their use in ceramics; the improvement of the quality of cast-iron or pig iron of ordinary coke grade, to make it the equal of higher-priced charcoal iron; the influence of β -iron on the hardening of steel; the relative merits, as regards corrosion, of various iron products, and especially pure iron as compared with ordinary open-hearth and copper-bearing steels;† the cause of internal transverse defects in rails; satisfactory substitutes for imported magnesite as an iron and steel refractory (zirconia is too costly)—this problem actually resolves itself into how to use domestic

magnesite—and for graphite as a foundry facing; the cause of the lack of success in the use of ferro-silicon to replace entirely the ferro-manganese in the deoxidation of steel; and the possibility of recovering by-products from blast-furnace gases, such as compounds from which cyanides might be made.

Mention has been made in several other communications* of certain of the problems encountered in the metallurgy of zinc. The treatment of flotation concentrate is one of the present troubles of the zinc smelter, owing to its great fineness. While the proportion of this grade of ore which the smelter is obtaining is still small, the supply of it is, however, certain to increase. The roasting of ferruginous blende in such a manner as to convert all of the zinc into sulphate and oxide, avoiding the formation of sulphite and ferrite, is another interesting subject for research. Two other problems in this field are the manufacture of retorts of higher tensile strength and greater durability, and the relation of the elements of the ash ingredients of the reduction fuel to the same elements in the ore, having in mind a more satisfactory blending of the ore and the reduction material.

The increasing adaptation of flotation to the treatment of low-grade copper ores has somewhat discouraged the use of leaching methods and accordingly these processes have not made the progress expected; but the field is still open for oxidised ore where flotation has not thus far been successfully applicable. Successful flotation assumes that the copper content of the ore is in the form of disseminated mineral. In the case of ores in which the copper compound is diffused throughout a mass of gangue, such as is undoubtedly true of the copper silicate ores found at Inspiration, it is certain that flotation is out of the question and that some leaching process must be used.

The acidity of the gases from copper and lead smelting works presents a problem which still awaits solution. In electrical precipitation, the treatment of enormous volumes of gases in the smelter flues introduces several problems: in addition to the magnitude thereof, there are the problems connected with the handling of the fumes and dust and their metallurgical treatment. It is, of course, possible at present to separate from certain fumes thousands of tons of arsenic annually and it would probably be feasible to separate an amount of sulphur which would run into hundreds of thousands of tons annually, were there markets for such quantities of these by-products. The problem therefore resolves itself into the establishment of new tonnage uses for arsenic and sulphur.

In the metallurgy of the precious metals, the high price of zinc has stimulated renewed study of electrolytic methods of precipitation (the new plant at Great Falls, Montana, is illustrative of the trend in this direction) and a large amount of experimental work is in progress on the application of the flotation process. In the case of concentrate produced by flotation, the minerals composing the product are substantially the same as those obtained by gravity concentration, consisting of the sulphides and the double sulphide of the heavy metals, and therefore similar difficulties are encountered in their treatment.

Other more familiar metallurgical problems are the prevention of zinc loss in the brass industry, the elimination of arsenic from antimony, and the cheap deoxidation (retrieving) of aluminium remelted from scrap; but after all the conservation of our metals and their protection after they have been manufactured and put into service, holds out most interest.

* In collating these I have drawn from all available sources of information and especially from my experience at the Mellon Institute.

† Because of the immense amount of research which has been carried out on this subject, I have hesitated in citing the above-mentioned problem as unsolved. However, the fact that controversy still prevails places it in that class. Personally I believe that the advocates of the use of copper-bearing steels have much the best of the argument.

* See Bacon, *Science*, N. S., **40** (1914), 877; and *J. Ind. Eng. Chem.*, **7** (1915), 535.

Among the less used metals, the alkaline-earth elements are begging utility. There is no doubt that calcium could be produced economically even by methods now known if it were manufactured on a large scale to fill an extensive demand, but markets therefor must first be established by the discovery of important new uses. Results of commercial significance might be obtained by the investigation of the alloys of calcium and of its application as a chemical purifying agent in melting and casting metals. Calcium has been used in Germany as a substitute for ferro-manganese in the deoxidation of steel. In the cases of barium and strontium, uses could be developed if methods were known by which these metals could be isolated cheaply; while with magnesium an electrolytic method is required which will enable its production for about 25 cents per pound (direct reduction of the oxide, as in the case of alumina, is suggestive). Beryllium is another metal whose properties should receive broad investigation, for at present its known uses do not justify its cost.

The production of boron and ferro-boron of uniform quality requires expert study. Cheap and pure chromium is now unobtainable; the electrolysis of its fused salts is difficult on account of their high melting-points, but perhaps the electrolysis of aqueous solutions of chromium salts could be so controlled that heavy deposits would be produced. Then, too, chromium electroplating is for many purposes superior to nickel, but the technique of constantly producing perfect plating has not been accomplished.

Since there is no lack of raw materials, broad study should be made of the methods for producing pure titanium and zirconium and of their prospective uses. The same statement also applies to molybdenum, although the greatest need of the molybdenum industry at the present time is a more economic utilisation of its sources of raw material: in general, the deposits have been neither properly prospected nor opened up, and then not wisely worked; and loss and waste should be minimised as the result of a careful investigation of crushing and concentrating methods. However, the relatively small tonnage of molybdenum needed at present is a handicap in the exploitation of its ore deposits.

Other problems of industrial inorganic chemistry.

There is real need of extensive experimental research on the chemical character of coal. The knowledge regarding the combustion and distillation of coal is principally empirical, and will of course remain so until a clearer insight is had of the actual nature of the complex compounds contained in the coal substance and of the mechanism of their decomposition by heat. Two very important problems in the preparation of coal for the market have to do with "wastes": the production of an absolutely smokeless fuel in the manufacture of briquettes from anthracite culm; and the utilisation of the high-ash (60–75%), high-sulphur (5–10%) waste from bituminous coal washers.

Many other problems exist in the domain of mineral technology. New uses are desired for tripoli; the Gypsum Industries Association is engaged in furthering the development and advancement of the uses of gypsum; and the employment of slate in the manufacture of blackboards and school "slates" has so decreased that new applications are wanted to replace this loss of market. Then there are the problems in connection with the use of the natural abrasives, emery and corundum; one still hears of the sudden and wide variation in the composition of different shipments; but since the development of high-grade artificial abrasives and the exploitation of

larger corundum deposits in Ontario, no corundum has been produced and only a small quantity of emery has been mined in the United States, and accordingly new uses are being sought for these minerals. The abrasive garnet market is also strictly limited and shows little tendency to extension at present. Reference may be made here to several problems in the technology of fullers' earth, the literature of which is meagre and unsatisfactory. Little is known regarding the qualities of fullers' earth which adapt it to its applications; there is a needless obscurity concerning the changes which it occasions in oils and to which it is itself liable; it is not clear why certain earths possess a tendency to cause spontaneous combustion in the material from the filter presses; and, finally, what is the cause of the malodour which sometimes accompanies the use of a particular earth?

The problem of commercially separating a soluble potassium salt from brine containing sodium chloride, carbonate, and sulphate and other salines remains unsolved; the cleaning and drying of phosphate rock should be done more economically; and the regenerative system of heating has not been profitably applied to the pottery industry. In fact, an attractive variety of problems is found in all sections of the inorganic field, and many—particularly a compact apparatus for generating hydrogen which could be erected on a freight car and easily conveyed about for Governmental purposes; the economic production of nitric acid from ammonia by the catalytic process; the development of a commercial process for manufacturing aluminium nitride; and the direct preparation of hydrated sodium carbonate in a stable, powdered form and of sodium silicate in a readily powdered, solid, soluble form—might be attacked to advantage outside the purlieus of industry.

However, of all the anxious inquiries coming in from our manufacturers, those pertaining to refractories possibly possess the most notable academic interest. What is the exact inversion point of the crystalline form of calcium oxide? Why is the porous form of calcium oxide so much more reactive than the crystalline? What are the physico-chemical properties of ferrous oxide at high temperatures? What are the relations of the inversion points of the iron oxides to one another? Can alumina be satisfactorily made (sintered) into a dense, hard refractory without the aid of a bond, thus obviating the troublesome shrinkage which occurs at temperatures far below the melting-point of alumina? And finally there are the troubles in the case of refractories for open-hearth furnaces. The principal source of difficulty is the slagging tendency of the dust, which is derived partly from the producers and partly from the charges. Perhaps a satisfactory means of suppressing the dust might be devised, but another possible way out of the trouble might consist in replacing the acid bricks of the checkerwork by basic ones. Magnesite and bauxite bricks have been tried, but are liable to shrink; this weakness might be overcome in the case of the bauxite bricks by burning at a sufficiently high temperature and by suitably modifying the texture and composition. Dolomite bricks have not been experimented with.

In fact, it sometimes seems to me that the greatest single problem in chemical technology is the one of refractories. There are many industrial problems that now appear to be impossible of commercial solution, which could be immediately solved, provided we had some ideal refractory substance which would retain its shape and strength at high temperatures and would not be acted upon by the acid or alkaline constituents of a charge or by the gases evolved during the reaction.

Problems of industrial organic chemistry.

The inquiries which come from the domain of organic technology are well illustrative of the opportunities which exist for co-operative research as well as explanatory of the existing anxiety for new ideas in manufacture. More numerous, perhaps, than any others are queries regarding coal products and their manufacture.

In particular, the problems in connection with the by-product coking of coal are of especial importance at the present time. It is generally conceded that "coke breeze" is not being utilized in the most economical manner; new uses should be found for pitch and cumarone resin; the acid tar from the chemical treatment of light oil should be recovered and worked-up; and, for availability in times of peace, there should be accumulated a reserve of knowledge on new uses for benzene and toluene.

The related tar distillation industry presents the following problems*: What is the cause of corrosion in tar stills? Is the present method of separating fractions the best in view of the products required? Uses are also wanted for creosote oil and for lesser known bodies in the distillates; there is required a broad investigation of coal tar pitch to discover ways for rendering it more suitable for replacing natural asphalts; and the methods of testing coal tar products should be standardized. Two questions which have arisen in the manufacture of coal gas are worthy of mention in this place; these are: Have we exhausted the chemical possibilities of by-product or retort coal gas when we have recovered from it the ammonia it contains; and is it feasible to make gasoline from coal gas? This last problem does not appear to me to be commercially practicable in America, but it is under consideration in England and other countries which produce no petroleum.

The numerous problems of the petroleum industry have been considered at length elsewhere,† but reference may be made here to several problems of the Scottish shale oil industry. Much remains to be learned regarding the best conditions for the production of crude shale oil, in particular the form of retort and the temperature of working; 80 to 85% of the raw shale put into the retorts is sent to the waste heaps as spent shale, the utilization of which has not been the subject of sufficiently extensive research; and the refinery tars, now used as fuel, should be investigated with the object of separating commercially valuable substances. These problems are of more than mere passing interest to American chemists on account of the probable early development of certain of our large domestic oil-shale deposits.

The problems of technical phytochemistry are of considerable economic importance. Many of our plants are wasted either because of a lack of knowledge regarding their possibilities or because of a deficiency of interest in their industrial development. The processes for obtaining rubber from guayule sap are unperfected; the method employed for extracting wax from candelilla is crude; algerita and osage orange contain dyestuffs, but have received practically no attention; the commercial possibilities of mesquite seed and wax are unknown, and the same statement applies to the wax or gum from prickly pear cactus; no suitable process is known for degumming ramie fibre and making it suitable for spinning; there is no knowledge of the industrial possibilities of bear grass; the use of rice straw and cotton stalks as paper-making materials requires more study; and the castor bean, sunflower, and camphor tree are well

adapted to the coastal plain of Texas and should constitute the bases of well-established industries.

The cotton industry holds out engaging opportunities for chemical research. The following are some of the problems which confront the planter of cotton: What is the action of various fertilisers on the yield of cotton and on the quality of the fibre produced? Are there available any fertilisers which can be substituted for potash, and, if so, what conditions must be observed in their application to the soil? Can a chemical treatment be devised for destroying the Mexican boll weevil or at least rendering it harmless? And then there are the problems in preventing the production of stained cotton during seasons of excessive rain and in bleaching stained cotton a pure white.

The chemist has been of inestimable value to the wood turpentine industry. In addition to developing processes and designing suitable plants, he has standardized the products, created markets therefor, and found uses for the important by-product, pine oil. However, there are still opportunities for other chemical contributions. Fresh crude turpentine contains normally about 30% of spirits of turpentine, but under the most improved methods of collection and distillation in use at present yields of only 18 to 20% are obtained; this loss of at least one-third of the volatile oil remains to be overcome. The French method of bleaching rosin is slow and otherwise uneconomic, but the chemical methods which have been proposed are unsatisfactory; methods of distillation by the use of superheated steam or vacuum, although apparently desirable, have so far had no altering influence on methods of manufacture; and the disadvantages of wood fibre from turpentine production as a source of pulp remain to be overcome. Notwithstanding its charcoal and bark contents, this fibre is said to produce a satisfactory grade of brown wrapping paper, and there is now some activity in this utilization. The question of substitutes for wood in the manufacture of paper pulp is a pressing one, and any source of relief is gratifying. Perhaps the manufacture of tannic acid extract from palmetto roots and other sources might be made profitable by the production of paper pulp from the fibre residue.

Other problems in the organic branch of chemical industry are the production of a satisfactory butter-substitute from soya-bean oil, the cheap extraction of vitamins from rice hulls and from yeast, the recovery of the wax occurring on the outer surface of the sugar cane, and the economic production of ammonia from sources in the various stages of beet sugar manufacture.

The many opportunities that lie everywhere at hand in this entire field, and particularly in pharmaceutical chemistry, make one frankly consider why expert organic chemists should devote laborious days to preparing some substance of purely academic interest, while there is urgent need for practical working processes for the synthesis of atropine, cocaine, morphine, and quinine. One is reminded of Chesterfield's remark that:—

"Very few people are good economists of their fortune, and still fewer of their time."

when this mismanagement of laboratory resources is further evidenced by citation of the following instances of desired commercial syntheses: formaldehyde, acetic acid, amyl alcohol, tartaric and citric acids, sanguinarine, hydrastine, caffeine, and nicotine.

A favourable occasion for industrial service also exists for the physical chemists of our universities. To mention one illustration from the field of organic chemistry, but little progress has been made in the employment of light in the manufacture of such chemicals as the chlorides of carbon, although photochemistry has developed into an important theoretical branch. Light is a powerful, uncon-

* On other problems of the coal-tar industry, see Bacon, J. Ind. Eng. Chem., 7 (1915), 535.

† Bacon and Hamor's "American Petroleum Industry," 1916, 2, 798-807.

taminating catalyst for effecting certain chemical reactions, and the white flame arc has opened up many possibilities for controlling and altering oxidation and halogenation processes.

The problems listed above represent only a fraction of those which might be disclosed, but they are illustrative of the opportunities for applying scientific knowledge and investigational methods to the domain of industry. On every side the research men of our universities are needed for the execution of real attainment in the technical world, with its difficulties, wastes, and unexplored lines of manufacturing.

Yorkshire Section.

Meeting held at Leeds on Tuesday, December 5th, 1916.

PROFESSOR J. W. COBB IN THE CHAIR.

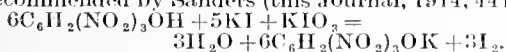
THE ESTIMATION OF FREE SULPHURIC, NITRIC, AND PICRIC ACIDS IN THE PRESENCE OF EACH OTHER.

BY F. W. RICHARDSON, F.I.C.

The estimation of sulphuric and nitric acids in the presence of each other presents no special features, and good results may be obtained by well-known methods. The entrance of the third factor, picric acid, creates difficulties. Effluents from picric acid works contain much sulphuric and but little nitric acid, with some picric acid from the wash liquors obtained in the subsequent purifying processes.

In pure solutions picric acid can be very easily estimated. The hydroxyl group gives to the acid the characteristics of quite a strong univalent acid. As the molecular weight of picric acid is 229, 1 c.c. of decinormal alkali is equivalent to 22.9 mgrms. of the acid, an undesirably large figure when the analyst is dealing with minute amounts. In a direct titration of 70 c.c. of an effluent 0.1 c.c. of *N*/10 alkali would represent 2.29 mgrms. or 2.29 grains per gallon of the acid.

I find that while phenolphthalein and methyl orange are good indicators for picric acid, methyl red is more delicate than either. I cannot agree with Minovici and Kollo (see this Journal, 1915, 789) that the use of phenolphthalein requires an excess of alkali to give the end point. Nevertheless these chemists are right in recommending methyl red (*p*-dimethylaminoazobenzene-*o*-carboxylic acid). The end-point is very sharp—the passage from bright red to orange and from orange to pure yellow requires only two drops of decinormal alkali. Iodo-iodate of potassium has been recommended by Sanders (this Journal, 1914, 441):



One molecule of the acid liberates one atom of iodine; therefore the value of 1 c.c. of the thio-sulphate is exactly that of 1 c.c. of decinormal alkali. Leo Schwarz finds that complete reaction only occurs when the solution has been heated for some time in a closed vessel at 100° C.

I have found that 0.5 gm. of picric acid in 100 c.c. of aqueous solution at 15° C. required 13.5 c.c. of *N*/10 thiosulphate, equivalent to only 0.309 gm. or 61.8% of the picric acid taken, and

that the heating process described by Schwarz was necessary. For several reasons the use of iodo-iodate is not to be recommended. The delicacy is no greater than that of methyl red. Heat is required and iodine is volatile. During the heating process free iodine acts upon organic matters present in effluents and introduces a loss, minimising the true proportion of picric acid.

I have tried to utilise the well-known properties of such liquids as benzol and ether for dissolving picric acid, but the results have not been encouraging. Benzol is troublesome on account of the readiness with which it forms emulsions. Ether dissolves so much water that repeated washings with water are necessary, and the peculiar manner in which picric acid passes from ether to aqueous liquid, and *vice versa*, is most disturbing. Moreover, most stream and river waters polluted with picric acid works' effluents contain only very small amounts of the acid itself, say from 1 to 3 grains per gallon. I have therefore abandoned solvent processes and have resorted to colorimetry. Picric acid solutions have the great advantage of being pure yellow, and are easily comparable with the yellow units of Lovibond's tintometer.

One hundred parts of cold water dissolve about 0.6 part of picric acid; this represents about 420 grains of the acid in a gallon of water. A solution containing only 2 parts of the acid in a million parts of water, or $\frac{1}{500}$ grain of the acid in a gallon, can be readily matched as to its yellow colour in a one-inch cell. By using much longer cells quantities as little as $\frac{1}{2500}$ grain of picric acid in a gallon can be matched, and therefore estimated.

It is not very troublesome to work out charts giving the values of thicknesses of picric acid solutions varying from $\frac{1}{8}$ of an inch to 24 inches. In the case of the longer cells I use the special arrangement devised by Mr. Lovibond. To avoid complications I use a glass cell which happens to give 23/25ths of an inch thickness of liquid.

I do not recommend a greater range of units than from 0.5 to 6.0. By dilution or concentration it is very easy to bring the colour depth within these limits. One very necessary caution must be made; the colour depth of picric acid solutions increases very considerably with rising temperature. The following chart shows the increase in colour depths from 0° C. to 60° C., the units increasing from 3.7 to 6.1. From 10° C. to 20° C. the colour increases from 4.05 to 4.5 units.

TABLE A.

Increase of colour-depth on heating a dilute solution of picric acid, using Lovibond's tintometer.

° C.	Yellow units.	° C.	Yellow units.
0	3.7	25	4.7
5	3.85	30	4.9
10	4.05	50	5.7
15	4.30	60	6.1
20	4.50		

I have used 15° C. as the most convenient or the least inconvenient temperature. In the summer months, particularly in July and August, a scale of unit-values for 20° C., or even 25° C., should be used. This scale can be made in a few minutes.

The following table (B) gives the colour-depths of picric acid solutions in a glass cell of $\frac{3}{8}$ inch internal diameter. By a direct reading, obtained in a few moments, the amount of picric acid can be estimated when varying from 1.25 to 60 parts per million or 0.0875 to 4.2 grains per gallon.

TABLE B.

Colour values of dilute solutions of picric acid in a $\frac{3}{16}$ -inch glass cell. (Lovibond's units).

Yellow units.	Grain of picric acid per gall.	Yellow units.	Grain of picric acid per gall.	Yellow units.	Grains of picric acid per gall.
0.3	0.0875	2.1	0.90	3.5	1.61
0.6	0.1750	2.2	0.92	3.6	1.68
0.8	0.2800	2.3	0.95	3.7	1.82
1.0	0.35	2.4	0.98	3.8	1.84
1.1	0.39	2.5	1.05	3.9	1.86
1.2	0.42	2.6	1.09	4.0	1.89
1.3	0.49	2.7	1.12	4.1	2.03
1.4	0.53	2.8	1.19	4.2	2.10
1.5	0.56	2.9	1.33	4.3	2.16
1.6	0.59	3.0	1.37	4.4	2.24
1.7	0.63	3.1	1.40	4.5	2.31
1.8	0.67	3.2	1.43	4.6	2.38
1.9	0.70	3.3	1.47	4.7	2.45
2.0	0.875	3.4	1.54	4.8	2.52

I find that this chart is sufficient for most stream, river, or canal waters containing picric acid effluents. By concentration or dilution to fixed volumes any picric acid solution can readily be brought within this range.

I estimate the nitric acid by phenoldisulphonic acid in the well-known manner with certain modifications, using the table given by Hollings and myself (see this Journal, 1903, 616—617). I have worked out a table giving the values of the colour depths in a one inch (really $\frac{13}{14}$ inch) Lovibond cell from 0.1 unit to 6.2 units of yellow, representing a range of 0.002 to 0.139% of nitric nitrogen in the diluted yellow solution (Table C).

TABLE C.

Estimation of nitrogen as nitrates by phenoldisulphonic acid. Value of yellow units (Lovibond) in a $\frac{1}{16}$ -inch cell.

Yellow units.	Mgrms. N in 100 c.c.	Yellow units.	Mgrms. N in 100 c.c.	Yellow units.	Mgrms. N in 100 c.c.
0.1	0.002	2.2	0.050	4.3	0.095
0.2	0.004	2.3	0.053	4.4	0.098
0.3	0.005	2.4	0.055	4.5	0.100
0.4	0.007	2.5	0.057	4.6	0.103
0.5	0.010	2.6	0.059	4.7	0.105
0.6	0.011	2.7	0.062	4.8	0.108
0.7	0.014	2.8	0.064	4.9	0.109
0.8	0.015	2.9	0.066	5.0	0.111
0.9	0.017	3.0	0.069	5.1	0.113
1.0	0.020	3.1	0.070	5.2	0.115
1.1	0.023	3.2	0.072	5.3	0.118
1.2	0.025	3.3	0.074	5.4	0.120
1.3	0.027	3.4	0.077	5.5	0.122
1.4	0.030	3.5	0.080	5.6	0.123
1.5	0.032	3.6	0.082	5.7	0.125
1.6	0.034	3.7	0.0832	5.8	0.128
1.7	0.037	3.8	0.086	5.9	0.130
1.8	0.039	3.9	0.087	6.0	0.132
1.9	0.042	4.0	0.090	6.1	0.135
2.0	0.045	4.1	0.092	6.2	0.139
2.1	0.048	4.2	0.093		

An actual example of working may be of value. Known amounts of the three acids were used in such dilution as fairly to represent a canal or river water containing effluents from picric acid works.

(1) 70 c.c. of the solution when tinged with methyl red required 6.9 c.c. of $N/10$ sodium hydroxide for neutralisation.

(2) 10 c.c. of the solution after mixing with 5 c.c. of $N/10$ sodium hydroxide was evaporated to dryness on the water-bath. The residue was well mixed with 1 c.c. of phenoldisulphonic acid mixture, and after warming gently for about 5 minutes the acid liquid was diluted with about 50 c.c. of water, transferred to a 100 c.c. flask, made alkaline with ammonia, cooled to 15°C.,

and diluted to 100 c.c. In the $\frac{3}{16}$ inch glass cell the colour depth was found to be exactly 2.3 yellow units (Table C).

(3) The original solution of the three acids gave a colour in the $\frac{3}{16}$ inch glass cell equal to 0.8 yellow unit. Reference to the table shows that this is equivalent to 0.28 grain of picric acid per gallon.

The calculation is now simple: 70 c.c. contains 0.28 mgrm. of picric acid, equivalent to 0.0121 c.c. of $N/10$ NaOH. The nitric nitrogen found was equal to 0.0533 mgrm. in 100 c.c. or 0.0371 mgrm. in 70 c.c., equal to 0.167 mgrm. of nitric acid, representing 10 times (on account of the tenfold dilution) the amount, or 1.67 mgrms. of nitric acid in 70 c.c. of the original liquid.

1.67 mgrm. of nitric acid is equal to 0.2650 c.c. of $N/10$ NaOH. 0.28 mgrm. of picric acid is equal to 0.0121 c.c. of $N/10$ NaOH.

Therefore the combined nitric and picric acids represent in 70 c.c. 0.2771 c.c. of $N/10$ NaOH.

The total acidity of 70 c.c. equalled 6.9 c.c. of $N/10$ sodium hydroxide, hence the acidity due to sulphuric acid is 6.6229 c.c., or 32.48 grains of H_2SO_4 per gallon.

Grains per gallon.	Present.	Found.	Error.
Sulphuric acid	32.60	32.48	— 0.12
Nitric acid	1.76	1.67	— 0.09
Picric acid	0.28	0.28	nil.

I give the following example to show the necessity of deducting the requisite number of yellow units from the cell reading obtained in the estimation of the nitric acid.

4.4 units were required to match the yellow colour. 0.7 unit was found to match the yellow colour of the liquid itself when a similar tenfold dilution was made.

3.7 yellow units were therefore required for the colour developed by the nitric nitrogen alone.

Grains per gallon.	Present.	Found.	Error.
Sulphuric acid	15.0	14.2	— 0.8
Nitric acid	2.5	2.63	+ 0.13
Picric acid	2.5	2.52	+ 0.02

Only 70 c.c. of the liquid was used for the total acidity and an error of only 0.16 c.c. of the $N/10$ alkali was required to account for the error of — 0.8 grain of sulphuric acid per gallon.

The intensity of the colour given by picric acid to water is evident from the fact that when pure water contains as little as the $\frac{1}{325}$ th grain per pint of picric acid it will require 2 units of yellow to match the colour in a $\frac{1}{16}$ -inch Lovibond's cell. This represents about $\frac{1}{32}$ grain of picric acid per gallon.

My attention was naturally directed to other methods of estimating nitric nitrogen in the mixtures. Unfortunately the Halle zinc-iron and caustic soda method results in the decomposition of some 37% of the picric acid, and cannot be used. Moreover, any nitric nitrogen reduction process, zinc copper couple for example, applied to extremely small amounts of substance requires final Nesslerisation of the small amount of ammonia, and no advantage over the phenoldisulphonic acid method can reasonably be expected.

"Nitron" is now unobtainable, moreover it was quoted at about 10s. an ounce before the war. As a 10% solution of the acetate is used in liberal amounts the process is costly. Also nitron pre-

precipitation is only applicable to appreciable weights of nitric acid and nitrates. As the total amount of nitric acid in the samples frequently supplied to analysts does not exceed a few centigrams, a gravimetric process is scarcely advisable.

The action of dilute solutions of sulphuric, nitric, and picric acids upon iron.

Waters containing picric acid effluents often come in contact with iron machinery and iron boilers. It has been suggested that even small amounts of nitric acid in the presence of larger proportions of sulphuric acid might produce corrosive effects far greater than the mere acidity might indicate.

Very dilute solutions of sulphuric acid as compared with solutions containing the same molecular equivalents of nitric acid act even more readily upon chemically clean wrought iron surfaces. Strips of wrought iron 3 in. by 1 in. were immersed for three days at 10°–20° C. in 500 c.c. of acid solutions. The following figures show the proportions of iron dissolved:—

Acid.	Iron dissolved.
N/250 sulphuric acid	82
N/250 nitric acid	49
Equal parts of N/250 sulphuric and nitric acids	53

With solutions of ten times these acid strengths the amounts dissolved were 529, 512, and 500 respectively, or in the ratios 105·8 : 102·4 : 100·0.

The dilute nitric acid forms a brown-red coating upon the iron sheet and this, in the case of very dilute solutions, may well prove slightly protective.

When the diluted acids alone and mixed are boiled down upon sheet iron, a copious brown-red coating appears only in the case of the solutions containing nitric acid.

Addition of water with re-evaporation caused a much greater action upon the iron in the case of the nitric acid solutions. The percentages of action in this case were sulphuric acid, 100; nitric acid, 127; mixed acids, 116.

It was evident that hydrolytic action was caused by the evaporation process in the case of the nitrate of iron:

$\text{Fe}_2(\text{NO}_3)_6 + 6\text{H}_2\text{O} = \text{Fe}_2(\text{OH})_6 + 6\text{HNO}_3$.

The nitric acid set free again acts upon the iron. Nitric acid solutions when concentrated in boilers will therefore produce extensive corrosive action.

Picric acid of N/250 strength (0·0916% equal to 64·12 grains per gallon) readily acts upon iron. My experiments show that as compared with sulphuric acid the amounts of iron dissolved are roughly proportional to the molecular equivalents, 49 parts of sulphuric acid producing the same result as 229 parts of picric acid.

DISCUSSION.

The CHAIRMAN said that for measuring the action of the effluents upon iron more details of the method used were desirable. The action was made more complicated and comparison more difficult by factors not noticed at first sight, which provided a wide sphere for discussion. He was not surprised that tintometry gave the best results in estimating very small quantities of picric acid but asked whether the process was possible in artificial light, and if so what precautions were necessary?

Mr. LOWSON suggested that the method used for the determination of nitric acid would include also any nitrates present, and that if the latter were in appreciable amount, errors would be introduced.

Mr. F. HULSE said that he had obtained constant

results by making alkaline with caustic soda, evaporating down, and testing in the nitrometer. He quite agreed with Mr. Richardson with regard to the benzol extraction process.

Mr. F. W. BRANSON said that in his experience the best artificial light was supplied by the new electric lamp known as the "Pointolite."

Mr. W. McD. MACKEY said that he had used the colorimetric process and found that by making the solution alkaline with caustic soda the colour was deepened. With regard to the action of acids upon iron it had been found that steel was more readily attacked than wrought iron.

Mr. MILLER agreed with Mr. Mackey with regard to the deepening of the colour by making alkaline with caustic soda. Tatlock had found (see this J., 1904, 429) that in the presence of chlorides the phenolsulphonic acid method gave low results for nitrates. In his experience methyl red gave a very sharp end point.

The CHAIRMAN shared the high opinion of methyl red as an indicator, but said that the use of any indicator involved certain assumptions which Professor James Walker had shown how to avoid in studying the action of liquids on metals.

Mr. H. J. HODSMAN asked if Mr. Richardson had observed that the presence of picric acid accentuated the corrosive action of acid effluents. If corrosion were electrolytic in character, it might be facilitated by the depolarising action of a compound so highly nitrated as picric acid. In support he mentioned the rapid oxidation of hydrogen by sodium picrate in presence of colloidal palladium—a reaction which had been used in gas analysis for the estimation of hydrogen.

Mr. B. A. BURRELL mentioned that during the past summer he had inspected some agricultural property the vegetation on which had been badly damaged by the fumes arising from a recently erected picric acid works.

The CHAIRMAN said that some experiments with regard to the action of acids on lead had been carried out some years ago by Lunge and a collaborator.

Mr. BEDFORD asked if the West Riding Rivers Board was taking any action with regard to the pollution of streams with these effluents.

Mr. RICHARDSON replied that with regard to the action of acids on iron, sulphuric acid gave a clean surface while nitric acid gave a rusty appearance, and for a time the coating of oxide was slightly protective. Daylight was decidedly the best light to use but fairly accurate results had been obtained with the "Dufton Gardner Lamp." If the effluent were treated with soda ash it did not cause any undesirable action on boilers. When nitrates were present the sulphuric acid liberated the nitric acid; the nitrogen might therefore be regarded as being present as free nitric acid. No appreciable amount of nitrates need be expected in either the picric effluents or in river and canal water. With the nitrometer accurate results might be obtained with large quantities, but for small quantities it was useless. He had found that caustic soda did not deepen the colour. In his experience, also, the presence of large quantities of chlorides interfered with the results; in such a case the chlorides must be removed, but in ordinary river and canal waters one did not find an excess of chloride.

He had not made any experiments with regard to the combined action of picric, sulphuric, and nitric acids on lead.

The use of lime for neutralising the effluents was objectionable because it made the water unfit for boiler purposes. He had reason to believe that the authorities were fully alive as to pollution by picric effluent.

Communication.

A PRELIMINARY INVESTIGATION ON THE ESTIMATION OF FREE AND COMBINED SULPHUR IN VULCANISED RUBBER, AND THE RATE OF COMBINATION OF SULPHUR WITH DIFFERENT TYPES OF PLANTATION PARA RUBBER.

BY B. J. EATON AND E. W. F. DAY.

The many methods of estimation of sulphur by oxidation which involve the use of nitric acid, bromine, and alkaline fusion were tried and found unsatisfactory (*cf.* a paper by H. E. Potts in "The Rubber Industry," 1911).

Rheinhardt's proposed method of burning the rubber in a current of oxygen and absorbing the resultant gases in brominated hydrochloric acid, fails to arrest *all* the sulphur compounds liberated. Gaunt (*Analyst*, 1915, 40, 9; *this Journal*, 1915, 146) suggests hydrogen peroxide as the absorbent and uses a short glass tube in place of the usual combustion "boat." He then titrates the sulphuric acid produced or weighs as barium sulphate.

Our experiments showed that the acidity could only be relied on when the combustion was complete. In practice, perfect combustion is difficult of attainment and this modification was abandoned. It was even found that, without the use of platinumised asbestos, hydrogen peroxide allowed some escape of compounds containing sulphur, as also did strong solutions of barium peroxide in hydrochloric acid. Strong caustic soda, however, stopped *all* sulphur compounds without the use of platinumised asbestos in the combustion tube, and on subsequent acidification with brominated hydrochloric acid the whole of the sulphur was recovered as barium sulphate. The type of combustion, *i.e.*, whether "complete" or slightly smoky, has little effect on the results. Full working details of the new method are as follows:—

The vulcanised rubbers are crumbed between small crepeing rollers and representative portions are selected for analysis. These in turn are carefully picked over under a lens for "skin," insufficiently crumbed particles, etc., and are finely snipped with scissors. 0.1374 gm. of each sample is wrapped up in little filter paper packets marked in pencil for identification later. These are stacked together in bundles of six or eight and extracted in a Clayton Beadle and Stevens' Soxhlet apparatus (*Analyst*, April, 1913) with boiling acetone. The extraction is carried on for about 100 hours and at suitable intervals the packets are opened, teased out with a finely pointed glass rod and forceps, and repacked. They are stacked again into bundles and subjected to further extraction. In the present work each sample was teased out in this way three times. On completing the extraction, the determination of sulphur should be carried out as soon as possible. It is found in practice that a more easily controlled combustion is obtained with the freshly extracted rubber than in the case of extracted samples that have been preserved for, say, a month. Furthermore, such samples ignite more easily and so dry distillation before ignition is reduced to a minimum.

The paper packet is pushed into a glass tube 3 cm. long \times 1 cm. diameter, sealed at one end, and the whole placed in the combustion tube with

the open end forward, and about 8 cm. from the forward end. The combustion tube is of hard glass and about 20 cm. long and 2 cm. in diameter. At the forward end it is drawn out and bent downwards to take a short piece of rubber tubing which connects it to the absorption apparatus.

This latter consists of two 15 cm. \times 1.5 cm. test tubes, the first containing 1.5 c.c. and the second 0.2 c.c. of 7N aqueous sodium hydroxide. This strength is used as being the strongest that one can employ without fear of the leading tube jets being blocked by the carbonate formed during absorption.

As a safeguard against the necessity of having to rush through a quick current of oxygen, if the combustion becomes a little violent, it is advisable to attach a couple of small U-tubes filled with glass beads and moistened with a little 2N caustic soda to the absorption tubes.

Our practice here, as already pointed out, is to extract the samples in groups of six or eight, and to control the results by estimating the soluble sulphur dissolved out of the group by the acetone. It is convenient, therefore, for us to deal with the sulphur compounds absorbed by the U-tubes after the combustion of all the members of each group. Thus the barium sulphate so obtained is determined separately for each group. A group of six or eight members usually returns 0.5 to 2 mgrms. which is distributed evenly among the members of the group (see Table IV. under group correction).

To effect the combustion, which occupies ten to fifteen minutes, dry oxygen is passed slowly through the apparatus and a strong roaring flame is applied about 2 cm. in front of the mouth of the small tube. This is maintained until the paper packet begins to darken. To minimise the chance of a minor explosion spoiling the estimation, a strong current is now passed along the tube (up to 400 c.c. per minute) until ignition occurs. The current is then much reduced, and regulated so as to secure a small bright flame with as little smoke as possible.

When nothing but a whitish ash remains in the smaller tube, the test tubes and leading tubes are washed into a 200 c.c. beaker to which later are added the washings of the combustion apparatus obtained as follows:—The large combustion tube is rinsed out with very dilute brominated hydrochloric acid and the small combustion tube is boiled in this mixture until all bromine is driven off. The liquid is then cooled and washed into the 200 c.c. beaker. The total bulk is now made up to 100 c.c. or over and 6 c.c. of brominated hydrochloric acid (pure acid 10 parts, water 10 parts, and bromine 1 part) added from a burette. The liquids are gently mixed with a glass rod, covered with a watch glass, and allowed to stand. After evaporating off the excess of bromine, filtering, and making up to 50 c.c., the sulphate in solution is precipitated by adding 2 c.c. of a 10% barium chloride solution. The filter paper and precipitates are burnt together in a muffle; there is no risk of reducing the sulphate to sulphide. All the filtrates from the first fifty-nine estimations in Table IV. were collected and mixed, and the recovered barium sulphate appears as a percentage of sulphur distributed among the samples in Table IV., column 6.

Each 0.01 gm. of barium sulphate represents 1% of sulphur in the rubber. The following figures (Table I) illustrate the constancy and accuracy of this combustion method.

An unvulcanised mixing (Slab rubber No. 221 S. 3, A), containing 90% of rubber and 10% of sulphur, was analysed, the samples being taken from different parts of the mixing.

TABLE I.

No.	Total sulphur on the mixing.
	%
1	9.81
2	9.82
3	9.76
4	9.85
5	9.79
6	9.81
Mean	9.81

After vulcanising this mixing for 3 hours, which yielded a much overcured rubber, containing consequently a high percentage of combined sulphur, the same mixing yielded the results given in Table II.

TABLE II.

No.	Total sulphur on the mixing.
	%
1	9.80
2	9.93
3	9.89
4	9.91
5	9.98
6	9.81
Mean	9.89

Combined sulphur (sulphur of vulcanisation).

On extracting with acetone, the "free" sulphur is removed and the residue contains the "combined" sulphur.

As illustrating the constancy and accuracy of the acetone extraction process employed, followed by the combustion of the residual rubber as already described, the following duplicate figures serve. The results in Table III. below were obtained on the same sample (No. 221 S. 3, A) vulcanised for different periods.

Determination of sulphur in vulcanised rubber prepared from different types of plantation Para rubber.

In order to trace the combination of sulphur with samples of plantation Para rubber having different rates of cure, as indicated by the physical properties of the vulcanised material, a complete set of results arranged in three tables (IV., V., and VI.) was obtained in the case of samples No. 244 A, B, and C, consisting of specimens of slab (244 A), sheet (244 B), and crepe (244 C). All of these samples were prepared from similar latex and under identical conditions except as to machining.

TABLE III.

Number of hours vulcanised.	Combined sulphur per cent. on the mixing.	Type of combustion.	Combined sulphur per cent. on the mixing.	Type of combustion.
	(Original.)		(Duplicate.)	
0	0.10	—	0.15	—
$\frac{1}{2}$	1.73	Clean.	1.82	Clean.
$\frac{1}{2}$	2.44	Slow, smoky.	2.51	Combustion rapid at start.
$\frac{1}{2}$	3.06	Slow start; normal otherwise	2.93	Clean start, later very rapid.
1	4.18	Unexpected start; rapid; much smoke.	3.96	Clean, quick combustion.
$1\frac{1}{2}$	4.38	Very badly smoked.	4.38	Clean, trifle dry distilled at start.
2	6.42	Rapid start, normal later.	6.38	Rapid start; very slow later.

(NOTE.—The optimum cure of this sample was taken to be 1 hour 8 min., which corresponds to 4.22% combined sulphur.)

TABLE V.

Results of estimation of the "soluble sulphur" extracted from the various groups; and the balance between this sulphur and the residual sulphurs of Table IV.

Group No.	Grammes of BaSO ₄ (less blanks).		Total BaSO ₄ grammes.	Total sulphur in group %
	Soluble.	Combined.		
1	0.4241	0.2602	0.6843	9.78
2	0.3414	0.3478	0.6892	9.85
3	0.4153	0.2742	0.6895	9.85
4	0.5561	0.1288	0.6849	9.78
5	0.4899	0.2026	0.6925	9.89
6	0.4024	0.1816	0.5840	9.73
7	0.1077	0.4795	0.5872	9.79
8	0.1960	0.3964	0.5924	9.87
9	0.1930	0.3979	0.5909	9.85
10	0.3849	—	—	—

Method of estimation of soluble sulphur.

The acetone extract of each group was dried, treated under a reflux condenser with nitric acid and bromine mixture, evaporated to dryness with a little potassium nitrate, mixed with potassium chlorate (1 part) and fusion mixture (6 parts), ignited in a nickel dish, the aqueous extract filtered, acidified with hydrochloric acid, boiled to remove carbon dioxide, diluted to half a litre, and precipitated with 10 c.c. of 10% barium chloride.

TABLE VI.

No. of hours vulcanised.	Percentage of combined sulphur on the mixing.		
	Vulcanised slab rubber. No. 244 A.	Vulcanised sheet rubber. No. 244 B.	Vulcanised crepe rubber. No. 244 C.
0	0.29	0.26	0.30
$\frac{1}{2}$	1.29	0.51	0.43
$\frac{1}{2}$	2.22	0.78	0.77
$\frac{1}{2}$	2.91	1.15	0.97
1	3.63	1.74	1.36
$1\frac{1}{2}$	4.44	2.00	1.63
$1\frac{1}{2}$	5.06	2.32	1.84
$1\frac{1}{2}$	5.47	2.77	2.18
2	6.19	3.26	2.45
$2\frac{1}{2}$	6.96	3.54	2.78
$2\frac{1}{2}$	7.22	3.93	3.00
$2\frac{1}{2}$	7.54	4.26	3.27
3	8.03	4.68	3.75
$3\frac{1}{2}$	8.48	4.98	4.05
$3\frac{1}{2}$	8.73	5.32	4.38
$3\frac{1}{2}$	8.91	5.74	4.90
4	9.11	5.96	5.02
$4\frac{1}{2}$	9.18	6.61	5.57
5	9.54	7.32	6.10
6	9.51	8.16	7.32
7	9.56	8.71	8.20
8	9.79	9.06	8.87
9	—	9.28	9.48
10	—	—	9.63

TABLE IV.

Results of analysis of the "residual sulphur" arranged in the groups as extracted and showing the application of the two corrections.

Group No.	Ref. No.	Hours vulcanised.	Percentage of sulphur.	Additional percentage of sulphur recovered from		Final experimental figure.	Group total, Barium sulphate.
				Group.	Filtrate.		
1	244 A	21	6.91	0.02	0.03	6.96	0.2666 grm.
	244 A	14	5.42	0.02	0.03	5.47	
	244 A	14	5.38	0.01	0.02	5.39	
	244 A	2	6.16	0.01	0.02	6.19	
	244 A	1	1.26	0.01	0.02	1.29	
	244 C	1	0.40	0.01	0.02	0.43	
Mixg.	244 A	0	0.26	0.01	0.02	0.29	0.3478 grm.
	244 A	34	8.43	0.02	0.03	8.48	
	244 A	24	7.50	0.01	0.03	7.54	
	244 A	24	7.18	0.02	0.02	7.22	
	244 A	3	2.19	0.01	0.02	2.22	
	244 A	3	8.00	0.01	0.02	8.03	
2	244 B	1	0.48	0.01	0.02	0.51	0.2744 grm.
	244 B	1	0.75	0.01	0.02	0.78	
	244 B	14	2.74	—	0.03	2.77	
	244 B	2	3.22	0.01	0.03	3.26	
	244 B	24	3.51	0.01	0.02	3.54	
	244 B	24	3.90	0.01	0.02	3.93	
3	244 B	24	4.23	0.01	0.02	4.26	0.2744 grm.
	244 B	3	4.65	0.01	0.02	4.68	
	244 B	31	4.95	0.01	0.02	4.98	
	244 C	1	0.72	0.02	0.03	0.77	
	244 C	1	1.32	0.01	0.03	1.36	
	244 C	14	1.60	0.01	0.02	1.63	
4	244 C	14	1.81	0.01	0.02	1.84	0.3258 grm.
	244 C	14	2.16	0.01	0.02	2.18	
	244 C	24	2.75	0.01	0.02	2.78	
	244 B	14	2.29	0.01	0.02	2.32	
	244 B	1	1.70	0.01	0.03	1.74	
	244 B	14	1.96	0.01	0.03	2.00	
5	244 C	2	2.41	0.02	0.02	2.45	0.2026 grm.
	244 C	24	2.96	0.02	0.02	3.00	
	244 C	24	3.23	0.02	0.02	3.27	
	244 C	3	3.71	0.02	0.02	3.75	
	244 C	31	4.01	0.02	0.02	4.05	
	244 A	14	5.02	0.01	0.03	5.06	
6	244 A	14	4.40	0.01	0.03	4.44	0.1816 grm.
	244 A	1	3.59	0.02	0.02	3.63	
	244 A	2	2.88	0.01	0.02	2.91	
	244 B	1	1.12	0.01	0.02	1.15	
	244 C	1	0.94	0.01	0.02	0.97	
	244 A	6	9.46	0.02	0.03	9.51	
7	244 A	5	9.49	0.02	0.03	9.54	0.4795 grm.
	244 B	6	8.12	0.02	0.02	8.16	
	244 B	5	7.27	0.03	0.02	7.32	
	244 C	6	7.28	0.02	0.02	7.32	
	244 C	5	6.05	0.03	0.02	6.10	
	244 C	31	1.86	0.01	0.03	1.90	
8	244 C	4	4.97	0.02	0.03	5.02	0.3964 grm.
	244 B	31	5.70	0.02	0.02	5.74	
	244 B	4	5.92	0.02	0.02	5.96	
	244 A	31	8.87	0.02	0.02	8.91	
	244 A	4	9.07	0.02	0.02	9.11	
	244 A	14	9.13	0.02	0.03	9.18	
9	244 B	14	6.55	0.03	0.03	6.61	0.3979 grm.
	244 C	14	5.53	0.02	0.02	5.57	
	244 A	31	8.69	0.02	0.02	8.73	
	244 B	31	5.28	0.02	0.02	5.32	
	244 C	31	4.33	0.03	0.02	4.38	
	244 A	7	9.52	0.01	0.03	9.56	
10	244 A	8	9.79	0.01	0.02	9.82	0.3849 grm.
	244 C	9	9.45	0.01	0.02	9.48	
	244 C	10	9.60	0.01	0.02	9.63	

Table V. shows the amount of "soluble sulphur" weighed as barium sulphate obtained from each group. As will be seen, the estimation of the soluble sulphur in this manner acts as a check on the operations, and the figures in the last column show that practically all the sulphur is accounted for.

In Table VI. the results are rearranged for each of the specimens 244 A, B, and C, in order to show the combination of sulphur with progressive periods of heating.

It will be seen from Table VI. and Diagram I. that the figures give smooth curves up to seven hours for the slab (244 A), and ten hours for the sheet (244 B) and crepe (244 C).

Physical properties of the vulcanised rubbers.

In order to compare the rate of combination of the sulphur in the case of each type of rubber, with

the tensile properties of the vulcanised material, we include the following diagram (Diagram II.) of the load-stretch curves for the different periods of cure at 1 hour intervals, in which the progressive state of cure of the samples as judged by their tensile properties can be seen at a glance. The curve marked X in each case is the curve of optimum time of cure as estimated by our standard curve method (*vide* this Journal, 1916, 35, 715—728. "Vulcanisation experiments on plantation Para rubber. II. The cause of variability and some contributory factors," by B. J. Eaton and J. Grantham) but, as we have stated elsewhere, the standard curve obtained at this "optimum cure" may not be strictly correct, although it constitutes a good basis of comparison between different rubbers, since it is relative rather than absolute. It represents, however, a similar state of cure in each sample.

Young (*loc. cit.*) and other experimenters have found.

The small deficiencies from 10% are attributed to small losses during the mechanical processes in mixing, which up to the present have not been traced, to slight increases in weight such as are sometimes observed after mixing, and to the addition of French chalk to the surface of the mixings. It is possible also that some sulphur remains combined in the insoluble ash obtained on combustion. Some slight loss is unavoidable also in the process of teasing out the residues during the acetone extraction.

We are thus able to balance the free sulphur and the combined sulphur against the total sulphur and against the original sulphur put into the mixing, as is shown in Table V. (Note:—The combustion method here described, would, of course, be inadmissible for estimating sulphur in vulcanised mineral mixings.)

Industrial Notes.

NATIONAL SULPHURIC ACID ASSOCIATION.

IS a circular letter addressed to about fifty of the principal sulphuric acid manufacturers in this country by the managing director of a firm of acid makers, the writer says that for a long time he has been anxious that the makers should meet together with the object of finding ways and means to prevent the absolute chaos which must inevitably arise in the sulphuric-acid trade upon the conclusion of peace if manufacturers are not more closely associated.

Continuing, the writer says:—

"Before the war is over—and in the opinion of many this desirable end is still far distant—the daily tonnage of sulphuric acid consumed in the manufacture of explosives in this country will have attained a stupendous figure. The further we are from the cessation of hostilities, the greater will be the paralysis in the sulphuric-acid trade when that time does arrive, so that it behoves us to make every provision with the best possible equipment in our power to enable us to face the situation which will then obtain.

"At that time no maker will know at what price to sell his product, owing to the impossibility of accurately forecasting the cost of production.

"The advantages of co-operation at such a critical time are self-evident, and this one reason alone convinces me of the desirability of the makers extending forthwith a serious effort to consider means of overcoming the difficulties which have been the cause of lack of co-operation in the past. The idea I have in mind is that every maker shall exercise his strongest endeavours towards the formation, in his district, of an association, of which he would be a member, similar to that now existing in the Midland district, in which all interested in the sulphuric-acid trade, dealers as well as makers, are pledged to co-operation.

"In South Wales, also, there has been in existence for very many years past an excellent association, but there are one or two important makers in that district who are not members, and these abstentions from membership must of necessity greatly impair the usefulness of any association.

"Surely every local association should represent every local maker, and the appointed representatives of all the local associations throughout the country should constitute a national association. It should be the function of these local associations to prevent fruitless competition.

"I desire that the sulphuric-acid trade shall be closely united for the reason that in the future any trade without co-operation is bound to be at a great disadvantage to a similar trade closely associated in other countries.

"It seems to me that if at the termination of the war the whole sulphuric-acid trade were so united as to be in a position to speak with a single voice, then a trade of such vital national importance as sulphuric acid should be able to influence legislation necessary to its interests and the national welfare.

"Legislation could materially assist our trade with specially low freights upon the imported sulphur material, reduce railway rates in this country for carrying the necessary raw material and finished product, and, if need be, grant bounties for the treatment of special classes of sulphur material.

"Again, surely it is not in the national any more than in the individual interest for manufacturers in the same trade to be bidding against each other for pyrites and other sulphur material imported from foreign countries, such as Norway and Spain? Would it not be preferable if the trade made its purchases through one organisation, thereby eliminating competitive bidding and obtaining the advantage which is always obtained by a large over a small buyer?

"As mutual confidence became engendered through co-operation, such further economies would gradually follow as were in the national interest. For example, costs of production would be reduced all round by inter-comparison derived from more economic administration, distribution, and manufacture, thereby benefiting the consumer by reducing the selling price without impairing the profit-earning capacity of the vast capital invested in the sulphuric-acid trade.

"Where industries are so organised I can conceive even a British Government consenting to legislation whereby the entirely wasteful introduction of capital by superfluous and speculative parties without experience in the trade would be prohibited until the merits of the proposition had been examined by a committee of expert manufacturers in conjunction with expert Government representatives.

"In my opinion, this country will be placed for many years after peace is declared at such a disadvantage as compared to neutrals, such as America, through the loss of lives and treasure in the war, that I believe it will be found in the national interest to prevent men inexperienced in any trade from exploiting their own or public money in competition with existing interests. It must either mean a waste of that capital or reduction in the capital value of existing interests. In either case this seems to be a waste of the nation's resources. It is the duty of the nation's future leaders to do all in their power to prevent the individual even as much as the public from rashly investing his capital.

"Surely hereafter it is for the Government to take such control of the community's wealth as will prevent it being invested without a reasonable prospect of good interest."

The letter concludes with a request for information in regard to the existence of local sulphuric acid associations in the various districts, asking if manufacturers will take steps to create local associations in districts where such do not exist at present.

ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS.

THIS Association was registered on December 28th as a company limited by guarantee, and not having a capital divided into shares, with an unlimited

number of members, each liable for not more than £25 in the event of winding up, to promote co-operation between British subjects engaged as manufacturers in the chemical or closely allied industries; to place before Government and Government officials and others, either in the British Dominions or elsewhere, the views of members of the Association and others upon matters affecting the chemical industries; to develop technical organisation; to promote industrial research, industrial efficiency and the advancement of applied industry, etc. (see this Journal, 1916, 561, 1040).

The management is vested in a Council, consisting of not less than 16 or more than 20, the first members of which are:—

Dr. E. F. Armstrong (Joseph Crosfield and Sons, Warrington).

F. H. Carr (Boots Pure Drug Co., Ltd., Nottingham).

Dr. C. Carpenter (South Metropolitan Gas Co., London).

Dr. M. O. Foster, F.R.S. (British Dyes, Ltd., Huddersfield).

J. Gray (Lever Bros., Ltd., Port Sunlight).

C. A. Hill (British Drug Houses, Ltd., London).

N. N. Holden (Hardman and Holden, Ltd., Manchester).

D. L. Howard (Howards and Sons, Ltd., Ilford).

C. P. Merriam (British Xylonite Co., Ltd., Hale End).

The Right Hon. Sir Alfred M. Mond, Bt., P.C., M.P. (Almond Nickel Co., Ltd., London).

Max Muspratt (United Alkali Co., Ltd., Liverpool).

R. G. Perry (Chance and Hunt, Ltd., Oldbury).

Sir William Pearce, M.P. (Spencer Chapman and Messel, Ltd., London).

R. D. Pullar (J. Pullar and Sons, Ltd., Perth).

A. T. Smith (Castner-Kellner Alkali Co., Ltd., Liverpool).

The Right Hon. J. W. Wilson (Albright and Wilson, Ltd., Oldbury).

Dr. A. Ree (President Society of Dyers and Colourists).

There are to be "Group" Committees, each consisting of not less than three members, representing: Group 1. Acids (including acetic and oxalic), carbonic acid, hydrogen, oxygen and gases, alum, chrome, zinc, copper, and iron compounds, fertilisers (including superphosphates). Group 2. Alkalis, cyanides, chlorine and compounds, silicates, chlorates, borax, hydrogen peroxide, magnesia compounds (not medicinal). Group 3. Fats, greases, waxes, resins, glycerin, soap. Group 4. Gelatin, sizes, glue, varnishes, paints, polishes, tanning. Group 5. Distillation of coal, shale, oils, and wood, alcohol, acetone, coal-tar primary products (including ammonia and ammonia products), charcoal, fuel. Group 6. Fine chemicals, analytical, pharmaceutical, photographic, rare earths, synthetic essences, and perfumes, alcohol derivatives, ethers. Group 7. Phosphates, manganese, potassium, sodium, barium, calcium, cadmium, etc., lead, arsenic, antimony, tungsten, molybdenum, etc. Group 8. Cellulose products (including paper), celluloid, rubber and substitutes. Group 9. Explosives, and dyes and their intermediaries. Group 10. Glass, porcelain, pottery, refractory materials, lime, cement, chemical-resisting materials. Group 11 (allied industries). Bleachers, dyers, and textile printers.

TRADE DURING AND AFTER THE WAR.

In the Third Report of the Special Committee of the London Chamber of Commerce on "Trade During and After the War," as adopted at a special meeting of the Council on December 20th, the Committee affirm their conviction that the

practical application of measures for the extension of trade and industry after the war will be mainly a matter for private enterprise, for individual and collective efforts, voluntarily undertaken, supplemented and not superseded by Government action.

Among the State-aided efforts recommended are:

The early adoption of a tentative and *ad valorem* tariff.

A Ministry of Commerce and Industry, for the promotion of business interests.

The improvement of the commercial side of the Consular Service.

Restriction of the operations of enemy traders within the Empire.

State aid in improving the means of transport on land and water, and penalising enemy shipping.

The co-operation of the State in the promotion of trade banks to furnish financial accommodation of a special kind to traders doing business abroad.

Employers and employed.

The Committee deal at length with the question of future relations between employers and employed, and make the following recommendations as a basis for negotiation between capital and labour.

(a) As regards the remuneration of employees the principle of payment by results should as far as possible be adopted by employers and employed.

(b) The basis of rates of payment for labour should involve such a scale as will ensure for all willing and efficient workers a fair and reasonable standard of living.

(c) The Government should afford opportunities for considering the amendment of the Trade Disputes Acts and of any provisions of the Factory and Workshops Acts other than those relating to the health of the workers.

(d) Encouragement should be given, as far as possible, to profit-sharing and co-partnership agreements, or premium and bonus systems on lines which have proved beneficial to employers and employed in the past, subject to the special conditions of particular trades, and to the maintenance of the standard of wages.

Industry after the war.

The Committee also make the following suggestions with regard to the development of industry after the war:

The utilisation, for the purposes of private enterprise after the war, of factories now engaged in the production of munitions, in connection with industries for which they may be suitable.

The encouragement of the technical education of younger employees by giving them greater facilities for attending the necessary classes beyond the statutory school age.

The amendment of the Patents, Designs and Trade Marks Acts so far as they may be restrictive of the adoption of new processes, labour-saving appliances, and new inventions.

The improvement and cheapening of means of transport by rail, road, and waterways including canals.

Increased facilities for obtaining information through Government Departments regarding competition in the markets of the world and new openings for the sale of British goods.

Such further direct representation of manufacturers individually and collectively in the Dominions, Allied, and neutral countries as may be in harmony with the legitimate interests of the merchant.

A more sympathetic attitude on the part of the Government in regard to the promotion and amendment of legislative measures affecting British industry, especially in relation to conditions of labour.

A preference on the part of Government Departments and Local Authorities for goods produced within the British Empire when needed for the requirements of the State.

Other sections of the Report deal with commercial and industrial policy, the treatment of enemy shipping, and finance and insurance.

GOVERNMENT LABORATORY : REPORT OF THE GOVERNMENT CHEMIST ON THE WORK OF THE — FOR THE YEAR ENDED 31st MARCH, 1916. (Cd. 8391.)

THE number of samples examined during the year was 239,706, as compared with 230,101 during the previous year, exclusive of those dealt with at the chemical stations; 8901 samples of food were examined in connection with the supply of the Expeditionary Forces.

Beer, brewing materials, cider, and perry. 350 samples of finished beer were examined for saccharin, saponin, and other prohibited ingredients, but except occasional traces of arsenic, nothing of a deleterious or illegal character was observed. 11,198 samples of unfinished worts and beers were examined. The original gravity had been under-declared in 2931 cases, the percentage of under-declarations having been 33.3%, compared with 12.6% in 1911-15. Twelve samples imported as "malt extract" were found to correspond with beer and were charged duty accordingly. Of 1797 samples of beer and brewing materials examined for arsenic, only six were found to contain arsenic in excess of the Royal Commission limits. The highest proportion of arsenic found in beer or wort was 1/26 grain per gallon. Three samples, out of 123 of imported cider examined, were found to be factitious and assessed for duty on their spirit content. One sample of commercial cider was found to contain 1.6% proof spirit, and six samples purchased as cider were prepared liquors containing no apple juice.

Spirits. Eighteen samples of fusel oil from distilleries in this country were examined, and one was found to contain more than 15% of proof spirit. Of ten samples of imported fusel oil, none contained more than this limit. Evidence of the extraction of spirit from the wood of spirit casks ("grogging") was obtained in several cases, and proof that spirit had been obtained by illicit distillation was furnished in three cases. No evidence of the illicit use of methylated spirit was obtained in the 3081 liniments, hair washes, etc., tested, but in a number of cases the declared spirit strength of spirituous preparations for export was over-stated. In 59 cases importations entered as "wood naphtha" or "crude methyl alcohol" were found to consist of methyl alcohol so purified as to be liable to spirit duty. For use in preparing methylated spirit, 1353 samples of wood naphtha and of mineral naphtha were approved, and 21 samples of petroleum ether, used in admixture with methylated spirit in the manufacture of felt hats, were also approved. A considerable increase in the use of all these denaturants is noted. For the purpose of controlling the use of methylated spirit in connection with manufacturing operations, 268 samples of still residues, articles manufactured with industrial spirit, and preparations containing such spirit were examined, and in connection with the use of duty-free alcohol 28 samples of spirit and 83 samples of specially denatured alcohol and denaturing substances were submitted and approved.

Sugar and saccharin. 21,682 samples of sugar and articles containing sugar were examined for

assessment of duty or drawback: of these 21 samples consisted of sugar, molasses, and beetroot from the Cantley beetroot sugar factory. Of 68 samples of honey examined, five afforded evidence of the addition of invert sugar. In 38 samples out of 309 examined, saccharin was found to be present.

Matches. No evidence of the presence of white phosphorus was discovered in the 375 samples of matches examined.

Imported dairy products. Of the 82 samples of condensed milk examined, 56 were condensed whole milk (8.1 to 11.3% fat) and 26 condensed skimmed milk. In several samples the concentration was low, the milk having been evaporated to only half its bulk. All the samples were free from preservatives. Three samples of skimmed milk powder were taken from packages not bearing the description "skimmed milk," and in three other cases the labelling of the packages was unsatisfactory. The greatest amount of boric acid found in the samples of "churn cream" examined was 0.45%. Of 1037 samples of imported butter, 402 contained boron preservative and 42 added colouring matter. Six samples of imported butter contained more than 16% of water. There was no evidence of the presence of fat other than butter fat in any of the samples. In 42 cases the Reichert-Wollny number fell below 24. Of 524 samples of imported margarine, none contained more butter fat than is legally permissible, but excess of water was found in eight cases. No foreign fat was detected in the samples of imported cheese, but in some cases the percentage of fat was low. Forty-five samples of butter out of 307 samples taken under the Butter and Margarine Act, contained excess of water and five samples were mixtures of butter and margarine.

Sheep dips. Thirty-one samples were examined in connection with applications from manufacturers to include their preparations in the official "Schedule of efficient dips." Twelve samples were deficient in active ingredients at the proposed dilution, and in ten cases the formulae submitted required modification. Twelve samples of approved dips were purchased, and in three cases it was found that they had not been prepared according to the formulae previously submitted and approved.

River pollution. Two sea trout taken from a stream believed to have been polluted, contained small quantities of copper, lead, and zinc.

Glazes. The samples examined were generally found to comply with the Home Office requirements. Samples of lead glaze were examined as regards total lead content and amount of lead soluble in dilute hydrochloric acid. In 19 cases where lead poisoning had occurred, almost all the lead was soluble in the dilute acid.

Sale of Food and Drugs Acts. Seventy-five samples were referred by magistrates under these Acts, viz., milk 61, butter 5, rum 2, cream, whiskey, coffee, and ipecacuanha wine, one each. In ten cases the result of the examination of the Government Laboratory differed from that of the public analyst.

Fertilisers and Feeding Stuffs Act. Nine fertilisers and 35 feeding stuffs were examined. The fertilisers consisted of superphosphate, basic slag, bone meal, and potato manures. They were deficient in phosphates or nitrogen. Several of the samples of feeding stuffs were deficient in oil or albuminoids, and in some cases a considerable proportion of unsuitable substances was present.

Reference is also made to work carried out by the Laboratory for the Admiralty, Central Control Board, Crown Agents for the Colonies, Geological Survey, India Office, Inland Revenue, Local Government Board, Post Office, Stationery Office, Trinity House, Board of Trade, War Department, War Trade Department, Office of Woods and Forests, and Office of Works.

UTILISATION OF TERRESTRIAL HEAT.

AN interesting description is given by Professor Luiggi, in a recent issue of *Engineering*, of the attempts made to utilise terrestrial heat in Italy. It is well known that in Central Tuscany, near Volterra, there are numerous cracks in the ground, from which powerful jets of hot steam ("Soffioni") are projected into the air, carrying with them boric acid and other substances; for many years these have been utilised as a source of boric acid and borax, but the greater part of the steam has been wasted, with the exception of a small quantity occasionally used for warming houses in an adjacent village.

The first attempt to utilise this superheated steam as a source of power was made in 1903 by Prince Ginori-Conti, who applied it to a small rotary motor, then to a reciprocating steam engine connected with a dynamo, which generated sufficient current to light part of the borax works. A more ample supply of steam was obtained by boring holes in the ground, lined with iron pipes, to a depth of 300 to 500 ft. These holes vary from 12 to 20 in. in diameter and from them the steam issues at a pressure of 2 to 3 and occasionally 5 atmospheres and at a temperature of 150°–190° C. For several years the flow of steam from these jets has not abated, nor do new borings appear to affect preceding ones providing the distance apart is not less than 50 ft. Experiments showed that each bore-hole could produce steam at the rate of 15,000 to 25,000 kilos. per hour, at 150° C., i.e., about 1000 to 2000 theoretical horsepower per hour.

In 1906 the steam was applied to an ordinary steam engine of about 40 H.P., with satisfactory results as far as power is concerned, but the

impurities in the steam seriously corroded the iron structure. To avoid this difficulty the steam was applied instead of fuel to a multitubular boiler, in which steam was produced at 2 atmos. pressure, then passed through a superheater, and afterwards used for driving a 300 H.P. condensing steam engine, directly connected with a triphase electric generator, which supplies the works and villages round Larderello. This installation had been working successfully for several months before war broke out.

The enormous increase in the price of coal has resulted in further plant being installed, three groups of condensing turbo-electric engines, each of 3000 kw., having been put down. The engines work with steam at 1½ atmos., generated in multitubular boilers arranged vertically and with aluminium tubes. The temperature of the steam falls from 180° to about 120° C. in the boilers, and it is then used for the borax works.

The current, generated at 4500 volts and 50 periods per second, is converted in an oil transformer to 36,000 volts and sent to Florence, Leghorn, Volterra, Grosseto, and smaller towns in Tuscany, where it is used principally for motive power.

One of the 3000 kw. units has been working successfully for a year and another for nine months, the third having only been started recently.

The production of power from this source could be increased very largely in the district in question, since the region of the soffioni is known to extend for many square miles around Larderello. Near Naples, also, in the Campi Flegrei, the ground in places, at a depth of 100 feet, is very hot, and similar utilisation of this source of power is in contemplation.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.

United States.—1s. each, to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—Patent number, date, name of patentee, and title of invention.

French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56 Rue Ferou 8, Paris (Se.); Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

Klingerite [asbestos preparation]. A. Dubosc. Cautehouc et Gutta-percha. 1916, 13, 9070—9071, 9085—9088.

KLINGERITE is the trade name of a material of German manufacture, used as a packing for steam pipe joints, for which purpose it is excellently adapted. The shortage due to the war has been extensively felt and attempts—not completely successful—have been made in France to produce a substitute. The author publishes the results of an examination—chemical and physical—of the material, with practical suggestions as to how it might be prepared in a satisfactory condition. A sample in the form of a card 3.75 mm. thick was found to consist of 15 thicknesses of a thin felt of asbestos fibre mixed with about 2% of flax threads. The asbestos was of the finest commercial quality of long fibre. Each layer appears to have been coated on both sides with an agglutinant composed of a mixture of rubber and balata with a small quantity of sulphur. By pressure the whole had been worked into a uniform and compact mass. When the packing is heated in use vulcanisation occurs, rendering it more impervious and accordingly more resistant to the destructive action of steam under pressure. The results of chemical analysis gave:—Asbestos,

80-40%; cellulose (flax), 2.21%; agglutinant, 17.16% (rubber, 5.19, balata, 11.97%); sulphur, 0.13%. The percentage of sulphur is doubtful; the author suggests the use of 5% of the weight of agglutinant. The purpose of the flax is apparently to strengthen the constituent layers of asbestos for the process of coating with the agglutinant.—H. J. H.

PATENTS.

Separating water and other impurities from oil. J. L. Sands. Dublin. Eng. Pat. 14,217, June 12, 1914.

Refrigerating machines. E. T. Williams. New York. Eng. Pat. 15,788, Nov. 9, 1915.

Separating salts from solutions or separating miscible liquids from one another; Process and apparatus for —. J. A. Newby and C. J. Montgomery. Fr. Pat. 479,972, Oct. 9, 1915.

SEE Eng. Pat. 9110 of 1911; this J., 1915, 1131.

Concentrating apparatus. J. Harris and D. H. Thomas. Fr. Pat. 480,293, Nov. 22, 1915.

SEE Eng. Pat. 23,114 of 1911; this J., 1915, 891.

Lubricating oils; Separation of foreign matter from used —. C. J. Skildmore and P. F. Conerty. Fr. Pat. 480,034, Oct. 19, 1915.

SEE Eng. Pat. 11,781 of 1915; this J., 1916, 528.

Cooling molten material to obtain the solid in a finely divided state; Method of —. J. W. Leitch. Fr. Pat. 480,669, Jan. 13, 1916.

SEE Eng. Pat. 45,063 of 1915; this J., 1916, 204.

Drying apparatus. Sturtevant Engineering Co. Fr. Pat. 480,431, Dec. 11, 1915.

SEE Eng. Pat. 21,232 of 1914; this J., 1915, 478.

Receptacle for chemical purposes. B. Hansen, Notoddén, Assignor to Norsk Hydro-Elektrisk Kvaestofaktieselskab, Christiania, Norway. U.S. Pat. 1,205,619, Nov. 21, 1916. Date of appl. June 7, 1916.

SEE Eng. Pat. 100,117 of 1916; this J., 1916, 1096.

Method and means for recovering certain constituents from gaseous bodies. U.S. Pat. 1,201,906. See XI.

Means for producing discharge of electricity into gases. U.S. Pat. 1,201,907. See XI.

II.A.—FUEL; GAS; MINERAL OILS AND WAXES.

Gas coals; Weathering of —. A. H. White. American Gas Inst. J. Gas Lighting, 1916, 136, 541—544.

The author describes and gives results of tests conducted at the gas experimental station maintained by the Michigan Gas Association and the Chemical Engineering Department of the University of Michigan. The tests were made on Pittsburgh and Fairmont gas coals stored for varying periods. Open gas-pipes for the reception of thermometers were laid horizontally in the coal piles, but no heating of the coal was detected. At the end of each weathering period the top 6 inches of each pile was removed carefully, sampled, and sent to the Bureau of Mines for analysis, a sample of the whole pile being then taken. The Experimental Station commenced operations in 1911, using for the distillation tests a single clay retort which lasted 3 years and was then replaced by a sectional silica retort; the temperature of the retort was observed by an optical pyrometer. The remainder of the plant consists of a jacketed condenser, an electrical tar precipitator, a Sirocco blower acting as an exhaustor, an ammonia scrubber of the tower type, an oxide purifier, a wet station meter, and apparatus for physical and chemical examination of the final gas. Ammonia passing the scrubber is estimated at the outlet and allowance made. Results of retort tests are summarised, the author observing that the higher yield of gas in the fourth and fifth year may possibly be due to the use of the silica retort. The following results were obtained with the Pittsburgh coal:—

Duration of weathering.	Gas, cub. ft. per ton.	Candle-power.	Heating value, B.Th.U. per cub. ft.	Candle-feet per lb. of coal	B.Th.U. in gas per lb. of coal.
6 months	10,135	15.4	631	78.3	3197
1 year	9,353	17.4	645	81.3	3013
2 "	10,346	16.9	624	87.7	3217
3 "	10,373	16.3	615	84.9	3188
4 "	10,509	15.0	613	79.2	3210
5 "	11,102	15.5	620	86.2	3146

No deterioration in the quality of the coke could be noted visually. The results with Fairmont coal were very similar to those with Pittsburgh coal, the influence of the silica retort being again evident. Variations in proximate and ultimate analyses on both coals stored in air were almost all within the limit of error of analysis; the only distinct change was in coal stored under water for 4½ years, the volatile matter in this case increasing to a maximum of 2% over the mine sample. The author concludes that the changes in the coals were too small to be discovered by present methods of testing and analysis, and that gas coals of the above type can be exposed to the weather for five years (provided they do not heat in storage) and at the end of this term be entirely satisfactory gas coals.—J. E. C.

Coal; Oxidation of —. G. Charpy and M. Godchot. Comptes rend., 1916, 163, 745—747.

MEASUREMENTS were made of the changes undergone by samples of coal on exposure to the air at temperatures of 100° to 150° C. for given intervals. A diminution of weight was first observed, which is shown to be equivalent to the loss of water through evaporation. At 100° C. this loss continues for about 3 hours. A gradual increase in weight then takes place, reaching a maximum value of 3 to 5% after an interval of 2 to 3 months. This change is accelerated by increase of temperature, but at 150° C. an evolution of carbon dioxide occurs, resulting in loss of weight. This slow oxidation of coal causes a loss in its calorific value, which was found to amount to 13% in some cases. The amount of ash and volatile matter were found to be unaffected by prolonged oxidation. The results show that since this oxidation of coal can proceed under ordinary atmospheric conditions, the calorific power of different samples cannot be deduced from the content of ash and volatile matter, but that a direct calorific measurement is necessary.—J. N. P.

Benzol recovery in gas-works. D. Bagley. J. Gas Lighting, 1916, 136, 491—493.

A DESCRIPTION of the Carl Still system of recovering benzol from coke oven gases is given. The gas and absorbing oil are passed through a series of tower scrubbers in opposite directions, and the benzolised oil is treated by steam in a continuous still to produce crude benzol. The debenzolised oil is continuously returned to the scrubbers, and the crude benzol is fractionated by steam into intermediate products which are then purified and rectified. The chief difficulties which arise when applying this system in a gas-works, namely: (1) the necessity of maintaining a standard calorific value for the washed gas; (2) the need for keeping the naphthalene ratio of the absorbing oil within such limits as will prevent naphthalene passing on with the washed gas in such quantities as will give trouble; and (3) the irregularity in the make of gas, are discussed.—W. H. C.

Benzol recovery [from gas]. J. A. Wilson. J. Gas Lighting, 1916, 136, 447—449.

At the Coke Oven Plant of the Staveley Coal and Iron Co., Ltd., the gas is first washed in tower scrubbers and finally in rotary scrubbers, centrifugal pumps being preferred for feeding the wash oil. Considerable improvement in controlling the working of the plant has been secured by using meters to measure the fresh absorbing oil added to the scrubbers. A more satisfactory method of determining the amount of benzol in the gas both before and after the scrubbers is desired. Variations in the temperature of the gas, owing to deficiency of cooling water in summer and autumn, have a considerable influence on the quantity of benzol recovered, which has varied from a max-

imum of 3.03 galls. of rectified benzol per ton of dry slack in February to 2.40 galls. in September. It is very important that the debenzolised oil returned to the scrubbers should contain as little water and benzol as possible. The scrubbing space should be at least 16 cubic feet per ton of coal and the amount of oil circulated such that the benzolised oil does not contain more than 3 to 4.5% of benzol.—W. H. C.

Coal gas: Determination of light oils in — and description of still for separating the light oils from the absorbing oil. D. H. Duvall. Met. and Chem. Eng., 1916, 15, 626—627.

AFTER removal of hydrogen sulphide and naphthalene by successive treatment with sodium hydroxide and picric acid, measured quantities of gas are passed through a train of 5 or 6 bottles containing a suitable absorbent, preferably oleic acid. The light oils are then separated from this solution by distillation. The still and water-cooled worm condenser are made of copper. After raising the temperature of the benzolised oleic acid to about 100° C., steam is admitted from a separate generator, and a temperature of 180° C. is finally attained. The distillate is separated from water and subjected to dry distillation. The new distillate is saponified with sodium hydroxide to remove the last traces of oleic acid, then washed with water, dried with calcium chloride, and fractionally distilled in an Engler flask.—J. N. P.

Gasoline: Effect of temperature and the time factor in the formation of — in the gas phase at constant pressure. G. Egloff, T. J. Twomey, and R. J. Moore. J. Ind. Eng. Chem., 1916, 8, 1102—1105.

THE residue of a Pennsylvanian crude oil, after the gasoline had been removed, was subjected to temperatures of 600°, 650°, and 700° C., at a constant pressure of 150 lb., and varying rates of oil flow of 17, 23, 30, 36, 45, and 65 galls. per hour, the other conditions being similar to those described previously (this J., 1916, 1004). The amount of oil recovered decreased with increase of temperature and increased with increase of the rate of oil flow. The maximum yield of gasoline (b.pt. up to 150° C.) was 28.3% of the original oil, at 600° C. and 17 galls. per hour, but taking into account the yield of gasoline per hour and the proportion of treated oil available for re-cracking, the best working conditions were 65 galls. per hour and 650° C. with a yield of 22.1%. The specific gravity of the recovered gasoline was always higher than that of ordinary gasoline, owing to the presence of aromatic hydrocarbons. It increased with increase of temperature and decreased with increase of rate of oil flow. The minimum specific gravity of the recovered gasoline was 0.745 at 36 galls. per hour and 600° C., the yield being 19.5%. The amount of olefines ranged from 22 to 29% of the recovered oil, or 3.9—7.9% of the original oil, and the amount of oil converted into uncondensable gas and carbon ranged from about 10 to 70%. (See also this J., 1916, 1209.)—A. S.

Ozokerite from the Thrall oil field. E. P. Schoch. J. Ind. Eng. Chem., 1916, 8, 1095.

A DARK brown waxy material obtained together with crude petroleum at Thrall, Texas, has been found to consist of ozokerite of good quality. Its melting point is 79.5° C., as compared with 50°—58° C. for paraffin of the same consistency. The ceresin prepared from the Thrall ozokerite melts at 75° C., has sp.gr. 0.926—0.928, and refractive index 1.4414—1.4420 at 90° C. Its solubility in carbon tetrachloride is 3.08 grms. per 100 c.c. of solvent. It is free from paraffin, for when dissolved in chloroform and fractionally precipitated with

alcohol, the fractions all had a considerably higher refractive index than that of paraffin (1.4220—1.4275 at 90° C.).—A. S.

Recovery of fats and nitrogen compounds [and manufacture of gas] from sewage. Rideal. See XIXB.

Preparation of the lower chlorides of methane from natural gas. Bedford. See XX.

PATENTS.

Gases [e.g., acetylene]: Storing of — under pressure. Acetylene Illuminating Co., Ltd., and A. Stephenson, London, Eng. Pat. 12,205, Aug. 2, 1915.

A STORAGE receptacle containing a solvent or absorbent material is subjected to a temperature low enough to enable acetylene or other gas to be dissolved or absorbed at a pressure merely sufficient to cause the gas to flow into the receptacle. The rate of flow may be augmented by an exhauster. On returning to normal temperature the gas will be at a desirable storage pressure.—J. E. C.

Gas condensers. T. A. Vanston, Bolton. Eng. Pat. 16,416, Nov. 22, 1915.

A CONDENSER for coal gas or the like consists of an outer casing, easily removed, with inner walls across two opposite sides leaving narrow vertical passages on these sides. The vertical passages lead to tubes connecting the two inner walls, and are provided with baffles so as to compel water entering at the bottom to follow a sinuous course through groups of tubes. Gas enters at the top and also follows a sinuous path in horizontal streams by reason of baffles between the inner walls, openings being left at alternate ends. The direction of these horizontal gas streams is at right angles to the direction of the cooling tubes.—J. E. C.

Converting heavier [mineral] oils into lighter oils. F. Lamplough, London. Eng. Pat. 16,830, Nov. 30, 1915.

THE vapour from a heavy oil is heated to a temperature approximately 25° to 50° C. lower than that at which fixed gas is formed or at which cracking will occur. The heated vapour is then passed over electrically heated elements maintained at a dull red heat, the resulting products being led away to suitable condensing apparatus.—J. E. C.

Coal gas generating apparatus: Manipulating mechanism for —. A. E. White, London. From Riter-Conley Manufacturing Co., Leedsdale, Pa., U.S.A. Eng. Pat. 16,526, Nov. 23, 1915.

Carbon powder: Manufacture of finely-divided —. P. J. Mitchell and A. C. Evans, Fr. Pat. 180,487, Dec. 18, 1915.

SEE Eng. Pats. 24,313 of 1911 and 8901 of 1915; this J., 1916, 170.

Cohering masses [briquettes]: Manufacture of resistant —. D. H. Bibb. Fr. Pats. 479,900 and 479,901, Oct. 1, 1915.

SEE U.S. Pats. 1,158,363, 1,158,364, and 1,158,365 of 1915; this J., 1915, 1199.

Furnace for preparing artificial fuel. V. Groom. Fr. Pat. 180,153, Dec. 15, 1915.

SEE Eng. Pat. 24,085 of 1914; this J., 1916, 103.

Gas producer. L. Nelson. Fr. Pat. 180,533, Dec. 1, 1915.

SEE Eng. Pat. 16,088 of 1915; this J., 1916, 1254.

Coal gas: Treatment of —. A. E. White, London. From Riter-Conley Manufacturing Co., Leedsdale, Pa., U.S.A. Eng. Pat. 17,891, Dec. 22, 1915.

SEE U.S. Pat. 1,169,015 of 1916; this J., 1916, 298.

Oils; Removal of sulphur from ——. E. V. Evans, and South Metropolitan Gas Co. Fr. Pat. 180,129, Nov. 1, 1915.

SEE Eng. Pat. 22,117 of 1911; this J., 1915, 1210.

Oils and petrol; Treatment of ——. W. O. Smelling. Fr. Pat. 180,899, Oct. 29, 1911.

SEE Eng. Pat. 18,119 of 1911; this J., 1915, 1045.

Emulsion products [mineral oils, etc.]; Process for solidifying ——. L. Berend. Amöneburg. Germany. Eng. Pat. 16,315, Nov. 19, 1915.

SEE U.S. Pat. 1,167,373 of 1916; this J., 1916, 209.

Hydrocarbons; Process for converting heavy ——. into light hydrocarbons. H. Strache and P. Porges, Vienna. U.S. Pat. 1,205,578, Nov. 21, 1916. Date of appl., May 13, 1911.

SEE Eng. Pat. 11,120 of 1911; this J., 1915, 826.

IIb.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

Incandescence gas mantles; Recent developments in ——. E. L. Knoedler. Met. and Chem. Eng., 1916, 15, 635—639.

THE durability of incandescence gas mantles, and the maintenance of a yellowish light instead of greenish-white depends mainly on the quality of the cotton or ramie threads used for the fabric, and to the presence of a sufficiency of thoria. Regularity of fabric and the absence of loose fabric are important in preventing the development of too much resistance to the passage of the gas. A satisfactory material now used consists of viscose artificial silk. Threads of this material are thin, strong, and capable of heavier impregnation than either cotton or ramie threads. Artificial fibre also possesses the advantage of uniformity of chemical composition, diameter, and other physical properties, and gives a mantle which is more durable, is a more constant light producer, and does not undergo shrinkage.—J. N. P.

PATENTS.

Incandescence electric lamps, and method of manufacturing the same, especially applicable to the manufacture of so-called half-watt lamps or gas filled glow lamps. C. O. Bastian, London. Eng. Pat. 11,332, Aug. 5, 1915.

THE atmosphere within the lamp is rarefied and the globe then sealed, with a de-oxidising agent, such as sodium, phosphorus, etc., inside the lamp, or in a connection such as a pocket which may afterwards be removed. Heat is applied externally for a prolonged period to raise the temperature of the globe, without raising the filament or electrodes to their oxidising temperature, and the oxygen in the atmosphere is withdrawn by the agent.—B. N.

Exhausting [tungsten incandescence] lamps; Process of ——. J. T. Marshall, Metuchen, N.J., Assignor to General Electric Co., New York. U.S. Pat. 1,205,002, Nov. 11, 1916. Date of appl., Oct. 23, 1911.

THE tungsten filament and metal supports are dipped into a liquid containing phosphorus distributed uniformly through it, and then dried so as to leave a coating of phosphorus on the metal parts. The lamp is exhausted to a predetermined degree, sealed, and current is then passed through the filament to render it incandescent. The phosphorus is vaporised, and reacts with the oxygen, leaving a suitable residual atmosphere, whilst the glass of the lamp is kept below the temperature at which occluded gases and water vapour are evolved.—B. N.

Destructive distillation of coal and other carbonaceous substances; Process and apparatus for the ——. S. N. Wellington. Fr. Pat. 179,912, Oct. 2, 1915.

SEE Eng. Pat. 20,157 of 1911; this J., 1915, 1131.

Carbonaceous materials; Process for obtaining volatile products distilled from ——. J. R. H. and W. L. St. J. Prioleau. Fr. Pat. 480,286, Nov. 20, 1915.

SEE Eng. Pat. 9375 of 1915; this J., 1915, 1082.

Device for drying tubular fabrics [e.g., incandescence gas mantle fabric]. Eng. Pat. 102,210. See V.

III.—TAR AND TAR PRODUCTS.

Bromination of [aromatic] hydrocarbons by means of bromine and nitric acid. R. L. Datta and N. R. Chatterjee. J. Amer. Chem. Soc., 1916, 38, 2515—2552.

THE bromination of aromatic hydrocarbons may be effected by the combined action of nitric acid and bromine, commencing in the cold, and completing the reaction by the aid of heat. The chief advantages of the method are that all the bromine used is available for bromination, the hydrobromic acid liberated being immediately re-oxidised to bromine by the nitric acid. Further the reagent is very reactive and effects a speedy and energetic bromination, proceeding to varying extents according to quantity of bromine used and the duration of the treatment. From benzene either mono- or di-bromo-derivatives were obtained. Toluene gave *o*-bromotoluene and 3,4-dibromotoluene by short treatment, and pentabromotoluene on prolonged treatment. The xylenes gave monobromoxylenes, accompanied in the case of the *o*-compound by small quantities of toluic acid, and by dibromo-derivatives with *m*- and *p*-xylenes. Prolonged action gave tetrabromocompounds. Mesitylene gave the mono-substitution product in the cold, and the tribromocompound on heating. With ethylbenzene *o*- and *p*-bromoethylbenzenes formed the chief product. As would be anticipated bromination could also be effected by means of a mixture of 40% hydrobromic acid and nitric acid (sp.gr. 1.35).—G. F. M.

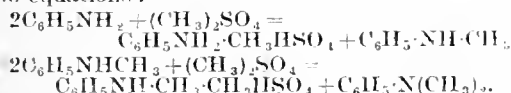
Aromatic alcohols; Action of ——. on aromatic compounds in the presence of aluminium chloride. I. R. C. Huston and T. E. Friedemann. J. Amer. Chem. Soc., 1916, 38, 2527—2533.

AMONG the products of the interaction of benzyl alcohol, benzene, and aluminium chloride are diphenylmethane, produced in largest amount, and smaller amounts of *p*- and *o*-dibenzylbenzene, a compound $C_{17}H_{14}$, b.pt. 308°—316° C. at 20 mm., which is probably a tribenzylbenzene or methylene-bisdiphenylmethane, and anthracene. The yields of these products are greatly influenced by the proportions of the reagents used, an excess of benzene favouring diphenylmethane formation. Similar products were obtained from benzyl ethyl ether, benzene, and aluminium chloride, and from chloromethyl ethyl ether, benzene, and aluminium chloride. In the latter case formaldehyde is probably an intermediate product.—G. F. M.

Amines; Researches on ——. VI. Utilisation of hypochlorite colour reactions in establishing the mechanism of the action of dimethyl sulphate on aniline. N. A. Shepard. J. Amer. Chem. Soc., 1916, 38, 2507—2514.

THE interaction in benzene solution of equimolecular proportions of dimethyl sulphate and aniline does not result in the formation of a quantitative yield of the methylsulphate of monomethylaniline as stated by Werner (Chem. Soc. Trans.,

1914, 105, 2762), but reactions occur, expressed by the equations:



The main product separating out in crystalline form is thus aniline methylsulphate, and mono- and dimethylanilines are formed in lesser amount. The course of the reaction was followed by means of the hypochlorite colour reactions which the three bases give under specific conditions. In neutral solution a reddish purple coloration is characteristic of aniline, the other bases giving only insignificant yellows or browns. In faintly acid solution a deep orange-yellow is characteristic of dimethylaniline, whilst aniline and monomethylaniline both give an indigo blue, which with the former is most pronounced if the addition of hypochlorite is made last. Monomethylaniline gives its most characteristic reaction in faintly alkaline solution, when a white precipitate with a slowly developing navy blue coloration fading to yellow is produced.—G. F. M.

Benzol recovery in gas works. Bagley. See II A.

Benzol recovery [from gas]. Wilson. See II A.

Relation between the toxicity and volatility of creosote oils. Bateman. See IX.

Application of the nitrometer for the determination of constitution and estimation of nitrogen in a class of nitro-compounds, viz., nitroamines. Cope and Barab. See XX.

IV.—COLOURING MATTERS AND DYES.

Use of the spectrophotometer for the examination of food colouring substances. Mathewson. See XIX A.

Modification of Price's method for the separation of the seven permitted coal-tar dyes, to include Tartrazine. Estes. See XIX A.

Methylene Blue as a reagent in chemical analysis. Monnier. See XXIII.

PATENTS.

a-Hydroxydisazo dyes capable of being chromed; Process for preparing secondary——. Fabr. de Prod. Chim. ci-dev. Sandoz. Fr. Pat. 480,462. Dec. 17, 1915.

SEE Eng. Pat. 17,607 of 1915; this J., 1916, 531.

Dyes of the phthalcin series; Preparation of——. J. R. Geigy Soc. Anon. Fr. Pat. 480,295. Nov. 22, 1915.

SEE Ger. Pat. 290,508 of 1915; this J., 1916, 532.

Acid wool dyes fast to copper; Process of making——. Soc. pour l'Ind. Chim. à Bâle. Fr. Pat. 479,998. Jan. 20, 1915.

SEE Eng. Pat. 1611 of 1915; this J., 1916, 301.

Colouring matters; Manufacture of——. C. Menschling and E. F. Ehrhardt. Fr. Pat. 480,002. Oct. 11, 1915.

SEE Eng. Pat. 10,716 of 1915; this J., 1916, 301.

Colouring matter and process of obtaining it. W. Somerville. Fr. Pat. 480,503. Dec. 22, 1915.

SEE U.S. Pat. 1,193,838 of 1916; this J., 1916, 960.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Celluloid; Miscellaneous vegetable fibres as raw material for——. H. Nishida. J. Ind. Eng. Chem., 1916, 8, 1096-1100.

THE author has compared loose cotton of various kinds, mercerised cotton yarn, and tissue papers prepared from various other cellulosic materials as raw material for the manufacture of celluloid. Nitration was effected with a mixed acid containing H_2SO_4 61.0-65.5, HNO_3 15.0-16.5, HNO_2 0.8-1.0, H_2O 18.0-19.0%. To obtain the same degree of nitration it was found necessary to keep the product of the temperature ($^{\circ}\text{C}$) and time of nitration (mins.) constant. The value of the constant was 1500 for cotton or relatively pure forms of cellulose, 2100 for linen and allied bast fibres, 2100 for wood and straw cellulose, and 2700 for mechanical wood pulp and other fibres difficult to nitrate. When paper thicker than corresponds to 40 grms. per sq. m. is used, a correction is made as follows:

constant $0.9\sqrt{\frac{D}{40}}$, for D 40-100 grms.

constant $>0.85\sqrt{\frac{D}{40}}$, for D 100-200 grms. per sq. m.

The characters of the celluloids obtained from the different raw materials are tabulated. From the results the author classifies the various raw materials as follows: 1st class. Unbleached mercerised cotton; tissue paper from white rags and cotton fishing nets. 2nd class. Bleached mercerised cotton; tissue from coloured rags; tissue from linen fibres. 3rd class. Papers from bast fibres; weavers' waste cotton yarn, scoured and bleached. 4th class. Bamboo tissue as free from adulteration as possible, and wet-beaten. 5th class. Chemical wood fibre, and straw, as free from knots as possible. 6th class. Mechanical wood fibre mixed with a little cotton.—A. S.

Paper making industry in South Australia; Investigation into the prospects of establishing a——. W. A. Hargreaves. Dept. Chem., S. Australia. Bull. No. 1, 1916, pp. 1-56.

THE Commonwealth of Australia depends mainly on imported paper; there is one paper mill in Victoria and one in New South Wales and there are a few millboard and strawboard mills in these two States. The imports of paper (1913) are estimated at 50,000 tons of news printings, 20,000 of ordinary printings and writings, 3000 hand-made and special papers, and 10,000 tons of wrappings; of these quantities South Australia accounts for about 10%. The total import of strawboards was 3630 tons, of which 574 tons came to South Australia. So far as can be seen there is no opening for the home manufacture of news paper in Australia, there being no considerable supplies of soft-wood timber suitable for mechanical pulp, but South Australia is favourably situated for the operation of a mill producing 5000-6000 tons per annum of fine printings, writings, and wrappings, possibly in conjunction with a straw- and millboard plant under the same control. So far as native raw materials are concerned, the staple cellulose fibre must be straw, of which over half-a-million tons is available annually in a radius of 100 miles from the principal seaport. From the points of view of labour, water supply, and sea-transport, Port Adelaide offers the most favourable site for such a mill, although not at the centre of the cereal districts; it is estimated that straw could be delivered at the mill at a price not exceeding 30s. per ton. For the manufacture of the grades of paper contemplated, the straw cellulose would have to be blended with some other materials which, apart from rags and waste papers, would have to be

imported, pending the development of supplies of home-grown cellulose pulps. Several of the possible native materials have been investigated; one of the most promising appears to be a grass, *Lepidosperma gladiatum*. Other materials, such as Marram grass, Stink wort, and the inner trunk of the Grass Tree or Yacca, are capable of treatment, but give low yields and may present economic difficulties. The large deposits of Marine Fibre (*Posidonia*) afford a material giving a high yield of cellulose but very difficult to treat, so that its exploitation for paper making seems doubtful.—J. F. B.

Recent developments in incandescence gas mantles. Knoedler. See IIb.

PATENTS.

Fabrics: Device for drying tubular —. S. Cohn, New York. Eng. Pat. 102,210, Aug. 7, 1916. (Appl. No. 11,132 of 1916.)

A TUBULAR fabric, *e.g.*, incandescence gas mantle fabric, is propelled continuously over a mandrel which passes inside the tube, stretching the fabric radially, while the feeding devices stretch it longitudinally. The mandrel is surrounded by a casing through which heated air is blown in a counter direction to the fabric in order to dry it. The mandrel may be fluted near the end where it passes into the tube of fabric and smooth for the remainder of its length. At both ends of the mandrel are constricted necks in each of which two pairs of soft rollers revolve in contact with the conical surfaces and feed the tubular fabric on to and off the mandrel.—J. F. B.

Wool, rags, cotton and other loose material: Dryers for —. M. F. Kelvin, Pittsfield, Mass., U.S.A. Eng. Pat. 102,313, Mar. 30, 1916. (Appl. No. 4715 of 1916.)

The material is fed upon a platform composed of a longitudinal series of transversely extending shelves preferably perforated and capable of movement relatively to one another lengthwise of the table, movable reciprocating shelves being arranged alternately with stationary shelves, each pair overlapping the succeeding one at a slight inclination, so that the reciprocating movement of the alternate shelves between the stationary ones causes the material to be advanced along the table while exposing it to the action of the drying air.—J. F. B.

Textile material: Production of —. J. C. M. van Diggelen. Fr. Pat. 480,167, Dec. 18, 1915. SEE Eng. Pat. 10,899 of 1915; this J., 1916, 108.

Magnesium sulphite solution: Preparation of acid — and its use in extracting cellulose from vegetable fibrous material. J. L. Jardine. Fr. Pat. 480,933, Feb. 11, 1916.

SEE Eng. Pat. 2509 of 1915; this J., 1916, 533.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Indian sumach. Singh. See XV.

PATENTS.

Fibrous materials: Apparatus for treating —. E. D. Jefferson, Boston, Mass. U.S. Pat. 1,204,357, Nov. 7, 1916. Date of appl. Jan. 13, 1915.

AN apparatus for treating fibrous materials consists of a horizontal cylindrical cage mounted inside a concentric cylindrical tank. The tank and the cage are each provided at one end with a removable head, so that the materials in the cage

may be emptied by opening these heads and rotating the cage. The end of the cage is normally supported by a trunnion journaled in a bearing on the removable head of the tank, and separate means are provided for supporting the free end of the cage when the removable heads of the tank and cage are removed.—F. W. A.

Bleaching, dyeing, and similar kiers; Carriages of —. Jackson and Bro., Ltd., Bolton, and J. Edge, Fleetwood. Eng. Pat. 102,351, July 13, 1916. (Appl. No. 9853 of 1916.)

Bleaching apparatus: Electrolytic —. J. F. Webb and W. W. Williams. Fr. Pat. 479,902, Oct. 1, 1915. SEE Eng. Pat. 20,711 of 1914; this J., 1915, 1139.

Printing on fabrics, etc.; Machines for —. H. D. Herring and H. Harrison. Fr. Pat. 481,141, Mar. 9, 1916.

SEE Eng. Pat. 1411 of 1915; this J., 1916, 251.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Sulphuric acid: Maximum prices for sales of —. Ministry of Munitions, Dec. 30, 1916.

THE Minister of Munitions has cancelled the figures for maximum prices for the sale of sulphuric acid given in previous circulars (see this J., 1916, 251) and substituted the following, which refer to sales of sulphuric acid of all descriptions and for all purposes, unless expressly excepted:—

		Maximum price per ton for acid delivered into tank wagon, cart or barge at makers' works.
Class A.—Arsenical acid	140° Tw. at 60° F.	70/—
Class B.—Non-arsenical or de-arsenicated ..	144° Tw. at 60° F.	85/—
Class C.—Arsenical ..	95% H ₂ SO ₄	130/—
Class D.—Non-arsenical or de-arsenicated ..	95% H ₂ SO ₄	110/—

With regard to sales of acid of strengths other than those given above, the Minister recommends that the following adjustments in price should be made:—

Classes A and B comprise acid containing 90% or less H₂SO₄.

In the case of acid in Class A, an adjustment of fivepence per degree Twaddell should be made in respect of each complete degree by which the specific gravity differs from 140° Tw., at 60° F.

In the case of acid in Class B, an adjustment of sixpence per degree Twaddell should be made in respect of each complete degree by which the specific gravity differs from 144° Tw., at 60° F.

Classes C and D.—All acid of over 90% H₂SO₄ is contained in these classes. Payment should be made on the basis of percentage of monohydrate in each consignment. The following scales for payment are recommended:—

	Arsenical.	De-arsenicated or non-arsenical.
Over 90% and up to 91%	£ s. d.	£ s. d.
Over 91% and up to 92%	5 3 0	5 13 0
Over 92% and up to 93%	5 9 0	5 19 0
Over 93% and up to 94%	5 15 0	6 5 0
Over 94% and up to 95%	6 1 0	6 11 0
Over 95% and up to 96%	6 4 0	6 14 0
Over 96% and up to 97%	6 7 0	6 17 0
Over 97% and up to 98%	6 10 0	7 0 0
Over 98% and up to 99%	6 15 0	7 5 0
Over 99% and up to 99%	7 0 0	7 10 0
Over 96, in both cases, an additional 1/- for each complete %.		

Packages. 1. When the acid maker supplies the railway tank wagons he shall be entitled to make a further charge of not more than 5s. per ton for filling and hire of such wagons. 2. When the acid maker supplies the acid in his own drums he shall be entitled to make a further charge of not more than 10s. per ton for filling and hire of drums. When drums are supplied by the purchaser a charge of 2s. per ton may be made to cover the cost of filling. 3. When the acid is supplied in the acid maker's own carboys he shall be entitled to make a further charge of £1 per ton for filling and hire of carboys. When carboys are supplied by the purchaser a charge of 5s. per ton may be made by the acid maker, to cover the cost of filling.

Notes. 1. The maximum prices apply to sales of sulphuric acid made by sulphuric acid makers and their agents, but not to sales by dealers and merchants who are themselves not makers of sulphuric acid. 2. Merchants and dealers will be required to furnish a monthly return of sales (of sulphuric acid) made by them, setting out the prices charged in each instance. 3. The maximum prices do not apply to exports of sulphuric acid under permit to persons, companies or firms abroad, nor do they apply to the sale of sulphuric acid imported from abroad. 4. The maximum prices do not apply to the sale of sulphuric acid made wholly from brimstone, or to sulphuric acid specially purified for laboratory purposes. 5. In cases where a maker of sulphuric acid has, in order to supply his customers, to purchase supplies of acid from a third party, it will be permissible for him, in so far as this is a departure from his normal procedure, to charge to his customers any extra cost of carriage thereby incurred.

The above maximum prices came into force on the 1st January, 1917.

Sulphur in pyrites: Results of co-operative work on the determination of —. H. C. Moore. J. Ind. Eng. Chem., 1916, 8, 1167—1170.

THE results obtained in 25 different laboratories by three different methods are tabulated and discussed. Allen and Bishop's method (this J., 1912, 919) gives much more concordant results than Lunge's method, and is recommended as an accurate method for the determination of sulphur in pyrites. It has been modified as follows to allow of using a smaller sample: 0.5495 gm. of the powdered sample, dried at 100° C., is treated with 6—8 c.c. of a mixture of 2 parts of bromine and 3 parts of carbon tetrachloride by volume, and left for 15 mins. in a tall covered beaker, with occasional shaking; 10 c.c. of concentrated nitric acid is then added and after standing for 15 mins., with occasional shaking, the mixture is heated below 100° C. until most of the bromine has been expelled, and then evaporated to dryness on a steam plate. The residue is treated with 10 c.c. of concentrated hydrochloric acid, the mixture evaporated to dryness, and the residue heated at 100° C. for $\frac{1}{2}$ —1 hour to dehydrate the silica, and then moistened with 1 c.c. of concentrated hydrochloric acid and heated with 50 c.c. or more of water until solution is complete. After cooling for 3—5 mins., 0.1 gm. of powdered aluminium is added and when reduction is complete the solution is filtered, and the residue washed nine times with hot water. The solution is treated with 2.5 c.c. of concentrated hydrochloric acid, then diluted to 650 c.c., and 50 c.c. of cold 5% barium chloride solution added slowly, without stirring, preferably in single drops at the rate of about 5 c.c. per minute. The mixture is stirred, allowed to stand for at least 2 hours, and the precipitate collected on a thick layer of asbestos in a Gooch crucible, using suction. After washing with cold water, the precipitate is dried and ignited.

Smoot's method (this J., 1912, 918) also gives good results but possesses no advantage over the above process and requires special apparatus. —A.S.

Potash from kelp in the United States. Board of Trade J., Dec. 14, 1916.

A PLANT on a commercial scale is to be set up by the United States Department of Agriculture for the conduct of experimental work in the production of potash from kelp, an appropriation of 175,000 dols. (about £36,000) having been made for this purpose. It is expected that the plant will be established in Southern California, either at Santa Barbara or Long Beach, and that constructive work will be begun soon after the site has been decided upon. The plans are for a plant capable of dealing with approximately 200 tons of wet kelp per day. The equipment will consist of drying kilns, distilling chambers, vats, handling machinery, etc. Electric power will probably be used for all mechanical operations, while heat for drying and distillation will be furnished by the use of crude petroleum. From the 200 tons of kelp treated daily about 5 tons of muriate of potash will be manufactured. The primary purpose of the plant will be to determine the most economical processes for producing potash from kelp and to work out methods for the recovery and utilisation of by-products. Numerous methods will be employed experimentally, but for the most part the Department of Agriculture will rely on distillation processes.

The area of the kelp beds along the United States Pacific coast is nearly 400 square miles. From this area, it is officially estimated, the annual cuttings, including two cuttings per annum off the coast of south-western California, would yield 59,000,000 tons of kelp from which 2,300,000 tons of potassium chloride could be produced.

Alunite deposits in Vancouver. C. H. Clapp. Bull. Imp. Inst., 1916, 14, 483—484.

A DEPOSIT of alunite at Kyuquot Sound, Vancouver, has been found to cover an area of 4½ acres and is estimated to contain 600,000 tons above sea-level. The rock contains 20—45% of alunite, 40—50% of quartz, up to 14% of sericite, a little diaspore, and usually some pyrite. Analysis of two samples showed 4.4 and 2.4% K₂O, and indicated that the alunite is of the sodic type. It is doubtful whether the deposit will prove to be of economic value as a source of alum.

Potassium chlorate: [Electrolytic] manufacture of —. A. G. Betts. Met. and Chem. Eng., 1916, 15, 627.

THE oxidation of potassium chloride to chlorate by electrolysis is determined largely by the nature of the materials of the electrodes. With most metals, a serious loss of the product results through reduction at the cathode. By using platinum electrodes and a small quantity of a soluble chromate in the electrolyte, as in the process of Inhoff, a very high current efficiency is obtained. A process devised by the author (U.S. Pat. 918,650 of 1909; this J., 1909, 529) for treating alkali chlorides obviates the use of platinum by employing carbon anodes and magnesium cathodes. A coarse diaphragm is preferably used so as to hinder the intermixing of anode and cathode liquors. The acid anolyte and alkaline catholyte thus obtained favour the preservation of the electrodes, while the conversion of hypochlorite into chlorate is accelerated, and the evolution of oxygen depressed, through the presence of acid in the anode liquor. The raw material used is felspar, which is ground, treated with lime, and lixiviated. The mixed chlorides are electrolysed and the potassium chlorate crystallised out. By using water power, potassium

chlorate can, in this way, be produced at the present time, at a cost of 6 to 7 cents (3-3½d.) per pound.—J. N. P.

Thiocyanates; Detection of —. L. J. Curlman and B. R. Harris. J. Amer. Chem. Soc., 1916, **38**, 2622-2629.

THE reaction between ferric chloride and a thiocyanate is a very sensitive test for iron but not so for thiocyanates, since the maximum coloration depends on the presence of an excess of thiocyanate. Moreover, arsenates, phosphates, tartrates, fluorides, and borates interfere with the reaction, ferrocyanides mask the red colour, and iodides, acetates, and nitrates yield colorations with ferric chloride similar to that given by a thiocyanate. A method recommended for the detection of thiocyanates depends on the fact that silver iodide is not attacked by hot 5% sodium chloride solution, whilst silver thiocyanate is converted into silver chloride and sodium thiocyanate by this treatment. The solution to be tested is rendered just alkaline with sodium hydroxide, then barium nitrate, calcium nitrate, and cobalt nitrate are added in excess in the order given (this treatment removes sulphides, cyanides, ferrocyanides, and other interfering substances), the mixture is boiled, 3 grms. of washed asbestos is added, and the solution filtered. The filtrate is acidified with nitric acid, silver nitrate is added, the mixture boiled, and the precipitate collected on a filter. The precipitate is washed, then boiled for 5 minutes with 10 c.c. of 5% sodium chloride solution, filtered, the filtrate evaporated to 4 c.c., acidified with a drop of 10% nitric acid and treated with 0.5 c.c. of 2N ferric nitrate solution. The coloration obtained does not afford a means of determining the quantity of thiocyanate present, especially in the case of relatively large amounts; between 25 and 250 mgrms. of thiocyanate there is no appreciable difference in the coloration. The quantity of mercuric chloride solution required to change the red colour to a definite brown tint furnishes, however, an approximate measure of the thiocyanate.—W. P. S.

Fluorine in soluble fluorides; Determination of —. J. G. Dinwiddie. Amer. J. Sci., 1916, **42**, 464-468.

A NEUTRAL solution of the fluoride is heated to boiling and powdered calcium sulphate is added; after standing for 1 hour, with frequent stirring, the precipitate, consisting of calcium sulphate and calcium fluoride, is washed several times by decantation and then collected on a filter. The latter consists of a disc of filter-paper fitted into the bottom of a perforated platinum crucible. The precipitate is now washed (the wash-water used should be saturated previously with calcium sulphate and calcium fluoride), then rinsed into an ordinary platinum crucible and the water evaporated; the disc of filter paper is, meanwhile, ignited on the crucible lid and the ash introduced into the crucible. The dry contents of the crucible are then heated at 300° C. for 1 hour, or until constant in weight, then sulphated, again heated at 300° C., and weighed. The increase in weight after sulphating is due to the replacement of two atoms of fluorine by the sulphuric acid radicle, and a simple calculation gives the quantity of fluorine present. The error of the method is about 0.1%.—W. P. S.

Perchlorates, periodates, persulphates, percarbonates, and perborates; Reactions for distinguishing between —. A. Monnier. Ann. Chim. Analyt., 1916, **21**, 237-240.

THE following reactions are given for the detection and identification of per-salts in aqueous solution, but the latter must be free from heavy metals,

vanadates, tungstates, molybdates, bichromates, and ferricyanides. *Perborates and percarbonates.* These salts give the general reactions for boric acid, carbon dioxide, and hydrogen peroxide. To detect their presence when mixed with borates and carbonates, a portion of the solution is treated with dilute potassium bichromate solution acidified with sulphuric acid; a blue coloration indicates that a percarbonate or perborate is present. To identify a perborate, a solution of chrome alum is treated with an excess of the solution to be tested, ether and dilute sulphuric acid are added, and the mixture is shaken gently; the ethereal layer is coloured blue. Percarbonates and hydrogen peroxide do not give this reaction. *Iodates and periodates.* To the solution is added a small quantity of chloroform and then titanium trichloride solution; a white precipitate is formed and iodine is liberated, giving a violet coloured solution with the chloroform. Titanium trichloride also liberates iodine from potassium iodide in the presence of chlorates or perchlorates, but in this case a white precipitate is not produced. The reaction with silver nitrate serves to distinguish periodates from iodates. If an alcoholic solution of benzidine is poured on the surface of the solution under examination, a brown zone appears in the presence of periodates but not with iodates. *Chlorates and perchlorates.* A portion of the solution is shaken with the addition of potassium bromide, chloroform, and titanium trichloride solution; chlorates liberate bromine and this gives a brown chloroform solution, but perchlorates do not give the reaction. Another portion of the solution is treated, drop by drop, with a 0.2% Methylene Blue solution; a violet precipitate, which detonates when heated on a piece of platinum foil, indicates the presence of a perchlorate. In testing for chlorates and perchlorates, iodides, if present, must be removed previously by treatment with silver oxide, and iodates and periodates by means of silver nitrate, the excess of the latter being then removed by the addition of potassium bromide. *Detection of bromates in the presence of chlorates and iodates.* To the solution is added manganous sulphate solution acidified with sulphuric acid; in the presence of a bromate, the solution is coloured violet, owing to the formation of manganic sulphate, and bromine is liberated. This reaction is not given by chlorates or iodates. *Persulphates.* In the absence of iodides and perchlorates, a rose-red precipitate is obtained when a persulphate is treated with Methylene Blue solution. Persulphates may be identified in the presence of perchlorates by pouring an alcoholic benzidine solution on the surface of the solution to be tested; a blue zone at the junction of the two liquids denotes the presence of a persulphate. A 2% aniline solution may be used in place of the benzidine solution.—W. P. S.

Oxidation-reduction reactions without the addition of acid. III. Ferrous chloride and potassium permanganate. A method for the preparation of colloidal hydrated ferric oxide. M. Neidle and J. N. Crombie. J. Amer. Chem. Soc., 1916, **38**, 2607-2613. (See also this J., 1915, 1089; 1916, 253.)

THE same stoichiometric relations obtain in the permanganate-ferrous sulphate and permanganate-ferrous chloride reactions whether or not acid is added. In the latter reaction the oxidation of the chloride ion is practically prevented by adding the permanganate gradually while the mixture is stirred; the products of this reaction are potassium, manganese, and ferric chlorides, and colloidal hydrated ferric oxide, whilst in the permanganate-ferrous sulphate reaction the corresponding sulphates are formed together with hydrated ferric

oxide which is precipitated by the sulphate ion. When 1 gram.-equivalent of permanaganate, dissolved in 600 c.c. of water, is added slowly to 1 gram.-equivalent of ferrous chloride, dissolved in 1 litre of water, and the resulting deep brownish-red solution diluted to 2 litres, the latter remains clear for several weeks, then gradually becomes more and more turbid, and a precipitate settles. Until the latter stage is reached, dialysis yields a perfectly clear brownish-red hydrosol of hydrated ferric oxide; after the precipitate has settled out, dialysis gives a hydrosol of hydrated ferric oxide which is slightly turbid in reflected light but clear in transmitted light.—W. P. S.

Calcium tartrate; Crystallisation of—. F. D. Chattaway. J. Amer. Chem. Soc., 1916, 38, 2519—2522.

WHEN a soluble calcium salt is added to a neutral solution of a soluble tartrate the compound which first separates, in fine needles if the solutions are sufficiently dilute ($N/5$ or less), is a hexahydrate. This is unstable at the ordinary temperature and is transformed even when in contact with water into the denser orthorhombic tetrahydrate, small crystals of which quickly appear amongst the needle-shaped crystals and grow at their expense. The change is much accelerated on warming.

—G. F. M.

Dehydration of some crystalline hydrates; A period of induction in the—. W. N. Rae. Chem. Soc. Trans., 1916, 109, 1229—1236.

AN initial period of induction in the dehydration of crystalline hydrates, during which the weight remains sensibly constant, has been previously observed, and certain of the determining conditions have now been investigated using copper sulphate pentahydrate and dehydrating over sulphuric acid. The state of division made no difference in the period of induction, which lasted about two days, after which a rapid loss of about 2 mols. of water occurred before the dehydration finally slowed down. The induction period was absent when specimens re-hydrated in the air were used, when the material was mechanically stirred, and also when it was inoculated with at least 1% of the trihydrate. On the other hand the induction period was lengthened by using copper sulphate crystallised from a dilute gum arabic solution, and by a reduction in temperature. Similar results were observed with other crystalline hydrates, and the theoretical aspect of the phenomenon is discussed, but no explanation is offered which can account for all the results.—G. F. M.

Tellurium; Behaviour of — towards hydrogen peroxide. G. Schluck. Monatsh. Chem., 1916, 37, 489—494. J. Chem. Soc., 1916, 110, ii., 615.

THE behaviour of tellurium towards hydrogen peroxide is found to depend on the physical condition of the element. Colloidal tellurium is acted on by very dilute solutions of the peroxide, whilst the crystalline modification only reacts slowly with 60% hydrogen peroxide at 100° C. The rate of dissolution increases with the amount of telluric acid formed. Amorphous tellurium, precipitated from hydrochloric acid solution by sulphur dioxide and dried at 105° C., behaves similarly to crystalline tellurium, but if the amorphous variety is dried by treatment with alcohol and ether, it dissolves quite readily in concentrated hydrogen peroxide solutions.

Recovery of fats and nitrogen compounds from sewage. Rideal. See XIXb.

Fume poisoning from nitric acid and mixed acid. De Blois. See XIXb.

Boiling method for the determination of soluble arsenic in lead arsenate. Gray and Christie. See XIXb.

Quantitative determination of small quantities of sulphate. Hamburger. See XXIII.

Methylene Blue as a reagent in chemical analysis. Application of the process to the detection and determination of perchlorate in Chili saltpetre. Monnier. See XXIII.

PATENTS.

Electrolytic cells [for decomposing nitrates]. H. C. Jenkins, and C. I. (1914) Syndicate, Ltd., London. Eng. Pat. 16,643, Nov. 25, 1915.

AN electrolytic cell of the bell type (see Eng. Pat. 25,415 of 1913; this J., 1914, 1906), for the decomposition of nitrates, is arranged so that the electrodes almost fill the interior of the bells, and the electrolyte within the bells is maintained under a reduced pressure. A high current density is employed, and each of the bells is heated externally by superheated steam or by other suitable means.—B. N.

Calcium cyanamide; Production of—. G. Tofani, Rome. Eng. Pat. 14,662, Oct. 16, 1915.

IN the production of calcium cyanamide from calcium carbide and air or nitrogen, the latter is purified by making it traverse a layer of filtering material, e.g., sand, quick-lime, carbon, bricks, asbestos, or layers of wire cloth or net of small mesh. The filter may surround and be in contact with the calcium carbide, or it may be placed in the tubes which supply the nitrogen.—E. H. T.

Calcium cyanamide; Process for the production of—. G. Tofani, Rome. Eng. Pat. 14,663, Oct. 16, 1915.

IN the manufacture of calcium cyanamide from calcium carbide and nitrogen, the reaction is started by embedding in the mass of pulverised carbide a freshly cast and still incandescent ingot of the carbide.—F. SODN.

Sodium perborate; Electrolytic production of—. Deutsche Gold- u. Silber-Scheideanstalt, vorm. Roessler, Frankfurt, Germany. Eng. Pat. 102,089, Mar. 1, 1916. (Appl. No. 3099 of 1916.) Addition to Eng. Pat. 100,152 (this J., 1916, 1261).

THE cathodes composed of iron, copper, or other materials with a hydrogen potential practically equal to zero, are protected by metallic nickel at the points of exposure to the electrolytic liquid and air.—E. H. T.

Active oxygen; [Alkali perborate] compound containing — and process of making same. O. Liebknecht, Frankfurt, Germany, Assignor to The Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,200,739, Oct. 10, 1916. Date of appl., Dec. 24, 1913.

AN alkali perborate is combined with the carbonate of a "basic metal" other than an alkali metal. For example, an alkali carbonate is generated in a mixture yielding an alkali perborate, and the mixture is then allowed to react with a soluble compound of an alkaline-earth metal. The product is claimed to be stable.—F. SODN.

Limckiln. A. Zimmerman, York, Pa., Assignor to L. M. Palmer, Brooklyn, N.Y. U.S. Pat. 1,199,856, Oct. 3, 1916. Date of appl., Feb. 25, 1915.

A STACK, divided into feed, combustion, and discharge zones, has a number of gas inlets around the surface of the inner wall, on a level with the bottom of the burning zone, and a number of air

inlets entering the discharge zone at spaced intervals around its inner face and spaced from and beneath the gas inlets. The combustion and discharge zones are preferably divided into chambers into which gas and the main portion of air are introduced as above, whilst the discharge zone has an opening at the bottom through which also air may enter the stack; the air inlets, which may be open to the atmosphere at their outer ends, should not be in vertical alignment with the gas inlets.—F. SODX.

Line: Process and apparatus for hydrating—.

A. M. Schofield, Amherst, Ohio, U.S. Pats. (A) 1,204,699 and (B) 1,204,700, Nov. 14, 1916. Dates of appl. (A) Jan. 31 and (B) June 12, 1916.

(A) QUICKLIME is slaked in a container, through which the materials are passed at a uniform speed. The steam evolved near the intake end is retained under pressure, and that evolved near the outlet is led away and used for heating the water that is required for further slaking. (B) The container is furnished with means for admitting lime and water and for discharging the slaked product. A heat-retaining jacket is placed on the container near the intake end, and a water jacket, fitted with inlet and exit pipes, on the other end.—E. H. T.

Bleaching powder: Machine for making—.

I. Ishikawa, Tokio, Japan, U.S. Pat. 1,200,499, Oct. 10, 1916. Date of appl. Jan. 8, 1916.

A SERIES of superposed tubes, communicating with each other at opposite ends, is provided with means for introducing lime into the top tube and causing it to travel through each tube in succession, in opposition to a current of gas which is admitted into the bottom tubes. The bottom tube is fitted with a device for sifting the product, and there are means for filtering the gas which has passed through the tubes. The tubes are preferably arranged in sets of three, and mounted in each tube is a shaft with agitators and scrapers (adjacent the ends of the tube), the shafts of each set being rotated by chains actuated from a common source.—F. SODX.

Alkali-metal [potassium] compound from silicates [felspar]: Process of obtaining—.

W. A. Schmidt, Assignor to International Precipitation Co., Los Angeles, Cal. U.S. Pat. 1,200,887, Oct. 10, 1916. Date of appl. Feb. 18, 1915.

THE mineral is heated in the presence of an alkaline earth (e.g., lime) and of hot gases, preferably containing sulphur dioxide, so as to volatilise and carry off potassium compounds, which are then condensed and precipitated by cooling the gases sufficiently and subjecting them to the action of an electric field; or, the gases may be subjected to a series of successive precipitating actions in electric fields, in order to throw down dust and other suspended impurities before precipitating the particles of potassium compounds.—F. SODX.

Ammonia: Process of hydrogenating organic materials and of producing—.

C. Ellis, Montclair, N.J., U.S. Pat. 1,201,226, Oct. 10, 1916. Date of appl. July 1, 1914.

THE material to be hydrogenated is treated with a gas containing hydrogen, in presence of a catalyst which contains a hydrogen-occluding metal, such as nickel, and a nitrogen-occluding solid non-metallic element capable of forming a hydride, e.g., boron, parts at least of the metal and non-metal being chemically combined with each other. Ammonia is produced by bringing nitrogen and hydrogen into contact with such a catalyst.

—F. SODX.

Liquefaction and rectification of air: Apparatus for the—.

H. Filippo, jun., P. Schoonenberg, and Naamlooze Vennootschap Philips' Metaal-Gloeilampenfabriek, Eindhoven, Holland, Eng. Pat. 101,860, Jan. 20, 1916. Under Int. Conv., Oct. 16, 1915. (Appl. No. 949 of 1916.)

COMPRESSED air, cooled by passing through a heat-exchanger, is passed downwards through a tubular rectifying column and a bath of boiling oxygen situated at the base. The liquefied air flows over into a higher part of the column the interior of which consists of an inner column or chamber provided with bubbling devices and draw-off pipes at various levels. In this chamber the oxygen containing argon is separated into a purer oxygen and a gas rich in argon which can be used for filling electric lamps.—E. H. T.

Oralic acid: Process of producing—.

E. von Portheim, Prague, Austria-Hungary, U.S. Pat. 1,205,493, Nov. 21, 1916. Date of appl. Mar. 27, 1916.

SEE Eng. Pat. 14,234 of 1915; this J., 1916, 889.

Chlorates of alkali metals: Manufacture of—.

A. E. Gibbs, Wayne, Pa., U.S.A., Eng. Pat. 13,452, Sept. 21, 1915. Under Int. Conv., May 5, 1915.

SEE U.S. Pat. 1,173,346 of 1916; this J., 1916, 469.

Alkali chlorates and perchlorates: Manufacture of—.

A. E. Gibbs, Fr. Pat. 479,833, Sept. 25, 1915.

SEE U.S. Pat. 1,173,346 of 1916; this J., 1916, 469.

Electrolytic apparatus for producing solutions for bleaching and other purposes—.

A. Holliday and G. E. Ward, Fr. Pat. 480,451, Dec. 15, 1915.

SEE Eng. Pat. 1672 of 1915; this J., 1915, 622.

Phosphorus sulphides: Process for producing—.

Fr. Pat. 479,992, Oct. 13, 1915.

SEE U.S. Pat. 1,153,051 of 1915; this J., 1915, 1055.

VIII.—GLASS; CERAMICS.

Optical glass: A precision method of uniting—.

The union of glass in optical contact by heat-treatment. R. G. Parker and A. J. Dalladay, Faraday Soc., Dec. 18, 1916. [Advance proof.] 8 pages.

THE cements available for uniting pieces of glass in the construction of cells and optical instruments have numerous defects. These can be wholly avoided by accurately cutting and polishing the two glass surfaces which it is desired to unite, placing them in optical contact under moderate pressure, then heating them very slowly to about 70°–80° C. below the true annealing temperature of the glass (e.g., to 150°–550° C.) and keeping them at this temperature for 1½ hours or longer. Glasses of different composition unite perfectly if their annealing temperatures do not differ by 50° C. The annealing temperature is ascertained by placing a piece of the glass having two plane, parallel and polished sides in an electric furnace and observing the temperature at which the strain caused by unequal heating (rendered visible by changes in the intensity of polarised light transmitted through the glass) disappears. When this process of uniting glasses is used all the optical surfaces remain quite free from deformation, little internal stress is observable, and almost perfect parallelism between the sides of glass cells can be readily secured. When the pieces are properly united and force is applied to separate them, pieces of one are removed with the other and a crack or cut spreads through the two pieces as through one piece of glass. Rayleigh cells and polarimeter tubes, of soda-lime glass, with windows

of plate glass, produced by this process are convenient on account of ease of cleaning and freedom from corrosion. The process appears to be equally applicable to articles made of fused silica, the annealing temperature of this material being about 1100°C .—A. B. S.

Refractories; A carbon tube furnace for testing the softening points and compressive strengths of —.

E. and E. A. Griffiths. Faraday Soc., Dec. 18, 1916. [Advance proof.] 9 pages.

THE furnace described has a vertical carbon tube 2 in. outside diam., $1\frac{1}{2}$ in. inside diam., and 11 in. long, with a longitudinal slot, $\frac{1}{4}$ in. wide, for observation purposes, extending the whole distance between the electrodes. This tube is surrounded by a cylinder of crude zirconia and the latter by one of magnesia-asbestos lagging, 3 in. thick. A sheet-iron casing 12 in. diam. with end-plates of asbestos slate boards encloses the whole. Pressure up to 150 lb. per sq. in. may be applied to the test-piece by means of two spiral springs of equal length attached to a cross bar which can be screwed up and down by a handwheel. These springs act on the cross-head of a vertical plunger which applies the pressure to a small carbon rod lying on the test-piece. The amount of pressure is shown by a vertical scale. The electrodes are made by bending a copper tube into a zig-zag form for each half electrode, fitting this into a mould made of sheet iron with the carbon cylinder of the electrode as a core, and pouring in white bearing metal so as to fill in the intervening space and so produce a casting which gives perfect contact between the copper cooling tube to which the electric cables are attached and the carbon tube. One of the electrodes must have sufficient flexibility to enable the carbon tube to expand and contract freely. The furnace is heated by an alternating electric current of about 350 amps. The test-piece is a cylinder, $\frac{5}{8}$ in. diameter and 1 in. long, made by grinding a piece of the sample to the required size and shape. It is supported on a carbon rod. During observations a current of nitrogen is passed through the furnace to ensure freedom from dust and fog and a neutral atmosphere. A temperature of 3000°C . can be maintained for short periods, but above 1700°C . it is impossible to avoid particles of carbon being shot off the tube on to the test-piece. The temperatures were estimated by matching the light from the test-piece with that from a lamp through which a constant current was passed. Bibliographies on electric furnaces, the melting points and softening points of refractory materials under load, and products of electric furnaces are given.—A. B. S.

IX.—BUILDING MATERIALS.

Portland cement; Slow volume changes in —.

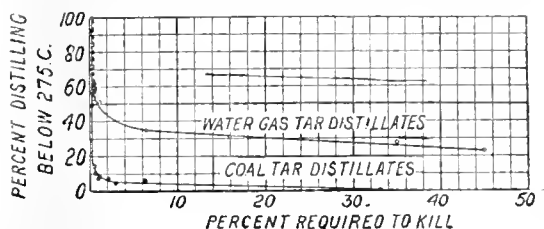
E. D. Campbell. J. Ind. Eng. Chem., 1916, 8, 1101—1102.

SOME of the test-bars used in a previous investigation on the effect of free lime and magnesia on the constancy of volume of Portland cement (see this J., 1906, 1097) have been kept under water for further periods, extending in some cases up to 13 or 14 years, and then again examined. The results are tabulated. They confirm the conclusions previously drawn as to the injurious effect of free magnesia. Attention is drawn to two test-pieces, both containing about 7% total magnesia, but one somewhat more finely divided and with a lower basic ratio than the other. The more finely divided cement passed all the ordinary tests

and even after immersion for 13—14 years had not expanded to any extent likely to be dangerous, but the other cement—similar to the first except that it had a slightly higher basic ratio (280:2 mols. CaO as against 270:7 mols. CaO per 100 mols. SiO_2) and was somewhat coarser—gave very nearly double the amount of expansion after the first year. If raw material high in magnesia is used, much greater care in manufacture is required to obtain a satisfactory product than when purer raw material is used.—A. S.

Cresote oils [for wood preservation]; Relation between toxicity and volatility of —. E. Bateman. J. Ind. Eng. Chem., 1916, 8, 1094—1095.

DIFFERENT coal-tar cresotes and water-gas tar cresotes were tested as to their toxicity against *Fomes annosus*, and it was found that if the



toxicity (per cent. required to kill the organism under definite conditions) be plotted against the volatility (per cent. distilling below 275°C .), two regular curves are obtained (see fig.). The relationship between the toxicity and volatility is so regular that if the authenticity of an oil is without question, its toxicity can be predicted accurately from the result of a distillation test. The results indicate that the toxicity of coal-tar cresote is largely due not to hydrocarbon oils and solids but to high-boiling tar acids and bases; and that it might be possible to determine the purity of tar oils by some such test as the Rideal-Walker test on the high-boiling fractions.—A. S.

PATENTS.

Cement or hydraulic lime; Manufacture of —. L. P. Basset, Montmorency, France. Eng. Pat. 22,614, Nov. 17, 1911. Under Int. Conv., Nov. 18, 1913. Addition to Eng. Pat. 17,873, Mar. 4, 1913.

SEE Addition of Nov. 18, 1913, to Fr. Pat. 466,518 of 1913; this J., 1915, 1091.

Cement; Water-tight — and process of producing the same. A. M. H. Hansen and M. C. J. Neve, Hamburg, Germany. U.S. Pat. 1,205,735, Nov. 21, 1916. Date of appl., Jan. 23, 1913.

SEE Fr. Pat. 453,751 of 1913; this J., 1913, 753.

Metal coating on cement mortar plaster, gypsum, trass, etc.; Process for forming a —. L. A. and A. J. Sanders. Fr. Pat. 479,965, Oct. 8, 1915.

SEE Eng. Pat. 14,226 of 1915; this J., 1916, 1111.

Asphalt cement; Manufacture of — from natural asphalts. Barber Asphalt Paving Co. Fr. Pat. 480,271, Nov. 19, 1915.

SEE U.S. Pat. 1,163,593 of 1915; this J., 1916, 118.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Sulphur in iron and steel; Determination of —.
H. B. Pulsifer. J. Ind. Eng. Chem., 1916, 8, 1115—1123.

THE methods for the determination of sulphur in iron and steel are classified and discussed, and a bibliography covering 285 original articles dating from 1797 onwards is given. The effect of the segregation of sulphur in the metal is emphasised and it is shown that the material used for analysis should be capable of passing an 80-mesh screen in order to correct the effect of segregation. The author has compared the method of oxidising with nitric acid, Bamber's method (this J., 1894, 665), and the chloric acid method (this J., 1901, 1162) on 22 samples ranging from 0.008 to 0.25% S, making in all 238 determinations. The nitric acid method gives good results, and it was found that moderate amounts of hydrochloric acid do not appreciably increase the solubility of barium sulphate in the ferric chloride solution. Bamber's method is liable to give high results, but if carried out in a special laboratory free from dust and fumes, the results agree almost exactly with those obtained by the nitric acid method. The chloric acid method usually gives results intermediate between those furnished by the other two methods and has the advantage that it is possible to precipitate the barium sulphate in 20 minutes from the time the sample is weighed out.—A. S.

Iron: Do equiatomic solutions in — possess equal resistances? E. D. Campbell. Faraday Soc., Dec. 18, 1916. [Advance proof.] 8 pages. (See also this J., 1916, 1018.)

INVESTIGATION was made with very pure basic open-hearth, hypoeutectoid and eutectoid steels, the specific resistances of which were determined after quenching, tempering, and annealing. The values found differed considerably from those calculated by means of Benedicks' formula (this J., 1902, 1031), and the differences were inexplicable on the assumption that equiatomic concentrations of carbon produce equal effect on the specific resistance. From the results obtained, and by analogy with aqueous solutions, it is suggested that equimolecular concentrations of carbides in solution exert equal influence on the specific resistance of steels. The results are regarded as confirming Benedicks' assumption that the total specific resistance of steel is made up of two components, due to the solvent and solute respectively; and as indicating almost conclusively that the increase in specific resistance with increased temperature of measurement is due almost entirely to the increase in specific resistance of the solvent, that of the solutes in solid solution being very slightly, if at all, affected by temperature.—W. E. F. P.

Steel: Grain-growth in deformed and annealed low-carbon —. R. H. Sherry. Faraday Soc., Dec. 18, 1916. [Advance proof.] 15 pages.

THE formation of coarse grains in low-carbon steels occurs after limited permanent deformation and subsequent annealing within certain temperature ranges. In the present investigation, various commercial low-carbon steels were subjected to forging, hot rolling, cold drawing, cold pressing, etc., and then examined for size of grain; the amounts of deformation were measured by determining the reduction of area in each case. The deformation limits within which grain growth occurred were found to correspond to reductions of area between about 7 and about 25—30%; and

the annealing range to be 650—900° C. Within these limits, the greater the strain imposed the smaller was the grain size produced by annealing; but when the strain was less than a certain or "critical" amount (corresponding to a reduction of area of about 9%), the annealing range within which the grain growth occurred appeared to be limited by thermal critical points at about 690° and 780° C. Grain growth was suppressed by the presence of carbon, this effect being very pronounced in steels containing 0.15% C, although negligible in those of very low carbon content; no appreciable grain growth occurred in steels containing above 0.18% C.—W. E. F. P.

"Invar": Modifications in the dilatibility of — produced by mechanical and thermal treatment. C. H. Guillaume. Comptes rend., 1916, 163, 651—658.

FOR commercial uses, "invar" (a nickel steel containing approximately C 0.5, Mn 0.5, Ni 36%) is usually rolled at a cherry-red heat and cooled in air. The present investigation was made to determine the effects of annealing, quenching, and cold working on the dilatibility of the alloy as ordinarily supplied. The coefficient of expansion was increased by annealing for several hours at 900° C. and cooling in air or in the furnace, and decreased by quenching in water, the range of variation from these causes being 1.18×10^{-6} . By cold drawing the annealed or quenched alloy, the dilatibility was rapidly decreased, the combined effects of the thermal and mechanical treatments being to reduce the original coefficient of expansion by 2.18×10^{-6} . The dilatibilities of quenched rods and cold drawn wires, already 0.49×10^{-6} and 1.50×10^{-6} below that of the alloy as commercially supplied, were increased by 0.42×10^{-6} and 0.80×10^{-6} respectively, by prolonged heating at temperatures up to 250° C.; whereas the dilatibility of the alloy in the "natural" (as supplied) or annealed condition was scarcely affected by this treatment. From the results obtained it is concluded that the effect of cold drawing on the dilatibility of commercial "invar" is practically neutralised, and the alloy stabilised as far as geodetic requirements are concerned, by prolonged heating at 100° C.—W. E. F. P.

Copper: Restrictions on the use of and dealing in —.

THE Minister of Munitions has made the following Orders under date 8th December:—

A.—Restrictions on the use of copper. The use of copper, whether wrought or unwrought, in any kind of manufacture is prohibited, except for the purposes of a contract or order for the time being in existence certified to be within Classes "A" or "B" of Circular L 33 as to control of output issued by the Minister of Munitions on 31st March, 1916.

The Order of 6th November relating to the manufacture of copper wire and cable containing copper is cancelled.

All applications in reference to this Order should be addressed to the Ministry of Munitions of War, Priority Branch, 1, Caxton Street, Westminster, London, S.W.

B.—Restrictions on dealing in copper. 1. No person shall as from the date mentioned buy, sell or, except for the purpose of carrying out a contract in writing existing prior to such date, enter into any transaction or negotiation in relation to the sale or purchase of copper of any class whether wrought or unwrought situated outside the United Kingdom unless such person is authorised by a special permit from the Minister of Munitions to purchase or sell the same.

All applications for special permits should be made to the Director of Materials, Armament Buildings, Whitehall Place, London, S.W., and marked "Copper Permit" and all persons to whom such permits are granted should observe and perform all the conditions subject to which such permits may be granted.

2. All persons, except as mentioned below, shall send in to the Director of Materials, Armament Buildings, Whitehall Place, London, S.W., not later than 16th December, returns of:—

- (a) All unwrought copper held by them in stock or otherwise under their control at the above-mentioned date.
- (b) All unwrought copper due for future delivery to them at the above-mentioned date.
- (c) All contracts existing for the sale to or purchase by them of unwrought copper at the above-mentioned date.

Notwithstanding the above, no return is required from (1) any manufacturer or smelter of stock in hand or due for future delivery for the sole purpose of manufacture or smelting at his works, or (2) any person whose total stock in hand and due for future delivery does not exceed two tons.

Copper; Commandeering of —.

ACCORDING to an Order issued on January 2nd, the Minister of Munitions takes possession until further notice, upon specified terms, of all unwrought copper, including copper scrap and swarf, in any form whatsoever, subject to the following exceptions:

(A) Rough copper, copper ore, and copper scrap and swarf in the possession of, or due under an existing contract in writing for future delivery to, a smelter or refiner for the purpose of conversion into refined metal.

(B) All copper, including copper scrap and swarf, in the possession of or due under an existing contract in writing for future delivery to a manufacturer for use in such manufacturer's own works.

(C) Copper scrap and swarf specially excepted under the written authority of the Minister of Munitions.

If any person having control of any metal to which this notice applies, without the consent of the Minister of Munitions, sells, removes, or secretes it, or deals with it in any way contrary to any conditions imposed in any license or permit that may have been granted in respect thereof, he will be guilty of an offence against the Defence of the Realm (Consolidation) Regulations, 1914.

All existing licenses issued by or on behalf of the Minister of Munitions for dealing in any scrap or swarf to which this notice applies are cancelled.

The Minister of Munitions requires every smelter or refiner to make a return to the Director of Materials at the end of each calendar month, including the month of December, 1916, of the total quantities of refined copper of each description in stock, distinguishing between: (1) that sold for use on Class "A" or Class "B" work; (2) that allocated for such use in his own works; and (3) the residue not so sold or allocated; and he further requires every maker and holder of copper scrap or swarf to make a return to the Director of Materials at the end of each calendar month, including the month of December, 1916, of the total quantities of each class of such scrap or swarf in stock distinguishing between: (1) that sold for use on Class "A" or Class "B" work; (2) that allocated for such use in his own works; and (3) the residue not so sold or allocated.

All applications with regard to this order should

be addressed to the Director of Materials, A.M.2B., Armament-buildings, Whitehall Place, London, S.W., and marked "Copper Permit."

Copper concentrates; Possibilities in the wet treatment of —. L. Addicks. Met. and Chem. Eng., 1916, 15, 628—630.

CHALCOPYRITE and chalcocite concentrates are calcined and leached with dilute sulphuric acid which is recovered from the gases evolved during roasting. The percentage extraction of copper by leaching varies according to the degree of calcination; it may amount to over 90%, and the iron content may be lowered to 10%. The smaller the size of the particles, the more complete is the elimination of sulphur during the roasting and the higher the extraction of copper on leaching. A calcined product containing 15% copper, leached in a V-trough with a solution containing 5.6% of free sulphuric acid at a temperature of about 125° F. (52° C.), gave a residue at the end of the trough containing 8% copper. With efficient agitation during leaching, this was reduced to 3.5% Cu. The copper and silver still remaining can be dissolved by again roasting the residue in presence of salt, and leaching the chloridised product as before. The copper, silver, and gold in solution can be recovered by displacing with iron, by electrolysis, or by a combination of these methods.—J. N. P.

Zinc ores; Removal of iron from —. Min. and Eng. World, 1916, 45, 987.

THE presence of large percentages of iron in zinc concentrate has been a source of considerable trouble in certain districts. According to a method worked out in the University of Utah, the mixed zinc and iron sulphides are treated in a reducing atmosphere at 600° C., whereby the pyrites is converted into a form in which it will react with dilute sulphuric acid whilst the zinc sulphide remains unattacked. The requisite amount of cheap acid to ensure the success of the process will be obtainable by utilising the smelter gases.

Lead of radioactive origin; Atomic weight of —. T. W. Richards and C. Wadsworth. J. Amer. Chem. Soc., 1916, 38, 2613—2622.

FOUR samples of radio-lead from different sources had the following atomic weights:—From Colorado carnotite, 207.00; from Australian carnotite, 206.34; from Norwegian bröggerite, 206.12, and from Norwegian cleveite, 206.08. A specimen of ordinary lead had an atomic weight of 207.18. No new lines were observed in the ultra-violet or visible spectra of any of the specimens. The magnitude of the radioactivity of the leads did not bear any relation to the lowering of the atomic weight. (See also this J., 1916, 363, 1020.)

—W. P. S.

Tungsten ore exports from Malaya. Board of Trade J., Dec. 21, 1916.

THE total quantity of tungsten ores exported from the Federated Malay States in 1915 amounted to 291 tons, as compared with 261 tons in 1914 and 225 tons in 1913, most of this being ore containing less than 65% of tungstic acid. In addition to these exports, tungsten ores aggregating 407 tons were imported from other countries in 1915 and re-exported after treatment at separating works in the States. The value of wolfram alone exported from the Federated Malay States in 1915 was £32,174.

The quantities of wolfram imported into the Straits Settlements from the undermentioned territories during 1913—15 were as follows:—

	1913.	1914.	1915.
	Tons.	Tons.	Tons.
Burma	115	28	22
British Malay States	268	230	220
Siam	270	179	266
Netherlands East Indies	—	—	18

The value of the total exports of wolfram from the Straits Settlements in 1915 was £69,200, as against £51,130 in 1914 and £71,638 in 1913. The principal countries to which these exports were consigned are shown in the following table:—

	1913.	1914.	1915.
	Tons.	Tons.	Tons.
Belgium	21	—	—
France	129	103	183
Germany	327	307	—
United Kingdom	5	76	400

The excess of exports over imports is not due to the mining of wolfram in the Straits Settlements, but to its extraction from the tin ore sent for treatment to the large tin-smelting establishments in the Colony.

Scheelite production in New Zealand. Chem. Trade J., Dec. 30, 1916.

SCHEELITE is found in several sections of New Zealand in the neighbourhood of the gold mines both in the North and South Island, and has of late been quite extensively mined. The output has increased from 58 long tons, valued at £1200, in 1909, to 135 tons, valued at £13,000, in 1912, and to 194 tons, valued at £27,000, in 1915. Since September, 1915, the British Government have requisitioned all supplies of scheelite and other ore containing tungstic acid, and from that date all exports to other markets have been prohibited. It was reported in the latter part of 1915 that a large body of scheelite was located in the eastern part of the North Island in the Hawke's Bay district.

Tungsten and molybdenum ores in Tasmania. Bull. Imp. Inst., 1916, 14, 487—188.

ACCORDING to recent publications of the Geological Survey of Tasmania, promising deposits of molybdenite occur at Mount Stromach and Constable's Creek; deposits have also been observed near Lottah and at Upper Scamander, and in the Middlesex and Mount Claude districts. It is considered possible that the production of molybdenite may be profitable, though the amount in the ore is very small. There are important wolframite mines in the Middlesex and Mount Claude districts of Northern Tasmania; the total output is estimated at about 350 tons of concentrate containing 70% of tungstic acid. The present rate of output is about 6 tons of wolframite per month. Wolframite also occurs near Lottah, at Constable's Creek and Upper Scamander, and at Gipp's and Story's Creeks. Mining is at present confined to the last two localities, the output being about 12 tons of mixed tin and tungsten concentrates a month, of which about 7 tons consists of wolframite. It is estimated that the Story's Creek deposits can be worked to yield from 8 to 10 tons of wolframite per week.

Tungsten; Preparation of lamps of —. D. Kremer. Diss., Tech. Hochschule, Aachen. Engineering, 1916, 102, 623.

POWDERED tungsten was alloyed with manganese and the alloy heated in the electric arc to volatilise

the manganese. The product had a conchoidal fracture, and contained 97% W, 1.6% Mn, and small amounts of iron, silicon, and carbon. It was not possible to obtain lumps weighing more than 50 grms. by this method. When larger masses of metal were used, the arc heating period was so extended that the tungsten was oxidised. Tungsten will not dissolve in calcium, aluminium, or magnesium, nor will it alloy with copper or tin, but it forms both solid solutions and compounds with metals of the iron group and also with platinum.

Thermo-electricity and thermal conductivity of metals; A new effect, relative to the —. C. Benedicks. Comptes rend., 1916, 163, 751—753. (See also this J., 1916, 362.)

THE proportionality between the thermal and electrical conductivity of metals, as enunciated by Drude, is invalidated by the fact that a homogeneous metal when heated unequally generates electric currents which cause a considerable transport of heat. This is proved experimentally, and it is also shown that the thermal conductivity of metals is not independent, as hitherto supposed, of the dimensions of the sample. A bundle of thinly insulated copper wires was found to have a considerably lower thermal conductivity than massive metal of the same section, though the electrical conductivity remains the same.—J. N. P.

Results of co-operative work on determination of sulphur in pyrites. Moore. See VII.

PATENTS.

Furnace for fusion of metals and alloys; Recuperative crucible —. A. Hermansen, Ingelstad, Sweden. Eng. Pat. 15,887, Nov. 10, 1915. Under Int. Conv., Nov. 16, 1914.

A RECUPERATIVE crucible furnace, heated by gas from a producer beneath, has a vertical burner at the middle of the floor of the heating chamber. Air for combustion is preheated by the recuperator, and secondary air is delivered partly beneath and partly into the burner, while the products of combustion pass through channels in the outer wall of the furnace into a surrounding annular passage and thence to the recuperator. A chamber for collecting any waste metal falling through the burner is situated immediately below the latter, and means are provided for preventing the entry of such metal into the recuperator.—W. E. F. P.

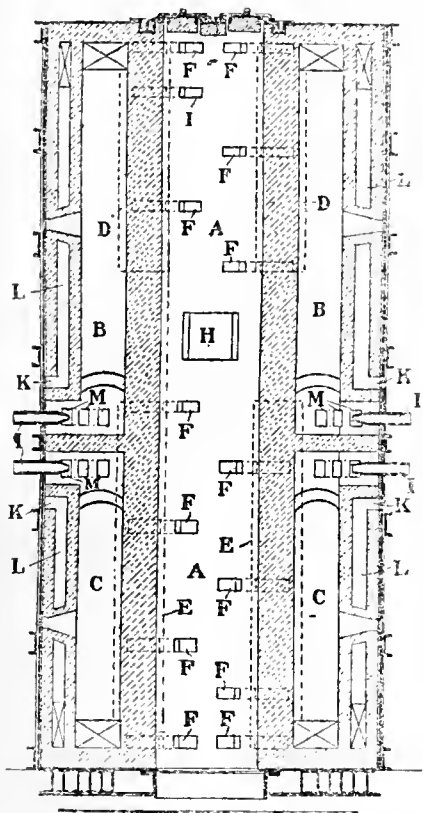
Furnace for melting metals [brass, gun-metal, etc.]. H. N. Davis and W. R. Twigg, Luton, Beds. Eng. Pat. 16,110, Nov. 15, 1915.

THE metal to be melted is charged through a fire-clay tube extending below the surface of the molten metal nearly to the bottom of the closed melting chamber or crucible, the latter having an external spout for discharge by overflow or being provided with other discharging means. (Reference is directed in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pat. 15,165 of 1910; see U.S. Pat. 950,880; this J., 1910, 436.)—W. E. F. P.

Furnace for heating, hardening, tempering, annealing, carbonising, and other processes. A. Smallwood, London. Eng. Pats. 16,309, Nov. 19, 1915, 102,212, Nov. 19, 1915 (Appl. No. 12,200 of 1916), and 102,213, Nov. 19, 1915 (Appl. No. 12,201 of 1916).

THE furnace comprises an elongated vertical heating chamber, *a*, with combustion chambers,

b, c, in the walls, extending in opposite directions and heated by gaseous or liquid fuel supplied by the nozzles, *i*. The combustion chambers, *b, c*, communicate, at the top and bottom respectively, with flues, *d* and *e*, parallel to them, and these flues communicate with the chamber, *a*, by ports,



f, which may each be regulated by a movable bung. The air supply enters at *k*, and is heated by passing through flues, *l*, and thence through parallel return flues to the openings, *m*, close to the fuel nozzles, *i*. The heating chamber is closed at the bottom by a bung supported on a carriage which rests on rails. The rails are supported at their ends by links so that they may be lowered and the carriage and bung moved laterally. An annealing tank may be provided below the heating chamber, the intermediate space being completely enclosed. The mouth of the chamber is sealed by an annular sealing member carrying the bung, and the mouth of the tank is closed by a short, vertically movable tube carrying a similar annular sealing member.

—W. F. F.

Furnaces and the like; Gas fired melting — I. Hall, Birmingham. Eng. Pat. 102,174. Jan. 24, 1916. (Appl. No. 1072 of 1916.)

A FURNACE for melting metals is provided with atmospheric burners and pressure burners for alternative use. Both sets of burners are fed from a gas chamber of comparatively large capacity, and the pressure burners are also connected to a similar air distributing chamber. The burners are arranged in the furnace alternately, in the same horizontal plane, or they may be arranged in two series at different heights. —W. F. F.

Furnaces; Open-hearth regenerative — The Clyde Furnace Co. (A), Ltd., and W. Dixon, Glasgow. Eng. Pat. 102,234, July 22, 1916. (Appl. No. 10,341 of 1916.)

IN the repair of blocks of regenerative open-hearth

furnaces as described in Eng. Pat. 10,853 of 1913 (this J., 1913, 1116), the metal "centre" has an inclined slot at its inner end supporting a retaining plate which maintains the plastic repairing composition in position during its solidification. —W. F. F.

Furnaces heated by oil fuel for melting metals. J. Ward, A. P. Townsend, and R. G. Forgham, Birmingham. Eng. Pat. 102,278, Jan. 12, 1916. (Appl. No. 495 of 1916.)

An open-hearth metal melting furnace is mounted on two curved rockers which rest on two pairs of small rollers. The rockers carry toothed segments which engage with two spur wheels for tilting the furnace. A hydrocarbon burner is mounted at one end of the furnace so as to blow directly on the metal, and a waste gas outlet at the other end is connected to a flue passing under the furnace through which the air supply pipes pass to the burner. The oil supply pipe to the burner is heated by a jacket connected to a branch pipe from the main air supply pipe. (See also Eng. Pat. 22,789 of 1911; this J., 1916, 313.) —W. F. F.

Furnace; Crucible — H. Stokes, Birmingham. Eng. Pat. 102,092, Mar. 11, 1916. (Appl. No. 3672 of 1916.)

IN a crucible furnace the firebars are disposed across a rectangular, cast iron frame with relatively broad sides, and the brickwork is supported on a plate above and spaced apart from the frame. Air is supplied both above and below the grate from the ash-pit, and is also admitted above the frame through a front passage. When the furnaces are built in series, the spaces above all the grates communicate by means of a longitudinal air passage, and gaps are formed between the abutting ends of the frames. —W. E. F. P.

Zinc; Electro-deposition and extraction of — U. C. Tainton, London, and J. N. Pring, Chester. Eng. Pat. 16,336, Nov. 19, 1915.

ACCORDING to Eng. Pat. 7235 of 1911 (this J., 1912, 780) zinc was deposited in a lustrous, smooth, coherent form by the use of a high current density, which may amount to 600 amps. per sq. ft. of cathode, with an electrolyte having a high concentration of free acid, which may exceed 15%, and containing a small quantity of a suitable colloid. The present improvement relates to the winning of zinc from ores. For this purpose, where smoothness and lustre of the deposit are of little importance, it is found to be unnecessary in some cases to add a colloid to the electrolyte obtained by leaching the roasted ore. —J. N. P.

Copper; Precipitation of — A. Ramén, Helsingborg, Sweden. Eng. Pat. 100,588, May 18, 1916. Under Int. Conv., May 31, 1915. (Appl. No. 7119 of 1916.)

THE solution containing copper is placed in a closed container together with scrap metal such as iron or zinc. The container is then rotated or oscillated on a horizontal or sloping axis. When the precipitation of the copper is complete, steam or compressed air is admitted to the vessel and the contents are forced through a sieve which retains the scrap metal but allows the precipitated copper to pass through. The solution then passes to a filter-press or the like to separate the copper.

—J. N. P.

Copper; Process for treating — F. L. Antisell, Perth Amboy, N.J. U.S. Pats. (A) 1,204,925 and (B) 1,201,927, Nov. 14, 1916. Dates of appl., Feb. 16, 1911, and Nov. 1, 1912.

(A) PREHEATED copper is melted and then con-

ducted beneath a cover of boron trioxide or a non-metallic salt. (B) Copper melted under oxidising conditions is passed through or conducted beneath a layer of carbon or carbonaceous material.

—W. E. F. P.

Case-hardening compound. L. C. Mann, Stourport. Eng. Pat. 102,205, Mar. 24, 1916. (Appl. No. 4365 of 1916.)

A CASE-HARDENING compound is prepared by depositing barium carbonate on and in the pores of granules of charcoal. This precipitation can be brought about in the following ways:—(1) By treating the charcoal granules with a hot concentrated solution of baryta, and exposing to a stream of carbon dioxide; (2) by impregnating with barium carbonate held in solution by the action of carbon dioxide under pressure, and then expelling the excess carbon dioxide by removing the pressure and heating; (3) by treating with a soluble barium salt, such as the chloride, adding an alkali carbonate, and washing free from the alkali chloride; (4) by adding a hot solution of a soluble organic salt of barium which is converted into carbonate on heating.—J. N. P.

Welding: Process of — and composition therefor. J. A. Hope, Montreal, Canada. Eng. Pat. 102,237, July 26, 1916. (Appl. No. 10,548 of 1916.)

THE patent relates to the welding of a cutting edge of high-speed steel to a low-carbon shank in such a manner as to avoid the necessity of any separate process for rehardening the edge after the weld. The parts to be welded are heated to about 1500° F. (820° C.), and a welding mixture, consisting of ferro-silicon and burnt borax, together, in some cases, with ferro-manganese, is then applied to the prepared surfaces. The faces are brought together and submitted to a pressure of about 300 lb. for a few minutes. The joined parts are then raised to a temperature of from 2100° to 2500° F. (about 1150°–1370° C.), and removed to a press where they are subjected to a pressure of from 200 to 1000 lb., which is maintained until all "working" of the flux at the joint ceases. The high-speed steel edge is then immediately exposed to a cold air blast.—J. N. P.

Castling steel and other metals: Method and apparatus for —. R. and J. R. Hyde, Sheffield. Eng. Pat. 102,206, Mar. 24, 1916. (Appl. No. 4371 of 1916.)

Crucible furnaces: Lids or covers for —. J. and G. Keith, London. Eng. Pat. 102,365, June 22, 1916. (Appl. No. 13,060 of 1916.)

Electric welding: Method of —. D. H. Wilson, Franklin Township, N.J., U.S.A. Eng. Pat. 18,114, Dec. 29, 1915. Under Int. Conv., July 9, 1915.

SEE U.S. Pat. 1,187,410 of 1916; this J., 1916, 849.

Ores: Reduction of —. F. A. Eustis, Boston, C. P. Perin, and Moa Bay Iron Co., New York. Eng. Pat. 102,411, Feb. 23, 1916. (Appl. No. 2713 of 1916.)

SEE U.S. Pat. 1,185,187 of 1916; this J., 1916, 741.

Dental alloys or amalgams. T. J. Davis. Fr. Pat. 479,867, Sept. 28, 1915.

SEE Eng. Pat. 12,806 of 1915; this J., 1916, 850.

XI.—ELECTRO-CHEMISTRY.

Overvoltage tables. III. Overvoltage and the periodic law. E. Newbery. Chem. Soc. Trans., 1916, 109, 1107–1117. (See this J., 1916, 1265.)

CATHODIC overvoltage appears to be one of the definite periodic properties of the elements. Based

on the consideration of a large number of determinations the following are regarded as overvoltages typical of their respective groups: Group 0, nil; I., 0.35 volt; II., 0.70 volt; III., 0.50 volt; IV., 0.15 volt; V., 0.42 volt; VI., 0.32 volt; VII., 0.25 volt; VIII., 0.18 volt. A rise of voltage of two equal steps is thus observed from groups 0 to II., followed by a gradual fall through the rest of the table. Of the metals examined the only ones not appearing in their proper groups are cobalt and palladium, values for the former as low as 0.18 volt not having been obtained, whilst the latter shows values above and below. When, under different conditions, such as varying current density, and in acid or alkali, metals have overvoltages corresponding with more than one group, in nearly all cases compounds of these metals are known in which the metals shows a valency corresponding with the characteristic valency of all the groups in which it is placed. The anodic overvoltages do not show the same degree of regularity as the cathodic, owing to the greater complexity of the anions involved, and to the formation of stable oxides and peroxides in many cases.—G. F. M.

Electrolytic manufacture of potassium chlorate. Betts. See VII.

Carbon tube furnace for testing the softening point and compressive strength of refractories. Griffiths. See VIII.

PATENTS.

Galvanic [dry] batteries. G. L., and G. J. A. Fuller, London. Eng. Pat. 102,291, Feb. 28, 1916. (Appl. No. 2968 of 1916.)

THE excitant, such as ammonium and zinc chloride, forming the electrolyte, is mixed with gum tragacanth, tapioca, or the like, and the mixture baked in an oven to remove moisture and render the particles crisp. The dry material is packed in the usual manner in a zinc case around a carbon rod and manganese dioxide depolariser, and water added when the cell is to be used.—B. N.

Gaseous bodies; [Electrical] method and means for recovering certain constituents from —. W. A. Schmidt, Los Angeles, Cal., and L. Bradley, East Orange, N.J., Assignors to Research Corporation, New York. U.S. Pat. 1,201,906, Nov. 14, 1916. Date of appl., July 23, 1911.

A GASEOUS mixture containing suspended dust particles and constituents having different condensing temperatures, is subjected to an electrical discharge in an electric field to precipitate the dust, and then cooled by admixture of a cooler gas. The temperature is reduced to a point producing condensation of one constituent in the form of a cloud, and an electrical discharge is passed to precipitate this constituent. The process is repeated at lower and definite temperatures to form clouds of definite composition, and these are each treated in turn electrically, until the material having the lowest condensing temperature has been finally separated.—B. N.

Discharge of electricity into gases; Means for producing —. W. A. Schmidt, Assignor to International Precipitation Co., Los Angeles, Cal. U.S. Pat. 1,201,907, Nov. 14, 1916. Date of appl., June 17, 1915.

THE collecting electrode, in the electrical precipitation of suspended particles from gases, is made in the form of a pipe, through which the gas to be

treated is passed. The discharge electrode is formed of several smooth elongated conductor members, extending longitudinally through the pipe, connected together electrically but spaced apart to form a polygon, the intensity of the electric field adjacent to each conductor member being thus controlled by the influence of adjacent conducting members.—B. N.

Electrolytic battery. McKay Copper Process Co., Assignees of H. S. McKay, Norwich, Conn., U.S.A. Eng. Pat. 100,264, Jan. 26, 1916. Under Int. Conv., Apr. 9, 1915. (Appl. No. 1278 of 1916.)

SEE U.S. Pat. 1,182,096 of 1916; this J., 1916, 695.

Electrolytic cells; Replenishing — to maintain a constant level of electrolyte. W. S. Smith. Fr. Pat. 480,289, Nov. 20, 1915.

SEE Eng. Pat. 15,761 of 1915; this J., 1916, 608.

Electric furnace. Leeds and Northrup Co. Fr. Pat. 481,001, Feb. 19, 1916.

SEE U.S. Pat. 1,165,055 of 1915; this J., 1916, 261.

Carbon electrodes; Joining together ends of —. Soc. Franc. des Electrodes. Fr. Pat. 480,802, May 3, 1915.

SEE Eng. Pat. 18,222 of 1915; this J., 1916, 897.

Electric insulating materials; Manufacture of —. W. E. W. Richards. Fr. Pat. 481,093, Mar. 1, 1916.

SEE Eng. Pat. 3364 of 1915; this J., 1916, 608.

Electrolytic cells [for decomposing nitrates]. Eng. Pat. 16,643. See VII.

Electrolytic production of sodium perborate. Eng. Pat. 102,089. See VII.

Process for ageing wine. U.S. Pat. 1,204,669. See XVIII.

XII.—FATS; OILS; WAXES.

Esters of oleic acid and their hydrogenated products. C. Ellis and L. Rabinovitz. J. Ind. Eng. Chem., 1916, 8, 1105—1108.

THE methyl, ethyl, propyl, isobutyl, amyl, benzyl, and glyceryl esters of oleic acid were prepared. They were all liquid at the ordinary temperature, and yielded practically saturated products when hydrogenated in the liquid state, at an increased temperature, in presence of reduced nickel. Some of the characters of the esters and of their hydrogenation products are shown in the following table:—

Ester.	Acid value.	Iodine value.	Hydrogenation product.	
			M.pt., °C.	Iodine value.
Methyl oleate	1.3	87.0	37	0.4
Ethyl oleate	0.6	83.3	31	5.3
Propyl oleate	0.5	77.9	27	1.3
Isobutyl oleate	0.4	75.7	25	0.2
Amyl oleate	0.7	71.3	22	1.7
Benzyl oleate	0.7	62.3	28	6.3
Glyceryl mono-oleate	0.6	69.4	59	6.5

A product obtained by heating together equivalent proportions of aniline and oleic acid under a reflux condenser, had an acid value of 3.6, iodine value 69.5, and m.pt. 34° C. When hydrogenated it yielded a product of m.pt. 76° C. and iodine value 30.5.—A. S.

Recovery of fats and nitrogen compounds from sewage. Riled. See XIX.

PATENTS.

Fatty and other substances; Recovery of — from liquids. T. W. Barber. Fr. Pat. 480,343, Nov. 27, 1915.

SEE Eng. Pat. 23,711 of 1914; this J., 1915, 1061.

Waste liquors of oil works; Recovery of solid constituents from the —. D. A. Hansen. Fr. Pat. 480,492, Dec. 20, 1915.

SEE Eng. Pat. 17,915 of 1915; this J., 1916, 898.

[Soaps.] *Method of solidifying normally solid materials or compositions.* W. D. Richardson, Chicago, U.S.A. Eng. Pat. 100,138, Mar. 3, 1916. Under Int. Conv., Mar. 3, 1915. (Appl. No. 3241 of 1916.)

SEE U.S. Pat. 1,161,397 of 1915; this J., 1916, 186.

Process of hydrogenating organic materials and of producing ammonia. U.S. Pat. 1,201,226. See VII.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

PATENTS.

Rubber and the like; [Kneading] machine for —. S. C. Davidson, Belfast. Eng. Pat. 16,406, Nov. 20, 1915. Addition to Eng. Pat. 22,490, Nov. 13, 1914.

Rubber articles; Processes for eliminating porosity in —. Boston Rubber Shoe Co. Fr. Pat. 480,402, Dec. 7, 1915.

SEE U.S. Pat. 1,161,860 of 1915; this J., 1916, 264.

Celluloid or leather; Plastic substitute for —. S. J. Peachey. Fr. Pat. 480,301, Jan. 29, 1916.

SEE Eng. Pat. 1891 of 1915; this J., 1916, 479.

XV.—LEATHER; BONE; HORN; GLUE.

Hides and other animal by-products; Disinfection of — for importation into the United States.

JOINT Regulations have been drawn up by the Secretary of Agriculture and the Secretary of the Treasury of the United States, governing the certification and disinfection of hides, fleshings, hide cuttings, etc., for entry into the United States. The circular of the Treasury Department (T.D. 36, 754) containing these regulations, which took effect on Jan. 1st, 1917, is reprinted in the "Board of Trade Journal" of Dec. 21st, 1916, pp. 884—887.

Sumach; Indian —. Puran Singh, Indian Forest Bulletin No. 31, 1916.

SPECIMENS of the bark of Indian sumach (*Rhus*

colinus) from various localities, dried in the shade, contained from 8.25 to 20.86% of tannin. That giving the highest yield was collected in the rainy season, but on the whole the results appear to throw little light on the question of the best time for collection. In the case of the leaves, however, it seems clear that they should be collected in India in the autumn, after the rains, since specimens collected during this time contained from 18 to 22% (in one case 31%) of tannin, as against 6 to 13% in leaves collected during spring and summer. In winter the percentage falls. The leaves gathered in autumn thus compare favourably as regards tannin content with European sumach, which averages 18–20% tannin.

PATENTS.

Hides; Composition for treating — J. H. Yocum, East Orange, N.J., Assignor to The Clarendon-Yocum Co., Newark, N.J. U.S. Pat. 1,205,694, Nov. 21, 1916. Date of appl. Apr. 17, 1913.

SEE Fr. Pat. 479,771 of 1914; this J., 1915, 190.

Tanning hides and skins. E. W. Merry. Fr. Pat. 480,917, Feb. 10, 1916.

SEE U.S. Pat. 1,191,527 of 1916; this J., 1916, 935.

Leather and skins; Treatment of — for use in making gloves. Soc. Anon. des Gants Alexandre. Fr. Pat. 480,772, Apr. 21, 1915.

SEE Eng. Pat. 100,311 of 1916; this J., 1916, 935.

Artificial leather; Manufacture of — N. G. Scheuer. Fr. Pat. 480,809, Jan. 29, 1916.

SEE Eng. Pat. 100,038 of 1916; this J., 1916, 748.

Tanning process. H. Morin. Fr. Pat. 479,908, Oct. 22, 1914.

SEE Eng. Pat. 100,163 of 1916; this J., 1916, 854.

Tanning hides and skins; Process and apparatus for — E. Wilson. Fr. Pat. 480,998, Feb. 18, 1916.

SEE Eng. Pat. 3485 of 1915; this J., 1916, 60.

XVI.—SOILS; FERTILISERS.

Soils; Use of two indirect methods for the determination of the hygroscopic coefficients of — F. J. Alway and V. L. Clark. J. Agric. Res., 1916, 7, 345–359.

THE hygroscopic coefficient of a soil, *i.e.*, the maximum water content after exposing it in an air-dried state to a saturated atmosphere until equilibrium has been established, can be deduced from its maximum water capacity, but the values obtained are frequently so different from those which result from direct determinations that the method cannot be recommended. Quite satisfactory results are, however, obtained by calculating the coefficient from the amount of hygroscopic moisture found in a soil which has been brought into equilibrium with an atmosphere only partially saturated. If *a*, *b*, be the hygroscopic coefficients of two soils A and B, of which A is a typical soil whose coefficient has been determined directly; and if *a'*, *b'*, be the amounts of hygroscopic water found in them after being brought into equilibrium with a partially saturated atmosphere (and these values are determined directly much more readily than *a* and *b*): then $a : a' = b : b'$.—E. H. T.

Carbon in soil; Determination of total — by wet combustion. C. J. Schollenberger. J. Ind. Eng. Chem., 1916, 8, 1126–1127.

THE author has obtained good results in the determination of total carbon in soils by a modification of the wet combustion method of Ames and Gaither (this J., 1914, 800). A mixture of phosphoric acid and sulphuric acid with chromic anhydride is used as oxidising agent, and barium hydroxide is used to absorb the carbon dioxide in a Meyer absorption apparatus or a Truog head tower (J. Ind. Eng. Chem., 1915, 1015).—A. S.

Nitrogen-fixing bacteria; New (Russian) studies of — V. L. Omelianskij and M. Solunskov. Arch. des Sciences biol. L'Institut. impér. de médec. experim. à Petrograd, 1915, 18, 459–482, 338–377, 327–337; 19, 162–208. Bull. Agric. Intell., 1916, 7, 941–945.

THE nitrogen-fixing organisms, *Clostridium Pasteurianum* and *Azotobacter chroococcum*, were found to be very prevalent in Russian soils, and the power of the former was slightly greater than that of the latter. The organisms which act in combination with the nitrogen-fixing bacteria of upper soil strata are very numerous and play a most important rôle in soil activity; and the synergetic activity of both kinds varies with the species and the environment. In some cases the species which were added to the cultures of nitrogen-fixing bacteria supplied the carbon compounds necessary for the latter to fulfil their specific function: aerobic organisms, such as *Azotobacter chroococcum* favour the activity of anaerobes, *e.g.*, *Clostridium*, by creating an oxygen-free atmosphere; and the injurious, acid disassimilation products of *Clostridium* are neutralised by the alkaline product of the azotobacter. The optimum form of micro-organic combination is that of symbiosis between aerobic and anaerobe, and especially between the species mentioned. To investigate the interdependence of nitrogen fixation and the consumption of non-nitrogenous organic substances, *Azotobacter* and *Clostridium*, isolated from different soils, were cultivated in a medium containing in 100 c.c.: 80 c.c. drinking water, 20 c.c. linseed extract (5%), 2 grms. dextrose, 0.1 gm. potassium phosphate, 0.05 gm. magnesium sulphate, and 0.5 gm. calcium carbonate. The experiments lasted six weeks, and at intervals of five days, sugar and nitrogen determinations were performed. The curves obtained, representing nitrogen fixed and sugar consumed, ran parallel, and showed unmistakably that a close relation existed between the assimilation and the disassimilation processes in the cell: they showed continuous increases until the sugar was used up, the maximum rise taking place between the fifth and the fifteenth day. Although the absolute amount of nitrogen fixed in the first five days was very small, it was relatively much greater than the quantity of sugar consumed. The efficiency diminished after this period, and during the last five days it remained stationary.—E. H. T.

Phosphorus pentoxide [in fertilisers]; Determination of — after citrate digestion. O. C. Smith. J. Ind. Eng. Chem., 1916, 8, 1127–1128.

BY the following method it is possible to obtain in less than one hour a clear solution from the filter paper and residue remaining after digesting with neutral ammonium citrate solution, and filtering, in the analysis of fertilisers. The paper and residue (from a 2-grm. sample) are digested with 10 c.c. of concentrated sulphuric acid and 50 c.c. of nitric acid (1:1) until white fumes appear, when 1–2 c.c. of concentrated nitric acid is added to the boiling solution and digestion continued until

white fumes again appear. These operations are repeated until the solution is colourless, after which the usual procedure is followed.—A. S.

Plants; Mechanism of absorption of salts in —. E. Pantanelli. *Rend. Accad. Sc. Fis. Mat. Napoli*, 1915 [iii], 21, 55—63. *J. Chem. Soc.*, 1916, 110, i., 871—873.

THE author has made extensive series of experiments on the absorption of many different salts from their solutions by fresh-water plants, terrestrial plants, yeast, and marine algae. The last two classes of organisms were totally immersed in the solutions, whilst only the roots of the land plants were immersed, after the plants had been reared in nutrient solutions. The principal results obtained are briefly as follows. In general, the absorption of one ion of a salt is quite independent of the absorption of the other. In a few cases, the two ions of a salt are absorbed proportionally, the absorption being apparently one of undissociated molecules, but in all such cases, either the salt contains a toxic ion which alters or tends to alter the osmotic properties of the plasma, as is shown by the subsequent behaviour of the same cells towards plasmolytic agents, and towards the penetration of dyes, etc., or both ions have nutrient properties, or both have toxic or unfavourable properties. That the proportional absorption of the ions is accidental is shown by the fact that the same ions in the same salts are absorbed by some plants in equivalent proportions, whereas by other plants, or even by the same plants under different external or internal conditions, they are absorbed in proportions quite different from those corresponding with undissociated molecules. In some cases the cation and in others the anion is absorbed the more, in accordance with the preference which each species of plant exhibits. Comparison is drawn between the results obtained with two salts having one common ion, whilst the other ion is harmful in one case and, although similar, nutrient or useful in the other, for instance, with barium and calcium chlorides, lithium and potassium nitrates, ammonium and potassium sulphates, zinc and magnesium sulphates, potassium arsenate and phosphate. In most cases there is complete independence in the absorption of the two ions, the useful cation penetrating with the same rapidity in presence of a nutrient anion as if accompanied by a poisonous anion; the latter, however, remains outside, whereas the nutrient anion enters the plant in large amount. Similar relations govern the behaviour of a useful anion towards nutrient and harmful cations. In a few instances, the absorption of a nutrient cation was found to be restricted by the presence of a harmful anion, and *vice versa*. No case has been observed in which the absorption of a toxic ion is facilitated by an accompanying nutrient ion. During the initial stages of the growth of plants in these salt solutions, increase of acidity or alkalinity of the external solution occurs in consequence of the predominating absorption of one of the two ions. After some hours, or sometimes days, the cell exhibits the power to develop in the liquid a more favourable degree of acidity, this being attained by the excretion of other ions; this effect is most marked with the marine algae. Whilst those ions which readily enter the cells do so with such rapidity that the concentration inside may exceed that outside after a few moments, those showing the opposite behaviour do not, as a rule, reach a state of equilibrium except in those cases where they are supplied in toxic concentration and alter completely the osmotic properties of the plasma. Further, the absorption of ions of the first type is not continuous, but resembles the damped vibration of a pendulum, a large and vigorous absorption being followed by a partial excretion

of the same ion and then by a second smaller absorption and an excretion, and so on, these processes being repeated until a definite proportion is established between the internal and external concentrations of the particular ions. The curves connecting the proportion of ion absorbed under similar conditions with the concentration are typical adsorption isotherms for all ions, although the curves for the two ions of a salt do not coincide and vary with the specific organism and with other factors. As regards the mechanism of these processes the conclusion is drawn that the absorption of salts insoluble in the lipoids is possible only in so far as these salts are dissociated. The absorption is facilitated by the presence of H^+ or OH^- ions in the external solution or in the plasma. Confirmation is obtained of the independence of the absorption of water from that of the ions present in it, cellular colloids thus exhibiting the property of negative adsorption.

Nitrites and ammonia; Presence of — in diseased plants; its significance with regard to crop rotation and soil depletion. P. A. Bonquet. *J. Amer. Chem. Soc.*, 1916, 38, 2572—2576.

THE presence of nitrites in plant tissues, in the cases observed, comprising the sugar beet, tobacco leaves, potato leaves and tubers amongst others, is due to the reducing power of internal bacteria, and this reduction, which may proceed as far as ammonia, is the cause of the nitrogen starvation of plants affected by certain peculiar diseases. Starvation may occur even when the soil is rich in nitrates, and these nitrate-reducing bacteria may be a direct factor in soil depletion where crop rotation is not practised, owing to the increased virulence and invading power of the micro-organisms. A lack of crop rotation provides soil organisms a better opportunity to establish themselves in the veins and tissues of plants by means of adaptation.—G. F. M.

PATENTS.

Seeds; Treatment of — [before sowing]. C. E. De Wolf, London, and H. E. Fry, Dorchester. Eng. Pat. 102,081, Feb. 14, 1916. (Appl. No. 2172 of 1916.)

THE productivity of seeds may be increased by steeping them, before they are sown, in natural mineral waters such as are used for medicinal purposes. Cereals are treated for 24 hours, or for a shorter period if an electric current be passed through the liquid (0.75 amp. per 10 gallons). The steeping is carried out in wooden or earthenware tanks; the seeds, which should not exceed 18 in. in depth, must be well immersed and the liquid occasionally stirred. The treated seeds are either dried at about 90° F. (32° C.), or spread on a floor, sprinkled with petroleum at the rate of $\frac{1}{2}$ -pint per bushel, and turned over three or four times; they should then be sown as soon as possible.—E. H. T.

Soil; Process for increasing the productive power of the —. J. J. W. H. van der Toorn. Fr. Pat. 480,509, Dec. 23, 1915.

SEE Eng. Pat. 21,778 of 1914; this J., 1916, 268.

XVII.—SUGARS; STARCHES; GUMS.

Galactose and dextrose; Variations in the rotatory power of — in aqueous propyl alcohol of different concentrations. D. Foulkes. *J. Pharm. Chim.*, 1916, 14, 361—366.

THE rotatory power of galactose in propyl alcohol diminishes with increase in the concentration of the alcohol; with dextrose, however, the

rotatory power increases with the concentration of the alcohol, results which are parallel with those obtained by C. Tanret, in ethyl alcoholic solution.—F. C.

Quantitative microscopy. Wallis. See XXIII.

PATENT.

Sugar; Method of recovering— from massecuite. H. A. Vallez, Bay City, Mich. U.S. Pat. 1,204,617, Nov. 14, 1916. Date of appl., Jan. 11, 1916.

MASSECUTE is placed in a receptacle containing a screen on which a uniform layer of sugar crystals is deposited by applying air pressure to one side of the screen and alternately immersing the screen in, and withdrawing it from, the massecuite. The layer of crystals is afterwards washed with steam under pressure and then dissolved by introducing a solvent into the receptacle and agitating the screen. The screens may be in the form of disc-shaped chambers with perforated walls mounted on a rotating hollow shaft inside a horizontal cylinder.—J. H. L.

XVIII.—FERMENTATION INDUSTRIES.

Alcohol; An accurate aeration method for the determination of— in fermentation mixtures. A. W. Dox and A. R. Lamb. J. Amer. Chem. Soc., 1916, 38, 2561—2568.

THE isolation of alcohol from fermentation mixtures in a concentration suitable for oxidation to acetic acid cannot be carried out quantitatively by distillation methods even from a saturated salt solution. Results accurate to within 1.5% were, however, obtained by aspirating air at the ordinary temperature through the dilute alcoholic liquid saturated with ammonium sulphate, and absorbing the alcohol in concentrated sulphuric acid. The aeration train consists of a guard tube containing oxidising solution, the alcoholic solution containing ammonium sulphate in a gas washing bottle, and two tubes containing the sulphuric acid. Air is drawn through at the rate of about 25 litres an hour, for 8—10 hours, when practically all the alcohol will have been absorbed by the sulphuric acid. The alcohol-sulphuric acid solution is then mixed with 10—15 grms. of bichromate in aqueous solution and after standing 15 minutes the acetic acid is distilled off, care being taken that the volume of liquid does not get too small, and distillation being continued until all the volatile acid has passed over. The distillate is titrated with standard baryta solution. Volatile fatty acids in the fermentation mixture are not volatilised under the conditions described above. Acetone, though volatilised, is but slightly oxidised; methyl alcohol is almost completely oxidised to carbon dioxide and water, but esters such as ethyl acetate interfere with the determination and must be estimated separately.—G. F. M.

β -Glucosidase; Influence of acetic acid on the synthetic and hydrolytic action of—. E. Bourquelot and A. Aubry. J. Pharm. Chim., 1916, 14, 359—363. (See this J., 1915, 728.)

THE catalytic effect, at the ordinary temperature, of β -glucosidase (contained in emulsin) on the synthesis of β -methyl-*D*-glucoside in aqueous methyl alcohol, is almost unaffected by the presence of acetic acid in quantities below 0.10 gm. per 100 c.c. The synthetic action decreases, however, with further increase in the acetic acid and reaches zero in presence of 2 grms. of acid per 100 c.c. The hydrolytic action of the enzyme,

under similar conditions, is also diminished when the acetic acid exceeds 0.10 gm. per 100 c.c. This diminution in activity is shown to be due to an actual destruction of the enzyme. α -Glucosidase, the similar enzyme present in bottom fermentation beer yeast, is much more sensitive.—F. C.

PATENTS.

Enzyme-fillers. M. Kiutsi, Hakodate, Japan. Eng. Pat. 16,096, Nov. 15, 1915. Under Int. Conv., Nov. 15, 1914.

A SECTION of the stem of bamboo or other plant of the *Graminaceæ*, open at the top and closed by a node at the bottom, is converted into a cylindrical dialysing vessel, by removing the outer layers of the stem, leaving the thin inner membrane intact, and then repeatedly extracting with boiling water. It is claimed that if such a vessel, filled with urine, serum, or other liquid containing enzymes, is immersed in water, the enzymes alone will pass through the membrane.—J. H. L.

Wine; Process for ageing—. A. Lachman. Berkeley, Cal. U.S. Pat. 1,204,669, Nov. 14, 1916. Date of appl., July 28, 1913.

A CONTINUOUS current of wine, flowing under pressure, enters a large vessel whereby its velocity is greatly reduced. In the vessel it is heated and subjected to an electric current, and on leaving it communicates its heat, in a counter current apparatus, to fresh wine flowing towards the vessel.—J. H. L.

Beverages; Process of manufacturing unfermented—. H. Heuser, Chicago, Ill. U.S. Pat. 1,204,869, Nov. 14, 1916. Date of appl., June 12, 1916.

A THICK mash of grain containing proteins, is subjected to proteolysis by means of lactic bacteria between 20° and 40° C. The bacteria may subsequently be destroyed by addition of hot water, and after the acidity has been reduced, the liquid may be separated from the solid matter and hopped.—J. H. L.

Enzyme fillers. M. Kiutsi. Fr. Pat. 480,236, Nov. 15, 1916.

SEE Eng. Pat. 16,096 of 1915; preceding.

XIXA.—FOODS.

Food colouring substances; Use of the spectrophotometer for the examination of—. W. F. Mathewson. J. Assoc. Off. Agric. Chem., 1916, 2, 164—169.

BY means of a Koenig-Martens spectrophotometer fitted with a Rutherford prism the author has determined the absorption by dye solutions of light of various wave lengths. The results are calculated into "extinction coefficients," e , using the formula: $e = \log \tan a_1 + \log \cotan a_2$, where a_1 and a_2 represent the angular readings with the Schütz glass cube before the right and left parts of the slit, respectively. The results for seven permitted dyes (Naphthol Yellow S, Orange I, Ponceau 3R, Erythrosine, Amaranth, Indigo-Carmine, and Light Green SF Yellowish) are given in tabular form, the figures corresponding with the values for 0.001% solutions. The determination of a dye is made by determining the approximate concentration of its solution by the use of this table, changing the concentration, if necessary, so that the values for e will be from 0.6 to 1.00 in the

region of maximum absorption, making a standard solution of the same calculated concentration from a pure colour, and determining the absorption constants for each under the same conditions. The method is applicable to dyes other than those mentioned, to natural colouring substances, and to mixtures of dyes.—W. P. S.

Coal-tar dyes; Modification of Price's method for the separation of the seven permitted—to include Tartrazine. C. Estes. J. Ind. Eng. Chem., 1916, 8, 1123—1124.

ACCORDING to Food Inspection Decision 164, Tartrazine may be used in the United States to colour food products, in addition to the seven colours previously permitted. Price's scheme for the separation and detection of the permitted colours (this J., 1912, 41) has therefore been modified so as to include Tartrazine. The dyes are first isolated by dyeing on to wool from a slightly acid aqueous solution, and then removed from the wool by boiling with a very dilute solution of ammonia. A small quantity of the separated dyes is triturated with 25 c.c. of a supersaturated solution of ammonium sulphate, filtered, and the residue washed with small portions of the ammonium sulphate solution. The residue is examined as described by Price (*loc. cit.*). The solution may contain Amaranth, Tartrazine, and a small quantity of Naphthol Yellow S. The Naphthol Yellow is removed by shaking several times with ethyl acetate until the latter is no longer coloured yellow, and Amaranth and Tartrazine are extracted from the residual aqueous solution by means of acetone. The acetone solution is diluted with water, evaporated to expel the acetone, then supersaturated with sodium chloride, filtered, and the filter and residue washed with a supersaturated solution of sodium chloride until the washings are no longer coloured yellow. Tartrazine is separated in a pure state from the sodium chloride solution by adding excess of glacial acetic acid or concentrated hydrochloric acid and extracting with acetone, and Amaranth is separated in a similar manner from the residue on the filter.—A. S.

Crude fibre; Determination of—. C. E. Mangels and P. F. Trowbridge. J. Assoc. Off. Agric. Chem., 1916, 2, 132—134.

THE following method was found to be rapid and to yield satisfactory results. The fat-free substance was mixed with 200 c.c. of 1.25% sulphuric acid, heated to boiling, and boiled for exactly 30 mins.; the mixture was then filtered through muslin (98 by 102 threads per sq. in.), the insoluble portion washed with hot water, and then boiled for 30 mins. with 200 c.c. of 1.25% sodium hydroxide solution. The alkaline solution was filtered through the same muslin filter, and, after washing, the residue was rinsed into a Gooch crucible, washed with alcohol, dried at 102° C., and weighed. The contents of the crucible were then ignited and re-weighed, the difference between the two weights giving the amount of crude fibre present. The results obtained were slightly higher than those found by the official (American) method, *e.g.*, 11.08% against 10.12%. Still higher results were obtained when the filtration after the acid digestion was omitted.—W. P. S.

Agar agar; Analysis, purification, and some chemical properties of—. C. R. Fellers. J. Ind. Eng. Chem., 1916, 8, 1128—1133.

ANALYSIS of fifteen samples of agar from widely different sources gave the following results:—moisture, 14.57—17.84 (average 16.57); protein (N x 6.25), 1.53—3.26 (2.34), nitrogen-free extract, 72.72—78.21 (76.15); ether extract, 0.17—0.45

(0.30); crude fibre, 0.39—1.50 (0.80); ash, 3.08—5.68 (3.85); and silica, 0.31—1.11 (average 0.68) per cent. A specially purified commercial agar for bacteriological purposes contained: moisture, 5.72; protein, 1.14; nitrogen-free extract, 89.25; ether extract, 0.32; crude fibre, 0.15; ash, 3.12; silica, 0.29 per cent. High ash or silica content is indicative of an inferior product. An aqueous solution of agar is acid to phenolphthalein. A purified agar for use in bacteriological work where a gelatinising agent containing a minimum of nutrients is desired, may be prepared by washing agar shreds in a dilute solution of acetic acid, washing out the acid, dissolving the agar to a 5% solution, and pouring the hot solution slowly into a large volume of 95% alcohol or acetone. The precipitated agar contains considerably less nitrogen than the original material. Part at least of the nitrogen compounds present in agar is available as nutriment for micro-organisms. The setting power of aqueous solutions of agar is not destroyed by acid or alkali between the limiting concentrations of 4.5% HCl and 5% NaOH; but if the solution be heated for 15 mins. under a pressure of 1 atmosphere the range of concentrations within which solidification occurs is reduced to from 2% HCl to 4.5% NaOH. The gelatinising power is increased by addition of peptone and slightly diminished by potassium chloride.—A. S.

Quantitative microscopy. Wallis. See XXIII.

PATENTS.

Sterilising and preserving alimentary products; Method of— and means therefor. C. Jovignot. Paris. Eng. Pat. 1275, Jan. 16, 1914. Under Int. Conv., Jan. 18, 1913.

THE receptacle containing the food is closed with a double lid, the lower lid being a thin metal sheet, a portion of which is perforated with small holes, and the outer lid being of stouter metal with one or more perforations. Between the two lids is a layer of cotton or other filter material. In another form of construction a single lid is used, perforated with one hole, through which passes a short tube with a thin plate or disc attached to its inner end. The space between the plate and lid is packed with the filtering material. The side of the tube is perforated so as to allow an air passage from the exterior through the filter to the interior. Sterilisation is effected in a steam or air steriliser, and when completed the receptacles are allowed to cool in presence of air or an inert gas. When cold, the openings in the outer lid are closed with solder.—J. H. J.

Cereal preparations. W. A. Rullman, Red Bank, N.J., U.S.A. Eng. Pat. 16,531, Nov. 23, 1915.

BARLEY and wheat grains are steeped separately for two days, then placed in heaps about 14 in. high and allowed to stand for germination to take place. The heaps are aerated and moistened at intervals. After germination the rootlets are removed, the wheat is ground to a pulp, and to it is added half its weight of the malted barley in the form of extract. The mixture is heated at 100° F. (38° C.) for an hour, at 153° F. (67° C.) for 15 mins., and at 156° F. (69° C.) for 15 mins. with stirring, when part of the starch is converted into maltose and dextrin. It is now heated at 165° F. (74° C.) for 15 mins., 20% of agar-agar added, and the heating continued for half an hour. After cooling, salt and yeast are added, the mass allowed to stand for 12 hours, and baked. It is then reduced to a granular form, and consists of 75% of nitrogenous matter, starch, maltose, and dextrin, and 25% of bran and agar-agar.—J. H. J.

Flesh of bovine animals; Preparation of — for use as human food. J. Balzari. Fr. Pat. 1,80,087. Oct. 28, 1915.

SEE Eng. Pat. 15,559 of 1915; this J., 1916, 1175.

Cheese; Process of sterilising — and product by such process. J. L. Kraft. Chicago. Eng. Pat. 102,433, June 28, 1916. (Appl. No. 9102 of 1916.) Under Int. Conv., Mar. 25, 1916.

SEE U.S. Pat. 1,180,521 of 1916; this J., 1916, 861.

XIXB.—WATER PURIFICATION; SANITATION.

Sewage; Recovery of fats and nitrogen compounds from —. S. Rideal. Assoc. of Managers of Sewage Disposal Works. Chem. Trade J., 1916, 59, 571–572.

PRESSED dry sewage sludge may contain as much as 8% of fat which can be extracted by means of a solvent; the lowest figure is 3.5% and the average for peace-time sludge is probably 5%. Assuming that the percentages of fat in sewage from military camps and from towns are the same, it is estimated that the camps in this country would yield 100 cwt. of fats daily, and the rest of the population 4000 cwt.; probably not more than 20% of this is saponifiable, so that the daily yield of glycerin, with 10% recovery, would amount to 8 cwt. and 80 cwt. respectively. Before the war, from 12 to 15 tons of fat per day was recovered at Bradford, and was valued at £8 to £10 per ton. In Dresden it was the practice to separate the sludge mechanically; after partial drying it contained 13.35% of fat which was extracted by ethylene trichloride.

The production of gas from sludge was studied in Paris by Cavel in 1912; the sludge was burnt with 20% of coke in a producer, giving a gas of 3500 cal. per cub. m. It was estimated that from Paris and the Seine Departments 300 tons of dry sludge could be obtained daily, yielding 24,500 cub. m. of gas worth 147,000 fr. per annum. These gases might be used in the Heusler engine, in which the nitrogen compounds are recovered.

If all the nitrogen in sewage could be recovered, it is estimated that our military camps would yield 11,640 tons per annum and the civil population 116,400 tons. It is suggested that the free ammonia should be recovered from sewage by heating, possibly after addition of lime; heat exchangers are now designed to work with a very small loss of energy, so that the removal of the free ammonia from a tank effluent is not impossible. Another method suggested to recover the free ammonia is by means of air. In the ordinary process of aeration and activation, the escaping gases do not contain ammonia, but when air is passed through ordinary sewage, the ammonia is removed. If the "activation" is carried out in presence of lime, nitrification will probably not be complete and some ammonia will be present in the escaping gases. Dried activated sludge, with 10% moisture, contains 5 to 9% of nitrogen, and if retorted, should give higher yields of ammoniacal liquor than are obtained from coal in gas works.

To recover nitrates from effluents after oxidation of ammonia, it is suggested that a filter bed with no effluent drain, protected from rainfall, might be irrigated with the effluent, so that the nitrates would become gradually concentrated by evaporation.

Fume poisoning from nitric and mixed acids. L. A. De Bois. National Safety Council. Chem. Section. Detroit, Oct., 1916. J. Ind. Eng. Chem., 1916, 8, 1162–1163.

THE best means of preventing poisoning by nitrous

fumes in works where nitric acid and mixed acid are used, is the provision of efficient ventilation. In the E. I. du Pont de Nemours Powder Co.'s works, the fumes are removed by means of large down-draught exhaust fans. The earthenware pots in which cotton is nitrated are placed in partial enclosures over slatted openings through which the fumes can be drawn at a velocity of about 830 ft. per minute between the slats with full opening, and in some cases 2500 ft. per minute close to the top of the pot. Before an efficient exhaust system was developed, good results were obtained by spraying ammonia or ammonium carbonate solution directly into the air by compressed air atomisers. Each atomiser consumed about 2½ cub. in. of ammonia solution of 30° B. (sp. gr. 0.875) per hour at an air pressure of 25 lb., and this was sufficient to neutralise "rather dense" fumes over an area of about 252 sq. ft. of floor surface. Respirators are not generally very satisfactory. The most efficient type was an aluminium respirator having an exhaust valve and inflated rubber face-cushion, and with the usual sponge replaced by a disc of "Filtros," 2½ in. diam. by 1½ in. thick, fitted with rubber gaskets and moistened with a 20% solution of caustic potash. The discs may be washed and recharged until the pores are blocked, when they can be replaced at a cost of about 25 cents (1s. 0½d.). —A. S.

Formaldehyde and potassium permanganate fumigant. J. R. Hill. Pharm. J., 1916, 97, 589–590.

THE usual method of using the fumigant is to add 8 oz. of permanganate crystals to 10 fl. oz. of commercial formalin, a mixture which is sufficient to fumigate a room containing 500 cb. ft. of air. The heat of reaction is sufficient to vaporise a large part of the formalin, but a considerable proportion of the formaldehyde is wasted owing to conversion into formic acid. The nature of the reaction is indicated by the following equations:—(1) $3\text{HCOH} + 2\text{KMnO}_4 = 3\text{HCOOH} + \text{K}_2\text{O} + 2\text{MnO}_2$, (2) $\text{K}_2\text{O} + 2\text{HCOOH} = 2\text{HCOOK} + \text{H}_2\text{O}$, (3) $3\text{HCOOH} + 2\text{KMnO}_4 = \text{K}_2\text{CO}_3 + 2\text{MnO}_2 + 3\text{H}_2\text{O} + 2\text{CO}_2$. The presence of formate in the liquid at the end of the reaction was proved by the reduction of mercuric chloride solution to metallic mercury, and by the formation of ferrie formate. Fumigation by formaldehyde can be effected without danger by direct boiling of formalin in an open vessel. Fumigation may be replaced with advantage by direct spraying of a 1% solution of formaldehyde on the walls.—J. H. J.

Lead arsenate; Boiling method for the determination of water-soluble arsenic in —. G. P. Gray and A. W. Christie. J. Ind. Eng. Chem., 1916, 8, 1109–1113.

THE soluble arsenic compounds in commercial lead arsenate preparations can be completely extracted by boiling with water for 5–10 mins., whereas complete extraction is almost impossible by digesting with cold or tepid water as in the provisional methods recognised by the Association of Official Agricultural Chemists (U.S.A.). No solution or hydrolysis of lead arsenate occurs even on prolonged boiling with water or by digesting on the steam bath for several hours. The following rapid method is recommended both for ordinary analytical work and for factory control. It gives higher results than the provisional methods referred to, but is considered to be more accurate than the latter. 0.5 gm. of the dry powdered sample is boiled briskly for 10 mins. with 200 c.c. of water. If the liquid is cloudy or the sample does not settle readily, the mixture is digested on the steam bath for 1 or 2 hours or until the supernatant liquid is clear. The solution is filtered, the filter

washed with a small quantity of hot water, and the filtrate treated with 1 gm. of potassium iodide and 4 c.c. of concentrated sulphuric acid, evaporated till the volume is reduced to about 40 c.c., diluted to 200 c.c., and any free iodine removed by means of $N/20$ thiosulphate. After adding methyl orange and nearly neutralising with concentrated sodium hydroxide solution, an excess of sodium bicarbonate is added, and the arsenic titrated with $N/20$ iodine solution, using starch paste as indicator. The aqueous extract may be tested for lead and the latter, if present, removed in the usual way before titrating the arsenic, but in most cases an appreciable amount of lead is not present.—A. S.

Paris green analysis: An oxalate-iodide process for —. C. A. Peters and L. E. Fielding. J. Ind. Eng. Chem., 1916, 8, 1114—1115.

ABOUT 0.25 gm. of the sample is treated with less than 1 c.c. of sulphuric acid (1:10), diluted to 50 c.c., boiled for 2 mins., and 2 grms. of oxalic acid crystals added slowly to the hot liquid. After again heating to the boiling point, the mixture is allowed to stand overnight, the precipitated copper oxalate collected on an asbestos filter, washed, treated with water and 5—10 c.c. of sulphuric acid (1:1), heated nearly to boiling, and titrated with permanganate. The filtrate is treated with an excess of dry sodium bicarbonate, and the arsenic determined by titration with iodine.—A. S.

Factors connecting the concentration and the optical rotatory power of aqueous solutions of nicotine. Tingle and Ferguson. See XX.

PATENTS.

Water softening reagents: Automatic regulation of the supply of —. R. Player, London, and E. G. Weddell, Birmingham. Eng. Pat. 102,439. May 22, 1916. (Appl. No. 7272 of 1916.)

Carbon dioxide: Absorbent for — in respirators used for mine rescue and other purposes. E. J. Bevan and R. H. Davis. Fr. Pat. 480,226, Nov. 13, 1915.

SEE Eng. Pat. 22,719 of 1914; this J., 1915, 448.

Formaldehyde: Manufacture of —. G. Calvert. Fr. Pat. 480,597, Dec. 31, 1915.

SEE Eng. Pat. 814 of 1915; this J., 1916, 328.

Tar-oils: Process for improving the antiseptic, fungicidal, and insecticidal action of —. H. Noerdlinger, Flörsheim, Germany. U.S. Pat. 1,205,924, Nov. 21, 1916. Date of appl., Sept. 24, 1912.

SEE Ger. Pat. 259,665 of 1911; this J., 1913, 659.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Opium and cocaine: Prohibited importation of —.

A ROYAL Proclamation dated December 11, 1916, prohibits the importation of cocaine and opium excepting under licence. The word "cocaine" includes all preparations, salts, derivatives, or admixtures prepared therefrom or therewith and containing 0.1% or more of the drug, or any solid or liquid extract of the coca leaf containing 0.1% or more of the drug. The word "opium" means raw opium, powdered or granulated opium, or opium prepared for smoking, and includes any solid or semi-solid mixture containing opium.

New Defence of the Realm Regulations have been made to carry out the provisions of this Proclamation.

Morphine: Microchemical distinction of — from codeine. O. Tummann. Apoth.-Zeit., 1916, 31, 148—150. J. Chem. Soc., 1916, 110, ii, 655—656.

WHEN treated with hydriodic acid, morphine and codeine yield crystals which have always the same forms and allow of the differentiation of the two bases. A little of a salt of the base is sublimed by heating on an asbestos plate, and the sublimate covered with a cover-glass, at the edge of which a drop of hydriodic acid is then introduced. A slight granular precipitate is thus formed, and this disappears on heating. When the preparation is cooled, crystals of the tetra-iodide are formed immediately in the case of morphine, whereas with codeine, crystals of the tri-iodide are formed only after three to five minutes, but more rapidly in presence of a small drop of alcohol. The morphine tetra-iodide crystals are always very flat, quadrangular, mostly rectangular plates, on the average 30—50 μ broad by 80—120 μ long, and are of prismatic character and show direct extinction, and a blood-red to brownish-red colour. The bulk of the crystals are united to ladder- and step-like aggregates more than 1 mm. in length, and these in their turn are combined to stars and crosses. Pleochroism is either very slight or non-existent. Codeine tri-iodide crystals are paler, thicker, and smaller, the aggregates being not more than one-third of the size of morphine tetra-iodide crystals. Single crystals (20—50 μ , 40—80 μ) are very rare, and form half-moon-like triangles with a concave base and a blunted apex. The majority are twinned crystals, which always grow out on the convex side and give butterfly- and goblet-like forms, by which these crystals are recognisable at the first glance. Strong pleochroism is observed in this case.

Strychnine: Chemical and physiological action of — masked by quinine. E. Filippi. Arch. Farm. Sperim. Pharm. J., 1916, 97, 593.

WITH a mixture of quinine sulphate and strychnine nitrate, in which the former preponderates, a characteristic reaction for strychnine cannot be obtained with the sulphuric acid and potassium bichromate test. Crystals of strychnine picrate precipitated from such a mixture are not characteristic. In presence of an excess of quinine, strychnine no longer gives the physiological reaction with the frog. Death ensues, but the symptoms are quite distinct from typical strychnine reactions. The only rapid and accurate method is to precipitate the quinine as tartrate with sodium potassium tartrate, and apply the tests for strychnine to the filtrate.

Nicotine: Factors connecting the concentration and the optical rotatory power of aqueous solutions of —. A. Tingle and A. A. Ferguson. Trans. Roy. Soc. Canada, 1916 [iii], 10, 19—25. J. Chem. Soc., 1916, 110, ii, 656.

WORKING with a polarimeter using "j" light, the authors have carried out experiments which show: (1) that for solutions of concentration between 4 and 0.37%, the rotation of aqueous nicotine solutions is in simple inverse proportion to the concentration; (2) that the presence of potassium hydroxide and potassium salts has no influence on the rotation of nicotine salts; (3) that nicotine is not lost by vaporisation when an acid solution of nicotine sulphate is evaporated. In addition, the rotation, in terms of Ventzke sugar-scale divisions, of a pure specimen of nicotine in aqueous solution was determined, and found to be -1

division ($l = 200$ mm.) for every 0.2498 grm. of nicotine per 100 c.c. of solution, or 1 grm. of nicotine in 100 c.c. solution would read - 1.5 divisions in a 200 mm. tube for "j" light.

Phenylethylhydantoin (nirvanol), a new hypnotic and sedative. E. Wernecke. *Deut. med. Woch.*, 1916, 42, 1193—1194. *J. Chem. Soc.*, 1916, 110, i, 869.

77-PHENYLETHYLHYDANTOIN dissolves in 1650 parts of cold, and in 110 parts of hot water, and in 20 parts of alcohol; it has a hypnotic action of about the same intensity as phenylethylbarbituric acid (luminal), but is distinctly less toxic. Its hypnotic action is greater than that of diethylbarbituric acid (veronal).

Oxalyl chloride: Action of — on primary, secondary, and tertiary alcohols. R. Adams and L. F. Weeks. *J. Amer. Chem. Soc.*, 1916, 38, 2511—2519.

OXALYL chloride reacts smoothly with such primary alcohols as *n*-propyl, isoamyl, isobutyl, benzyl alcohols, etc., to give quantitative yields of the oxalic esters. Secondary alcohols such as phenylmethylcarbinol and menthol give the corresponding unsaturated compounds by the elimination of water, whilst in other cases small yields of ethers are formed. Tertiary alcohols mostly give the corresponding chlorides in good yield, but pinacene is converted into pinacoline and a smaller proportion of the carbonic ester of pinacene—G. F. M.

Amides: Pyrolytic decomposition of —. Parts I. and II. R. S. Boehmer, C. E. Andrews, and A. L. Ward. *J. Amer. Chem. Soc.*, 1916, 38, 2503—2507.

THE decomposition of acid amides into cyanides and water is greatly facilitated by the use of a contact substance such as alumina, sand, pumice, or graphite. The reaction may be carried out by heating the amide in a flask with about five times its weight of the contact material at such a temperature that the cyanide and water distil over whilst the unchanged amide condenses in the elongated neck and is returned to the flask, in which case dehydration to the extent of 50—70% is attained; or alternatively, an almost quantitative decomposition may be effected by carrying the vapours of the amide by means of a stream of air, over the contact material heated at about 425° C. in a hard glass tube.—G. F. M.

Nitroamines: Application of the nitrometer to the determination of constitution and estimation of nitrogen in a class of nitro-compounds. —. W. C. Cope and J. Karab. *J. Amer. Chem. Soc.*, 1916, 38, 2552—2558.

FURTHER evidence is adduced that the nitrometer reaction—liberation of nitric oxide by means of sulphuric acid and mercury—is not given by nitro-compounds in which the nitro-group is directly attached to carbon. On the other hand nitro- and nitroso-compounds in which these groups are attached to carbon through nitrogen, as in the nitro-amines and nitrosoamines, react like the nitrates and nitrites, giving a gas which was shown to consist entirely of nitric oxide. This class of substances, which includes nitro-urea, nitroguanidine, trinitrophenylmethylamine ("tetryl"), and all nitrosamines (but not such substances as *p*-nitrosodimethylaniline) may therefore be determined by means of the nitrometer, and in the case of unknown substances the nitrometer may be employed to determine whether the NO₂ or NO group is directly joined with

carbon or through a nitrogen atom. The nitrates of urea and guanidine behave anomalously, in that the nitrogen is not exclusively evolved as nitric oxide unless they are first converted into the respective nitro-compounds by treatment with concentrated sulphuric acid at 0° C. before introduction into the nitrometer.—G. F. M.

Halogenation. XIII. Methods of estimation of semicarbazide, semioxamazine, and oxalylhydrazide by their interaction with halogens and halogen oxyacids. R. L. Datta and J. K. Choudhury. *J. Amer. Chem. Soc.*, 1916, 38, 2736—2746.

WHEN semicarbazide and semioxamazine are treated with potassium bromate, iodate, or periodate and dilute sulphuric acid, carbon dioxide and 75% of the theoretical amount of nitrogen, along with ammonia, are obtained. Oxalylhydrazide gives carbon monoxide, carbon dioxide, and the whole of the nitrogen. The action of bromine or of hypobromite differs sometimes from that of the halogen oxyacids as regards the volume of gas evolved. Acidified chlorates and perchlorates are without action on semicarbazide or semioxamazine. Semicarbazide chlorate is violently explosive, and the nitrite decomposes giving a quantitative yield of urea.—F. C.

Chlorides of methane: Preparation of the lower — from natural gas. C. W. Bedford. *J. Ind. Eng. Chem.*, 1916, 8, 1090—1094.

IN the chlorination of methane intermediate compounds cannot easily be obtained unless the temperature is kept low, as otherwise the intermediate derivatives remain in the state of vapour and are chlorinated further in preference to the methane itself. As a means of accelerating the chlorination at a low temperature, light from the white flame are (this *J.*, 1916, 1211) proved very satisfactory. The reaction is accelerated by water, which serves to remove the reaction products and to bring the reacting gases into more intimate contact. The slightest trace of ammonia or similar nitrogen compounds stops the reaction at low concentrations of chlorine, and if a high concentration of free chlorine is used to overpower the negative catalyst a violent explosion results. In some experiments a wooden box, 28 in. × 28 in. × 41 in. inside, was placed with its open lower end in a vat of water and was filled with pieces of ice about the size of coconuts or larger. The box was closed by a clamped-on lid with a rubber gasket in between, and in one side was a glass plate through which the light from a white flame are passed. Air was displaced from the box by natural gas, and then the reaction was started by introducing chlorine in the proportion of about 1 vol. to 7 vols. of natural gas. As the reaction proceeded and the reaction products were condensed, the water rose in the box, and the introduction of further quantities of chlorine and natural gas was regulated according to the height of the water in the vat. The process was continued until the ice had sunk below the level of the window. The inside of the wooden box was coated with several layers of cellulose acetate dissolved in methylene chloride or chloroform to protect it from the action of chlorine and render the box gas-tight. The reaction product had little effect on the coating, for cellulose acetate is dissolved only by very pure methylene chloride or chloroform. In the apparatus described, 250 cu. ft. of natural gas was used in one experiment and the rate of consumption was from 14 to 30 cu. ft. per hour, several gallons of reaction product being obtained. The liquid product separating out under the water contained 35% of methylene chloride, 35% of chloroform, 3% of carbon tetrachloride, and 20% of chloro-ethanes. The portion dis-

solved by the water (14% of the total) was recovered by distilling off 5—10% of the water, the residue being about a 5% solution of hydrochloric acid. This soluble portion contained 61% of methylene chloride, 28% of chloroform, 1.5% of carbon tetrachloride, and 6% of chloro-ethanes. About 135 lb. of ice is required for 1 gallon of product. Methylene chloride can be made in large quantities by this process. It is an excellent solvent for cellulose acetate and closely resembles chloroform in properties. It is said to be superior to the latter as an anæsthetic. It is easily converted into chloroform by chlorinating in the presence of sunlight or the light from 150-watt tungsten lamps, the formation of carbon tetrachloride being avoided by chlorinating until only about 10% of the methylene chloride has been converted and then separating the chloroform by distillation. Up to 40% of methyl chloride is found in the gases removed from the ice chamber during the first few minutes after starting the reaction. It can be easily isolated by compression or by solution in water or other solvents.—A. S.

Peppermint oil; Effect of cultural and climatic conditions on —. F. Rabak. U.S. Bureau of Plant Industry, Prof. Paper 454.

A LIGHT sandy or loamy soil appears to be the most favourable for the production of peppermint oil of high quality. The yield of oil from fresh plants apparently decreases as the plant matures, but at the same time the percentage of esters in the oil, which impart to the oil its minty odour, increases. The menthol and ester contents of the oil are closely co-related. Drying the plants before distillation results in a considerable loss of oil, but the drying induces conditions favourable to producing esters, whilst the percentage of free and total menthol in oil from dried plants is also uniformly high. Drying also results in a considerable increase in free acidity. The formation of esters and menthol takes place most readily in the leaves and tops of the plants. The effect of shade is to decrease the formation of esters and of menthol, whilst frost has the reverse effect on the plants.

Lime juice; Concentrating — by freezing. Report of Agric. Dept., Dominica, 1915—46. Pharm. J., 1916, 97, 621.

RAW lime juice was placed in a receptacle of block tin or a glass jar, which was packed round with a freezing mixture of salt and ice. Ice separated on the side of the jar, and on continuing the process this layer gradually thickened until finally a solid mass was formed. The sides of the receptacle were warmed, and the solid mass removed, cut into pieces, and placed in the basket of a centrifugal machine. The mass was melted in stages whilst being centrifuged. The general conclusions arrived at are as follow:—Raw lime juice when frozen and treated in the centrifugal can be concentrated without affecting its properties as a beverage. If the juice is treated once only, the acid content may be increased from about 13 oz. per gallon to over 20 oz. per gallon. By repeating the process a juice containing 30 oz. per gallon can be obtained. The low testing juices can be converted into citrate of lime, thus eliminating all losses excepting those of handling. This process enables a very considerable saving to be made in freight, charges, and packages, amounting to between 40 and 60%.

Influence of acetic acid on the synthetic and hydrolytic action of β -glucosidase. Bourquelot and Aubry. See XVIII.

Quantitative microscopy. Wallis. See XXIII.

Determination of radioactivity. Furber. See XXIII.

PATENTS.

2-Naphthylquinoline-4-carboxylic acids. M. Bohm. Assignor to Chem. Fabr. auf Actien (vorm. E. Schering), Berlin. Re-issue No. 11,216. Nov. 21, 1916, of U.S. Pat. 1,197,162, Sept. 5, 1916. Date of appl., Oct. 7, 1916.

SEE this J., 1916, 1272.

Process of hydrogenating organic materials and of producing ammonia. U.S. Pat. 1,201,226. See VII.

Enzyme filters. Eng. Pat. 16,096. See XVIII.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

Photographic plates and papers; Temperature coefficients of the action of monochromatic light on —. M. Padoa and L. Mervini. Atti R. Accad. Lincei, 1916 [v.], 25, ii., 168—171. J. Chem. Soc., 1916, 110, ii., 592. (See also this J., 1915, 1273.)

THE authors have exposed a photographic plate under a negative at 15° C., and at -85° C., to the action of the following lights: red, λ 650—620 μ ; yellow, 620—585; green, 550—530; violet, 437—394, and white, the plates used with yellow and green light being sensitised with ammonia, silver nitrate, and erythrosin, and those used with red light with aqueous-alcoholic pinachrome solution. The exposures were adjusted so that in all cases positives of equal intensity were obtained on development with one and the same developer for equal periods of time. With each light the temperature-coefficient of the action of light on the plate is 1.05. The direct blackening of so-called citrate paper by white, blue (λ 470—490), and ultra-violet light (λ 100—350) at 15° C. and -85° C. was also investigated, the corresponding temperature-coefficients being 1.16, 1.49, and 1.07 respectively. The varying behaviour with the plates and papers seems to indicate that the formation of a latent image on the plate is not due to a photochemical process consisting in the decomposition of silver chloride into its elements.

PATENTS.

Silver from weak photographic emulsions; Recovery of —. F. F. Renwick, Brentwood, B. V. Storr, and Ilford Limited, Ilford, Essex. Eng. Pats. (A) 16,708, Nov. 26, 1915, and (B) 102,168, Nov. 26, 1915. (Appl. No. 683 of 1916.) Addition to Eng. Pat. 16,708 of 1915.

(A) VERY dilute photographic emulsions, in which the silver salt is too finely divided to settle from the gelatin solution, and which are too poor in silver for treatment by the usual recovery processes, can be concentrated by the action of suitable precipitants. The addition of small quantities of ferric, copper, or aluminium salts produces a precipitate of a gelatin compound which carries down the silver salt with it. The exact quantity of precipitant is dependent on the concentration of gelatin in the liquor and on the temperature, larger relative quantities being required for weaker liquors or at higher temperatures. In the example given, a liquor containing 0.2% of metallic silver as halide and about four times that quantity of gelatin required the addition of about 0.025% of ferric chloride for precipitation. Acidity of the liquor or excess of the precipitant or a temperature above about 86° F. (30° C.) prevents the reaction

Alkalinity of the liquor necessitates the use of a greater quantity of the precipitant, and the addition of alkali will cause precipitation to occur where too much precipitant has been added. Freshly made liquors require to be aged by cooling to about 45° F. (7° C.) or by standing for about a day at normal temperature in order to be precipitable by these salts. Precipitation of the gelatin and silver salt may also be obtained by addition of ordinary gelatin coagulants such as picric, chromic, and tannic acids, but much larger quantities are required than with the metallic salts mentioned. Ageing is not necessary and excess of the precipitant does not interfere. (B) The concentration of the silver salt may be produced by the addition of two or more substances interacting to form a precipitate which carries down the silver salt but little or no gelatin. Suitable precipitates are aluminium and ferric hydroxides, resin, and casein. Considerably larger quantities of precipitants are required than by the use of the metallic salts mentioned in the chief patent.—B. V. S.

Photographs in colours: Production of —. C. Raleigh and W. V. D. Kelley. Fr. Pat. 479,921, Oct. 5, 1915.

SEE Eng. Pat. 14,225 of 1915; this J., 1916, 1180.

Sensitised films for printing processes. L. A. Orans. Fr. Pat. 480,269, Nov. 19, 1915.

SEE Eng. Pat. 16,040 of 1915; this J., 1916, 755.

XXII.—EXPLOSIVES; MATCHES.

Fume poisoning from nitric acid and mixed acid. De Blois. See XIXB.

Application of the nitrometer for the determination of constitution and estimation of nitrogen in a class of nitro-compounds, viz., nitroamines. Cope and Barab. See XX.

PATENTS.

Detonating explosive: Process of making a —. A. J. Marin, Laeken, Belgium. U.S. Pat. 1,266,456, Nov. 28, 1916. Date of appl. Apr. 2, 1914.

SEE Fr. Pat. 478,351 of 1915; this J., 1916, 1181. The product is treated with a volatile substance insoluble in water and having a boiling point above 100° C. at atmospheric pressure.

Blasting cartridges. W. Weber, Hayingen, Germany. Eng. Pat. 8606, June 10, 1915.

SEE U.S. Pat. 1,157,270 of 1915; this J., 1916, 276.

XXIII.—ANALYSIS.

Microscopy: Quantitative —. T. E. Wallis. Analyst, 1916, 41, 357—374.

A METHOD described for the quantitative microscopical examination of mixed powders depends on the addition of a substance consisting of uniform grains and then determining the ratio of the constituents to the added grains. The details of the method are as follows:—A mixture of equal weights of the pure substance under examination and of the adulterant is prepared; 0.2 gm. of this mixture is mixed with 0.1 gm., or other suitable quantity, of lycopodium and sufficient of a suspend-

ing fluid (this may be an oil, soft paraffin, glycerol, or other suitable liquid) to produce a liquid of which 1 drop, when mounted and examined with a one-sixth inch objective, will show from 10 to 20 lycopodium spores in each field. In most cases this will be attained when the volume is about 20 c.c. A drop of the suspension is transferred to a slide, a cover glass is applied, and the numbers of particles of adulterant and of lycopodium spores are counted in ten different fields. Another drop is then mounted, and counts are made. The ratio of the number of lycopodium spores to the number of characteristic elements of the adulterant is expressed as a percentage of the lycopodium spores; the results of the two counts should not differ by more than 10%. A quantity of 0.2 gm. of the actual sample is then mixed with 0.1 gm., or other suitable quantity, of lycopodium and about 20 c.c. of the suspending fluid, drops are mounted on each of two slides, and counts made. The results of the counts are expressed in the same way as in the case of the standard mixture. The numbers obtained for the foreign ingredient are directly proportional to the amounts present and a simple calculation gives the quantity. Unless the powders have been dried previously, a correction must be applied for moisture. The method is applicable to a large variety of mixtures, including starches, food products, and drugs, of which examples are given. Even in the case of a mixture of two starches the addition of lycopodium is an advantage, since greater precision is secured.—W. P. S.

Radioactivity: Determination of —. F. B. Furber. J. Assoc. Off. Agric. Chem., 1916, 2, 116—119.

IN making measurements of low radioactivity, the radium emanation was separated from the substance under examination and its effect on an electroscope compared with that produced by a known amount of radium. In the case of waters, the emanation was separated by boiling; soluble substances were dissolved in water or acid, and insoluble substances were fused with alkali carbonate, treated with water, and the solution then acidified. For separating and collecting the emanation Boltwood's apparatus (Amer. J. Sci., 1904, 18, 378; Phil. Mag., 1905, 9, 599) has been found very satisfactory. An alternative method consisted in bubbling air through the heated solution. The gases obtained were kept for 10 minutes, to allow for the decay of any thorium emanation, and then transferred through a calcium chloride tube to the discharging chamber of an emanation electroscope. Some samples of artificial waters and medicinal preparations examined were found to be radioactive, as claimed on the label, but in other cases the radioactivity was so slight as to be negligible.—W. P. S.

Sulphate: Quantitative determination of small quantities of —. H. J. Hamburger. Proc. K. Akad. Wetensch. Amsterdam., 1916, 19, 115—125. J. Chem. Soc., 1916, 110, ii., 611.

THE micro-volumetric method, already applied in the estimation of small quantities of potassium (this J., 1916, 277), has been found to yield satisfactory results in the estimation of sulphate by precipitation as barium sulphate. The precipitate is forced into a calibrated capillary tube by centrifuging, and when constant the volume of the precipitate is read off. The tube is calibrated by preliminary experiments with solutions containing known quantities of sulphate. Experiments showed that the volume of a given quantity of precipitated barium sulphate, depends on the size and shape of the crystals, and it has been found necessary to carry out the precipitation under certain definite conditions. In particular, it is

essential that the precipitated barium sulphate should consist of very small crystals, and this result may be attained by the addition of acetone. The procedure adopted is to add 2.5 c.c. of hydrochloric acid (1 : 1) to 5 c.c. of the sulphate solution : to this solution is added 5 c.c. of a barium chloride solution (2.4% $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$) containing three to five drops of acetone. When the estimation is carried out in this manner, the result obtained is not affected by the presence of sodium, potassium, calcium, magnesium, chloride, or phosphate in the original solution.

Methylene Blue: Use of—*as a reagent in chemical analysis.* Application of the process to the detection and determination of perchlorates in Chile saltpetre. A. Monnier. Arch. Sci. phys. nat., 1916 [iv], 42, 210–216. J. Chem. Soc., 1916, 110, ii., 639–640. (See also Attack, this J., 1915, 1005.)

THE following acids in dilute solutions, preferably in the form of their alkali salts, give coloured, crystalline precipitates with a solution of Methylene Blue. Hydriodic acid gives a deep blue precipitate, showing bronze-green by reflection; perchloric and hydroferrieyanic acids, violet precipitates, bronze-green by reflection; persulphuric, dichromic, and permanganic acids, rose-violet precipitates, bronze-green by reflection; metavanadic, molybdic, and tungstic acids, deep blue precipitates. The precipitate with a persulphate is readily distinguished from that with a perchlorate in that the former when calcined leaves a slight residue showing the reactions of a sulphate, and the latter when heated decomposes violently with deflagration. The amount of potassium perchlorate can be readily estimated colorimetrically in a sample of Chile saltpetre by this method. To 20 c.c. of a 5% solution of the crude nitrate 1 c.c. of a 0.3% solution of Methylene Blue in water is added, and the mixture left overnight. A crystalline precipitate forms, and the supernatant liquid is tinted blue. This colour is compared with that of standard tubes containing varying amounts of pure potassium perchlorate. If the perchlorate is present to the extent of less than 0.2%, a 10% solution of crude nitrate, and if more than 0.5%, a 2.5% solution of crude nitrate is used. If the crude nitrate contains any iodide, this can be first removed by shaking the solution with moist silver oxide.

Determination of light oils in coal gas and description of still for separating the light oils from the absorbing oil. Duvall. See IIa.

Utilisation of hypochlorite colour reactions in establishing the mechanism of the action of dimethyl sulphate on aniline. Shepard. See III.

Results of co-operative work on determination of sulphur in pyrites. Moore. See VII.

Detection of thiocyanates. Curtman and Harris. See VII.

Determination of fluorine in soluble fluorides. Dinwiddie. See VII.

Reactions for distinguishing between perchlorates, periodates, persulphates, percarbonates, and perborates. Monnier. See VII.

A precision method of uniting optical glass. Union of glass in optical contact by heat treatment. Parker and Dalladay. See VIII.

Carbon tube furnace for testing the softening points and compressive strengths of refractories. Griffiths. See VIII.

Determination of sulphur in iron and steel. Pulsifer. See X.

Use of two indirect methods for determination of the hygroscopic coefficients of soils. Alway and Clark. See XVI.

Determination of total carbon in soil by wet combustion. Schollenberger. See XVI.

Determination of phosphorus pentoxide [in fertilisers] after citrate digestion. Smith. See XVI.

Aeration method for the determination of alcohol in fermentation mixtures. Dox and Lamb. See XVIII.

Use of the spectrophotometer for the examination of food colouring substances. Mathewson. See XIXa.

Modification of Price's method for the separation of the seven permitted coal-tar dyes to include Tartrazine. Estes. See XIXa.

Determination of crude fibre. Mangels and Trowbridge. See XIXa.

Analysis, purification, and some chemical properties of agar-agar. Pellers. See XIXa.

Boiling method for the determination of soluble arsenic in lead arsenate. Gray and Christie. See XIXb.

An oxalate-iodide process for Paris green analysis. Peters and Fielding. See XIXb.

Microchemical distinction of morphine from codeine. Tammann. See XX.

Chemical and physiological action of strychnine masked by quinine. Filippi. See XX.

Factors connecting the concentration and the optical rotatory power of aqueous solutions of nicotine. Tingle and Ferguson. See XX.

Application of the ultraviolet to the determination of constitution and estimation of nitrogen in a class of nitro-compounds, viz., nitroamines. Clegg and Barab. See XX.

Methods of estimation of semicarbazide, semicarbazide, and oxalylhydrazide by their interaction with halogens and halogen oxyacids. Datta and Choudhury. See XX.

PATENT.

Enzyme filters. Eng. Pat. 16,696. See XVIII.

Trade Report.

Prohibited exports. Orders in Council, Dec. 12 and 19, 1916.

The following headings are deleted: (1) Manganese peroxide of, (2) scheelite, (2) wolframite, (2) stron-

tium sulphate, (2) lead, pipe, scrap, or sheet, and solder containing lead. The following headings are added: (3) Formates, not otherwise prohibited, (3) iridium, osmium, palladium, rhodium, and ruthenium, compounds, (3) white lead, (1) manganese peroxide, and mixtures and preparations thereof, (3) oxalates, not otherwise prohibited, (3) soda lime, (3) sulphites, metallic, not otherwise prohibited, (3) thiosulphates, metallic, not otherwise prohibited, (1) zirconium compounds, (3) glue, osseine and concentrated size, fish glue, isinglass, finings and other kinds of gelatin, (3) Iceland, Irish and sphagnum moss, algin and its compounds, (3) iridium, osmium, palladium, rhodium, ruthenium, and alloys of these metals, (2) lead (except pig lead), alloys of lead, solder containing lead, and manufactures of lead and its alloys, not otherwise prohibited, (1) thorium and its alloys, (1) zirconium and its alloys, (2) oil varnishes, (1) wood pulp, (2) zirconium minerals, (1) strontium compounds, and mixtures containing strontium compounds, (2) tungsten ores (including ferberite, hubnerite, scheelite, and wolframite), (3) wines.

Note. The exportation of the goods mentioned above is prohibited as follows:—Goods marked (1), to all destinations. Goods marked (2), to all ports and destinations abroad other than ports and destinations in British Possessions and Protectorates. Goods marked (3), to all destinations in foreign countries in Europe and on the Mediterranean and Black Seas, other than France and French Possessions, Russia, Italy and Italian Possessions, Spain, and Portugal, and to all ports in any such foreign countries, and to all Russian Baltic ports.

Exports to Switzerland.

The Contraband Department of the Foreign Office has forwarded the following additions to and corrections in the list of articles in respect of which licences for export to Switzerland are only granted if the goods are consigned to the Société Suisse de Surveillance Économique (S.S.S.).

Additions to list. Abaca and similar fibres, Cadmium in all forms. *Changes in the details of items already on the list.* Bones, whole, dissolved, melted, calcined, or bone ash. Naphtha; naphthylamine (alpha and beta naphthylamine); naphthol (alpha and beta naphthol) and similar products; naphthalene and its compounds. Skins, raw and dressed, including fur skins not put together. Soap, including "Monkey Brand" soap. Perfumed toilet soaps.

Small parcel scheme. The following articles have been withdrawn from the benefits of the small parcel scheme, and should therefore no longer be printed in italics:—Benzoates of benzyl and of ethyl. Calcium cyanamide. Carbide of calcium. Cellulose. Condensed milk, sweetened or not. Hydrobromic acid. Infusorial earth. Mercury, and its compounds and preparations, and mixtures containing such compounds of mercury. Packings, engine and boiler, including slag wool. Salts of thorium and of cerium and other salts of rare earths. Slag wool. Sulphate of zinc. Titanium, metal and salts.

Contraband of war. Royal Proclamation, Dec. 29, 1916.

The following articles are declared absolute contraband:—Oxalic acid and oxalates. Formic acid and formates. Phenates. Metallic sulphites and thiosulphates. Soda lime and bleaching powder. Platinum, osmium, ruthenium, rhodium, palladium, iridium, and the alloys and compounds of these metals. Strontium salts and compounds thereof. Sulphate of barium (barytes). Bone black.

The following amendments are made in Schedule I. of the Royal Proclamation of the 14th October,

1915 (see this Journal, 1915, 1075):—For item 8, "ethyl alcohol; methyl alcohol," there is substituted "Alcohols, including fusel oil and wood spirit, and their derivatives and preparations." For item 35, "aluminium, alumina, and salts of aluminium," there is substituted "aluminium and its alloys, alumina, and salts of aluminium." For item 11, "wolframite, scheelite," there is substituted "tungsten ores."

In Schedule II. of the same Proclamation, for item 5, "fuel, other than mineral oils," there is substituted "fuel, including charcoal, other than mineral oils."

Books Received.

A TEXT-BOOK OF QUANTITATIVE CHEMICAL ANALYSIS. By A. C. CUMMING and S. A. KAY. Second Edition. Gurney & Jackson, 33, Paternoster Row, London. 403 pages, 8½ × 5½ in. Price 9s.

No fundamental alteration has been made in the arrangement of this useful book, the first edition of which appeared in 1913, but the text has been revised throughout, and new methods and exercises included. The book is divided into ten parts, as follows: I. General principles. II. Volumetric analysis. III. Gravimetric analysis. IV. Colorimetric methods. V. Systematic quantitative analysis. VI. The analysis of simple ores and alloys. VII. Gas analysis. VIII. Water analysis. IX. Quantitative analysis of organic substances. X. Determination of molecular weights. The volume concludes with an appendix and indexes.

DYEING IN GERMANY AND AMERICA. Second edition. By S. H. HIGGINS. Longmans, Green & Co., 39, Paternoster Row, London, E.C. 143 pages. 8½ × 5½ in. Price 5s.

THIS book, of which the first edition appeared in 1907, gives a general survey of the dyeing and allied industries of the United States and Germany, the material for which was collected during a tour of these countries in 1905-6. No further visit has been paid to either of these countries, but a considerable amount of new matter has been added as a result of experience gained in the dyehouse of the Municipal School of Technology, Manchester, and later as chemist and manager of a bleaching works. The last chapter of the first edition, on colour production, has been left practically unaltered, and a further chapter has been added containing a description of some recent developments in this branch of industry.

THE PORTLAND CEMENT INDUSTRY. By W. A. BROWN. Crosby, Lockwood & Son, 7, Stationers' Hall Court, London, E.C. 158 pages, 8½ × 5½ in. Price 7s. 6d.

A CONCISE description is given of the processes and plant used in the manufacture of Portland cement, and the methods of testing. The book is illustrated by 36 plates and 12 figures.

BULLETIN OF THE IMPERIAL INSTITUTE. Vol. XIV. No. 3. July to September, 1916. Price 2s. 6d.

THIS issue of the Bulletin contains the results of investigations in connection with recent work on monazite and other thorium minerals in Ceylon, the new coalfield in West Africa, the essential oil of Sherungulu tubers (2nd article), lemon grass oil from India, Ceara rubber from Nigeria, and fibres from the Belgian Congo. There are also general articles on the occurrence and utilisation of antimony and cobalt ores, and the cultivation of the pine-apple for fruit and fibre.

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Official Notices.

NEW YORK SECTION.

Dr. Parker C. Mellhiney has resigned the Secretaryship of the New York Section, a position which he has occupied with conspicuous success for the past 6½ years. He will be succeeded by Dr. Allen Rogers of the Pratt Institute, Brooklyn, N.Y. The Council at its last meeting passed a resolution expressing appreciation of the services rendered by Dr. Mellhiney to the Society.

BEIT FELLOWSHIPS FOR SCIENTIFIC RESEARCH.

The Trustees for the Beit Fellowships for Scientific Research announce that the next election of Fellows will take place on or about July 15th, 1917. Not more than three Fellowships will be awarded. Applications must be received on or before April 16th, 1917. Forms of application and all information may be obtained, by letter only, addressed to the Rector, Imperial College, South Kensington, London, S.W.

These Fellowships, of which the annual value is £150, are tenable for one year, but may be extended by the Trustees for a further period not exceeding one year. Every Fellow must be a person of European descent by both parents, but otherwise of any nationality, who at the date of election shall have taken a degree in any Faculty in any University in the British Empire approved by the Trustees, or is in possession of any Diploma or Associateship of any College approved by the Trustees. The holding of any other Scholarship or Fellowship will disqualify an otherwise eligible person. Candidates must be under 25 years of age at the time of election, and must state in their applications the general nature of the research which they propose to carry on. Fellows will be attached to a department of the Imperial College of Science and Technology and will work under the supervision of a Professor.

Editorial.

THE JOURNAL.

At the informal meeting of the London Section, held on December 19th last, a report of which appears on pages 63—65 of this issue of the Journal, there was a certain amount of criticism on the character of the Journal, to which some reference may be made here. The Journal consists broadly of two parts, for one of which—the original matter—we have to depend upon our members, whilst for the other the editorial staff is responsible. The original papers and communications should form the salient feature of the Journal, and the standard of these, both as regards quality and quantity, has been maintained at a consistently high level during recent years, although some falling off might have been anticipated during the period of industrial disturbance following the outbreak of war. At the same time, the members of a Society numbering over 4000 might reasonably be expected to provide more papers than is the case at present, and it is to be hoped that members will use every effort to provide or secure suitable matter for the Journal. Communications to the Society serve a twofold

purpose, for in addition to supplying material for the Journal they provide the wherewithal for meetings of Local Sections. In many of our Sections it has been found increasingly difficult of late to induce members to come forward with communications. There appears to be a mistaken idea that all papers must contain the results of some original research. This is far from being the case. Some of the most interesting papers which have appeared recently have been those in which nothing of an absolutely novel character is described—for example, some of the papers read at our last annual meeting in Edinburgh. At the meeting of the London Section referred to, it was suggested that papers or discussions on such subjects as labour in chemical works, and filtration problems, would be of great general value, and many other subjects suggest themselves, such as descriptions of various types of chemical plant (still, evaporators, etc.) and their suitability for different kinds of work. In every works, too, there are unusual occurrences and small problems which are worthy of note and will undoubtedly prove very interesting and suggestive to others. If any member has notes of matters such as these, which could be worked up into a paper, however short (and brevity is no objection), he is requested to communicate with the Secretary of his Local Section, or if he is not a member of a Section, with the Editor.

Another point in connection with original papers which calls for remark is concerning the discussions. Although comparatively very few members take part in these discussions there are probably many who have some interesting observations to make on the various papers, but who for a variety of reasons do not do so; and again, many members must find matter for comment in papers which they read in the Journal. The Editor will be glad to receive any remarks or comments by way of discussion on any paper which has appeared in the Journal or has been read at a Sectional meeting.

The abstracts in the Journal have from time to time been the subject of criticism from various standpoints. On the one hand it is sometimes urged that they are not full enough nor informative enough, but it must be pointed out that no abstracts can be sufficiently full to meet the requirements of those to whom the particular matter appeals directly. They are merely intended to indicate to those interested whether or not the matter in the original paper or patent specification is of sufficient importance to justify further reference to it. Again, some members have stated that only one or two pages of the abstracts, perhaps, in each issue of the Journal are of interest to them. Whilst it may be true that this is the proportion of matter which refers directly to some particular industry, it cannot be urged too strongly that members should peruse the abstracts of literature dealing with other industries than those with which they are connected, for not only will they find a large amount of general information in these sections, but they will undoubtedly come across many items which, though not bearing directly upon their own industry, will suggest the application therein of a new process or piece of apparatus, or in some other way furnish a useful idea.

In conclusion, members are invited to make suggestions as to the directions in which the value and utility of the Journal could be enhanced; any such suggestions will be very welcome and will receive careful consideration.

Glasgow Section.

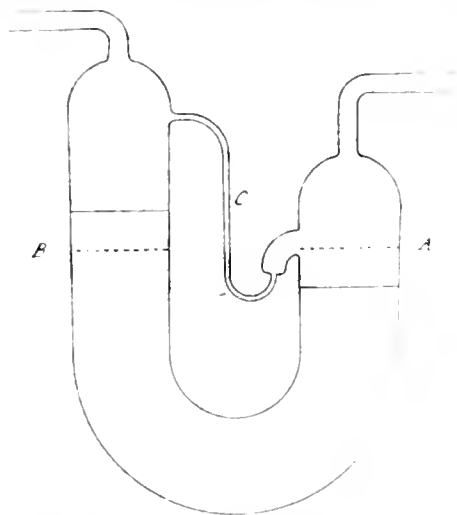
Meeting held at Glasgow on Tuesday, November 28th, 1916.

MR. JAMES MCLEOD IN THE CHAIR.

A LABORATORY GAS METER.

BY E. G. BECKETT.

It is often of interest to know the rate of a stream of gas employed in a laboratory operation, and as the following device has been found to be useful for this purpose, it was thought that a description of it might be helpful to other workers.



The diagram shows the design of the apparatus. It is filled up to the dotted line, AB, with water, which thus fills the siphon, C, connecting the two limbs of the U-tube. When the gas to be measured enters the apparatus, it forces the level of the water down in A and up in B until the difference in pressure causes the siphon, C, to empty itself into B. The gas in A then escapes into B through the siphon, while the level of the water readjusts itself in the U-tube and fills the siphon, C. The process then starts again. The siphon runs over each time after a definite amount of the gas has passed through the instrument, which amount, however, varies with the velocity of the gas. A determination of the capacity of the gas-meter for different velocities gave the following results:—

Rate, c.c. per sec.	Capacity in c.c.
15.5	41.5
10.0	42.5
7.61	40.5
6.56	40.0
3.75	37.5
1.93	36.5
0.51	35.1

As this siphon gas-meter is made entirely of glass, it may be used for any gas which is slightly soluble in water or in the liquid used. It is especially useful for highly corrosive gases, such as chlorine, for which the ordinary metallic gas-meter is out of the question.

If a constant stream is desired, gas at a high pressure should be employed, and the rate regulated or throttled immediately in front of the gas-meter. For gases very soluble in water, other liquids have

to be used instead, but only mobile liquids can be employed.

This apparatus can be obtained from Messrs. Baird and Tatlock, London.

I desire to thank Messrs. Nobel's Explosives Co., Ltd., for permission to publish this communication.

London Section.

Meeting held at Burlington House on Monday, December 4th, 1916.

MR. ARTHUR R. LING IN THE CHAIR.

In the absence of the authors, the following paper was read by Mr. J. A. Reavell.

PRODUCTION OF NITRATE OF SODA IN CHILE—PAST, PRESENT, AND FUTURE.

BY I. BIRKWOOD HOBSBAUM, A.M.S.T., AND J. L. GRIGIONI.

For an industry of such enormous dimensions and importance as the nitrate industry of Chile, very little text book information is available: nor can its progress be followed by the illustrious names coupled with steps of true importance which in other industries mark the grappling ground, where industrial problems are overcome by science. That is not to say that the nitrate industry has been in the hands of mediocrities throughout its history, but it must be freely admitted that its progress hitherto has been more commercial than scientific, and that its real development on scientific lines is yet to come.

There arises in all industries, especially in those in which the prime material is directly obtained from natural deposits, a crisis at some time, which no purely commercial ingenuity can overcome. When labour is reduced to its minimum cost, transport, both of raw material and finished product, as cheap as possible, selling price pushed to its economic limit, and mechanical device as satisfactory as can be expected, little more hope remains to an industry save that science can find a means of increasing efficiency or improving it in such a way that poorer, and necessarily cheaper, raw material may be used. We do not state that such is the position actually held by the nitrate industry, but that such a position is within sight. The richest of the known deposits have been used up: the medium deposits are being eaten into yearly, and yet the poorer deposits are practically untouched and only waiting for human ingenuity to devise the necessary means for making them useful.

We propose in this paper to trace the progress of the nitrate industry from the discovery of the deposits to the present day. We propose to analyse this progress—to point out the directions in which the methods of refining have been modified and brought up to date—to adumbrate the deficiencies caused by these types of modification and to show that even when the acme of mechanical efficiency is reached, the process still remains comparatively primitive. We will then describe the newer schemes by means of which it is hoped to put the nitrate industry on a level with well-organised industries. These introductory remarks will be made all the clearer when it is appreciated that the commercial preparation of nitrate of soda from the raw material, in which it naturally occurs, is essentially a mechanical problem of lixiviation (and separation of solution from solid) followed by a physico-chemical

problem of crystallisation. Caliche, as the naturally occurring nitrate-containing mineral is locally called, is essentially a mixture in which a variable amount of insoluble matter is bound together with crystals of soluble salts, the whole forming a conglomerate.

The composition of some typical caliches is shown in Table A.

TABLE A.
Analyses of caliches.

%	High grade.				Low grade.			
	1.	2.	3.	4.	1.	2.	3.	4.
Moisture	1.107	2.003	1.121	2.764	1.061	1.892	2.173	1.951
Nitrate of potash	—	—	—	—	0.958	—	—	—
" soda	52.960	48.700	50.250	33.687	13.270	12.4	14.034	13.160
Chloride of sodium	23.4	17.3	30.2	25.7	29.3	13.9	17.8	9.1
Iodate " "	0.074	0.151	0.026	0.014	0.059	0.062	0.010	0.153
Sulphate " "	2.976	6.958	1.226	—	8.220	9.075	—	6.246
Sulphate of magnesia	1.166	2.441	0.156	—	0.885	7.041	—	3.087
" lime	2.585	2.177	3.110	3.230	4.026	3.618	5.456	3.346
Nitrate of lime	—	—	—	—	—	—	3.935	—
Insolubles	15.677	20.213	13.9	34.597	42.213	51.934	50.543	62.938
Totals	99.945	99.943	99.989	99.992	99.992	99.922	99.951	99.981

It is not the intention of the authors to deal with the question of the origin of the deposits, nor with the methods of mining. A few remarks on the latter will appear towards the end of the paper, but enough has already been written on this part of the subject by others, and so little development has taken place since, as to leave what has been written quite up to date.

Since the use of Chilean nitrate was brought to notice in 1809 by Taddeo-Haenke, a German domiciled in Bolivia, the essential principle of the commercial method of separating the soluble from insoluble matter has not been altered. It might be broadly stated that from 1809 onwards the endeavour has been to prepare a concentrated solution of nitrate of soda by boiling the raw material with water and mother liquor for some time and running off such solution when a convenient maximum temperature and density are reached. Dependent upon this temperature is the relative quantity of nitrate of soda, salt and other impurities which are retained in solution.

The increase of solubility of nitrate of soda with rise of temperature and the decrease of solubility of sodium chloride in such a solution of nitrate, is such that an effective separation of the two salts can be brought about by this means and the liquors thus obtained, when allowed to crystallise, will deposit, as crystal, little or no sodium chloride. To follow adequately the progress of the industry from its inception it will be necessary to trace, through certain periods, the carrying out of the above outlined desideratum. These periods have no other significance than ease of classification for descriptive purposes.

1st Period, 1809-1856: 2nd period, 1856-1880: 3rd period, 1880-1900: 4th period, 1900-present day. The total production up to 1915 has been approximately 51,000,000 tons.

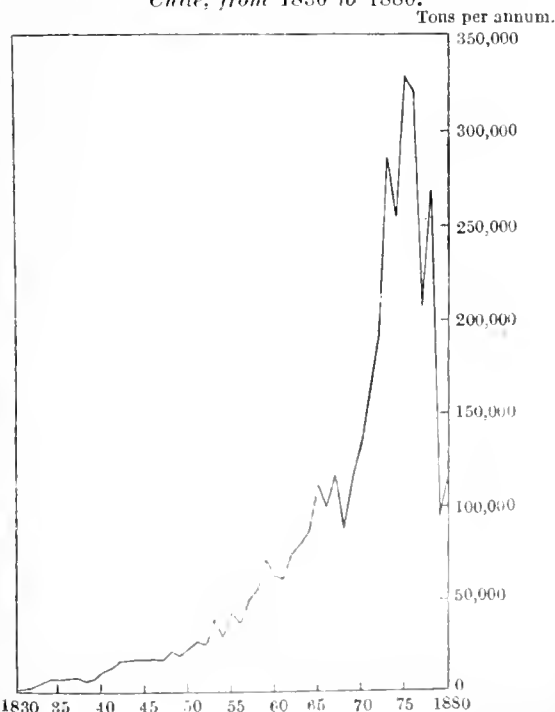
During the first period—1809-1856—which was the unorganised period of the industry, the nitrate bearing grounds lay in the three countries on the West Coast of South America, Peru, Bolivia, and Chile. As little importance was attached to these deposits at that time, and the workings were carried on under the most primitive conditions, it can easily be understood that nothing but practically the purest of the caliche was taken out of the ground to be refined. It is probable that the raw material worked contained as much as 80 % or more of nitrate of soda. The

nitrate of soda contained in the caliche was brought into solution by boiling the latter with water in copper pans (of native manufacture) heated by direct fire, the fuel employed being "carbonized wood." The liquors obtained were run off and the solid refuse disposed of. By virtue of the richness of the raw material one lixiviation with water and returned mother liquor

was enough to produce sufficient solution to be run off, from which comparatively pure nitrate of soda could be crystallised by gradual cooling in tanks exposed to the air.

During the years 1810-1812 six or eight of these primitive establishments were erected, which were able to produce between March, 1812, and January, 1813, 22,723 Spanish quintals of nitrate (roughly 1000 tons). In 1830 the value of this product as a fertiliser began to be recognised in Europe and the industry began to improve its output; thus from 1830-1834 production was 361,386 quintals, from 1850-1854 3,260,492 quintals.

TABLE I.
Increase of exports of nitrate of soda from Chile, from 1830 to 1880.



Period 2, 1856-1880. Although we have chosen to mark the year 1856 as the beginning of a new period we have done so for sentimental reasons more than any other, because although it marks officially the introduction of steam into the process, the full value of this innovation was not taken advantage of, save in very few works, until very much later. The modification, involving the use of steam, was the leading of the steam through perforated pipes into the mixture of caliche and liquor. Only about 60% yield was obtained, the "dumps" from these "parados," as they were locally known, containing 20-30% nitrate and the fines (or borras) about 40-50% after washing.

During this period the raw material used fell little short of the high percentage of nitrate above referred to and it may be stated on the authority of observers of that time that material of lower contents than 50% of nitrate of soda was not taken to the works for treatment. Table 1 shows the development of the export of nitrate of soda from 1830 until 1880. During this period the majority of the works were situated in the province of Tarapaca, which belonged to Peru, but was annexed by Chile as a result of the war which began in 1879 and was concluded by the Treaty of Ancón in October, 1883. Thus practically at the opening of the third period the nitrate bearing grounds of South America were in the hands of that most progressive of South American States—the Republic of Chile. As we have said, from 1856 onwards the means of producing nitrate of soda began to be divided between the works of the essentially primitive type, in which the pans were fire-heated and those representing the first step forward, in which the nitrate was dissolved in tanks by heat supplied by the introduction of steam through perforated pipes.

All this so far was the treatment of an exceedingly high grade material by boiling with water (and returned mother liquor) for the preparation of the concentrated solution for crystallisation. During this period also closed serpentine coils were introduced into the tanks through which coils passed steam from the boilers. This was of course the natural corollary to the perforated pipes as it avoided dilution of liquors by condensed water.

Period 3, 1880-1900. In 1876 a very radical change was introduced into the process and from that date the system adopted has not been varied, save for minor modifications and mechanical improvements. The honour of introducing this vital alteration belongs to Mr J. T. Humberstone, who is affectionately known in the nitrate districts as the "father of the nitrate industry."

He applied the counter-current system of lixiviation in tanks, which he adapted from the alkali makers in England, and which is known locally as the "Shanks system." In this system of counter-current lixiviation, the raw material is treated with the richest liquor and the successive stages with weaker liquors, the last wash being done with water. The temperature is highest in the richest tank and lowest in the tank receiving its final wash.

The liquors pass forward through a series of tanks in which they are strengthened up by lixiviating richer material, and the temperature in each forward tank is increased. The heating is done by means of closed steam coils, the condensed water from these being returned direct to the boilers. The effect of the introduction of such a system permitted of the disposal of the refuse insoluble material, with a much smaller content of nitrate of soda than heretofore owing, naturally, to the greater proportion of water which could be used in the lixiviation process. It had an all-round cheapening effect upon the production cost of the finished product, and permitted where necessary the exploitation of mixed deposits of poorer ley. It permitted the mixing of material of 60% nitrate

content with that of 30%, or 50% with 30%, but even at this period it was not considered advisable to remove from the grounds material of less than 30%. From this time onwards the newer system gained a very rapid following and was adopted by the English companies to whom the development of the industry was at this time most due, and in 1882 the Liverpool Nitrate Co. instructed Mr. (now Sir) Robert Harvey to prepare plans and estimates for the construction of their oficina "Ramirez." The details of this works were communicated to the Institution of Civil Engineers by Sir Robert Harvey in 1884 and by courtesy of this gentleman we are able to extract from his paper some of the important details of this then, then, largest works in Chile. We are indebted also to Sir Robert Harvey for much information regarding the processes in use prior to introduction of the Shanks system.

Ramirez Works, 1883. Extract from Minutes of Proceedings, Institution of Civil Engineers, Harvey (Nitrate of Soda 1884/5).

Six steel boilers, 30 ft. x 6 in., double flues, with 6 Galloway tubes, 12 boiling tanks, 30 ft. x 8 in. x 7 in. (1680 cub. ft. capacity each), with steel heating tubes; 90 crystallizing tanks, 16 ft. x 16 ft. x 3 ft. deep, sloping to 2 ft. 9 in. (736 cub. ft. capacity); 2 feeding tanks, a 5 compartmental washing tank, and 3 circular tanks, 25 ft. in diam. by 12 ft. high. Locomotives and rolling stock of 2½ miles of portable railway, by John Fowler and Co., of Leeds. Engines, pumps, machine tools, by Tangye Bros., and 3 crushing machines.

This works was erected by Sir Robert Harvey, and completed in 1884. The author says: "In order to provide caliche sufficient to meet the requirements of so large a system of machinery at least 250 mules and 40 carts would be required." To avoid this expense he introduced the innovation of a portable railway with two locomotives and eighty side tip cars and only used 30 mules and 5 carts for taking the caliche to the side of the railway line which runs out 1½ miles in the caliche quarries. The line has a 2 ft. gauge, 16 lb. rails; the cars carry 1½ tons of caliche. The works were built for a production of from 6000 to 6500 tons of nitrate of soda per month and the author mentions that the chemical analysis of his raw material was: Nitrate of soda, 51%; common salt, 26%; sulphate of soda, 6%; sulphate of magnesia, 3%; insoluble, 14%.

The cost of the machinery, plant, and construction amounted to £110,000 and for every 1 ton of coal burnt, 12 tons of nitrate of soda was manufactured. It is a far cry from 1884 to 1914, but during this period of 30 years no further alteration has been made in the process than the introduction of certain labour-saving devices, such as belts and bucket elevators, electrically driven machinery, the use of oil fuel for generating steam, and the introduction of Diesel engines. That is to say every improvement has been in the direction of perfecting the mechanical side of the system.

Table 2 will show the increase in export of nitrate of soda from 1880-1900.

Period 4, 1900-15. In 1911, an English nitrate company began the construction of a new oficina from the design of Messrs. Strain and Robertson, Consulting Engineers, Glasgow. This works was designed for an output of 90,000 qtls. nitrate per month from material containing 25% nitrate of soda.

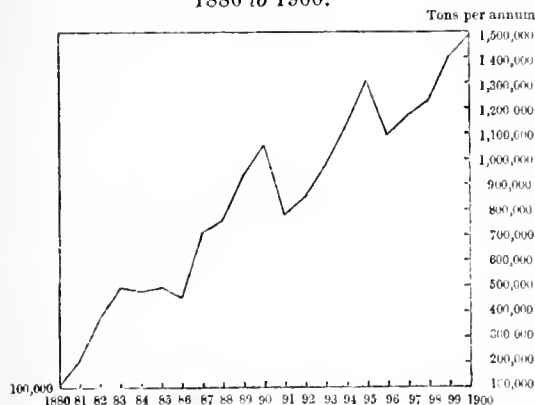
In this works the whole of the power for crushing and distribution of crushed material and for pumps was provided by a central electrical generating station containing two 200 B.H.P. Diesel engines by Willans and Robinson and two 3-phase alternators by Siemens Bros. direct coupled. For the transmission of power to the wells and outlying places step-up transformers are used and the current transmitted by bare copper aerial lines.

The steam for process work was generated by Lancashire boilers (30 ft. \times 7 ft. 6 in.) fired with oil fuel, of which 5 were installed.

The material was crushed in Blake Marsden crushers (24 in. \times 18 in.), driven electrically, five of these crushers being installed.

TABLE 2.

Increase of exports of nitrate of soda from Chile, 1880 to 1900.



The crushed material was elevated to the boiling tank stage by belt conveyers and distributed by belt to the tanks for loading. There are 18 boiling tanks, each 34 ft. \times 7 ft. 6 in. \times 8 ft. 6 in., provided with false bottoms 1 ft. above true bottom and fitted with the necessary connections for transference of liquors and three "ripio" discharge doors for discharging the spent caliche. The latter is drawn to the dump tip in side-tipping waggons drawn by petrol locomotives. The works is equipped with 154 crystallizing tanks, each 18 ft. \times 18 ft. \times 3 ft. 6 in., sloping to 3 ft., the whole of these mounted on a substantial steel structure. The raw caliche is brought into the works by a light railway 2 ft. 6 in. gauge, 35 lb. rails spiked being used.

The mileage of railway is 2-2½ miles, and the loading stations are fed by carts and mules from the actual mining localities.

The water supply is derived from wells, as is usual in these districts, the power for pumping being supplied from the central station.

The works is provided with a very complete engineering workshop fully capable of dealing with all necessary repairs for the efficient upkeep of so large a mechanical installation. It also has a small foundry for both brass and iron.

The details of this oficina as compared with the details of that constructed by Harvey in 1884 show that the power and mechanical side of the works have been completely modernised, with the result that lower grade material and consequently increased proportional amounts thereof can be commercially handled.

A description of one month's working will help to show what has been effected by the modernisation of the means of handling the large quantity of raw material.

During the 29 days worked in one particular month there were brought in 12,484 cartloads of raw material; estimated weight of cartload 41 Spanish quintals (101.2 lb.). Fifteen carts were employed in feeding the loading stations, each making about 28 trips per day. 2 locomotives and 65 side tip waggons were used to transfer the material from the loading stations to the treatment plant.

The raw material averaged 21.89% nitrate and the total treated—499,544 Spanish quintals—was divided into 350 charges (tank loads) of about 1430 qtls. each and the yield showed, on the figures taken, an efficiency of 56.4%.

The figures are as follows:—

Total caliche 499,544 qtls. at 21.89% nitrate = 109,350 qtls. nitrate.
Produced 65,000 qtls. of 95% nitrate = 61,750 qtls. nitrate.

In ripio 400,614 (dry weight at 5.04% estimated)	20,192.45 qtls.
In borra 33,900 at 17.45	5,915.55 ..
Unaccounted for	21,492.00 ..
	<hr/> 47,600.00 ..

That is a recovery of 56.4% of the nitrate contained was effected from raw material of about 22%.

For each quintal of petroleum consumed 7.98 quintals of nitrate was extracted, or in coal equivalent (taking the heat efficiency oil to coal as 18 to 12) one qtl. of coal produced 5.32 qtls. of nitrate.

Considering this figure of 1 to 5.32 coal for nitrate against that of 1 to 12 as obtained in 1884 it would seem as though no improvement at all had taken place during this period. It is necessary, however, to consider that in 1884 the material used contained 51% nitrate and 14% insoluble, while in 1914 the proportions were 21.89% nitrate and 45.00% insoluble, and that 1914 material could not have been treated by 1884 means.

The fuel cost for haulage of the increased quantity of raw material and discharge of the increased quantity of insoluble matter ought to increase in the proportion corresponding to the fact that 1000 tons caliche in 1884 becomes 2330 tons in 1914 to supply the same quantity of nitrate to the plant, i.e., haulage, loading, and treatment alone ought to increase fuel consumption in the proportion of 1:2.33 and costs of discharge of refuse ought to increase in proportion to the increase in insoluble residue. Hence without mechanical improvement the 1 to 12 might easily have been expected to have fallen to 1 to 2 in 1914. Thus the economy of fuel is one of the salient features of the modern plant as against the old type.

Method employed in the refining of Chile saltpetre from the raw materials.

In the most modern of the Chilean works the methods adopted to-day actually differ very little from those used 30 years ago. The raw material is passed through crushers of the Blake Marsden type and lifted to the boiling tanks either by belt conveyor, bottom emptying car and hoist, electrical or hydraulic, or drawn up an inclined plane in a side tipping or bottom emptying car. Where a belt conveyor is used the actual distribution of the material to the tanks is done by means of the cars above referred to or, as in some cases, by belt distribution. The tanks, 32 ft. \times 9 ft. \times 8 ft., provided with false bottom 9 in.–12 in. from the true bottom, three doors for discharging ripio (refuse), steam coils for heating purposes and connections for transferring liquors and running off finished liquor and washes, are loaded with the crushed material. The size of crushing is varied, according to the hardness of the raw product, from 3 in. for the softest to ¾ in. for the hardest types.

The charge weighs from 60–70 tons. It is now leached in stages, usually 4 or 5 operations being necessary. The first is with the strongest liquor available obtained from the tank immediately behind, and of which the origin will be seen from the description of the complete cycle, and this is carried out at the highest temperature to be obtained, the boiling being continued for a period of from 2–3 hours according to the grade of material under treatment.

At the expiration of this period the boiling liquor, which is now strong enough to send to

the crystallizing tanks, is slowly run off from a point about half way up the tank), the level of the liquor in the tank being maintained by feeding with the next strongest liquor from the tank behind. The "caldo," as it is called, is run off slowly for a period of from 2-3 hours, boiling and feeding being maintained all the time, and the flow is only stopped when the liquor has decreased in strength, due to the weaker feed not being able to be strengthened quickly enough in the boiling tank which is under review.

The feed liquor is intended to displace the caldo running off, but in actual practice it mixes with it and thus limits the efficiency of the operation. When the flow of caldo is stopped, the feed to this tank is stopped and the liquor in this tank is transferred by pump or by levelling action (or both) to the next tank forward which contains fresh caliche, and the preparation of caldo proceeds anew from this fresh caliche. The tank which has now been boiled once is filled up with liquor from the tank behind it (this liquor is the result of the second boiling of the material in this tank) and boiled for a further period during which the new caliche in the tank forward is being boiled for the first time, with the liquor it has received from the tank under description. In this way the caliche is successively leached with four or five liquors in a cycle of operations, the final wash liquor being cold water. The whole operation takes 18 to 20 hours per tank.

The strong liquor (caldo) is run into settling tanks, where it is clarified (sometimes by "time" settling only, sometimes with the aid of flour, dung, etc.) and the clear liquor decanted off into open troughs through which it is conducted to the crystallizing tanks.

These crystallizing tanks are 15 ft. \times 15 ft. \times 2 ft. 6 in.—3 ft. sloping to one side, and an outfit of these tanks is enough to allow of sufficient being filled each day, and occupied for 12-13 days with a two days' supply in reserve. Thus a works filling ten tanks a day will require about 150 tanks for its equipment.

The cooling is done by exposure to the atmosphere and takes 8-11 days, at the expiration of which the plugs, which are fitted in the bottom, are withdrawn, and the mother liquor drained off to open troughs below, which conduct it to the mother liquor stock tank. The crystalline deposit in the tanks is equal to 25-35 lb. nitrate from 1 cub. ft. caldo and for every 1 lb. nitrate deposited as crystal, 0.5 lb. returns to the system as mother liquor. The nitrate after draining contains 8-10% liquor and the crystals are heaped on the drying floors (into which some of the mother liquor drains and is lost) where the heaps are periodically raked over in order to expose more surface, and by atmospheric evaporation and draining, over a period of a month, the crystals are reduced to 2-3% moisture content, after which the lumps are broken down with wooden mallets and the nitrate filled into sacks for entrainment to port.

The factors which prevent this cycle of operations from being as successful as it might be are:—

(1) *The size of lumps of raw material.* This is one cause of inefficient leaching, the liquid only partially permeating the lumps of raw material. This is helped largely by the throwing out of solution, in the more concentrated liquors, of salt, which coats the lumps; and as all successive liquors are saturated with salt, the coating on the lumps becomes an insoluble covering which tends to prevent the liquor getting at the soluble nitrate contained in the lumps. As the final wash is a dilution, with cold water, of the liquor retained by the solid, and not a displacement, and as the material at this stage contains more salt than nitrate (this salt, which has been deposited from previous operations, being more accessible to the water than the nitrate in the lumps), it

follows that all the liquors passing forward from the wash tank and which are used for the lixiviation, in the successive stages forward, must be saturated solutions of salt at their temperature and nitrate content.

The result of this is that dissolution of nitrate takes place, in the further stages, where the liquors are raised in temperature, together with deposition of salt, and the tendency in the high temperature tanks is to deposit salt upon the lumps from which the nitrate is being extracted and thus protect them against the further action of saturated solutions of salt and nitrate.

It is a common thing to be able to pick out of the refuse material (ripio) lumps of quite fresh raw material which have doubtless owed their immunity from attack to the presence of a protecting coating of salt.

(2) *The disruption of the material during boiling.* This causes the insoluble mass to pack closely in the tank, and prevents the free circulation of the liquors in the solid mass, and this is further aggravated by the presence of fines in the raw material.

The raw material after crushing shows by screening analysis a certain proportion of "fines." These fines are due to the breaking down of the softer material during handling and crushing and also to the fines originally brought in with the raw material from the mines (these are produced during the blasting operations necessary to the mining of the material and by the falling in of the soft overburden).

The proportion of fines passing $\frac{1}{4}$ in. mesh varies from 25%-60%, depending on the hardness of the original material and the method employed in loading the carts at the mines (the harder varieties produce less fines in the crushing). Often the "smalls" are shovelled up and thrown into the carts with a lot of fines. Sometimes perforated shovels are used to eliminate the fines. The lumps 30-40 lb. in weight are loaded into the carts by hand.

The presence of these "fines" in the boiling tanks is very prejudicial to successful lixiviation as they interfere with the proper circulation of the liquors.

Furthermore the space between the true bottom of the tank and the perforated false bottom (crinoline), 9 in.-12 in., becomes filled with part of these fines which remain wet with a very strong nitrate solution mixed with nitrate crystals, for this space is the coolest part of the tank. Often enough the total loss of nitrate from this source alone accounts for 10% of the total production, or 4-5% of the total nitrate in the original material. This fine waste, locally known as "borra" has been the object of many experiments in order to reduce the high nitrate content, but, as washing the nitrate out only produces weaker liquors which cannot always be successfully introduced into the cycle, and filtration has only recently been tried, the borra is almost invariably thrown away without treatment.

(3) The presence of clay and other amorphous matter, oxides of iron, aluminium, etc., causes the otherwise fairly easily drained material, e.g., stones, gravel, and sand, to become much more "spongy" and augments its power to retain liquors on draining, with the result that when it is necessary to drain off stronger liquors previous to treatment with weaker ones for the purpose of lixiviation, a greater percentage of the stronger liquor remains than otherwise would do in the absence of such amorphous matter. The effect of this is the limitation of the amount of nitrate solution passed forward in the system, with a corresponding decrease in the efficiency of the process.

Furthermore the amount of liquor used in the cycle is strictly limited to the amount of nitrate to be dissolved, so as to be able to run off the

greatest quantity of sufficiently concentrated liquor from the first tank in the cycle, and hence the above inefficiencies cannot be rectified by the use of more wash water. The residues must of necessity be thrown out wetter and richer.

These factors not only make the cycle of operations as it is used to-day inefficient, but prevent this particular method being used with success to treat finely crushed material.

It will be readily understood that the process becomes highly inefficient when the raw material contains a high proportion of this insoluble matter, which, as refuse, contains not only nitrate still untouched in the lumps but 30-35% of liquor content, which liquor, due to bad draining and inefficient displacement by subsequent washes, is a fairly strong solution of nitrate and salt.

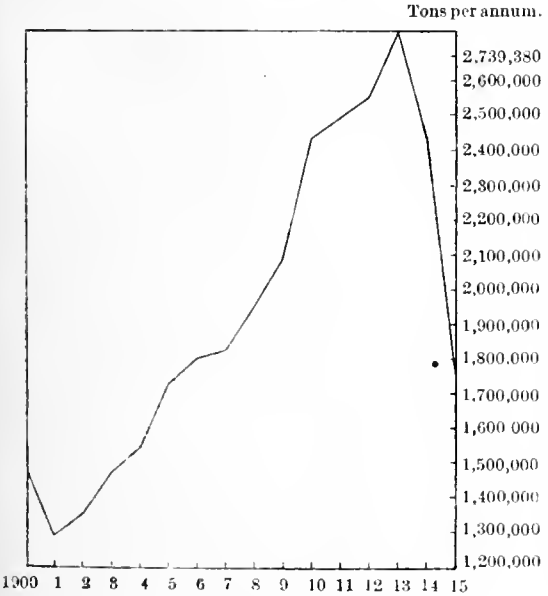
When very high grade material was used these features came into little or no prominence owing to the comparatively small proportion of insoluble matter in the raw material.

Even when the most primitive form of the process was in use and the dumps were discarded with 20-30% nitrate and the fines with 40-50%, the quantities of both dumps and borras were so small as still to leave the process efficient enough for the objects aimed at in those days, the losses being about 30-35% of the total nitrate in the caliche originally.

Now, however, with raw material containing 17 to 20% nitrate of soda or less and 20 to 25% salt and 50 to 60% of insoluble matter or more, these features assume considerable importance and, even with all the mechanical improvements and labour saving devices which are used to-day, there is a limit to the poverty of the material which can be successfully exploited by the process in use, the efficiency of which is still consistently so poor as to demand alteration and improvement.

TABLE 3.

Increase of exports of nitrate of soda from Chile, 1900 to 1915.



In fact 45-55% efficiency is all that can be expected, and although many works show a higher efficiency than the above figure in their returns it is very doubtful if accurate weights and samplings were taken as the bases of estimation, whether 50% efficiency was ever exceeded.

An average oficina's working may be expressed as follows:—

Weight raw material	unit	
Nitrate content 17%	1000 tons	
Nitrate produced (50% yield)	170	
Nitrate in refuse:—		85 tons 50%
Ripio at 3.4%		34 „ 20%
Borra		17 „ 10%
Unaccounted losses		34 „ 20%
		170 tons 100%

Table 3 shows the increase in export of nitrate of soda from 1900-1915.

Improvements in the method of lixiviation of the raw material.

As in old established industries, there is in Chile a distinct aversion from radical alteration and most of the newer schemes tried have had to be put forward as palliatives to the old process.

Unfortunately there have been up to the last two or three years no successes striking enough to draw attention to in detail, but projects for the economy of fuel, steam, labour and so on, have received attention and trial.

Forced circulation in the boiling tanks has been exhaustively tried without success; filtration through a medium placed between the true and false bottom of the tanks, alterations in shapes and sizes of tanks, details of manipulation, local changes in methods of introducing liquors, washes, etc., in fact all types of unorganised research, mostly devised and carried out by practical men without much scientific guidance, have been tried and discarded.

Methods of evaporation have come in for a share of experiment, the application of evaporators being based on the idea that by use of more water in the system and not running off fully concentrated liquors in the first boiling (concentrating up to crystallising strength in the evaporators subsequently) an additional extraction of nitrate from the raw material would take place.

This means, in effect, the use of weaker extracting liquors throughout the cycle. There is no doubt that evaporators have justified themselves to some extent, where they have been used. As, however, the expense of evaporation has been found to limit the application in the particular way desired, and the advantages are not always proportionate, evaporators have not been universally adopted.

Furthermore, weaker liquors produced by the old system must contain more salt than the previously stronger ones did. This salt is precipitated in the evaporators, entailing, in the subsequent freeing of the liquor from crystals of salt, by settling and decantation, a considerable loss of nitrate out of the caldo. An examination of the features outlined previously as defects in the present lixiviation system will prove that the addition of more water to the system can only have a partial influence, viz., that of weakening the liquors adhering to the solid refuse. The nitrate in the solid itself will not to any great extent be further extracted owing to the presence of the salt acting as a protector.

In effect the fringes of the problem only have been attacked, and great credit is due to those who endeavoured to attack them, hampered as they were by many circumstances both local and general. As stated previously, there was a great aversion from altering radically the type of plant in use then and to-day, an aversion which was justified only by the absence of results from co-ordinated experiment and research.

If the working of the lixiviation process had received thorough examination, and its defects had been properly located, a huge number of the trials and experiments would never have been carried out.

For example, efforts were made to crush the material finer, in order to bring the raw material in closer and more intimate contact with the liquors. As, however, the same lixiviation method was used it is obvious that this was foredoomed to failure, as indeed it subsequently turned out to be.

Cold water extraction combined with evaporation was also tried (Mason's system), but the methods of evaporation used did not prove satisfactory, neither did the lixiviation process, which was carried on in the same tanks as are in use to-day, the raw material being crushed slightly smaller.

An attempt was made to use the boiling tanks (this time egg-shaped and closed) in such a way that the boiled off steam from the strongest tank effected the preliminary heating in the next. The strong tank was worked partially under vacuum, not for boiling purposes, but for drawing through the mass the air used for agitating the contents of the tanks in order to procure the best mixing. This process, invented by Nordenlycht, was tried exhaustively but eventually failed.

Methods have been tried in which the principle (System Grillo and Perrori) was to work the tanks to weaker liquors and evaporate; the boiled off steam from the evaporators was used to provide the heat in the lixiviation plant (Shanks type), being introduced through perforated coils beneath the erioline plates or false bottom.

Some of these improvements indeed have given slightly better results, justifying themselves both by cost of installation and by final cost of production, but most have been too costly to install, and too complex and costly to work. All, however, have been palliatives and hence their utility has diminished with the ley of the raw material to be treated.

Within the last few years a revival of experimenting has taken place, with the result that there is ample opportunity for a new co-ordination of effort, which is now assisted by the fact that the old bias against a complete modification of the process and methods has weakened. In fact several processes are now available for test in actual practice, having been exhaustively worked out, and the experimenters are busy with hopes of success.

They aim at a complete or partial change in the process and plant, and we will pass on to as detailed a study of the two most prominent as is possible with the information at present available publicly, assisted by communications and reports from experimenters.

The year 1912 witnessed the initiation of two processes which are now undergoing commercial development in Chile and which merit detailed description, namely, the Butters process and the Gibbs process.

The following details of the Butters process are taken from a description thereof given by Mr. J. T. Humberstone at the Mining Congress held in Santiago de Chile in April, 1916, supplemented by reports and descriptions received from private sources.

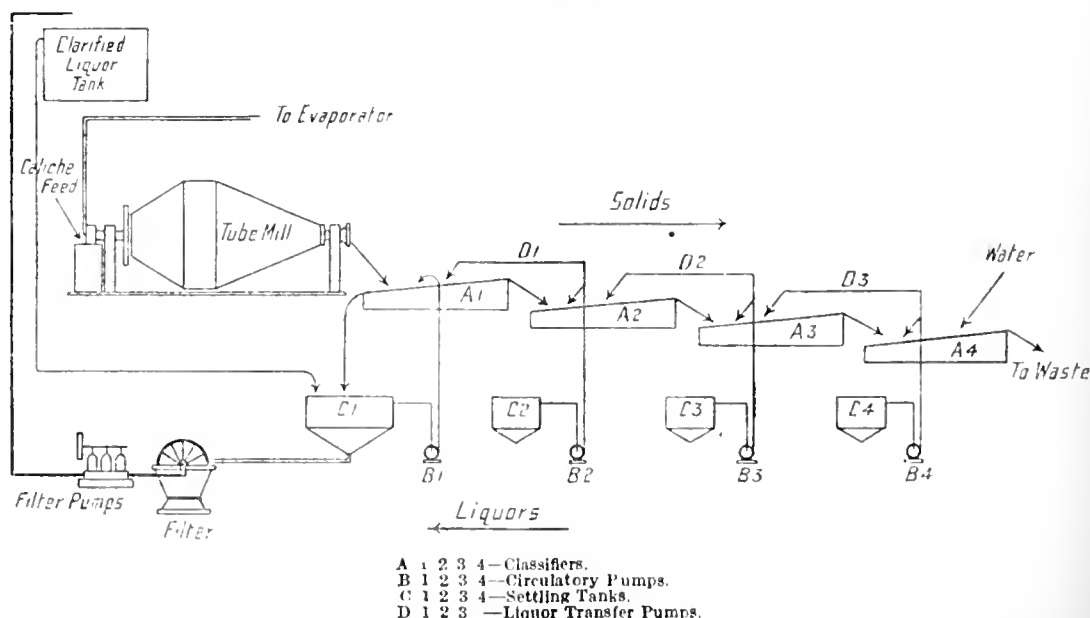
The Butters process was developed by the Butters Vacuum Filter Co. assisted by Mr. J. T. Humberstone in Oficina Agua Santa, Tarapaca, Chile.

It is based on the use of the Butters vacuum filter as the means by which the nitrate and salt solutions are removed from the insoluble matter. It is proposed to reduce the whole of the raw material to sufficient fineness, by grinding in ball mills with hot weak nitrate solution, that it will be amenable to treatment in the standard Butters filter. After grinding, the pulp is further heated by steam coils, in order to cause solution of the nitrate, air agitation going on the while.

In the Agua Santa works the fines (11% nitrate content) are mixed with liquor (150 grms. nitrate per litre) in the proportion of three of solid to one of liquid. The hot pulp is then filtered in the Butters vacuum filter and a certain proportion of liquor is extracted in this way. This liquor is of varying strength depending on the amount of weak liquor (and strength thereof) which is used for the extraction and the proportion and richness of the raw material used with it.

The inventors claim that it is possible to prepare a liquor, by this means, which can be sent direct to the crystallising tanks, but so far this claim has not been substantiated in practice. In fact the inventors state that it is preferable to work for the preparation of a liquor containing about 450 grms. of nitrate of soda per litre, which would

GIBBS PROCESS—DIAGRAM OF LIXIVIATION SYSTEM.



show a density of about 75° Tw. and temperature of about 80° C. Such a liquor would have to be concentrated in evaporators (a liquor generally considered good enough to go to the crystallisers will contain about 750 grms. per litre of nitrate of soda and 120 grms. per litre of salt, and have a density of 104° Tw. at 102° C.), separated from the insoluble salt, and crystallised in order to regain the nitrate, but the Butters process has not considered the necessity of evaporators so far. They prefer to use the process as an auxiliary to the existing system. The cakes are subsequently washed twice with weakening liquors: the washing is claimed to be by displacement only and the final wash is done with salt water (saturated brine) which leaves the cakes with about $\frac{1}{2}$ % nitrate of soda. The cakes are then discharged. The different liquors obtained from each successive displacement wash are used in the next round, the whole forming a cycle of operations, at one end of which the strong liquor is removed, while at the other end the cold brine "displacement" wash takes place.

As it is being used at present in Oficina Agua Santa, the Butters process acts as an auxiliary process to the main Shanks Maquina, and the results claimed so far are sufficiently good to restrict the working of the process to these lines.

The process, which has now worked there for nearly a year, consists in screening the whole of the crushed product in order to remove 20% of it as fines passing a 6 mm. mesh. These fines are treated by the Butters process as described above.

The coarser material alone is treated in the boiling tanks, as formerly, and the liquors obtained from the Butters process are introduced into the cycle of operations in the Shanks system, the whole process being assisted by evaporators previously installed in the works.

By the combination of Shanks process, Butters fines treatment, and evaporators, material of 14.5% nitrate content is worked successfully with an efficiency of 64% as against an efficiency previously obtained by the Shanks process *plus* evaporators alone of about 50%. Working costs appear to be fairly high, but in view of the increased yield of nitrate obtained from the same amount of raw material the combination of processes must be admitted to have met with success. As to what measure of this success is due to the Butters system alone it is difficult to state, as it is claimed that by the mere elimination of fines alone the lixiviation in the Shanks system is so very considerably improved as to increase the yield therefrom from 50% to 61%.

Without the use of evaporators it is doubtful whether any such improvement would be shown, and it is more doubtful still whether the strengthening up of the liquors produced by the auxiliary process by passing them over the coarse material in the Shanks system, is a satisfactory way of using these liquors, without recourse to evaporation.

But it is certain that there is a limit to the amount of such liquor which could be strengthened up in this way, without evaporation. If it is assumed that 75% of the total material is fine and the other 25% coarse, the fines will contain 75% of the total nitrate, of which 90% will be extracted and made into weak liquor: the coarse will contain 25% of the total nitrate only, of which but 65% at the outside can be extracted in the Shanks Maquina. This means that there will not be enough nitrate available in the coarse to bring the liquors from the fines to crystallising strength.

As the process stands at present it is claimed, (1) A 90-95% extraction of nitrate from raw materials as low as 11% in average and the ability to produce liquors which can be directly crystallised for their nitrate of soda content. (2) That this can be carried out at low labour and fuel cost. As we have pointed out, it has not so far

been worked in this way, but only as an auxiliary process to the Shanks system combined with evaporators, in which combination its actual success, cost of operation particularly, is obscured by other factors.

The process is still in course of trial and doubtless will be improved in many ways and perhaps, eventually, successfully applied to certain of the particular needs of the industry of the future.

The Gibbs process.

Early in 1912, Messrs. Gibbs and Co. of Valparaiso despatched their engineer and chemist, the writers of this paper, on a tour of investigation through the U.S.A., France, and Germany, in order to gather as much information as was possible on methods used in other industries, so as to be able to develop the Chilean nitrate industry on more modern lines.

This resulted in the initiation of a process, on completely new lines, consisting of a new method of lixiviation and a process of evaporation which combined the regaining of the nitrate direct together with the separation of the sodium chloride. The details of the process were worked out in England, the theoretical part at the Manchester School of Technology, and later at the experimental laboratories of Messrs. G. T. Holloway and Co., and the practical part at the latter laboratories and near Mitcham, where an evaporation plant was erected on the principle worked out in conjunction with the Kestner Evaporator and Engineering Co., Ltd., of London. The results were completely satisfactory and a demonstration was given in July, 1914, before the representatives of the nitrate industry and the Chilean Ambassador and his suite.

The Gibbs process aims at the treatment of the raw material as two separate sections in the problem. (1) Lixiviation of raw material; (2) Concentration of liquors from 1; and No. 2 may be subdivided into (2a) Separation of salt contained in the liquors from 1; (2b) Separation of nitrate of soda.

(1) *Lixiviation of raw material.* The Gibbs treatment of raw material is based on the observation that in typical caliches, both of high and low grade, the soluble material is the binding agent by means of which a conglomerate of insolubles is held together.

This insoluble material consists of stones and sands together with finer matter such as clay, oxides of aluminium and iron, etc., which may be considered to be slime formers. (It is these slimes which prevent the free lixiviation of the mass and complete removal of liquors therefrom, and the removal of these slimes is the prime object of the Gibbs lixiviation scheme.) The stones and particles of sand, etc., are quite in their native state and are free from soluble matter with the exception of what is crystallised round them. If, in the laboratory, the raw nitrate-bearing material is treated without any grinding or breaking at all, with dissolving agents (hot water) in such a way as to wash out all of the soluble contents, the insoluble remainder, when ground to an almost impalpable state, will show practically no further trace of soluble matter. The results of the washing will be to produce a stoney, sandy mass which is quite valueless for nitrate content.

A reference to the screening tests, Table B, on two extreme caliches will show what occurs after complete lixiviation.

It is on this principle of separation and removal of slimes during lixiviation that the Gibbs system of lixiviation is based and the objective is reached in practice in the following way. The raw material is crushed as usual to about 2 in.-3 in. and fed into a mill together with nitrate solution at about 50° C.

TABLE B.

Screen test and analysis of caliches.

Mesh 1 mm.	% of Insolubles.	A.	B.	Analysis.	A.	B.
Plus 5	Sands and stones.	21.75	45.30	Sodium nitrate	24.93	9.66
" 8	"	8.39	9.10	" chloride	25.30	9.87
" 10	"	3.06	4.80	" sulphate	2.20	8.27
" 20	"	10.71	11.70	Max. chloride	7.27	—
" 30	"	5.34	4.40	Calcium chloride	3.37	—
" 40	"	5.72	4.40	" sulphate	—	3.97
" 80	"	12.21	5.60	Other solubles	10.73	1.00
" 100	"	6.10	2.20	Total solubles	73.80	32.77
Minus 100	Sands	13.74	6.60	Insolubles	26.20	67.23
" 100	Slimes	12.98	5.90	Total	100%	100%

This mill, worked without balls or pebbles, acts purely as a disintegrating mill, in which the raw material is reduced to its ultimate particles with the minimum of grinding or slining action.

The pulp is passed continuously from the mill to a series of classifiers in which the lixiviation action takes place in counter-current.

Assuming four classifiers in the series, water is fed into No. 4 where it washes the already thrice washed insoluble matter and the wash from this is passed forward to No. 3 which it washes and in turn is passed to No. 2 and finally to No. 1. The insoluble matter passes from No. 1 to No. 2 and onward to No. 4 whence it is discharged.

The object of the classification is two-fold. In the first case the classification is for the separation of the slime-forming fines, together with a proportion of fine sand, in effect the washing off from the bulk of the raw material that portion of it which is about -80 mesh. In the second case, assisted by a rise of temperature to whatever is decided as convenient, solution of nitrate is brought about by intimate contact between wash liquors and particles of raw material.

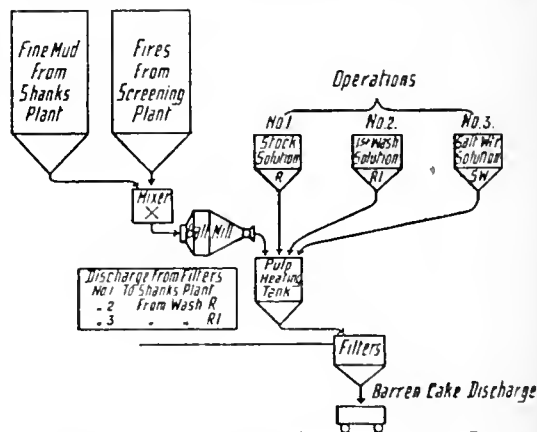
The liquor coming from classifier No. 1 contains then all the -80 insolubles while the +80, together with adherent solution (from which it is drained as much as possible on its passage to No. 2 classifier) and undissolved nitrate, passes to No. 2 where it meets the weaker wash from No. 3. Slight classification may take place here, but essentially the function of this and the following classifiers is to bring the solid particles into intimate contact with the weaker liquors. The action takes place in four stages and the final insolubles, passing out of No. 4 stage or classifier, are in the form of clean sand, gravel, stones, etc., which do not contain, locked up in crevices in the particles, any more than $\frac{1}{4}$ % nitrate of soda. As the mass can be easily washed and drained the loss of nitrate in this part ought to be little more than that quantity. Having extracted the nitrate and disposed of the bulk of the insoluble matter, the liquor obtained from No. 1 is a saturated solution of nitrate and salt together with the other soluble salts and containing the -80 insoluble *viz.*, fine sands and slimes.

It will be noted that the classification aimed at is not the fine classification desired in most mining propositions, and the principal object, that of removing from the insolubles the fine portion, permits of the easy and cheap washing and disposal of the rest of the bulk. As will be seen from the screen tests shown (taking the classification as separating the + and -80 mesh) the amount separated as -80 will be in the case A 32.82% of the insolubles or 8.6% of the total raw material, and in case B 14.7% and 9.88% respectively, and these quantities have to be filtered out of the liquor obtained from No. 1 classifier. This filtration is carried out by means of the Oliver

continuous vacuum filter, which is a revolving drum of which about one-third of the circumference at a time is dipping under the liquor to be filtered.

The drum is divided into segments which in turn are connected to vacuum and compressed air and the operation is mechanically controlled by means of a disc valve, the cake being sucked on by vacuum while that part is dipping into the liquor (kept agitated), sucked dry for part of the time it is out of the liquor, spray washed and dried also under vacuum, and finally scraped off after being loosened by compressed air.

DIAGRAM OF FILTER TREATMENT OF FINES
AUXILIARY TO MAIN (SHANKS) PLANT—BUTTERS
SYSTEM.



The net result of the operations is that about 10% of the raw material is treated by the more expensive filtration process while the rest of the insolubles, case A 17.6% of the raw material, case B 57.32% of the raw material, is washed quite free from its soluble nitrate contents and discharged without any filtration or expensive treatment. The advantage in the case of low grade material is obviously enormous.

The process has been designed to obtain a liquor containing about 450 grms. of nitrate of soda per litre and about 200 grms. of salt, with about 50 or 60 grms. of other soluble salts, as calcium and magnesium sulphate, chloride, and nitrate, sodium sulphate, etc.

By increasing the temperature of operation a stronger liquor may be obtained, but this increase in strength by rise of temperature is subject to economic limitations which it is intended shall be studied on the large scale on the spot.

The actual experiments on the large scale show

the losses to be approximately $\frac{1}{2}\%$ nitrate on the +80 mesh and 2% nitrate on the -80 mesh, or out of 1000 tons caliche A (24.93%):

262 tons insolubles would contain 86 tons slimes	
at 2%	=1.72 tons
262 tons insolubles would contain 176 tons coarse	
at $\frac{1}{2}\%$	=0.88 ..
	2.60 ..

Out of a total of 249.3 tons nitrate of soda hence 246.7 tons is recovered or 98.9% yield.

In case B—

1000 tons of material 9.65% nitrate:—	
98.8 tons slimes at 2% nitrate	=1.976
573.2 tons coarse at $\frac{1}{2}\%$ nitrate	=2.866

4.842 tons nitrate.

Out of a total content of 96.6 tons nitrate of soda the yield is 91.758 tons or 95%.

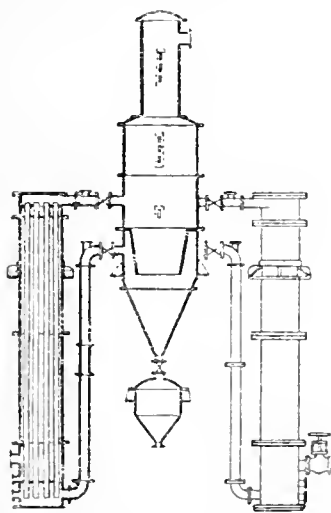
Evaporation.

As mentioned above, the standard liquor aimed at in the lixiviation system above outlined contains nitrate of soda 450 grms. per litre, salt 200 grms., other solubles 50 grms., water 650 grms.; total, 1350 grms. per litre.

The evaporation system is divided into two sections, one aiming at the almost complete separation and recovery of the salt, while the other recovers the nitrate of soda direct in the form of crystals.

In the first part the evaporation is carried out as a double effect. In the lower temperature effect the evaporation is done under vacuum at about 80° C. and the liquor from this goes to the second, the higher temperature effect, for evaporation at about 124° C. under normal atmospheric pressure.

At this temperature practically the whole of the salt is rendered insoluble and the plant, a modification of the well-known Kestner evaporator, is arranged so as to ensure the transference of the desalted liquor without loss of temperature (and consequently nitrate of soda) and completely free from suspended salt, to the nitrate crystallizer, which is a vacuum effect without calandrias.



KESTNER PATENT
SALTING TYPE EVAPORATOR

Here by cooling and self-evaporation under vacuum the nitrate crystallises immediately and is removed from the coded bottom by a screw and dried in hydro-extractors. The apparatus is shown in accompanying figure and works approximately as follows:—Effect No. 1, which is

worked under a suitable vacuum, causes the deposition of about 50% of the total salt contents of the liquor. This salt is removed by a mechanical screw and sucked dry and washed in a vacuum filter. The liquor from No. 1 passes to No. 2 where the maximum temperature desired is reached. This brings about the completion of the desalting and the liquor, now boiling at or about 124° C., is transferred to No. 3, a vacuum effect without calandrias where the nitrate is deposited.

The salt from No. 2 effect is periodically removed by means of the specially designed filter box, which permits of the salt being washed after draining and disposed of with the minimum loss of nitrate of soda. The steam produced in effect No. 2 is used for procuring the evaporation in No. 1 and all surplus steam is diverted to a preheater or to the lixiviation plant.

The advantages claimed by the Gibbs process are:—1. Cheapness of installation. 2. Ability to treat cheaply and effectively low ley caliches with an efficiency of 90% extraction over all. 3. Ease of control of process. 4. Direct crystallisation of nitrate, ensuring ability to trace losses and remove their causes almost at once. 5. Greater control over the working of the nitrate deposits.

Advantage No. 5 should give an incentive to the development of the mining of nitrate of soda. Many causes, chief among which is the necessity for hand selection of the material used to-day, have conspired to prevent the development of the use of mechanical drills and shovels in the Chilean nitrate fields.

It is to be expected that with the advent of the newer processes no longer necessitating the specially hand selected material, these causes will automatically disappear and the more rational mining come into its own.

The mother liquor from the hydro-extractor is periodically examined for lime and magnesia content, and treated for the conversion of these into sodium salts when necessary, separated from the insoluble magnesia and lime, and returned to the system, being introduced into either the high or low temperature effect according to circumstances. Periodically the accumulated iodine salts will be examined and the iodine extracted by precipitation in the usual way.

The cost of a complete installation of the Gibbs process is estimated to be about one half that of the present type of plant, and it is expected to be able to treat material of as low a ley as 10% with 90% efficiency, at a cost reduced in a marked degree. There can be no comparison of costs when working with 10% material with the Gibbs process because the present type of plant cannot deal with it at all.

The first Gibbs plant is now being constructed for the Fortuna Nitrate Co. for their Oficina Celia. Antofagasta, Chile, and it is expected to commence actual work within the next 9 months.

Future of the nitrate industry in Chile.

Without endeavouring to enter into the question of the prospects of Chile nitrate as regards the competition from the artificial nitrate industry or to attempt to forecast the possible effect of the war or future consumption of both artificial and natural nitrate, it may be confidently anticipated that the Chile nitrate industry has a rosy future before it.

In spite of the numerous statements issued to the effect that the natural deposits were rapidly approaching exhaustion it may be confidently asserted that such is by no means the case.

Although the year 1921 is mentioned as the crucial year in which Chile as a serious producer of nitrates will be *hors de combat*, there is as yet no sign of such a state of affairs arising. On the contrary, the quantity of available nitrate, estimated on the present basis of working and

based on the official Chilean Government reports, is particularly reassuring.

The idea of the rapid exhaustion of the Chilean deposits has been definitely refuted in a statement issued by the Chilean Nitrate Committee, under the auspices of the Chilean Embassy. This statement was issued in November, 1913, in response to the extensive advertisements issued by the Nitrogen Products Co., in their appeals to the public for support, and which emphasised the importance of their undertakings on the grounds (among others) that according to Sir W. Crookes and others, the Chilean deposits were due for exhaustion in 1921.

According to the official Chilean statement, which is reproduced here by permission of the Chilean Nitrate Committee, these opinions fall far short of the reality.

According to the latest official report presented to the Chilean Government by Mr. Francisco J. Castillo, the Inspector-General of the Nitrate Deposits, the zone of nitrate bearing grounds comprises 200,000 square kilometres, of which so far only 5811 square kilometres, that is to say, less than 3%, is examined, and their contents ascertained by excavations and test holes. These 5811 square kilometres belong to the existing companies, private firms, and in part are still in the hands of the Chilean Government.

The calculated contents of these 5811 square kilometres were 290,300,000 tons of nitrate of soda, of which up to the present 15,000,000 tons has been extracted and exported, leaving in the examined part of the area, 245,300,000 tons of nitrate of soda equal, at the present rate of production, to a supply for a further 100 years.

As the unexplored part is some 34 times larger than the explored grounds, it is safe to estimate that it contains altogether at least an equal quantity of nitrate of soda, and consequently the nitrate zone in Chile can certainly provide nitrate of soda for another 200 years at the present rate of production.

The quantity of nitrate of soda remaining in the examined grounds is sub-divided as follows:—

Province of Tarapaca	35,000,000 tons.
Tocopilla District	28,000,000 ..
Antofagasta (Central)	32,000,000 ..
Antofagasta (Aguas Blancas District)	49,000,000 ..
Taltal	95,000,000 ..
Chanaral and Copiapo	8,300,000 ..
Total	245,300,000 tons.

The Inspector-General of Nitrate Grounds, in his report to the Chilean Government, has arrived at these figures in the following way. In these examined grounds no raw material containing less than 11% of nitrate of soda has been taken into consideration, nor grounds where the thickness of the layer of raw material was less than one foot, except in the case of raw material of at least 25% of nitrate of soda, when the thickness of eight inches and above has been included. The superficial area of each portion of ground examined has been divided by the total number of test holes made, in order to arrive at the area applicable to each test hole, and this consequently determines the total nitrate-bearing area. From the theoretical quantity of pure nitrate of soda resulting from the above operations a reduction of 40% has been made in order to provide for losses in extraction, manufacture, errors of calculation, etc.

Of raw material of a lower grade vast quantities remain, which have been excluded from these calculations because they cannot be profitably extracted under the present system of work: but as improvements are being constantly made, there is every reason to assume that even this low grade material will be worked when the richer qualities are exhausted.

These statements therefore conclusively show that there is no fear of the Chilean nitrate deposits being exhausted for 200 years.

In 1913 the duration was estimated at 200 years on the normal working and normal efficiency of the plants. It will be obvious that with the present type of material the new process when installed will give an effective yield of about 85% in place of 50%, i.e., the quantity of raw material previously available for 50 years' work will become available for 85 years' work. This makes 200 years equal to 340 years.

In addition, no material of less than 11% is included in the above estimate, so that if the new processes can effectively deal with an average of 10% a vast field is opened for further exploitation which would probably treble the available duration of the grounds, and further with the ability to treat 10% material many of the huge dump tips will become available for use again very profitably.

It is from this point of view that the future of the Chilean nitrate industry is very bright.

Its development has only just been started and no doubt many fresh workers, both chemical and engineering, will be attracted to the spot to assist in bringing its development to a successful issue. With the manufacturers alive to the possibilities of the new processes and possessing the determination to try them thoroughly, and with the practically limitless quantities of raw material lying there, the future need fear nothing.

It is interesting to note, in this regard the question of iodine. Iodine is a very important by-product of this industry, the raw material often containing up to 1 part of sodium iodate in 100 parts. Up to the present only a small proportion of the available iodine is extracted from the prime product, the remainder being allowed to be lost in the dumps. The mother liquors which are returned to the lixiviating system are periodically treated for the iodine they contain by precipitating the element with sodium bisulphate. The methods employed are exceedingly crude. The work is carried on intermittently and during each period of working, sufficient iodine is extracted to last as stock, for the particular oficina, for years. No further extraction of iodine is done until such time as it becomes necessary to replenish the stock.

In the newer schemes it will undoubtedly become necessary to extract the iodine completely and constantly, thereby necessitating the modernising of the methods employed. At the same time the quantities available will become much larger and doubtless much work will be done at this end of the world in finding new outlets for so useful a product.

The Chilean nitrate industry would probably be very interested in helping to discover the uses for the greater production.

The authors are indebted to Mr. G. F. Morrison of Iquique for permission to use the analyses given, to Sir R. Harvey for his information of the earlier stages of the industry, to Messrs. G. T. Holloway for the screen analyses, and to the Chilean Nitrate Committee for information supplied.

DISCUSSION.

The CHAIRMAN, in inviting discussion, said that it was a remarkable fact that the nitrate industry had only recently commenced to use multiple effect vacuum evaporators. The system of evaporating in open pans was well known to entail an enormous waste of fuel.

Mr. W. G. MANN said that there were in connection with every "Oficina" some hundreds of open cooling tanks which ought to offer opportunities for very reliable data on the subject of atmospheric cooling and crystallising. In connection with the new system of nitrate production the problem of quick and efficient cooling and crystallising was exceedingly important, and

when he was working in conjunction with the authors he had been unable to find any really reliable data on the subject in the technical literature available. He suggested that some of the fundamental problems of chemical engineering might be dealt with by a Committee of the Society and thoroughly investigated in the same way that certain engineering problems were exhaustively examined by the mechanical and civil engineers.

In answer to the expressions of surprise made by the Chairman and others that multiple effect evaporators had not already been at work on caliche solutions, Mr. Mann drew attention to the very difficult nature of the caliche liquor from the point of view of the evaporator problem. The table giving typical analyses of caliches showed that a number of substances are present in addition to the sodium nitrate and chloride, which, although present in relatively small amounts, had a very great effect in hastening scale formation and incrustation. The trouble was further aggravated by the presence of fine dust from the crushing mills. The problem had been solved by the introduction of an evaporator which allowed for rapid circulation in the heating tubes and also the isolation and cleaning of the heating units by means of the multi-calandria arrangement attached to a central separator.

Mr. E. V. EVANS said that certain important apparatus now used in the chemical industry had originated from saltpetre recovery processes. One in particular had been communicated to him which served a very useful purpose in this country. It was often necessary to design a cooling system for hot saturated solutions of a crystallisable product, which, on cooling to normal temperatures set almost solid. The obsolete method of effecting such an operation was to place the liquor in crystallising vats, and the authors had shown that in the older installations in Chile each vat charge required about ten days to cool, and in consequence, a considerable ground space was covered by this portion of the process. The means suggested to overcome this difficulty was to employ a high speed centrifugal pump for pumping the hot liquor through a long coil of iron pipe, which was cooled externally by water. In the normal way this pipe would have become blocked by crystals, but it was found that if the speed of the centrifugal pump were sufficiently high the tendency for the crystals formed within the liquor to adhere to the pipe, was overcome by the high velocity of flow. Thus with each crystallisable liquid it became necessary to determine firstly, the rate of flow that would satisfy the above conditions, and secondly, the length of cooling pipe that would be required to bring the liquor to the required temperature. He had no knowledge of the value of this appliance when dealing with nitrate of soda solutions, but felt that the combination of the triple effect Kestner evaporator and the above-described cooling device should find frequent application in the chemical industry.

Dr. R. SELIGMAN drew attention to one point in the paper in which it was stated that crude oil was easily available for fuel purposes on the caliche fields, but presumed that what was meant was that crude oil was more readily available than coal and not that oil of local occurrence was used. He further asked whether on the caliche fields water was not extremely scarce and consequently valuable. If that were so, as he believed to be the case, it seemed all the more remarkable that methods of evaporation and drying were used which seemed especially designed to waste water rather than to conserve it. That should be an added incentive to the development of modern methods of evaporation.

Sir FREDERICK NATHAN said he could confirm the presence of iodine in Chile saltpetre, and he

had often seen crystals of iodine subliming over with the nitric acid produced from Chile saltpetre.

Mr. WALTER F. REID said that the iodine was very much required in the manufacture of organic chemicals. He asked if the question of evaporating in open tanks by means of the sun had ever been dealt with in Chile.

Mr. J. W. MACDONALD thought that a diffusion process similar to that used in the extraction of sugar from beet might probably replace the Gibbs system. Less water would be required.

Mr. T. D. MORSON said that the present price of iodine was altogether an artificial one, and he agreed that it should be recovered.

Dr. MESSEL enquired how much iodine (by weight) was contained in a ton of caliche.

Mr. REAVELL, replying to the discussion, said that the first point referred to crystallising out the nitrate solutions in large open tanks. The suggestion was made that instead of using the enormous number of tanks that were necessary in an oficina, the liquid should be pumped at high speed through coils, cooled externally by means of water flowing over them. It had to be borne in mind that, whilst it was possible to use such a system with some highly concentrated solutions, it had been found very difficult to pass hot nitrate solutions through pipes as, on cooling, the crystals fell out so rapidly that such a system as mentioned had never been found to be satisfactory. Similar expedients had been tried, but without success. From information at present available he understood that the iodine from Chile was practically in the hands of a "ring" who undertook only to produce a certain amount of iodine so as to keep up the price, the rest being thrown away. There was no reason why enormous quantities of iodine should not come from "caliche" as the quantity present in the "caliche" in accordance with the above tables, in the form of iodate of soda, varied from 0.01% to 0.15%. This iodine could easily be recovered. It had to be admitted that the methods adopted in the industry were antiquated, particularly on the chemical side, and that the only improvements for many years had been in the mechanical side in the way of electric driving and improved methods of handling raw material, etc.

Informal Meeting held at the Birkbeck Café, Holborn, W.C., on Tuesday, December 19th, 1916.

MR. ARTHUR R. LING IN THE CHAIR.

A Discussion was opened by the Chairman on—

THE WORK OF THE SECTION.

The CHAIRMAN, explaining how the idea of holding the meeting had arisen, said that it had come to the knowledge of the Committee that some of the younger members held the view that they were not taking a sufficiently active part in the business of the Section. For example, that the discussions were to a great extent monopolised by what he would term front bench members. The Committee were well aware that the younger members of the Section did not come forward in discussing the papers so freely as they ought, and if the majority of those taking part in the discussions were front bench members, that was because the younger members were shy, and the main object of informal meetings was to bring them out. It was thought that informal meetings should be held in some other place than Burlington House, in a place where there were no front benches, where all the members could sit round various tables, partake of light refreshments, and exchange seats during the discussion. In that way they would get to know one another and foregather.

There was a strong feeling among members, especially those in the provinces, in favour of the reporting of proceedings of the meetings other than papers and discussions, so that the different sections should become better acquainted with what each was doing. To some extent such proceedings were reported at the present time in the trade journals. But it was strongly urged, and he thought quite reasonably, that their own Journal was the place where they ought to find a record of their doings.

It had been the object of the Committee of the Section to get a series of papers from different authorities on certain branches of applied chemistry, and as would be seen in the Journal a most interesting programme had been arranged.

He believed that the question of the Federation of Chemical Societies, as suggested by Professor Armstrong in a paper read before their section last year (this J., 1916, 35, 502) would be promoted to a great extent by holding meetings such as the present one. There was no doubt that the time had come when chemistry in this country must make its voice heard as medicine has done. It was a remarkable fact that when the Government or any corporate body wished for any assistance in chemistry, they did not approach the Society of Chemical Industry, which it appeared to him was the proper body to deal with such matters. He might cite the fact that at the outbreak of war, the Government approached the Royal Society, who formed various Committees to deal with chemical questions. If the various chemical societies had been federated, then such questions would have been submitted to them. It seemed to him that it was just as logical for the Government to go to the Royal Society on a medical question as it was for them to go to that Society on a chemical question. The reason the medical profession had not been excluded was that they had made themselves known, and made themselves strong by federating.

Even before federation took place, it seemed to him that some steps ought to be taken to get a habitation in London. This project had been suggested many times previously, and some had held the view that it would meet with a certain amount of disapproval from the Provinces. That he could assure them was not the case. The Provincial member who was in the habit of coming to London desired some sort of Chemical Club in which he could meet his friends, even more than did the London member.

In 1898 when he became Secretary of the London Section the membership was about one thousand, and now it was slightly over that number, so that in those eighteen years there had been no substantial increase. Surely it should have been otherwise. He urged them to use their endeavours to induce their friends to join the Section.

Mr. A. H. DEWAR said that they wanted the Society to be, not only an instrument for the development of chemical industry, but a real live organism cultivated on enthusiasm. They should be a real live branch of chemical industry, and they therefore welcomed this meeting as an indication of a move in this direction and especially the invitation to young members. It must be remembered that they would be the future mainstay of the Society, and anything that would lure them from their shyness was to be commended. As to the work of this real live Section, endeavour should be made to have papers of a more technical nature. They had had many good papers, but most of them had been more suited for the Chemical Society than the Society of Chemical Industry. To get such papers difficulties would have to be overcome. Some directors were afraid to let their chemists speak—every opportunity should be taken to let such men see that intercourse between chemists was conducive to their companies'

advantage. Wise use must be made of the privileges thus obtained. The chemical industry must learn that the days of "splendid isolation" were past, and what now was needed was "splendid co-operation and collaboration." The work of the Society must be carried on, in a fraternal spirit, on these lines if it was to justify its claim to speak for chemical industry.

Dr. S. MALL alluded to the difficulty felt by a manufacturer who was rather ignorant of chemistry. He found few papers which were sufficiently elementary and general to interest him and hoped it would be possible to introduce more of such into the Journal. He called attention to the amount of space taken up by abstracts of highly technical matters. Finally he hoped the Section would be able to arrange visits to works.

Mr. W. J. COWAN said that in his opinion there were many matters that might be altered or improved with advantage to the Society. The establishing of a club for chemists and others allied to chemical industry and chemical engineering in some central position was, he believed, a long-felt want, and if launched would, he ventured to predict, be the means of creating a closer *esprit de corps* than at present existed among the members of the Society.

Mr. H. E. COLEY suggested the immediate formation of a small Committee, consisting preferably of members not at present on the Executive, to draw up a scheme for the formation of a Chemical Club in connection with the Society. It was absolutely necessary if the chemical industry of the country was to be welded into anything like a powerful body, that some better means should be provided to enable members to meet one another and exchange views. The impression in the mind of the ordinary member of the Society was that nothing had been done to make for unity, and that something ought to be done quickly.

Dr. H. V. A. BRISCOE suggested that an immediate step might be taken to arrange discussions on subjects chosen so as to provide opportunity for wide discussion and yet unlikely to be "dangerous." As typical subjects complying with the foregoing conditions, he suggested "The Chemical Worker," a discussion on whom might cover his carelessness and its results, and how best to guard against the latter, his health, and the methods by which it might be safeguarded, and the like; or "filtration," in respect of which he at least had many problems which he should be glad to discuss with other chemists; or again, such a subject as crystallisation might be widely discussed with general benefit and but the slightest risk that any secret could be disclosed. With reference to the complaint made by certain members that only one or two pages of the Journal were of interest to them, he suggested that that was too narrow a view of the matter, and that they might find it well worth while to study carefully the pages in which they were not "interested" in the narrower sense.

The HON. SECRETARY pointed out that as far back as April, 1914, he had proposed to the Committee a resolution which was agreed to unanimously:—

"That it was desirable in the interests of the Society to consider a scheme for the formation of a Chemical Club with suitable premises in London."

For various reasons that scheme could not be proceeded with at that time, but he believed that there were now large numbers of the members of the London Section who would be willing to support actively the furtherance of this proposal. The new list of members of the Section, now in proof, had a column attached showing the class to which they severally belonged. With the list of members would be published a more extended report than usual giving an account of the activity of the Section.

Dr. C. A. KEANE expressed himself thoroughly in sympathy with the proposal that steps should be

taken to effect some fuller opportunity than had existed in the past for the members of the Section to meet together on a social basis, and to get to know one another. It had been exceptionally interesting to hear so decided a demand for a development of this character, especially from the younger members of the Section, for this indicated the desire for real communal interest in the work of the Section which was bound to be of value. In the past the Committee of the Section had done their best to advance what they regarded as the best interests of the members, but as with all Committees and Councils the ideas for such advancement necessarily came from within the circle of the Committee itself, and they knew all too little of the views and desires of the bulk of the members of the Section. It appeared to him to be quite within the powers of the Section to take steps to initiate something in the form of a meeting place or club for social purposes, apart from the more formal gatherings for the reading of papers. The mutual relations of these functions of the Section was a matter which could well be left open for the present, but it was desirable that some beginning should be made which, if successful, should lead to important developments in the work both of the Section and of the Society as a whole.

The desirability of steps being taken to bring chemists more actively into association and co-operation had been in the minds of all during the period of this war crisis. The proposal under consideration formed a definite basis for this desirable objective and as such should be welcomed and supported by one and all of the many and varied interests represented in the Section.

Mr. BERNARD F. HOWARD said that many points had been raised that evening which could well form the basis for an evening's discussion at an informal meeting, *e.g.*, relation between chemists and directors, labour difficulties, etc.

Mr. Howard then proposed the following resolution, which was seconded by Dr. W. R. HODGKINSON, and carried:

"That a Committee be appointed to consider the steps that should be taken to form a Chemical Industry Club for the London Section of the Society of Chemical Industry, and to report to the Committee of the Section, and, subsequently, to a further Informal Meeting of the members of the London Section."

The following members were appointed to form a Committee—Messrs. H. E. Coley, A. H. Dewar, B. F. Howard, with the Chairman and Hon. Secretary *ex officio*.

Manchester Section.

Meeting held at Grand Hotel on Friday, December 1st, 1916.

MR. J. H. ROSEASON IN THE CHAIR.

THE ACTIVATED SLUDGE PROCESS OF SEWAGE PURIFICATION.

BY EDWARD ARDERN, M.Sc.

The rise and development of this method of sewage purification has been described in a series of three papers, entitled "The Oxidation of Sewage without the Aid of Filters," presented to this section of the Society during the past two years.

It was observed from the first that the purification process was subject to disturbance in the

presence of certain trade-wastes of inhibitory character.

For the purpose of investigating the effect of such trade effluents on the activated sludge process, the experimental plant employed previously when working with the Manchester sewage received at the Main Outfall Works, Davyhulme (a strong trade sewage), was transferred in July, 1915, to the Withington Sewage Works, Chorlton-cum-Hardy, where a purely domestic sewage is dealt with.

The preliminary results obtained during the period the activated sludge was being "built up" were, however, so remarkable that it was decided to postpone the trade-effluent trials pending a careful survey of the possibilities of the activated sludge process as applied to the purification of a weak domestic sewage free from manufacturers' effluents.

This communication is concerned with a brief account of the results of the investigation, which has extended over a period of fifteen months.

The plant employed consisted of wooden casks of 200 litres capacity (net). The aeration was effected by diffusing the air through a porous tile placed on the bottom of the cask. The air supply was always sufficient to maintain complete admixture and circulation of the sludge and sewage. The floating matters and grit had been removed from the sewage dealt with by prior screening and adequate detritus tank treatment.

The method of "building up" the activated sludge was that described in the last paper* on the subject.

For a period of nine days from the commencement of operations the cask was filled once each day, an aeration of 21 hours being allowed. The remaining 3 hours was occupied by quiescent settlement of the accumulated suspended matters, discharge of effluent, and refilling with sewage.

Subsequently the aeration period was reduced and the number of fillings rapidly increased without diminution in the purification effected, so that after the experiment had been in progress eighteen days, four fillings per day were allowed with an average of four hours' aeration. After operating for a fortnight in this manner the average aeration period was reduced to 2½ hours, and 5 fillings per day allowed for a period of eleven days. Eventually the cask received 6 fillings per day, with the following aeration periods: 3 fillings one hour, and the other 3 fillings, two hours, three hours, and four hours respectively, or an average aeration period of two hours.

Working in the manner described above, 15% by volume (measured after 2 hours' settlement) of partially activated sludge, *i.e.*, 30 litres or 6·6 gallons, were obtained from 2970 gallons of sewage dealt with during the first 31 days, which was increased to 31%, *i.e.*, 62 litres or 13·6 gallons, in the succeeding twelve days. At this point 5180 gallons of sewage had been treated in the cask. On this basis, the sludge production is equal to about 12 tons per million gallons of sewage treated.

The results obtained during this initial period were of such a character that it became of interest to determine whether they could be maintained indefinitely without regard to the establishment of active nitrifying organisms in the sludge.

At this stage, therefore, the partially activated sludge which had been accumulated was divided equally between two casks, one of which was operated with 6 fillings per day as previously, while the other was worked in such a manner as to allow a development of nitrifying organisms.

For this purpose, the first filling of sewage was aerated continuously until the free and saline ammonia content of the sewage had disappeared

* Ardern and Lockett (this Journ., May 30th, 1914, No. 10, Vol. XXXIII.).

* Ardern and Lockett (this Journ., Dec. 15th, 1914, No. 23 Vol. XXXIII.).

* Ardern and Lockett (this Journ., Sept. 30th, 1915, No. 18, Vol. XXXIV.).

* Ardern and Lockett (this Journ., Sept. 30th, 1915, No. 18, Vol. XXXIV.).

and nitrification was complete, which required 48 hours' aeration. Subsequent fillings were likewise aerated until the sewage was completely nitrified; the aeration period required during the following nine days, varying from 8 to 23 hours, dependent on the strength of sewage treated. Later it was found easily possible to allow 2 fillings per day with an average aeration period of 10 hours, and within 14 days of commencing to establish nitrifying organisms three fillings were being given (6 hours' aeration) with the production of highly nitrified effluents. Finally the quantity of sewage dealt with was increased by allowing 4 fillings per day with an average aeration period of 4 hours, at the same time maintaining a highly purified and well nitrified effluent.

It may be noted that nitrifying organisms were much more readily established in the sludge obtained from the Withington sewage than in that produced from the trade sewage at Davyhulme, e.g., the first filling of Davyhulme sewage usually requires 15 days' aeration in contact with the partially activated sludge for complete nitrification. Further, there is no ammoniacal fermentation of the sludge meanwhile or production of turbid effluents, and the alkalinity of the sewage is always sufficient to allow nitrification to proceed to completion.

During this period of complete maturing of the activated sludge, the cask containing the partially activated sludge continued to receive 6 fillings per day, but the total aeration periods had been reduced from 12 hours to 10 hours, divided as follows: four fillings one hour aeration and two fillings 3 hours' aeration, when the sewage was at its maximum strength, or an average of $1\frac{1}{3}$ hours' aeration per filling.

The average results obtained from the operation of the casks containing the two types of sludge over a prolonged period, embracing a great variation in temperature conditions, are given in the following table. The volume of sludge in each case varied from 20 to 25%, and the volume of purified effluent discharged after each filling was equal to 75% of the total capacity of the cask.

In general, the effluents obtained from the two casks were equally well clarified, although in some cases, especially during prolonged dry weather, when a stronger sewage was dealt with, the effluent yielded by the partially activated sludge exhibited a faint turbidity, whereas those from the fully activated sludge were invariably perfectly clarified.

The above results show that except for a somewhat lower albuminoid ammonia content, which is reflected in a reduced dissolved oxygen absorption, the difference between the effluent yielded by the fully activated sludge and that obtained from the partially activated sludge is confined to the amount of nitrification.

Their importance lies in the fact that they demonstrate that the activity of the sludge, so far as oxidation of carbonaceous matter and clarification is concerned, can be maintained without reference to the degree of nitrification.

This result is contrary to the experience gained in the earlier experiments when working with the trade sewage at Davyhulme; and means that if nitrification is not required, and it is certainly not essential, high-class effluents, easily within the standard suggested by the Royal Commission on Sewage Disposal, can be produced from domestic sewage by the activated sludge process, with a considerably reduced aeration period at consequently lower cost.

In view of this material difference between results obtained at Withington and Davyhulme, obviously it was important to ascertain whether similar differences were to be found with regard to the question of the effect of temperature on the purification process.

Operations with the two types of sludge were therefore extended throughout the winter and summer months.

In the following tables are given the results obtained when working (in each case) with from 20% to 25% by volume of sludge (measured after 2 hours' settlement) and removal of effluent

Results in parts per 100,000.

	Screened sewage.	No. 1 effluent.	Screened sewage.	No. 2 effluent.
4 Hours' oxygen absorption	3.34	0.70	3.40	0.64
Free and saline ammonia	2.61	1.66	2.64	0.35
Albuminoid ammonia	0.71	0.11	0.70	0.08
Nitrite and nitrate (as NH_3)	—	0.41	—	1.40
Dissolved oxygen absorption (Royal Commission test)	—	1.20	—	0.84
No. of fillings per day	—	6	—	4
Average aeration period	—	$1\frac{1}{3}$ hours	—	4 hours
Volume of sewage dealt with per day	—	187 gallons	—	125 gallons

No. 1 cask contained partially activated sludge and No. 2 cask fully activated sludge. after each period to the extent of 75% of the contents of the cask.

Results in parts per 100,000.

February and March, 1916. Temperature 5° to 10° C.				August and September, 1916. Temperature 16° to 19° C.		
Sewage.	Effluent No. 1.	Effluent No. 2.		Sewage.	Effluent No. 1.	Effluent No. 2.
4 Hours' oxygen absorption	3.30	0.74	0.63	3.76	0.65	0.64
Free and saline ammonia	1.90	1.53	0.44	2.77	0.60	0.20
Albuminoid ammonia	0.64	0.12	0.10	0.74	0.09	0.07
Nitrite and nitrate (as NH_3)	—	0.37	1.37	—	0.67	1.44
Dissolved oxygen absorption (Royal Commission test)	—	1.11	0.87	—	1.14	0.81
No. of fillings per day	—	6	4	—	6	4
Average aeration period	—	$1\frac{1}{3}$ hours	4 hours	—	$1\frac{1}{3}$ hours	4 hours
Volume of sewage dealt with per day	—	187 gallons	125 gallons	—	187 gallons	125 gallons
Percentage purification calculated on:						
4 hours' oxygen absorption test	—	78	81	—	82	83
Albuminoid ammonia test	—	81	84	—	88	91

There was no appreciable difference in appearance between the effluents obtained during the winter and summer months: in each case, they were invariably well clarified and contained only very small quantities of suspended matter.

It will be seen that the purification was not materially retarded by the low temperature experienced during February and March.

In the case of the partially activated sludge, however, there was a considerably reduced nitrification effect.

In the light of these results it would appear that the detrimental effect of low temperatures (below 10° C.) found when working with the Davyhulme sewage must be ascribed to the lowered vitality of the organisms present in the sludge, due to the constant presence of inhibitory trade waste, which renders them more susceptible to changes in temperature.

Activated sludge.

In the following table is given an average analysis of the activated sludge obtained from the Withington sewage together with comparative figures for the sludge produced from the Manchester sewage at Davyhulme, and from the Salford sewage.

Analysis of activated sludge (dry).

	Withington.	Manchester.*	Salford.†
Loss on ignition.	76.4	64.7	51.5
Mineral matter.	29.6	35.3	45.5
Total nitrogen (as N) .	6.0	4.6	3.75
Phosphate (as P_2O_5) .	4.2	2.6	2.1
Greasy matter, etc.— ether extract.	7.3	5.8	4.8

* Aldern and Lockett (this Journ., No. 10, Vol. XXXIII).
† S. E. Melling (this Journ., No. 23, Vol. XXXIII).

The activated sludge produced from the Withington sewage thus has an appreciably higher nitrogen content than either the Manchester or Salford sludge, due to some extent to the fact that the percentage of mineral matter is considerably less.

As stated in previous papers, the high percentage of nitrogen in activated sludge is one of the most important features of the process, in view of its direct concern with the question of the conservation of nitrogen.

Summary of results.

The results of the present investigation may be summarised as follows:—

1. That contrary to the opinion formed as the result of earlier experiments when working with a strong trade sewage, the maintenance of the activity of the sludge is not dependent on the stage to which nitrification is carried.
2. That when dealing with a sewage free from inhibitory trade effluents no appreciable loss of efficiency need be anticipated in this country during the winter months.
3. While the problem of disposal of the sludge remains to be fully developed, it would certainly appear from known data that the cost of dewatering and drying will be more than repaid by the value of the resultant dried sludge.

The investigation in regard to the effect of various trade effluents on the purification process is now well advanced and it is hoped that the results obtained will shortly be available for publication.

In conclusion the author has to thank Mr. H. Edwards (Withington Works Manager) for exercising general supervision, Mr. G. Smith (Laboratory Attendant) for intelligent operation of

the experimental plant, and Mr. C. Jepson, B.Sc., for able assistance in the analytical work involved. He is indebted to the Rivers Committee, Manchester Corporation, for permission to publish these results.

DISCUSSION.

THE CHAIRMAN enquired what was the effect of auto-digestion on the sludge and whether it was then more difficult to obtain a stable effluent.

Mr. S. E. MELLING was doubtful whether nitrification was, in all circumstances, vital. His experience of the continuous flow method of operation appeared to indicate that, by the use of 25% by volume of activated sludge, very satisfactory purification, notably in the colder winter months, could be obtained and maintained, practically without nitrification. He understood that the only effect of nitrification was to improve the stream into which the effluent passed by providing it with potential oxygen, which, however, was not the prime object of sewage purification. The point was, whether the elimination of the ultimate stage of more or less complete nitrification, would result in an appreciable saving of time, thus effecting economy in air consumption. One or two hours' treatment by the fill-and-draw method gave results very similar to those quoted in the paper, and conformed very satisfactorily to the suggested dissolved oxygen test of the Royal Commission. At the same time, the activity of the sludge was well maintained throughout. The figure of 3.8% of nitrogen (Salford sludge) given in the paper was now increased to 4.5% or thereabouts, and for all seasons of the year. Was it not possible to recover directly the nitrogen in the form of sulphate of ammonia. There was a very appreciable excess of nitrogen as compared with peat, and the latter, containing 2.0% of nitrogen and 40% of moisture, had, he believed, amply repaid for the recovery as the sulphate.

Mr. WILLIAM THOMSON asked whether it would be practicable to mix activated sludge with charred peat so that the large quantity of nitrifying bacteria in the sludge could be made available for the culture of vegetation. The charred peat would no doubt aid in the air drying of the sludge. He had Professor Bottomley's experiments in mind.

Mr. PERCY GAUNT enquired whether any difference in nitrogen content had been observed between the sludge employed for the maximum purification and the sludge employed for the less complete purification.

Mr. ARDERN in reply said the effect of auto-digestion of the sludge was to produce turbid effluents. In the absence of disturbance due to the presence of certain trade effluents, it was only met with during the initial period when nitrifying organisms were being established in the sludge by prolonged aeration periods. He agreed with Mr. Melling that nitrification was not essential and consequently in view of the fact, which had been established, that the activity of the sludge could be maintained without reference to the degree of nitrification, thoroughly well purified effluents could be obtained with a considerably reduced aeration period than was at first thought necessary, with consequent reduction in cost. He believed that the recovery of nitrogen by distillation of activated sludge was a practical proposition, but his view was that it would be better to utilise the dried sludge direct as a fertiliser. Its fertilising value had been thoroughly demonstrated by Dr. Bartow (Illinois University) and Mrs. Mumford (Manchester University). Activated sludge could, of course, be mixed with peat (either before or after inoculation) as suggested by Mr. Thomson, but seeing that the sludge itself contained appreciably more nitrogen than peat, it did not appear

desirable to do so. This suggestion, of course, raised the important question of soil inoculation which had been investigated by Professor Bottomley and others. He believed that the best results would be obtained by the direct use on the land of activated sludge with its normally high bacterial content, as there was every reason for believing that in addition to nitrifying organisms the sludge also contained nitrogen-fixing organisms. In devising means for drying or partially drying the sludge endeavour should therefore be made to avoid sterilisation.

The practical difficulty was, however, to maintain the organisms in the sludge in an active state particularly as the demand for manures was seasonal whereas the production of sludge would be regular all the year round. He had not observed any material difference in the nitrogen content of the partially and completely activated sludge.

Newcastle Section.

Meeting held at Bolbee Hall on Wednesday, December 13th, 1916.

MR. HENRY PEILE IN THE CHAIR.

A PORTABLE PLANT FOR THE DISTILLATION OF WOOD.

BY S. H. COLLINS, M.Sc., F.I.C.

The object of the plant is to obtain saleable products from branchwood, sawmill refuse, or other waste wood so as to clear the ground for other purposes such as replanting forest clearings or otherwise to utilise the ground previously covered with material of little value.

The plant is portable to permit its transport from place to place as may be required and consists of a cylindrical retort of $\frac{1}{2}$ -inch boiler plate, 16 feet long by 3 feet internal diameter, with a hinged door at each end falling downwards and supported so as to remain horizontal when open. The doors are closed by hinged bolts screwed up with nuts, and a strip of asbestos packing is used to make the doors as gas-tight as possible. Immediately outside the retort and forming part of it is a complete jacket of thin iron plate. The intermediate space 9 inches wide forms the flue and is divided horizontally by baffle plates into three parts so as to secure even and regular heating. There are two chimneys, one at each end, each fitted with a butterfly valve to control the draught. Outside the flue space is 2 inches of asbestos packing next the outside covering to retain the heat, and outside all is a light sheet iron cover. The whole is mounted on iron wheels so that it can be moved from place to place as required. Eight small tubes, $\frac{1}{2}$ -inch in diameter (to admit a thermometer), pass across the flues in order that the temperature may be observed from the outside. Owing to the breakage of thermometers and the expense and unsuitability of electrical appliances, a simple pyrometer of the calorimeter type is now used. The pipe which carries the products of distillation is connected with the top of the centre of the retort and after passing through a small tank, where much of the tar collects, proceeds in an upward direction to the cooling tank.

At the end nearest to the retort is a cross, or distributing pipe, to which are connected nine $1\frac{1}{4}$ -inch iron pipes extending the whole length of the condensing tank with a fall of about 3 inches to the far end. There they are connected with another cross pipe which has a small window to

permit of the inspection of the distillate as it passes into the collecting vessels. The cooling tank is filled with water but provision has to be made for supplying further water or for having some special cooling apparatus for the water in the tank. As the nine pipes above referred to are liable to become choked by the tar products from time to time, iron screw plugs are kept in the main pipes and holes with wooden spigots put in the cooling tank. A long iron rod serves to clean the pipes from time to time. Corrosion in the condenser is somewhat severe but experiments are being made to reduce this source of expense.

The collecting chamber consists of two closed 50-gallon barrels, each with one tap at the bottom and one tap about half way up. The lower tap is for the wood tar, and the upper one for the aqueous products of distillation. From the second barrel a 1-inch pipe is led on a rising gradient to the fire box, passing through a small tar trap on the way. This trap is intended to remove the remaining liquid products, whilst the whole of the gases pass into the fire box and assist in heating the retort. The fire box is built with ordinary white fire bricks and measures 2 feet 5 inches wide by 2 feet high and is about 4 feet long, connecting at the back with the retort flues. The only iron work about the fire box consists of the iron door and ten 1 inch iron fire bars set about 1 inch apart.

The speed at which the distillation proceeds is regulated more by the pressure than by temperature. For this purpose two simple water gauges are fitted on the side of the cooling tank connected by small pipes, one gauge with the upper cross pipe in the cooling tank and the other gauge with the collecting vessels. Under normal conditions these gauges should register 6 inches and 3 inches respectively. When the pressure on both gauges falls to zero it is an indication that the distillation is complete. Though extremely simple, these gauges are invaluable in working.

There are two precipitating tanks detached from the foregoing portions of the plant. They are used for converting the pyroligneous acid into acetate of lime. The first measures 5 ft. 6 in. \times 2 ft. 6 in. and the second is about 4 ft. 6 in. deep and 2 ft. 6 in. by 2 ft. 6 in. in section.

An iron tray about 4 feet square and 6 inches deep stands on the top of the fire box for the purpose of evaporating the solution of acetate of lime. This method is crude but more complex methods have been tried and given up.

The products of the distillation are charcoal, wood tar, pyroligneous acid, and water, together with various gases which are passed into the fire box and used for combustion.

The charcoal usually represents 25% of the total weight of the wood treated: that is from an average charge of one ton, 5 cwt. of charcoal is obtained. It is estimated that five to six cwt. of firewood is required for each charge, in addition to the gas produced. Coal has been used satisfactorily. The retort must be allowed to cool before being opened, otherwise the charcoal would be liable to ignite when coming into contact with the air. The charcoal as removed from the retort is stored in bulk or bags and can be sold readily.

The quality of the charcoal made depends upon the part of the tree from which the wood came and upon the temperature of the retort. Dense charcoals are preferred to light charcoals. The accompanying table shows that by keeping the proportion of bark low it is easy to get a charcoal with low ash. The conifers usually give a light charcoal. The proportion of gas left in the charcoal depends chiefly on the temperature of the retort.

From a ton of hardwood 18 gallons of water are thrown away and 30 gallons of pyroligneous acid obtained. The pyroligneous acid is transferred to

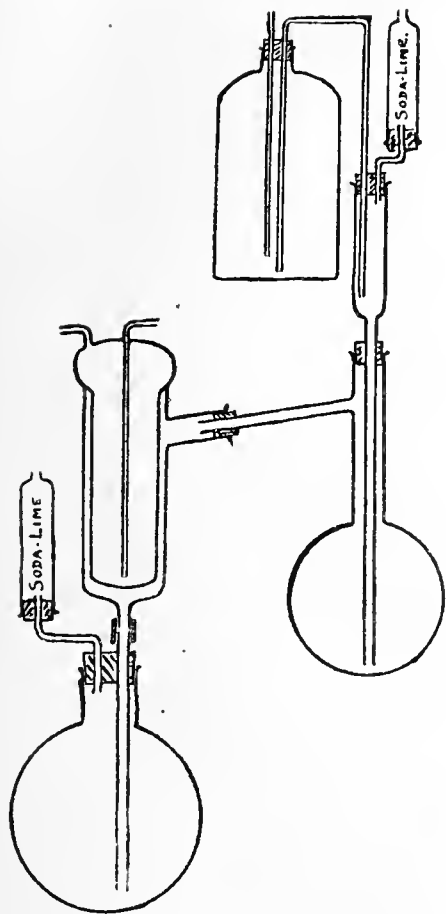
the first precipitating tank where it is mixed with 8 lb. of slaked lime for every 10 gallons of acid. As a rule, acetate of lime in solution is formed and a sludge is precipitated. After settling for a few days the solution is transferred to the evaporating tray for concentration, when it is either allowed to settle again or is filtered and finally evaporated to dryness, the solid residue, a grey substance of the consistency of chalk, forms the acetate of lime of commerce known as "brown acetate" or "grey acetate" according to purity. "Brown acetate" is approximately of 60% purity and "grey acetate" 80% purity. The former is used in the cotton industry and it is only the grey acetate that is of value in the manufacture of acetone. From a ton of hardwood about 4 gallons of wood tar is obtained. Its value is variously estimated from 6d. to 1s. per gallon, but

means of overcoming the difficulties. A Marriott dripping bottle supplies distilled water to the distilling flask which contains 2 grms. of the acetate and 15 c.c. of syrupy phosphoric acid. The Marriott bottle is adjusted to give a flow of about four drops a second. A flexible rubber tube joint, not shown in the sketch, facilitates this adjustment. The rate of boiling is arranged to maintain the liquid in the distilling flask at about the 50 c.c. level. The receiver contains 25 c.c. of $N/1$ soda, which at the end of the distillation is titrated with $N/5$ sulphuric acid using phenolphthalein as indicator. With pure acetates the whole of the acid distills in 300 c.c. but with very crude acetates as much as 1200 c.c. has been needed. In all cases it is necessary to continue the distillation for an extra 100 c.c. to make sure that all is over. The reason of this difficulty is that some acid of higher boiling point than acetic acid is always present. The proportion of such acid is greater in the cruder acetates than in the pure acetates.

Any slight draught on this apparatus only causes a small admission of air at the upper soda-lime tube to be followed by the expulsion of air at the lower soda-lime tube. This slight circulation of air is of great assistance in preventing bumping and frothing. The distilling flask may be about 200 c.c. capacity, the Marriott bottle about two litres, and the receiver about one litre.

Distilled water always contains some carbonic acid and it is difficult to prevent absorption during handling. The best way to surmount these difficulties is to perform a blank determination, which in my experience amounts to about one c.c. of $N/5$ acid. As the amount of alkali neutralised equals from 70 to 100 c.c., such a correction is not unreasonably large. No phosphoric acid spits over with this apparatus.

It is important to pack the retort as tightly as possible so that the maximum charge of wood can be put in, but sufficient space must be left to allow convection currents of hot gas to distribute the heat. If the pieces are straight and all of fair size, say 2 feet by 3 inches, as much as 25 cwt. can be put in, but if small and crooked wood is used, or quite small branches, the weight of material may be not more than 12 cwt. Sawdust is quite useless. To ensure freedom for the escape of the gas and vapours the small and crooked pieces are laid in the bottom of the retort and the large and straight pieces at the top. After the furnace is lit and the temperature in the retort commences to rise, water vapour is first given off. It is condensed and drawn off from the condensing chamber as soon as the pyroligneous acid begins to come over. This takes place when the temperature has reached a higher degree and simultaneously the wood tar also comes over. The window in the pipe connecting the cooling tank and the collecting chamber is most useful at this stage. The most suitable temperature for the distillation appears to be between 270° and 400° C. The temperature in the lower part of the flue space is about 450° C. and in the upper part of the flue space about 270° C., when the plant is in full working order. The plant is capable of dealing with about 120 tons of wood per annum or say three tons per week for 40 weeks with 12 weeks for bad weather, removing to new position, repairs, cleaning, etc. About two days are required for the complete distillation of each charge if the pieces are of fair size, and while the time required is less when the material is small, the weight of the charge is also less, and, in the end, the total production per week is less. In addition to the material consumed in the retort about 30 tons of firewood would be required for the furnace, or say 150 tons per annum in all. It is not easy to estimate how much small material would be derived from the felling area, but putting the



it would appear to be of much greater value for estate and local purposes than for sale in the open market. It is a very fine timber preservative. The acetate made by this plant has varied in composition but it seems likely that an acetate of about 70% could be obtained.

There is a good deal of literature dealing with the analysis of acetate of lime, especially about the year 1901, and the method adopted after many trials follows the lines already published. It is, however, desirable to emphasize the necessity of guarding against carbon dioxide from the air and to point out that the difficulties due to frothing with the cruder forms of acetate are not inconsiderable. The accompanying diagram provides a simple

amount at 5 tons an acre, the distillation plant would require the refuse material of 30 acres per annum to be fully employed. With regard to the question of labour, the work is not heavy but requires attention, and an elderly man has been quite able to manage all that is required. A handy motor circular saw would be a great help.

The actual accounts for twenty-two months are given in the following statement:—

FINANCIAL STATEMENT.

Period—July 1st, 1914, to May 1st, 1916.

RECEIPTS.			EXPENDITURE.		
11 tons 11 cwt 1 qr.	£	s. d.		£	s. d.
Charcoal = 65	9	6	Wages	61	8 11
Tar sold but not yet paid for	4	0 0	Time	1	13 6
In store, not sold—			Asbestos	0	14 7
Charcoal	10	0 0	Cartages	1	11 7
Tar	3	0 0		£65	8 7
Acetate	10	0 0	Experimental ...	70	0 0
	£95	9 6	Capital	212	8 1
				£277	16 8

Owing to the shortage of labour and bad weather, this plant has been out of action for several months at a time. Probably in normal times twice as much work could be done in a year as in the twenty-two months stated. However, a fair allowance for bad weather must be made.

The allowance of £70 for experimental expenses provides £20 for chemicals and preliminary trials, and £50 for early mistakes.

TABLE I.
Charcoal.

	Hardwoods.					Conifers
	Elm.	Oak.	Ash.	Chestnut.	Sycamore.	Larch.
Water	3.77	3.45	4.02	2.63	3.56	2.81
Volatile matter ..	20.15	30.43	19.10	17.13	27.66	33.88
Fixed carbon	73.88	59.08	75.30	78.92	67.34	62.59
Ash	2.20	1.01	1.58	1.32	1.11	0.72
Ash % fixed carbon	2.98	1.70	2.10	1.67	2.14	1.15

TABLE II.
Bark charcoals.

	Elm bark.	Oak bark.	Ash bark.	Chestnut bark.	Mixed screenings.
Water	3.02	3.87	4.24	3.42	3.20
Volatile matter ..	32.00	42.37	32.70	25.11	28.09
Fixed carbon	47.06	47.64	55.04	64.37	59.21
Ash	17.02	6.12	7.02	7.07	9.59
Ash % fixed carbon	36.20	12.85	12.53	10.98	16.20

DISCUSSION.

Professor H. LOUIS said that for a great many purposes the charcoal may contain far too high a percentage of volatile matter, and he pointed out the large differences in the percentage of this constituent. He was surprised that the author of the paper had made no mention of wood spirit, as this probably would have been a valuable by-product could it have been saved. He did not agree with the suggestions of the author that sawdust was practically impossible to distil economically; he believed that by briquetting this waste material with wood tar, quite good

charcoal could be obtained. He described the large brick steel-lined furnaces that were used in Sweden and Russia for carbonising wood on a large scale.

He considered a high ash content of the charcoal a serious detriment to the value of this product, because if the charcoal were used in conjunction with the preparation of high quality iron, it was very liable to part with its phosphorus content, thereby contaminating the metal. He understood that if the timber remained in water for a considerable period of time, say twelve months, a large proportion of the saline constituents were leached out.

Dr. J. H. PATERSON pointed out that the firm he was associated with, and who took a large proportion of the make of the charcoal, required a fair proportion of volatile matter in the charcoal for close annealing furnaces; and in his opinion the percentage of volatile matter in the charcoal was purely dependent on time and temperature, and that there would be no difficulty in reducing the volatile matter to a very low figure if it were found commercially advisable.

The CHAIRMAN said he was much interested in the question of low volatile matter in the charcoal in connection with his work of manufacturing tungsten. He had found 5% or more of ash in the charcoal his firm were using, and he pointed out that it was very desirable that this should be very materially reduced.

Dr. G. P. LISHMAN inquired how long each distillation took, and what were the signs which indicated the completion of the operation.

Mr. COLLINS in reply said that his plant was, firstly, merely experimental, and secondly, able to be transported easily from place to place, a fact which was of course impossible with the bigger and more permanent forms of plant mentioned by Professor Louis. The charcoal was purposely made with a high content of volatile matter to suit their largest consumers. He pointed out from figures already stated in the paper that a large proportion of the ash appeared in the bark of the various woods carbonised, and that if the pieces of wood were freed from the bark, the general ash percentage of the charcoal would be very much less. It was not difficult to undertake this. The time of distillation varied very much according to the degree of moisture in the timber put into the distilling plant, and anything from 24 to 48 hours might be required to carry through the operation. The conclusion of the distillation could be well ascertained by the quantity of gas that was given off towards the end of the distillation being considerably reduced, and also the pressure on the whole of the plant considerably diminished at the time when the distillation was completed. He desired to acknowledge his indebtedness to Dr. Paterson for the great help he had given him, both in the design and working of the plant.

Industrial Notes.

SOME MODERN EVAPORATORS.

More than eighty years ago it was recognised that in the ideal evaporator the liquid should be concentrated as rapidly as possible and that it should be kept moving with a high speed: in order to accelerate its movement the use of a thin film of liquid should be maintained. Most of the modern forms of evaporating apparatus have been designed on these principles, and the following descriptions of three types of plant indicate how these principles have been applied.

The Kestner climbing film evaporator, illustrated in fig. 1, consists of two parts, the separator, S, and the calandria, the latter being composed

of a shell, M, containing evaporating tubes, R, about 23 ft. long and fitted into upper and lower tube plates. The liquor enters the apparatus at T and passes into the tubes, where it is heated by live or exhaust steam introduced at A. The column of vapour formed in the tubes travels upwards at a high velocity, drawing up with it a continuous film of liquor on the inner surface of the tubes. The mixed liquid and vapour emerge from the top of the tubes into the separator, S, where they strike the baffle plate, D, with such velocity that effective separation of the concentrated liquor and the vapour takes place. The concentrated liquor leaves the separator at L, and the vapour, after passing through the save-all, V, is drawn off through B. The outlet for condensed water is shown at E, while G is an air drain.

Where a large amount of liquor has to be concentrated, the evaporators are worked in multiple effect, and when a very high concentration is required for the finished liquor, the multiple effect may be followed by a single effect "finisher." In a plant for concentrating caustic soda, consisting of a triple-effect evaporator and a finisher, the thin liquor at 16° Tw. enters the first effect after preliminary heating by vapour produced from the liquor itself. Leaving the triple effect at 100° Tw., the liquor is passed

to settling tanks where salts are deposited, and then goes to the finisher, where it is concentrated to contain 60% Na_2O .

When very viscous liquids have to be dealt with, the climbing film is not always convenient for the last effects, and for these a falling film evaporator may be used. In one type of this apparatus one set of tubes is of the climbing film type, and the liquid coming from the top of these passes down a second set of tubes in a descending film to the separator, which is connected with the lower part of the apparatus.

The Söderlund and Boberg evaporator, illustrated in fig. 2, consists of a shell, A, containing a calandria, B. The liquid is raised by the pump, F, from the lower portion, G, of the shell into the tray, H, whence it passes through nozzles in the top of the tubes, C, and is distributed in a thin sheet over the interior of the tubes. The liquid is heated by compressed steam introduced into the upper part of the calandria. The concentrated liquid collects in the bottom of the shell, fresh liquid being supplied by the constant-level feed, I. The steam evolved in the tubes, C, is separated from liquid by the baffles, J, and passes through the steam main, K, to the compressor, L, where it is compressed sufficiently to raise its temperature to the required degree and used for heating the tubes after addition of the necessary quantity of make-up steam at M. The condensed water from the outside of the tubes is drained off through N, and used to heat the incoming liquor in the counter-current regenerator, O. A very high efficiency is claimed for this apparatus in virtue of the fact that the difference of temperature between the boiling liquid and the heating steam is very small (from 1° to 3° C.). A plant on this system is being erected in Sweden for treating the waste liquors from wood pulp manufacture.

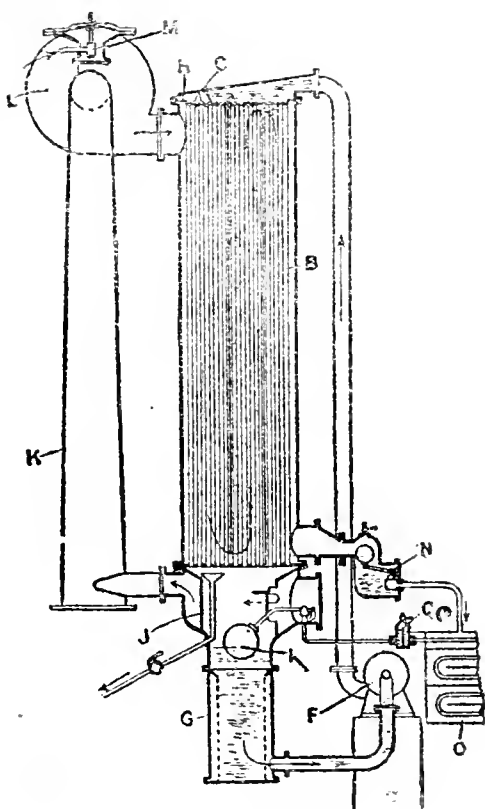


FIG. 2.

Another type of evaporator working on similar principles is the Prache and Bouillon "thermo-compressor," shown in fig. 3. The liquid to be concentrated enters the apparatus at A, passes through the heating tubes B, and thence through the horizontal tube into the lower part of H, where it is distributed in the tubes, G, the concentrated liquor falling into C and being drawn off at D. Live steam for heating the tubes enters

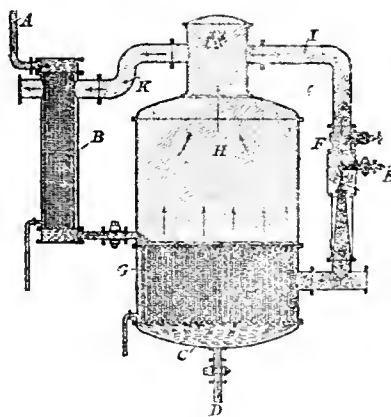


FIG. 3.

at E, drawing with it through F steam from H; the mixture flows around the tubes, G, and thence passes up into the chamber, H, a part returning through the tube, I, to be used again for heating the tubes G, and the remainder flowing through K to the heater, B.

The same firm has designed another type of evaporating plant (fig. 1) which has been used successfully for concentrating high-density sugar syrup, and is heated by steam at very low pressure. The liquid to be concentrated enters at A, passes upwards through the tubes, G, which it only partially fills, to the ebullition chamber, F, and thence the concentrated liquor flows back through

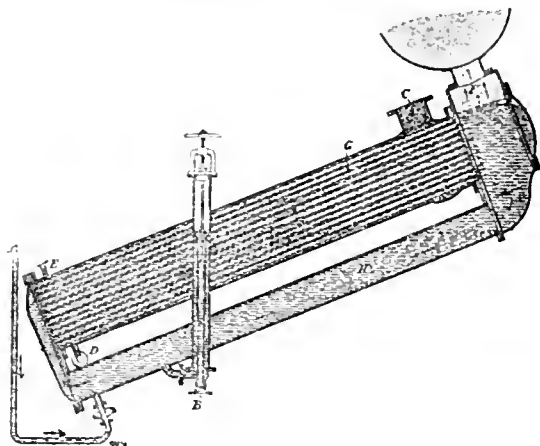


FIG. 1.

the circulation tube, H, and out at the bottom part, B, of the level-adjusting device. The heating steam, introduced at C, passes around the outside of the tubes, G, the condensed water being discharged at D and the non-condensable gases at E. Rapid evaporation of liquid is secured by reason of the rapidly moving mixture of liquid and vapour which occupies the upper parts of the tubes.

PRICES OF CHEMICALS IN 1916.

The "Annual Trade Review," issued as a Supplement to the January number of the "Chamber of Commerce Journal," contains an interesting article by J. C. Umney, dealing with the drug and chemical trades in 1917.

Broadly the drug and chemical trades have laboured in 1916 under the same general drawbacks as operated in 1915, such as stringency in labour, difficulties in home transport and in shipping facilities for abroad, export restrictions, and so on. The year has brought its own particular problems; among these have been difficulties in connection with the supply of alcohol, which have been overcome so far, although the article and the innumerable preparations into which it enters cost more. There have also been increasing difficulties in obtaining supplies of sugar for pharmaceutical purposes, and the restrictions on the sale and use of glycerin. Despite all the obstacles, however, the drug, fine chemical and essential oil trades have done well. War's demands on manufacturers and wholesale distributors have been heavy; export business, too, has increased, especially to Russia. There has also been a distinct increase in production of fine chemicals previously made abroad, and as time goes on we shall witness further extensions.

The course of prices in the synthetic group shows our experience in a department formerly mainly supplied by Germany. In leading items of this classification, 1916 prices summarised show as follows:—

lb.	Open.	Close.	Highest.	Lowest.	Pre-war rate.
	s. d.	s. d.	s. d.	s. d.	s. d.
Acetanilide	7 0	2 0	9 0	2 9	0 11
Acetosulcyllic acid	47 6	21 0	48 6	21 0	1 8
Barbitone	52 6	95 0	95 0	52 6	10 0
Guaiacol carbonate	75 0	110 0	150 0	75 0	7 6
Hexamine	5 3	2s. 6d.-3s.	5 3	2 6	2 0
Hydroquinone	35 0	13s.-14s.	45 0	13 0	2 6
Methyl salicylate	16 6	6 0	17 0	6 0	1 3-1 6
Paraldehyde	15 0	10 6	15 0	9 0	1 5
Phenacetin	60 0	105 0	115 0	60 0	3 0
Phenazone	72 6	35 0	77 6	34 0	6 9
Phenolphthalein	37 6	85 0	150 0	37 6	5 6
Resorcin	70 0	145 0	145 0	70 0	2 6
Salicylic acid ..	20 0	5s. 9d.-6s.	22 0	5 9	0 11
Salol	46 0	11 0	48 0	11 0	2 4
Soda salicylate ..	21 0	6 0	21 0	6 0	1 2
Sulphonal	45 0	30 0	45 0	22 6	9 9

It will be seen that the general upward movement in this group in 1915 was not sustained all round in 1916. Several of these substances indeed, show substantial reductions, owing to increased production, as in the case of the salicylates, hexamine, sulphonal, and vanillin, or because of a cheaper cost of raw material, as in acetanilide and hydroquinone. On the other hand, efforts to make such substances as phenacetin have not fructified sufficiently to relieve to any extent the stringency in supplies, and consequently the value has increased considerably; similarly as regards guaiacol carbonate, barbitone, phenolphthalein, and resorcin.

In the alkaloids, prices were:—

	Open.	Close.
	s. d.	s. d.
Atropine sulphate, oz.	120 0	115 0
Cocaine hydrochlor., net oz.	14 0	21 0
Codeine, pure cryst., oz.	22 0	21 0
Caffeine, pure, lb.	25 0	30 0
Morphine hydrochlor. pulv., oz.	13 3	13 3
Quinine sulphate, oz.	3 3	2 6
Pilocarpine hydrochlor., oz.	17 0	24 0
Sparteine sulph., oz.	36 0	72 0
Strychnine, pure cryst., oz.	2 6	3 4
Theobromine, pure, lb.	55 0	70 0

Of the above atropine sulphate at one time touched 165s. per oz., and cocaine hydrochlor. 27s. 6d. (compared with 4s. 5d. just before the war broke out). The highest price for quinine sulphate from dealers was 43s. 3d. per oz., and the lowest 2s. 2d. Pilocarpine steadily advanced and sparteine took a steep upward move in December. Strychnine has gradually advanced in sympathy with the higher cost of *Nux vomica*, accentuated by the shortness in supply.

Reviewing the more important heavy chemicals, the following epitome is given on page 73:—

Alum production has suffered from the shortage of sulphuric acid. The big rise in arsenic reflects the higher cost of mining and freights. Heavier demand has lifted prices of ammonium sulphate. War's requirements have depleted the supplies of bleaching powder available for ordinary purposes. Higher freights account for several rises in borax and boracic acid. Iron and copper sulphate reflect the dearer cost of the metals and acid. Potashes have been very scarce, especially Montreal certificated. Potassium chlorate prices have been sympathetic to the large inroads on supplies for war needs. Potassium permanganate, being rather more plentiful, declined until the autumn, when, however, a substantial recovery set in. The difficulty in getting consignments from Chile influenced an upward trend in nitrate of

	Open.	Close.	Highest.	Lowest.
Acetic acid, glacial, cwt.	£ 7 0 0	£ 8 0 0	£ 13 5 0	£ 5 15 0
Alum, lump, ton	10 10 0	22 0 0	25 0 0	10 10 0
Arsenic, Cornish white, cwt.	1 8 0	2 2 0	2 2 0	1 8 0
Ammonium sulphate, ton	17 0 0	17 10 0	17 12 6	15 5 0
Bleaching powder, ton	20 0 0	32 0 0	35 0 0	20 0 0
Boric acid powder, cwt.	2 3 0	2 17 0	2 17 0	2 3 0
Borax powder, cwt.	1 5 0	1 14 0	1 14 0	1 5 0
Citric acid, lb.	2 8	2 6	4 0	2 4
Carbolic acid—				
Crude 60% gal.	3 5	3 4	3 6	3 4
Crystals 39° C., lb.	1 4	1 3	1 6	1 3
Copper sulphate, ton	45 0 0	65 0 0	65 0 0	44 10 0
Cream of tartar, 98% cwt.	9 5 0	9 5 0	10 5 0	9 0 0
Epsom salts, ton	15 0 0	14 0 0	17 10 0	13 0 0
Iron sulphate, ton	4 10 0	8 0 0	8 10 0	4 10 0
Oxalic acid, lb.	1 4	1 7	1 9½	1 4
Potashes, Montreal, cwt.	7 15 0	7 5 0	10 10 0	6 10 0
Potassium chlorate, lb.	1 5	2 6	2 7	1 5
Potassium permanganate, lb.	4 9	11 6	12 0	4 9
Sal ammoniac, first lump, ton	55 0 0	70 0 0	70 0 0	55 0 0
Saltpetre, Eng. ref., cwt.	2 10 0	2 7 0	3 7 0	2 10 0
Sodium bicarbonate, ton	7 0 0	8 0 0	9 0 0	7 0 0
Sodium nitrate, ton	16 15 0	20 0 0	20 5 0	16 15 0
Sulphur flowers, ton	12 0 0	20 0 0	20 0 0	12 0 0
Tartaric acid, lb.	2 6	2 7½	3 11	2 6

soda. Sulphur supplies have been much below requirement and prices have risen enormously.

The following miscellaneous grouping is given:—

	Open.	Close.
Almond oil (sweet), lb.	£ 0 2 9	£ 0 2 6
Bismuth subnitrate, 1 cwt. lots, lb.	0 10 0½	0 11 0½
Calomel, 1 cwt. lots, lb.	0 6 1½	0 6 5½
Camphor, refined:—		
Japan, 1 oz. tabs., lb.	0 1 9	0 3 3
2½ lb. slabs	0 1 8	0 3 4
English bells	0 2 3	0 2 11
Color hydrate, duty paid, lb.	0 14 9	0 9 6
Cod liver oil, Norwegian, medicinal c.i.f. barrel	16 15 0	27 10 0
Cocoa butter, lb.	0 2 0	0 1 7
Formaldehyde, 40 vols., cwt.	2 16 0	3 15 0
Milk sugar, cwt.	3 12 6	8 15 0
Olive oil, Spanish, cwt.	2 14 0	3 7 6
Potassium bromide, lb.	1 5 0	7 6
Quicksilver, bottle	16 12 6	18 15 0
Santonin, lb.	7 15 0	8 0 0
Saccharin, 550, lb.	3 13 0	6 10 0
		(makers)
		10 0 0
		(secondhands)
Turpentine, cwt.	2 12 0	2 13 6

Bismuth subnitrate in second hands was lifted to 15s. per lb. at one time, the works themselves being full up with orders and often unable to supply for immediate delivery. In refined camphor there was a remarkable run-up in prices following on several advances in the Monopoly quotations for Japan crude. Cod liver oil prices, for the greater

part of the year, have been practically prohibitive of business (at one time as much as \$45s. per barrel c.i.f. was quoted for one brand), and have provided a good opening for the retined Newfoundland article. Formaldehyde at one time attained 125s. per cwt. Milk sugar has more than doubled its value owing to the shortage of receipts. There was a big drop in bromides, which, at American instigation, were on one occasion subjected to a most dramatic reduction.

A few spot prices of the leading essential oils and allied articles are also abstracted from "The Perfumery and Essential Oil Record" are given below.

DRUGS AND CHEMICALS FOR AUSTRALIA.

The Chemical Trade Section of the London Chamber of Commerce desires to give publicity to the fact that the attention of the British exporters of drugs and chemicals has been drawn by a Government Authority in Australia to the desirability that all drugs and chemicals exported from the United Kingdom shall be in all respects up to the British Pharmacopœia standards. It is believed that German exporters, before the war, complied strictly with this condition, and it is therefore suggested that if business is to be maintained after the war the correct standard of quality must be strictly adhered to by British firms, especially in view of the probability that enemy countries will, at all costs, make strenuous efforts to renew those business relations which they have temporarily lost.

	1916.		Pre-war.
	January.	December.	
<i>Essential Oils:—</i>			
Almond (essent.) s.a.p. lb.	s. d. 37s.—40s.	s. d. 42s. 6d.—45s.	s. d. 12 6
Anise, star, lb.	3 4	3 6	5 3
Bergamot, c.i.f., lb.	11s. 9d.—12s. 3d.	16s. 6d.—17s.	16 9
Cajuput, lb.	4 0	3 6	3 2
Caraway (double distilled), lb.	10 0	15 0	5 0
Cassia (80—85% c.a.), lb.	4 3	4 4	3 2
Citronella (Ceylon), lb.	1 7	1 9½	1 6
Clove (English), lb.	5 4	5 10	3 9
Eucalyptus, B.P., lb.	2s. 3d.—2s. 6d.	2s. 1d.—2s. 4d.	1 4
Geranium (Bourbon), lb.	10s.—11s.	11s. 6d.—12s.	9 6
Lemon, c.i.f., lb.	3s. 6d.—3s. 9d.	4s.—4s. 3d.	6 0
Orange, Italian, c.i.f., lb.	7s. 3d.—7s. 6d.	11s.—11s. 6d.	7 6
Peppermint, American bulk, lb.	9 0	10 6	13 0
" Japan, lb.	4 3	4 3	3 10½
Sandalwood, lb.	31s.—32s.	48s.—50s.	21 0
<i>Allied Articles:—</i>			
Cammarin	32 0	60 0	12 0
Heliotropin	12 0	27 6	3 10
Menthol	12 3	14 0	10 3
Thymol	45s.—55s.	30s.—32s. 6d.	9 6
Vanillin	45 0	27 0	14 0

THE WORLD'S COPPER SUPPLIES.

The output of copper in the various producing countries is reviewed in a recent issue of the "Engineering and Mining Journal." The world's production showed a steady increase up to 1912, when it reached a maximum at 1,021,100 tons. The term "production" includes copper obtained and obtainable from the ore mined. In 1913 the output fell to 1,002,300 tons, chiefly owing to the internal troubles in Mexico, where production declined from 73,700 to 52,800 tons. The principal producers in 1913 were: United States, 557,400 tons; Japan, 73,200; Spain and Portugal, 51,700; Mexico, 52,809; Australia, 47,300; Chile, 40,000; Canada, 34,900; Russia, 33,900; Peru, 25,700; Germany, 25,300; Serbia, 6,100; and Katanga (Belgian Congo), 6,000 tons. As showing the increase in output during the last quarter century, the figures for 1897 for some of the countries are given as follows:—United States, 224,000 tons; Japan, 13,500; Australia, 17,300; and Chile, 22,300 tons. The present output of ore at Chuquibambata is said to be 10,000 tons daily, the mine here being the largest in the world. The production of copper in most countries decreased in 1914, but rose again in the following year, as shown below:—

Country.	Production.	
	1911.	1915.
	Tons.	Tons.
United States	525,500	646,200
Mexico	36,300	31,000
Japan	72,800	75,000
Spain and Portugal	37,100	35,000
Australia	37,600	32,500
Chile	40,900	47,400
Canada	34,000	26,000
Russia	31,300	26,000
Germany	30,500	35,000
Peru	23,600	32,400

The total production in 1914 and 1915 was 927,200 and 1,061,600 tons, respectively.

The following figures, relating to 1913, are of interest as showing the output of mines, the activity of metallurgical works, and the copper consumption in the different countries:—

Country.	Output of mines.	Copper produced in metallurgical works.	Copper consumption.
	Tons.	Tons.	Tons.
United States	557,400	589,100	318,100
Germany	25,500	41,000	259,300
United Kingdom	300	52,100	110,300
France	—	11,900	103,600
Russia	33,900	34,200	40,200
Austria-Hungary	4,100	2,300	39,200
Italy	1,600	2,300	31,200
Belgium	—	—	15,000

Obituary.

ANDREA ANGEL.

The profound sympathy of all engaged in chemical industry will be extended to the relatives of Dr. Andrea Angel, who lost his life in the disastrous explosion which occurred in the East End of London on January 19th. Dr. Angel, who was educated at Christ Church, Oxford, was the chief chemist at the munitions factory in which the explosion happened; when the fire broke out he warned the operatives to leave and himself heroically returned to assist in the attempt to subdue the outbreak, though he must have known that in so doing his own life would be sacrificed.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each, to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.

United States.—1s. each, to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—Patent number, date, name of patentee, and title of invention.

French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Behn et Cie., 56 Rue Feron 8, Paris (Se); Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

PATENTS.

Grinding mill for wet or dry substances. T. Breakell, Wirksworth. Eng. Pat. 16,511, Nov. 23, 1915.

Is a horizontal grinding mill the lower, positively driven member, which is contained in a fixed casing, has a central cone projecting from its upper face which works in connection with a conical depression formed in the centre of the under surface of the upper or frictionally driven member. The latter is mounted eccentrically to the former in a spherical bearing which is carried by a hinged cover. A scraper is provided which bears against both members at the point where their outer edges coincide.—W. H. C.

Ball-grinding machine. E. Hamis, Tegel, Germany. U.S. Pat. 1,205,531, Nov. 21, 1916. Date of appl., Sept. 8, 1916.

A PAIR of vertical rotating discs are arranged parallel to one another with annular grooves on their inner faces. A pair of relatively fixed grinding discs are arranged between the rotating discs, with grooves on their outer faces registering with the first mentioned grooves. The relatively fixed discs have a limited axial and radial movement and are

pressed apart preferably by springs contained in recesses in a fixed central plate between them. A charging recess is formed by cutting away the fixed grinding discs and central plate.—W. F. F.

Separators; Centrifugal.—T. E. Brown, New York. Eng. Pat. 102,284, Jan. 26, 1916. (Appl. No. 1,277 of 1916.)

THE opening and closing of the outlet for the solid material, and the operation of the ejecting mechanism, are effected positively by fluid pressure from devices external to the centrifugal machine and controlled by valves actuated by solenoids.—W. H. C.

Furnaces. H. J. Yates, Birmingham, and S. N. and E. R. Brayshaw, Manchester. Eng. Pat. 102,318, Apr. 12, 1916. (Appl. No. 5333 of 1916.)

IN a gas- or oil-fired furnace several primary combustion chambers are arranged along one side of the furnace with ports leading into the latter. The waste gases leave the furnace by ports on the opposite side and pass by separate conduits to a main waste gas flue which passes longitudinally beneath the floor of the furnace. The secondary air is preheated by the waste gas in regenerators placed in the main waste gas flue, or between it

and the waste gas conduits, and then passes under pressure through nozzles at the rear of the primary combustion chambers and impinges on the flame, forcing the latter into the furnace.—W. H. C.

Filters; Method of operating —. C. S. Bradley, New York. U.S. Pat. 1,206,207, Nov. 28, 1916. Date of appl., Mar. 13, 1913.

A CHARGE of liquid is filtered through a stationary filtering medium and the greater part of the cake is removed by a scraper. A fresh charge of liquid is introduced, and the residue of cake is removed by applying pressure within the filtering medium substantially equally towards and away from the support of the filtering medium, whereby displacement is avoided and the residue of cake is blown into and mixed with the new charge.

—W. F. F.

Condenser; Surface —. A. Siegel, Charlottenburg, Germany, Assignor to General Electric Co. U.S. Pat. 1,206,605, Nov. 28, 1916. Date of appl., Apr. 3, 1914.

GROUPS of cooling tubes are provided with separate valve-controlled conduits for admission and discharge of cooling fluid in such a way that the groups may be connected in series or parallel or any group may be cut out. A partition in the enclosing casing separating the groups from one another is provided with an opening controlled by an externally operated valve.—W. F. F.

Drenching a material with a liquid; Apparatus for periodically — and thereafter draining it therefrom. A. T. Eyton, Nelson, and F. J. Henderson, Vancouver, B.C., Canada. U.S. Pat. 1,206,685, Nov. 28, 1916. Date of appl., Oct. 20, 1915.

A SERIES of vats are arranged in steps and each contains a perforated tray clear of the bottom, which carries the material to be treated. Each vat is connected with the one below it by a siphon which has one leg below the perforated tray, passes through the wall of the vat near the top, and terminates in the vat next below. The treating liquid which is supplied to the uppermost vat thus empties itself through all the vats to a tank at the bottom, from which it is periodically transferred to the uppermost vat. A draining valve is provided in the bottom of each vat.—W. F. F.

Atomising fused materials; Process and apparatus for preventing so-called "cold-blowing" in —. "Metallatom" Ges. m.b.H., Köln-Ehrenfeld. Ger. Pat. 291,850, May 28, 1914.

THE jet through which the fused material issues is surrounded by a slot through which hot air or hot waste gases are drawn by the injector action of the compressed gas used as atomising agent; the hot air or gas thus forms a mantle around the fused material and protects it from direct contact with the cold compressed gas.—A. S.

Thermostats. C. E. Hearson, London. Eng. Pat. 102,538, Feb. 9, 1916. (Appl. No. 1920 of 1916.)

Dehydrator. C. Robinson, Mount Vernon, N.Y., Assignor to Metallurgical Engineering and Process Corporation. U.S. Pat. 1,208,014, Dec. 12, 1916. Date of appl., Nov. 29, 1910.

SEE Eng. Pat. 2806 of 1913; this J., 1914, 341.

Condensing and vacuum-producing; Device for —. E. Josse and W. Gensecke, Assignors to Ges. für Kälteindustrie m.b.H., Berlin. U.S. Pat. 1,208,325, Dec. 12, 1916. Date of appl., July 9, 1915.

SEE Eng. Pat. 9724 of 1915; this J., 1916, 914.

II.A.—FUEL; GAS; MINERAL OILS AND WAXES.

Pulverised coal; Use of —. (1) J. E. Muhlfield. Amer. Soc. of Mech. Eng. (2) J. W. Fuller. Amer. Iron and Steel Inst. Engineering, 1917. 103, 3—4.

(1) ANY solid fuel having, in dry pulverised form, two-thirds of its content combustible can be used for generating steam. The best results are obtained when the fuel is mechanically dried and crushed so that the moisture does not exceed 1%, and 95% passes through a 100-mesh and 85% through a 200-mesh screen. The average cost of preparation is estimated at about 1s. per ton. Tests carried out with a ten-wheel type of goods locomotive gave an average of 12.8 ton-miles per lb. of coal. The prepared fuel is thoroughly mixed with air under pressure and blown into the fuel and air mixers, where additional induced air is supplied. The final mixture, now in combustible form, is drawn into the furnace, the flame produced attaining a maximum temperature of 2500°—2900° F. (about 1370°—1590° C.). The use of pulverised fuel, besides eliminating smoke and other disadvantages, is stated to increase the draw-bar horse-power per unit of weight, to improve the thermal efficiency of the locomotive as a whole, to reduce the non-productive time at the terminals, to reduce labour, and to produce more economical operation; moreover, otherwise unsuitable fuels can be utilised. An illustration of a triple burner and fire-pan as applied to locomotive firing is given. (2) Pulverised coal has been applied very satisfactorily to various kinds of metallurgical furnaces. Open-hearth furnaces are in operation, with powdered coal, having a fuel consumption equal to the best producer-gas practice. Coal can be pulverised and delivered to the furnace at a little more than half the cost required with gas producers. It is believed that there would be from 1 to 2% less oxidation in pig-iron and scrap in melting down from the cold state. Coal for this purpose should be high in volatile matter and low in ash. The discussion revealed the fact that in using pulverised coal, suitably designed chequers and slag pockets were necessary. Illustrations of a coal dust feeder and burner for steel furnaces are given.—J. E. C.

Gas works retort carbon.

THE Minister of Munitions has ordered that no person shall, as from 11th January, until further notice, purchase or take delivery of any gas works retort carbon except under and in accordance with the terms of a permit issued under the authority of the Minister of Munitions; and, further, that no person shall, as from the date mentioned, until further notice, sell, supply, or deliver any gas works retort carbon to any person other than the holder of such a permit. All applications for a permit in connection with this Order should be addressed to the Director of Materials (A.M.2.F.W.II.), Armament Buildings, Whitehall Place, London, S.W.

Carbon bisulphide; Removal of — from coal gas. H. Wanner. J. Gasbeleucht., 1915, 58. 456—457. Chem.-Zeit., 1916, 40, Rep., 414.

GAS coke, lignite coke, coke from sewage sludge, and kieselguhr were found to be incapable of absorbing carbon bisulphide from coal gas, and only a very small quantity was absorbed when the gas was passed over powdered retort carbon, boghead cannel, or hard pitch, or sawdust. By means of wood charcoal in small pieces both carbon bisulphide and hydrogen sulphide were removed to a considerable extent. For example, using 1 kilo. of charcoal per 5—6 cb. m. of gas, the total sulphur content of the gas was reduced from

73 to 20 grms. per 100 cb. m. The charcoal after use could be revived by heating at 105° C. for 2 days.—A. S.

Pentanes and hexanes; Thermal and pressure decomposition of—. G. Egloff, Met. and Chem. Eng., 1916, 15, 692—696.

The mixture of pentanes and hexanes used was derived from petroleum ether after removal of unsaturated hydrocarbons; the mixture had sp.gr. 0.656 at 15.5° C., and on distillation yielded: below 40° C., 36.0; 40—60° C., 29.6; and 60—70° C., 31.2%. It was subjected to temperatures of 450°, 500°, 650°, and 725° C. and pressures of 1 and 12 atmospheres, and the recovered oil examined for benzene, toluene, xylene, naphthalene, and anthracene. The percentage yield of recovered oil decreased with increase of temperature and pressure. The maximum yield occurred at 450° C. and 1 atmos. pressure. At 650° C. and 12 atmos. pressure, and at 725° C. and 1 atmos., the starting oil decomposed completely to carbon and gas. The percentage of benzene in the recovered oil increased as temperature and pressure were increased, the maximum of 15.1% being found at 650° C. and 1 atmosphere. The toluene and xylene content of the recovered oil decreased with increased temperature and pressure, the maximum being 0.9% for toluene and 8.2% for xylene, both at 450° C. and 1 atmosphere. Naphthalene and anthracene in the recovered oil increased with temperature and pressure, a maximum of 5.6% for naphthalene and 4.2% for anthracene being obtained at 650° C. and 1 atmosphere. The yields of benzene, toluene, and xylene calculated on the basis of the original oil decreased with increase of temperature and pressure; the highest yields were 3.2% for benzene, 5% for toluene, and 5.9% for xylene, all at 450° C. and 12 atmospheres. Naphthalene and anthracene increased with increasing pressure; the maximum for naphthalene was 1.7% and for anthracene 1.2%, both at 500° C. and 1 atmosphere. The mechanism of aromatic formation from pentanes and hexanes is probably as follows: Pentanes and hexanes $\rightarrow C_6H_{10} + CH_4 \rightarrow C_2H_4 + C_4H_6 \rightarrow$ naphthenes (alicyclic hydrocarbons) \rightarrow aromatic hydrocarbons. —T. H. B.

PATENTS.

Briquettes of coke, turf, iron or other ores, or the like; Manufacture of—. E. Kleinschmidt, Frankfurt, Germany. U.S. Pat. 1,207,180, Dec. 5, 1916. Date of appl., Oct. 3, 1916.

BRIQUETTE material is fed into a rotary inclined drum, which is moved so as to give a rising and falling motion to the material, and a binding material is sprayed into one end of the drum in a direction at right angles to the falling motion of the contents.—J. E. C.

Fuel, and process of making the same. C. Baskerville, New York, Assignor to S. Sternau and Co., Brooklyn, N.Y. U.S. Pat. 1,208,265, Dec. 12, 1916. Date of appl., Jan. 11, 1916.

A JELLIFIED mixture of alcohol and a salt, e.g., calcium acetate, is mixed with a weakly ionisable acid substance to prevent the formation of an alkali during combustion.—J. E. C.

Coke oven recuperative systems. J. E. Christopher, Hindley, Eng. Pat. 102,422, Mar. 18, 1916. (Appl. No. 4041 of 1916.)

Two regenerative chambers, J, are arranged side by side beneath each oven. Waste gases from the sole flue, H, pass through one or other of these chambers, the remaining chamber serving to heat

the air passing to the flues. The dampers, M, are reversed periodically by the levers, N, the change in direction of currents being shown in Fig. 2. The use of two chambers for each oven brings about a condition in which the hot waste products are always sandwiched between the air chambers and

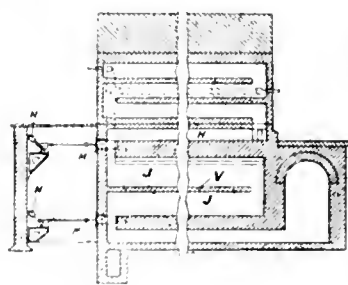


FIG. 1.

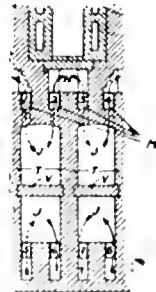


FIG. 2.

vice versa, whilst the horizontal partition, V, lengthens the passage of waste gases and air. Thus a portion of heat is recovered by transference through the dividing wall, T, as in the usual continuous recuperative systems, the remaining portion being absorbed from actual contact with checkerred filling material in the chambers, J. The course of gas and air in the flues is continuous, whilst the fluctuation of temperature of the hot air is less marked than in the usual reversing systems. A discontinuance of reversal of the dampers, M, converts the system into a continuous recuperator. All reversing levers, etc., are on one side of the battery, and individual ovens and regenerators are accessible for repairs.—J. E. C.

Coke oven; By-product—. G. H. Benjamin, New York. U.S. Pat. 1,205,698, Nov. 21, 1916. Date of appl., Dec. 11, 1911.

THE heating flues are of such size as to permit free development of flame and are heated by burners utilising gas and air at a pressure of 1 to 1½ lb. per sq. in.—J. E. C.

Smokeless fuel; Distillation of carbonaceous material for the production of—and recovery of by-products. R. S. Richards, Woodford, and The Smokeless Fuel Syndicate, Ltd., London. Eng. Pat. 15,933, Nov. 11, 1915.

TRough sections mounted on a chain conveyor are carried in a closed circuit through an upper and lower longitudinal chamber surrounded by masonry. The conveyor is charged with fuel at one end and discharges at the other. The fuel is heated by combustion chambers disposed between the upper and lower chamber.—J. E. C.

Carbonising fuel. H. L. Doherty, New York. U.S. Pat. 1,207,723, Dec. 12, 1916. Date of appl., Jan. 29, 1915.

FUEL is carbonised in a closed conduit with comparatively long end extensions. The volatile matter is expelled in an intermediate localised section of this conduit, the tarry constituents being condensed in the upper end extension. The flow of the gas current is periodically reversed to carry back the condensed tar into contact with hot fuel, and the re-vaporised tar is withdrawn from the conduit.—J. E. C.

Gas; Manufacture of combustible—. H. L. Doherty, New York. U.S. Pat. 1,207,724, Dec. 12, 1916. Date of appl., Jan. 29, 1915. (See preceding abstract.)

FUEL is passed through a comparatively long vertical conduit, and in an intermediate section a

oxidising mixture of air and steam is introduced, thereby generating combustible gas in this region. This combustible gas passes through the unburnt fuel and becomes cooled. The cooled gas is then passed into contact with that portion of the fuel body which has been subjected to partial combustion.—J. E. C.

Gas engine cylinders; Removing carbon from —. W. K. Rogers, Assignor to W. E. Tucker and H. Rigdon, Forest Hill, Md., and C. B. Whitaker, San Francisco, Cal. U.S. Pat. 1,205,264, Nov. 21, 1916. Date of appl., July 23, 1915.

CARBON deposits in gas engine cylinders are removed by introducing a water-free mixture of wood alcohol and ammonia.—J. E. C.

Gas washing, cooling, and drying apparatus. F. Balassa, Assignor to Hungarian Banking and Trading Co., Ltd., Budapest, Austria-Hungary. U.S. Pat. 1,205,964, Nov. 28, 1916. Date of appl., Dec. 27, 1913.

GAS is supplied by a pipe projecting through the cover of a vertical cylinder containing coke, and passes through the coke to the perforated lower end of an inner concentric cylinder containing iron filings. The purified gas is withdrawn from the top of the inner cylinder. A concentric water supply pipe within the gas supply pipe carries a sprayer immediately below the cover, which sprays the cooling water at right angles to the flow of gas.—W. F. F.

Hydrocarbon gases; Purifying and improving —. P. A. and E. A. Starke, Assignors to Standard Oil Co., Richmond, Cal. U.S. Pat. 1,206,156, Nov. 28, 1916. Date of appl., Jan. 24, 1916.

GASEOUS hydrocarbons of the general formula C_nH_{2n+2} are purified by passing over a catalyst consisting of a mixture of an alkaline earth, an alkali, and a metal of the iron group, at a temperature between 1000° F. (about 540° C.) and 1600° F. (870° C.). Nitrogen compounds are separated and a mixture of hydrocarbons and aromatic compounds left, from which the latter are separated by cooling and subjecting to a pressure of 500 lb. per square inch. The remaining gas is improved in heating and illuminating power.—B. V. S.

Fuel-briquetting plant and the like. T. Rigby, Dumfries, Assignor to Wetcarbonizing, Ltd., London. U.S. Pat. 1,208,658, Dec. 12, 1916. Date of appl., Feb. 16, 1912.

SEE Eng. Pat. 14,621 of 1911; this J., 1912, 1021.

Coke-ovens and the like; Method of heating —. R. Geipert, Assignor to Dessauer Vertikal Ofen Ges., Berlin. U.S. Pat. 1,208,134, Dec. 12, 1916. Date of appl., Apr. 10, 1914.

SEE Fr. Pat. 471,644 of 1914; this J., 1915, 414.

Gas producers. P. A. J. Cousin, Loos-lez-Lille, France. Eng. Pat. 101,640, Dec. 9, 1913. Under Int. Conv., Dec. 9, 1912. (Appl. No. 13,937 of 1916.)

SEE Addition of Dec. 9, 1912, to Fr. Pat. 435,532 of 1911; this J., 1913, 647.

Gas producer. J. Stewart, Alfreton, and W. Stewart, Motherwell. U.S. Pat. 1,208,689, Dec. 12, 1916. Date of appl., Nov. 18, 1910.

SEE Eng. Pat. 20,858 of 1909; this J., 1910, 1103.

Utilisation of aluminium chloride residues [from oil refining]. U.S. Pat. 1,206,874. See VII.

Continuous gas-calorimeter. U.S. Pat. 1,205,704. See XXIII.

IIb.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

PATENTS.

Destructive distillation; Apparatus for —. J. W. Barnes, Lake Charles, La. U.S. Pat. 1,208,453, Dec. 12, 1916. Date of appl., Feb. 15, 1916.

THE apparatus comprises a retort, the vapour from which is fractionally condensed, whilst liquid products pass through a pipe at the bottom of the retort to a second still, the vapour from which is also fractionally condensed in a separate cooling system. The gases from both cooling systems are withdrawn by an exhaustor and pass to a common gas bell.—J. E. C.

Heating furnace; Continuous —. C. D. Barnhart, Brooklyn, N.Y., and W. H. Jacobi, East Orange, N.J., Assignors to W. S. Rockwell Co., New York. U.S. Pat. 1,205,503, Nov. 21, 1916. Date of appl., Dec. 17, 1915.

IN a furnace for heating, annealing, etc., a horizontal heating chamber is provided with means for heating a horizontal zone in the upper part. The gases are dispersed below this zone, and the articles to be heated are transported by an endless conveyor below the heating zone and parallel with the same.—J. E. C.

Tank heating furnace. W. Seringeour, Assignor to Mires Fuel Oil Equipment Co., Lancaster, Pa. U.S. Pat. 1,206,383, Nov. 28, 1916. Date of appl., Oct. 1, 1914.

A HEATING furnace comprises a long narrow chamber having a channel at the bottom and vents at the top. A tank is mounted eccentrically in the chamber nearer the vents than to the channel. The channel communicates with and is heated by a series of combustion devices.—J. E. C.

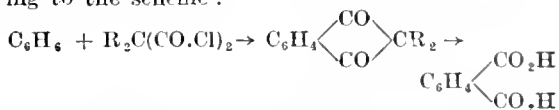
Arc-lamps; Electrode for —. W. R. Mott, Lakewood, Ohio, Assignor to National Carbon Co., Cleveland, Ohio. U.S. Pat. 1,205,377, Nov. 21, 1916. Date of appl., Nov. 8, 1911.

AN arc lamp electrode containing carbon and rare-earth titanates is claimed.—J. E. C.

III.—TAR AND TAR PRODUCTS.

Polycarboxylic acids of aromatic hydrocarbons; Preparation of — by means of dialkylindanediones. M. Freund and K. Fleischer. Z. angew. Chem., 1916, 29, 421.

AROMATIC polycarboxylic acids are readily obtained by oxidation with nitric acid of dialkylindanediones, which are themselves obtained by the action of dialkylmalonyl chloride on aromatic hydrocarbons in presence of aluminium chloride, according to the scheme:



IN this way certain otherwise inaccessible acids were synthesised, including 1,2,3,4-benzenetetracarboxylic acid (mellophanic acid) from *p*-xylene; 1,2,3,5-benzenetetracarboxylic acid (prehnitic acid) from *m*-xylene; α - α , α - β , and β - β -dicarboxylic acids of naphthalene; and also benzene-penta- and hexa-carboxylic acids from *p*-xylene by a double application of the reaction, the ketonic intermediate product being reduced to a hydriindene which in the one case was treated with acetyl chloride and in the other case with dialkylmalonyl chloride, and the products oxidised as above described.—G. F. M.

Thermal and pressure decomposition of pentanes and hexanes. Egloff. See II A.

PATENTS.

Nitro-compounds ; Manufacture of—, A. Heine-mann, Birmingham, Eng. Pat. 102,216, Nov. 12, 1915. (Appl. No. 6665 of 1916.)

NITROSULPHONIC acid is used in place of concentrated sulphuric acid to absorb the water formed during the nitration of aromatic compounds with nitric acid. *Example*: 50 grms. of *m*-dinitrobenzene is slowly heated with 100 grms. of nitrosulphonic acid until dissolved, 100 grms. of nitric acid is added to the solution, and the mixture is maintained at 100–120° C. until *s*-trinitrobenzene is formed.—F. W. A.

Amines ; Producing aromatic—, and *catalysts therefor*. O. Schmidt, Assignor to Badische Anilin und Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,207,802, Dec. 12, 1916. Date of appl., Oct. 21, 1914.

SEE Ger. Pat. 282,568 of 1913; this J., 1915, 708. The hydrogen may be mixed with carbon monoxide, and a zinc compound may be used to promote the action of the copper catalyst.

IV.—COLOURING MATTERS AND DYES.

Sulphonaphthalin series of indicators and the quinone-phenolate theory. Lubs and Acree. See XXIII.

PATENTS.

Dyestuffs ; Manufacture of aniline—, D. de Nagy, A. E. King, and G. H. Odell, London. Eng. Pat. 16,203, Nov. 17, 1915.

DYESTUFFS are produced in substance or on the fibre by the oxidation of aromatic amines by using molybdates instead of salts of copper, iron, arsenic, and vanadium. *Examples*: (A) 5 grms. of hydrochloric acid (18° B.; sp.gr. 1.143), 5 grms. of aniline, 1 gm. of *p*-nitraniline, 2 grms. of nitrobenzene, and 0.03 gm. of ammonium molybdate are boiled together, and the temperature raised to 220–230° C. until the mass forms a paste; this paste is dissolved in hot water and the red dyestuff precipitated with soda; it may be dyed from an acetic acid bath. (B) Black or black-blue shades are produced on the fibre by padding unmercerized silk, wool, or cotton with the following mixture at 70° C.: 5 grms. of *o*- or *p*-chloroaniline, 25 grms. of hydrochloric acid (18° B.; sp.gr. 1.143), 0.02 gm. of ammonium molybdate, 0.5 gm. of diphenylamine, 5 grms. of potassium bichromate, and 1.8 grms. of potassium chlorate dissolved in 1 litre of water; the material is subsequently immersed in dilute caustic soda.—F. W. A.

**o*-(Hydroxyazo dyestuffs sensitive to metals ; Manufacture of metal compounds of — and their application in dyeing animal and vegetable fibres.* O. Huray, London. From Society of Chemical Industry in Basle, Switzerland. Eng. Pat. 16,803, Nov. 29, 1915.

WATER-SOLUBLE compounds of *o*-hydroxyazo dyestuffs with nickel, cobalt, iron, aluminium, vanadium, and uranium, similar to the copper compounds described in Eng. Pats. 1611, 12,249, and 15,127 of 1915 (this J., 1916, 301, 922, 1104) in that they are no longer sensitive to metals, have been isolated. When dyed in an acid bath they give tints which are different from those obtained from ordinary salts of the dyestuff acids. They may also be applied according to the various processes in use for chrome mordant dyestuffs, giving shades of greater fastness to milling and to potting.—F. W. A.

**o*-Hydroxyazo dyestuffs and metal compounds thereof ; Manufacture of — and their application in dyeing.* O. Huray, London. From Society of Chemical Industry in Basle, Switzerland. Eng. Pat. 16,916, Dec. 1, 1915.

ORANGE to red azo dyestuffs, which on after-chroming become fast to milling, light, and potting, are obtained by combining diazotised *o*-amino-phenol or -naphthol or a derivative with a pyrazolone derivative of the benzene or naphthalene series containing a hydroxyl group in the aromatic nucleus, other than the pyrazolone from 2,5-aminonaphthol-7-sulphonic acid (see Eng. Pats. 12,250 and 12,932 of 1915; this J., 1916, 1008). The copper, chromium, iron, cobalt, nickel, aluminium, etc., compounds are obtained by the action of a metallic salt on an aqueous solution or suspension of the dyestuff, or by producing the dyestuff in presence of the metallic salt. Instead of using the after-chrome process, the dyestuffs may be dyed on chrome-mordanted wool or by the metachrome process.—F. W. A.

Azo dyestuffs and process of producing the same. A. L. Laska, Offenbach, Assignor to Chem. Fabr. Griesheim-Elkhron, Frankfurt, Germany. U.S. Pat. 1,206,232, Nov. 28, 1916. Date of appl., Feb. 25, 1916.

DIAZO compounds of asymmetrically alkylated *p*-diaminoazo compounds are combined with arylides of 2,3-hydroxynaphthoic acid. (See also Eng. Pat. 100,804 of 1916; this J., 1916, 888.) —F. W. A.

*Finely divided pigment dyestuffs of the *N*-dihydro-1,2,2'-indanthraquinone series ; Production of —.* Farb- u. vorm. Meister, Lucius, und Brüning, Ger. Pat. 294,530, Feb. 3, 1914.

By oxidation of the leuco-Indanthrene precipitated by acidifying an Indanthrene vat, Indanthrene is obtained in a very finely divided form suitable for the production of pigments.—F. W. A.

Azo-dyestuff [from 1-aminoanthraquinone] ; Manufacture of an insoluble—, Badische Anilin und Soda Fabrik. Ger. Pat. 295,025, Nov. 20, 1914.

DIAZOTISED 1-aminoanthraquinone is coupled with ethyl acetoacetate in presence or absence of substrata. A pure yellow dyestuff is obtained suitable for the manufacture of lakes on account of its insolubility in water, oil, and alcohol and its great fastness to light.—F. W. A.

Anthraquinone dyes and process of making them. H. Neresheimer, Assignor to Badische Anilin und Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,207,981, Dec. 12, 1916. Date of appl., Oct. 29, 1914.

SEE Ger. Pat. 287,614 of 1914; this J., 1916, 171.

Anthraquinone dyes and process of making them. H. Neresheimer, Assignor to Badische Anilin und Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,207,982, Dec. 12, 1916. Date of appl., Oct. 29, 1914.

SEE Eng. Pat. 17,764 of 1914; this J., 1916, 831.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Wool ; Chemical method of detecting deterioration of—, O. Sauer. Z. angew. Chem., 1916, 29, 421.

AN attempt to evaluate wool from a chemical standpoint was made, based on a determination of the proportion of the total nitrogen which it

yielded to solvents. The procedure consisted in treating 0.5 gm. of wool with 40 c.c. of water, 50 c.c. of 1% hydrogen peroxide solution, and 40 c.c. of $N/2$ potassium hydroxide for three days, after which the nitrogen in an aliquot portion of the solution was determined and thence the total dissolved nitrogen calculated as a percentage of the nitrogen content of the original wool. In wool that had been exposed for four months to sunlight, a much higher proportion (45–50%) of the total nitrogen was soluble than in non-illuminated specimens (11–13%). In the case of dyed wool this change due to light, though still noticeable, was greatly retarded.—G. F. M.

Textile plants; Industrial retting of — by microbiological action. G. Rossi. Bull. Agric. Intell., 1916, 8, 1067–1074.

THE retting of textile materials by the action of pure cultures of specific pectic bacteria, particularly *B. comesii*, offers great advantages over the ordinary methods of field retting and over all chemical retting processes, in that the destruction of the pectic matters may be carried out completely without any action on the cellulose fibre. Sterilised leaves or wisps of hemp treated with this bacillus are completely resolved into parenchyma cells, sclerenchyma skeleton, and epidermis, and the separated elements may be kept in presence of the living bacteria under aseptic conditions for two years without breaking up or weakening the fibre structure. In the industrial application of the process, sterilisation of the media is not practicable; the materials are steeped in ordinary water at 28°–35° C., which is the most favourable temperature for the fermentation, a sufficient quantity of a pure culture of the bacillus is added, and the mass is artificially aerated during the entire period of retting. The aeration regularises and intensifies the action of the aerobic pectic ferments and suppresses the development of foreign organisms inimical to the cellulose. The treatment of hemp may be effected either on the entire plant or on the material after scutching in the green state in the field or at the factory. The latter method, if the scutching be properly carried out, presents many advantages: the weight and bulk of the material to be treated are very considerably reduced and retting operations on the dry scutched material may be carried on all the year round under industrial conditions. Green scutching is a somewhat delicate operation because a particular machine is not equally suitable for all kinds of hemp, and the results are less favourable the greater the percentage of moisture and the finer the stalks; nevertheless it is possible to find suitable scutchers which reduce the weight of stalk by 38–61%, according to the quality of hemp, without producing abnormal quantities of tow. The fibre retted after scutching and drying is smoother, less divided, and more glossy than ordinary hemp fibre, and the strips appear to adhere, but a slight brushing process suffices to impart an excellent degree of flexibility, division, and colour. A factory has been working in France equipped for the conveyance of hemp stalks from the fields, trimming, drying, and scutching the stalks, comprising also a retting department containing 4 vats of 19.62 cub. yds. capacity each, which are further sub-divided, a pure culture department for the production of ferments, and plant for washing, draining, and drying the fibre. The retting of the hemp is regularly completed in 48 hours. The application of the method to flax is precisely similar. In the case of ramie, the method shows great promise, but is only practicable commercially in the case of the decorticated strips known as China grass. The product is different from the ramie fibre prepared by chemical means and in many respects superior.—J. F. B.

Kapok fibre; Characteristics and basis of valuation of —. C. F. Cross and E. J. Bevan. J. Soc. Dyers and Col., 1916, 32, 274–278.

THE true kapok is the seed hair of *Eriodendron anfractuosum*, but commercially other vegetable down has been classed under the same name. The most important use for kapok at the present time is as a stuffing for appliances for saving life at sea and its value depends primarily on its property of resisting the penetration of water for a considerable length of time. This property is not due to the presence of specific water-repellent substances, as the total content of oil, wax, and resin is comprised between the limits of 0.5–1.8%, but is attributable to the peculiar structure of the fibre as a thin-walled tube enclosing a relatively large volume of air. When distilled with hydrochloric acid, kapok fibre yields from 12.3 to 17.4% of furfural, the lower qualities giving the higher yields. The "furfureoids" or pentosans are readily hydrolysable and are not re-precipitated with the more resistant fibre-substance after dissolving in 73% sulphuric acid. From an examination of the seed residues it would appear that commercial specimens of lower value, giving high percentages of furfural, were derived from some species of *Asclepiad* and not from the true kapok; a range of seven samples was examined representing values from 34d. to 8d. per lb. When these were classified according to the diameters of the fibres, taking the ratio of the extreme dimensions, this showed remarkable uniformity (ratio of extremes 1:2.0), in the case of the best qualities, average 0.021 mm., and great variability (ratio 1:6.2) in the lowest qualities average 0.028 mm., accompanied by considerable flattening and weakening of the cell walls. When the fibre is immersed in a hydrocarbon liquid to displace the interstitial air, the air within the tubes is not expelled, and the apparent specific gravity thus determined is a valuable criterion of quality, ranging from 0.407 for the best to 0.686 for the lowest grade. The cell wall represents on the average about one-fifth of the total diameter of the fibre. "Sinking" tests with water take an inconvenient length of time but aqueous alcohol, sp. gr. 0.928, penetrates more rapidly, and tests with this liquid may be carried out so as to indicate the inferior grades within a reasonable time. The phloroglucinol test shows little or no coloration with the higher grades of kapok but a marked reaction with the lower qualities. Length and uniformity of staple, freedom from seed residues, and a careful comparison with authentic samples are additional factors in the commercial valuation. In the life-saving appliances, the kapok stuffing occupies about 15 c.c. per gm. of fibre and the jacket contains 700 grms. of stuffing, representing a floating power of 10.5 kilos. After 72 hours in water, with a weight of 9 kilos. attached, this jacket still required 1.3 kilos. more to submerge it, and after 192 hours the weight required was 0.9 kilo.—J. F. B.

PATENTS.

Wool or other fibrous material; Apparatus for drying —. H. Walker, Cleckheaton, Yorks. Eng. Pat. 102,391, Jan. 19, 1916. (Appl. No. 851 of 1916.)

IN a cylinder drying machine in which the material is passed in the form of a sheet of sliver around a series of superposed perforated rotating cylinders, arranged in staggered relationship to each other, in a drying chamber, hot air being forced into the cylinders and through the perforations, the material is carried by two endless aprons or sets of tapes over and under the consecutive cylinders and supported by guide rolls within the drying chambers. The aprons or tapes pass round a pair of feed rolls at one end of the machine and delivery rolls at the

other. (Reference is directed under Sect. 7, Subsect. 4, of the Patents and Designs Act, 1907, to Eng. Pat. 10,806 of 1886.)—J. F. B.

Textile fabrics for the manufacture of bills, coverings, containers, and the like: Process for treating —. E. C. R. Marks, London. From Aktieselskabet Drivremmfabriken "Dana," Copenhagen. Eng. Pat. 16,985, Dec. 2, 1915.

SEVERAL webs of textile fabric are treated separately in a bath of sulphuric acid of such a strength that the surface of the material is converted into an adhesive mass resembling amyloid. The treated webs are superposed and united by pressure while still moist, and the residual acid is removed by washing first in a rapidly flowing stream of water and subsequently by steeping in a bath of water containing a neutralising agent. —J. F. B.

Resinous woods: Process of treating —. H. C. Alford, Assignor to J. M. Walsh and B. Thurley, Mobile, Ala., and H. C. Alford, Baldwin Co., Ala. U.S. Pat. 1,206,283, Nov. 28, 1916. Date of appl., July 11, 1911.

A CHARGE of wood particles confined in a series of intercommunicating containers is subjected to the action of a hot resin solvent which is passed through the series under pneumatic pressure, the temperature of the solvent increasing progressively through the series; when the charge in the first container becomes exhausted it is cut out and a freshly charged container is substituted at the other end of the series. The solution of resin is distilled and the solvent recovered for further use. The residual wood is steamed until free from solvent, then converted into pulp by treatment with caustic soda. Caustic soda is regenerated from the spent solution by treatment with an oxide or hydroxide of an alkaline earth.—J. F. B.

Vegetable fibres: Process of treating — [for the manufacture of paper pulp]. H. G. Green, Chicago, Ill. U.S. Pat. 1,206,777, Nov. 28, 1916. Date of appl., Sept. 17, 1913; renewed Apr. 24, 1916.

IN the manufacture of paper pulp, the material is broken up to loosen the woody portion from the fibre proper, part of the woody portion is removed, and the residue is moistened with about 70% of its weight of water, treated with chlorine gas at the ordinary temperature, and boiled in a suitable solution to disintegrate the remaining woody matter.—J. F. B.

Wool and like washing machines. F. B. Petrie, Rochdale. U.S. Pat. 1,207,207, Dec. 5, 1916. Date of appl., Nov. 23, 1915.

SEE Eng. Pat. 22,838 of 1914; this J., 1916, 172.

Leather; Manufacture of a product analogous to — [from *lex tles*]. Aktieselskabet Drivremmfabriken "Dana." Fr. Pat. 480,433, Dec. 11, 1915.

SEE Eng. Pat. 16,985 of 1915; preceding.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Resorcinol: Application of — in dyeing and printing with the basic colours. A. Wosnessensky. J. Soc. Dyers and Col., 1916, 32, 278—280.

RESORCINOL in combination with formaldehyde has been proposed as a mordant for basic dyestuffs in substitution for the usual tannin mordant, but the results were not commercially favourable. The author has employed resorcinol as a solvent

for the lakes formed by tannin with the basic dyestuffs, whereby these colours may be applied by the "single bath" process and by the padding machine. For this purpose, resorcinol is a far more efficient and satisfactory solvent than certain others which have been proposed, e.g., various alcohols, phenol, and acids, and its action is continued in the steaming bath, where other solvents are volatilised. A process was described in Eng. Pat. 9052 of 1914 (this J., 1915, 901) in which 30 parts of basic dyestuff, 50 of resorcinol, 80 of tannin, and 200 of acetic acid are dissolved, diluted with hot water to 1 litre, and the goods padded with this solution, steamed, and passed through an antimony bath. The superiority of the effects obtained is attributed to the better penetration which takes place during the steaming. A process of printing with basic dyestuffs, whereby the passage through a separate bath of antimony salt is avoided, has also been described. The paste consists of basic dyestuff, resorcinol, tartaric acid, tannin, tartar emetic, and a tragacanth thickening; after printing, the goods are merely steamed and rinsed. The fastness is as satisfactory as in the ordinary method of printing, and the "whites" are clearer. The omission of the separate antimony bath is of special advantage when printing basic dyestuffs in conjunction with other dyestuffs. Another use for resorcinol is for dissolving the tannin lakes in discharge colours containing basic dyestuffs.—J. F. B.

Biological valuation of the so-called "solivines" (Turkey-red oils). Kobert and Greuel. See XII.

Theory of vegetable tanning. Procter and Wilson. See XV.

PATENTS.

Foam in the degreasing, soaping, mordanting, dyeing, degumming or other treatment of raw or finished textile materials: Process for producing —. R. Clavel, Basle, Switzerland. Eng. Pat. 102,310, Mar. 23, 1916. (Appl. No. 4316 of 1916.)

IN treating raw or finished textiles with foam, instead of producing the foam by boiling suitable solutions into which air may be introduced, or at lower temperatures by reducing the pressure, air, oxygen, or other oxidising, reducing, or indifferent gas is introduced under pressure through finely porous bodies such as tubes or plates of unglazed earthenware, agglomerated powdered graphite, or the like. For degumming silk the operation is carried out at 75°–95°C., and the action is accelerated by using an oxidising gas such as oxygen or air.—F. W. A.

Mordants on silk fibres or tissues; Fixing iron —. Gebr. Schmid, Basle, Switzerland. Eng. Pat. 102,331, May 30, 1916. (Appl. No. 7664 of 1916.) Under Int. Conv., Jan. 25, 1916.

SILKWORM chrysalides or silk-waste containing chrysalides, or the oily water obtained by boiling silk-worm chrysalides or waste containing chrysalides, may be used to replace entirely or in part the soap usually added to the bath used to fix iron mordants on silk fibres or tissues.—F. W. A.

Acid colours on cotton; Fixation of —. Know Mill Printing Co., Ltd., Manchester, and F. W. Weeks, Edgworth. Eng. Pat. 102,291, Feb. 15, 1916. (Appl. No. 2228 of 1916.)

SHADES fast to boiling and to soaping are obtained in dyeing and printing cotton goods with acid dyestuffs by using as fixing agents the condensation products formed by the interaction of aromatic amines and aldehydes or their chemical equivalents, for example, aniline salt and hexamethylenetetramine.—F. W. A.

Dyeings similar to Turkey-red; Production of fast —. Farbw. vorm. Meister, Lucius, und Brüning. Ger. Pat. 294,780, Mar. 20, 1914.

AROMATIC diazo compounds are coupled, on the fibre, with 2,3-hydroxynaphthylaminothiazole, its homologues or analogues, or their substitution products. A bright, very fast red is obtained in this way from diazotised *p*-nitro-*o*-toluidine.—A. S.

Azo dyestuffs on the fibre; Production of —. Farbenfabr. vorm. F. Bayer und Co. Ger. Pat. 294,798, Nov. 26, 1914.

THE arylides of 6-hydroxy-2-naphthol-3-carboxylic acid dissolve readily in dilute sodium carbonate solution on warming. The fibre is impregnated with such a solution and then treated with a solution of an unsulphonated diazo compound. Clear red to dark blue shades of excellent fastness are produced on unmordanted cotton.—A. S.

Black shades on wool; Production of —. Farbenfabr. vorm. F. Bayer und Co. Ger. Pat. 294,931, Dec. 9, 1915. Addition to Ger. Pat. 291,021.

SHADES fast to potting as well as to milling are obtained by using the sulphonic acids of *symms.*-di- β -naphthyl-4,4'-diaminodiphenylamine or its substitution products instead of the substances mentioned in the chief patent (this J., 1916, 834). —A. S.

Plants; Process for dyeing, in brown or black shades, parts of — containing tannin. A. Wieler, Aachen. Ger. Pat. 294,833, Jan. 15, 1916.

PARTS of plants containing tannin are treated with ammonia or with ammonium compounds, phenols, or pyridine bases, in the form of vapour, in order to convert the tannin into coloured insoluble compounds.—A. S.

Sizing and dyeing; Composition of matter for —. Composition of matter and method of making the same. M. N. Aisen, Chicago, Ill. U.S. Pats. (A) 1,206,189 and (B) 1,206,190, Nov. 28, 1916. Dates of appl., May 15, and July 6, 1914.

(A) HYDROLYSED glue in alcoholic solution is mixed with a basic dyestuff for sizing and dyeing. (B) Glue is hydrolysed by means of an alkali and dissolved in an organic solvent.—B. N.

Dressing for hats. W. Philippsthal, Berlin-Grünwald. Ger. Pat. 294,730, Feb. 26, 1916.

WATER-GLASS is used, with addition of glue, gelatin, flour, gum-tragacanth, Iceland moss, etc.—A. S.

Weighting silk with hamatoxylin; Process of —. F. Mueller, Zürich, Switzerland. U.S. Pat. 1,207,784, Dec. 12, 1916. Date of appl., Nov. 29, 1913. SEE Eng. Pat. 26,735 of 1913; this J., 1914, 418.

Weighting silk; Process for —. P. Schmid and K. Gross, Basle, Switzerland. U.S. Pat. 1,207,800, Dec. 12, 1916. Date of appl., Oct. 7, 1915. SEE Ger. Pat. 287,754 of 1914; this J., 1916, 171.

Manufacture of aniline dyestuffs. Eng. Pat. 16,203. See IV.

Manufacture of metal compounds of o-hydroxyazo dyestuffs sensitive to metals and their application in dyeing animal and vegetable fibres. Eng. Pat. 16,803. See IV.

Manufacture of o-hydroxyazo dyestuffs and metal compounds thereof, and their application in dyeing. Eng. Pat. 16,916. See IV.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Sulphuric acid manufacture by the contact process; Substitutes for platinum in —. Fahrenwaldt Bull. Amer. Inst. Min. Eng. Chem. Trade J., Jan. 6, 1917.

EXPERIMENTS carried out in Germany have shown that compounds of silver and vanadium can be used in place of platinum in the contact process of sulphuric acid manufacture. The author has found that other efficient substitutes for platinum are alloys of palladium with silver or gold, and also pure tungsten and to a certain extent molybdenum. Tungsten and molybdenum, however, are easily oxidised, but alloys of these metals with precious metals are even more efficient than platinum and its alloys, such as platinum-iridium.

Sulphurous acid; Electrolytic oxidation of —. M. de K. and N. J. Thompson. Met. and Chem. Eng., 1916, 15, 677—679.

THE authors used as diaphragm an earthenware cup containing a cylindrical nickel cathode with a cylindrical platinum gauze anode surrounding the diaphragm, the porous cup being filled either with sulphuric acid or sodium sulphite. Outside the cup was a solution of sulphur dioxide of 1 to 5% concentration; the anode solution was kept saturated during electrolysis by passing in a current of sulphur dioxide. The current density was about 0.0075 ampère per sq. cm. Results proved that sulphurous acid is easily oxidised at platinum anodes to sulphuric acid of any concentration below 95%. The concentration of sulphuric acid in the cell has a great effect on the current efficiency, as also has the current density but in a lesser degree. Oxidation takes place with high current efficiencies even in strong sulphuric acid solutions. For a given sulphuric acid concentration the current efficiency decreases with increasing current density.—T. H. B.

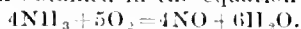
Formic acid; Catalytic decomposition of — by rhodium. P. C. Haas. Z. Elektrochem., 1916, 22, 443—445.

IT has been previously stated (Bredig and Blackadder, this J., 1913, 21) that the decomposition of formic acid into hydrogen and carbon dioxide by contact with rhodium is only brought about when this metal has been activated by the presence of occluded oxygen or traces of sulphur which act as depolarisers. This catalytic action can be closely imitated by electrolysis with platinum electrodes. By observing the decomposition voltage, a value is obtained which gives a measure of the tendency to decompose. The influence of catalysts and depolarisers on the decomposition can be determined quantitatively in this way. Measurements were made by the Le Blanc method, the potential difference between the electrode and surrounding electrolyte being plotted on a curve against the current. A sharp rise in the current on gradually increasing the voltage indicates the point of decomposition. With electrodes of platinumised platinum, a decomposition point could in some cases be observed with formic acid solutions at 0.18 volt. The presence of platinum black had a greater influence at the anode than at the cathode. Measurements were made with rhodium-plated platinum electrodes, but it was not possible to detect any difference in the decomposition voltages between active and non-active conditions of the metal.—J. N. P.

Ammonia; Catalytic oxidation of —. E. B. Andersen. Z. Elektrochem., 1916, 22, 441—443. THE oxidation of ammonia can be made to proceed in accordance with the equation:

$$4\text{NH}_3 + 7\text{O}_2 = 4\text{NO}_2 + 6\text{H}_2\text{O},$$

and the velocity of the reaction can be accelerated by means of suitable catalysts. The progress of the oxidation is also determined by the equilibrium condition obtained in the equation:



Since this reaction is exothermic, it follows that the higher the temperature, the greater is the quantity of ammonia that will remain unchanged when a state of equilibrium has been reached. However, in presence of excess of oxygen, this oxidation is practically quantitative within a large range of temperatures. On passing mixtures of air and ammonia containing from 2.5 to 5% NH_3 by volume, over a suitable catalyst at temperatures from 500° to 1000° abs., at a speed which ensured the mixture remaining in contact with the catalyst for a time varying from 0.18 to 1.15 seconds, the amount of ammonia converted to oxides of nitrogen was 98 per cent. The direct synthesis of nitric oxide from nitrogen and oxygen does not come into play in this reaction, as the equilibrium concentration of NO in the equation: $\text{N}_2 + \text{O}_2 = 2\text{NO}$ is only 0.0003% NO at 600 abs. Any catalyst which favours this synthesis, is unsuitable for the ammonia oxidation.—J. N. P.

Cape asbestos industry. G. E. B. Frood. *India-rubber J.* 1917, 53, 17—20.

IN a recently published Government report on mining in South Africa, a description of the occurrences of asbestos and of the product is given, together with an attempt to estimate the value of the blue asbestos for commercial purposes. The extent of the deposits in the Northern portion of Cape Colony is indicated, the three districts of Kuruman, Hay, and Prieska being mentioned as constituting the largest asbestos-bearing area in the world. The Cape Asbestos Company now possesses factories for milling and manufacturing the product in England, Turin, and Hamburg, whilst a sister company in Paris has been developed to control the interests of the company in France. The cheapness of working, due to native labour, is remarkable, as also the freedom from accident. The author suggests that all properties should be worked on an underground system from the start. The classification of the product based generally on the length of the fibre is discussed, it being understood that for textile purposes about 25% of the fibre must be 1 inch and over. Outside such purposes, there should be a good market, as in roofing material, in which the length of the fibre is less important. The whole Cape output of blue asbestos realises at present an average of about £25 a ton landed in England. Comparative analyses of blue asbestos and white asbestos (Canadian) are given. Blue asbestos possesses great heat-resisting properties, and is said to be unaffected by moisture, ordinary acids, chemical solutions, and particularly sea-water. The production of asbestos in various countries is given, indicating a remarkable increase in the figures for Cape Colony. With the assurance of a widening market the future progress is likely to be much more rapid.—J. E. C.

Zinc; Volumetric determination of — in its chloride, nitrate, and sulphate. F. W. Sjöström. *Farm. Revy*, 1916, 480—491. *Z. angew. Chem.*, 1916, 29, Ref., 511.

IN an alkaline solution of zinc chloride, nitrate, or sulphate, of known alkali content, be treated with excess of pure hydrogen peroxide solution, the zinc is precipitated quantitatively as zinc perhydroxide, and a certain quantity of alkali is neutralised by the liberated anion. The excess of alkali is titrated and the quantity of zinc calculated, allowance being made for any free acid present in the original zinc solution before making alkaline.—A. S.

Iron trisulphide [ferrie sulphide], and the formation of iron disulphide. V. Rodt. *Z. angew. Chem.*, 1916, 29, 422—423.

THE existence of ferrie sulphide, Fe_2S_3 , was confirmed and the contradictory statements found in the literature about this substance are explained by its instability when in a moist condition. It was obtained by the action of hydrogen sulphide on moist ferrie hydroxide. When dry it is comparatively stable except towards oxygen, but in presence of water and absence of air it decomposes almost entirely in the course of a week into a mixture of the mono- and di-sulphides: $\text{Fe}_2\text{S}_3 \rightarrow \text{FeS}_2 + \text{FeS}$. This change is arrested by the smallest trace of alkali. In presence of air moist ferrie sulphide is slowly oxidised to a hydrated ferrie oxide and free sulphur. The formation of iron disulphide was also observed as the result of the direct combination of ferrous sulphide and sulphur in aqueous suspension, even at ordinary temperatures, and the slow gradual addition of a solution of sodium polysulphide to a boiling ferrous sulphate solution, taking care that the mixture never became alkaline, resulted in the almost complete conversion of the iron into amorphous disulphide according to the equation: $\text{FeSO}_4 + \text{Na}_2\text{S}_3 = \text{FeS}_2 + \text{Na}_2\text{SO}_4 + \text{S}$. The amorphous iron pyrites often found in moorland soil, which is so deleterious to underground building work, has probably been formed by one or other of these precipitation methods.—G. F. M.

Iodine; Occurrence of — in German potassium salts. L. W. Winkler. *Z. angew. Chem.*, 1916, 29, 451—452. (See also this J., 1916, 1058.)

THE natural saline water from a potash deposit in Mecklenburg was found to contain 17 mgrms. iodine (as iodide) per litre, about 340 times as much as sea water contains. Iodine (0.5 mgrm. per litre) was also found in a sylvinite mother liquor from Alsace.—J. N. P.

Restrictions in use of magnesite. See VIII.

Solubility of calcium sulphite in water and in sugar solutions. Van der Linden. See XVII.

Stability of ammonium chlorate. Gelhaar. See XXII.

PATENTS.

Sulphuric acid; Manufacture of —. W. J. Alcock, Mill Hill, and G. K. Davis, Manchester. Eng. Pat. 16,981, Dec. 2, 1915.

WHEN ferrie oxide is used to convert sulphur dioxide into trioxide, the freedom from moisture of the air supply to the sulphur burners is essential. The sulphur, pyrites, or other sulphur-containing material is burnt in practically air-tight kilns, the gases from which pass first into a ferrie oxide column, afterwards into a Glover tower where a large proportion of the sulphur trioxide is absorbed. The acid from the Glover tower, when cooled, is brought into contact with the air to be used for combustion in the kilns, in special apparatus (see Eng. Pat. 17,005 of 1914; this J., 1915, 897). Any unconverted sulphur dioxide leaving the Glover tower is condensed in chambers connected with a Gay-Lussac tower.—T. H. B.

Sulphuric acid; Method of manufacturing —. A. M. Fairlie, Copperhill, Tenn. U.S. Pat. 1,205,723, Nov. 21, 1916. Date of appl., Feb. 25, 1915.

GASES free from nitrogen-oxygen compounds entering the acid-making system, and also those containing nitrogen-oxygen compounds at a pre-determined point in or near the Glover tower, where the percentage of sulphur dioxide is normally more than 0.7% by vol., are analysed, and by regulating the amounts of sulphur dioxide and of nitrogen-oxygen compounds introduced into the

system, the ratio between the percentages of sulphur dioxide in the gases at the two points is maintained at the value found best adapted to a commercially complete absorption of the nitrogen-oxygen compounds.—T. H. B.

Sulphur dioxide; Method of determining—A. M. Fairlie, Copperhill, Tenn. U.S. Pat. 1,205,724, Nov. 21, 1916. Date of appl., Feb. 23, 1916.

THE sulphur dioxide in gaseous mixtures, which may contain nitrogen-oxygen compounds, is determined by ascertaining the volume of the gas required to destroy the blue colour of a mixture of *N*/10 iodine solution, 1 c.c.; starch solution, 5–6 drops; saturated sodium acetate solution, 5 c.c.; strong acetic acid, about 5 c.c.; water, about 100 c.c.—T. H. B.

Gases [from sulphur or pyrites kilns]; Apparatus for cooling and purifying—H. B. P. Humphries, London, Eng. Pat. 17,232, Dec. 8, 1915.

AN outer shell is provided with an inner concentric shell depending from the cover and reaching nearly to the bottom of the outer shell. The annular space between the two shells contains a pipe coil for cooling fluid. Gases to be treated, e.g., gases from sulphur or pyrites kilns, are passed over the cooling coil and then up through the bottom of the inner shell which contains scrubbing and purifying material, to an outlet at the top.

—W. F. F.

Nitric acid and other products; Process of making—F. S. Washburn, New York. U.S. Pats. (A) 1,206,062 and (B) 1,206,063, Nov. 28, 1916. Dates of appl., Feb. 7, 1916, and May 6, 1916.

A) A MIXTURE of ammonia and oxygen-containing gases is subjected to a catalyst, at such a rate that free ammonia (not exceeding 20%) and nitrous gases appear in the products; a solution of nitric acid and ammonium nitrate is produced from the products, and this is concentrated and the nitric acid recovered. (B) The solution of nitric acid and ammonium nitrate, after concentration, is treated with sulphuric acid to concentrate the nitric acid and form ammonium sulphate.—T. H. B.

Sodium perborate; Manufacture of—Deutsche Gold- und Silber-Scheideanstalt, vorm. Roessler, Frankfurt, Germany. Eng. Pat. 100,153, Mar. 1, 1916. Under Int. Conv., Mar. 10, 1915. (Appl. No. 3127 of 1916.) (See this J., 1916, 1261.)

A SOLUTION containing a carbonate (13–15% anhydrous) and an alkali borate is electrolysed, the borate reacting with the percarbonate formed to produce perborate. It is essential that the solution be kept saturated with borax and that solid perborate be always present; and it is advisable that catalysts be absent. This may be effected either by using pure substances, or by adding such materials as alkali bicarbonate, stannic acid, or magnesium silicate (1–2 grms. per litre of electrolyte).—E. H. T.

Alkali perborates; Manufacture of—Deutsche Gold- und Silber-Scheideanstalt, vorm. Roessler, Frankfurt, Germany. Eng. Pat. 102,359, Aug. 8, 1916. Under Int. Conv., Mar. 17, 1916. (Appl. No. 11,185 of 1916.)

SODIUM perborate is made by electrolysing lyes containing soda and borax. The accumulation of bicarbonate, produced during the action, must be restricted to a maximum of 70–75 grms. per litre, otherwise the stability of the perborate would be affected adversely. Hence metaborate,

or free alkali and borax, are added during the electrolysis; or lime or other alkali is added to the waste lye prior to its treatment or re-treatment.

—E. H. T.

Silicon compound [for water softening] and process of making same. R. Boehringer, Newark, N.J., Assignor to Staten Island Chemical Corporation. U.S. Pat. 1,205,509, Nov. 21, 1916. Date of appl., Oct. 26, 1915.

A SILICON compound is produced by mixing a solution of an alkali silicate with a faintly alkaline solution of borax, and removing and drying the precipitate formed. The proportions and concentrations of solutions used are such as to form a compound which when dried and ground may be used as a filtering medium for the removal of calcium and magnesium from water.—T. H. B.

Magnesium compounds; Process of producing—S. Peacock, Philadelphia, Pa., Assignor to Marden, Orth and Hastings Co., Inc., New York. U.S. Pat. 1,205,659, Nov. 21, 1916. Date of appl., July 15, 1915.

MINERALS containing magnesium are finely powdered and treated with sulphuric acid, the heat of reaction being allowed to rise high enough to prevent formation of gelatinous silica; less sulphuric acid is used than is necessary to combine with all the magnesium. The magnesium compound thus produced is recovered.—T. H. B.

Nitrogen compounds; Synthetic production of—P. A. and E. A. Starke, Berkeley, Assignors to Standard Oil Co., Richmond, Cal. U.S. Pat. 1,206,155, Nov. 28, 1916. Date of appl., May 3, 1915.

CYANOGEN compounds are formed by passing a mixture of methane and air, heated to a temperature not lower than 600° C., through a catalyst consisting of a mixture of alkalis, or alkali and alkaline earths, with a metal of the iron group, and containing no carbon.—B. V. S.

Ammonia and compounds thereof; Manufacture of—H. W. Lamb, Portsmouth, Va. U.S. Pat. 1,207,567, Dec. 5, 1916. Date of appl., Sept. 17, 1913.

A METALLIC carbide, or a substance containing calcium carbide, is heated and exposed to the alternating action of nitrogen and hydrogen under pressure, the temperature being raised and lowered alternately.—E. H. T.

Ammonia generator. C. W. Vogt, Louisville, Ky. U.S. Pat. 1,208,242, Dec. 12, 1916. Date of appl., Oct. 15, 1915.

A CLOSED, horizontal, cylindrical shell contains a liquor chamber, an ammonia chamber, and a steam chamber nearly filled with a series of tubes which are closed at one end and communicate with the ammonia chamber at the other. Each tube is fitted with an inner tube which extends through the ammonia chamber into the liquor chamber. That part of the shell in which the tubes are situated is provided with a steam-inlet and a condenser-outlet; strong liquor is supplied to the liquor chamber, and weak liquor is drawn off from the ammonia chamber, the latter being also provided with an exit for ammonia gas.

—E. H. T.

Nitrogen compounds [from distillers' spent wash]; Manufacture of—E. Kochenderfer, Frankfurt, Germany. U.S. Pat. 1,207,416, Dec. 5, 1916. Date of appl., Mar. 26, 1913.

DISTILLERS' spent wash, or similar nitrogenous

matter, is carbonised and the gases evolved are passed through a superheater. The period of contact of the gases with the superheating surface is controlled by varying the ratio between the area of that surface and the speed of the gases, and the speed is adjusted according to the composition of the gases.—E. H. T.

Titanium oxide; Method of obtaining —, L. E. Barton, Niagara Falls, Assignor to The Titanium Alloy Manufacturing Co., New York, U.S. Pats. (A) 1,206,796, (B) 1,206,797, and (C) 1,206,798, Dec. 5, 1916. Date of appl., Mar. 7, 1916.

(A) MATERIAL containing titanic and iron oxides is heated either with an alkali sulphide, or with a carbonaceous substance and an alkali sulphate, to a temperature below the melting point of the charge, but sufficiently high to effect the formation of ferro-sodium sulphide and alkali titanate. The sintered product is then treated with an acid liquid, suitably diluted, which dissolves out more of the iron than of the titanium compounds. In the initial stage, the titaniferous material may be mixed with melted nitre cake, and digested at 175–250° C. until the substances have interacted; the reducing agent is then added and the process continued as before. (B) The acid solvent employed is dilute sulphurous acid, which may be added as such, or produced by passing sulphur dioxide into a mixture of the sintered product and water. (C) The product of the interaction of the original material and alkali sulphide is poured in a molten state into a vertical mould. By controlling the rate of cooling, two separate layers are formed, the upper one containing most of the iron, and the lower one most of the titanium compounds. After solidification these layers are separated from the rest of the casting.—E. H. T.

Aluminium chloride residus [from oil refining]; Utilisation of —, A. McD. McAfee, New York, Assignor to Gulf Refining Co., Pittsburgh, Pa., U.S. Pat. 1,206,871, Dec. 5, 1916. Date of appl., Mar. 2, 1915.

To coke residues containing aluminium chloride, as obtained in oil refining, some of the same material which has been oxidised by roasting in a limited air supply, is added, and the mixture is fused and electrolysed, whereby the carbon in the residues is oxidised and metallic aluminium is obtained.—E. H. T.

Air; Separating the gases of —, Apparatus for the separation of the constituents of air, J. P. Place, Glen Ridge, N.J., Assignor to American Air-Liquefying Co., New York, U.S. Pats. (A) 1,205,177 and (B) 1,205,178, Nov. 21, 1916. Dates of appl., June 8 and 9, 1915.

(A) AFTER a preliminary compression and cooling, in which water and carbon dioxide are removed, the compressed air is further cooled in several stages, using as cooling agents the nitrogenous products of rectification, boiling liquid nitrous oxide, and finally liquid oxygen at atmospheric pressure. (B) An arrangement of condensers and receptacles suitable for the above process.—B. V. S.

Carbonic acid gas; Absorbent medium for —, J. Cadman, Edgbaston, U.S. Pat. 1,207,273, Dec. 5, 1916. Date of appl., July 17, 1914.

SEE Eng. Pat. 12,451 of 1911; this J., 1915, 228.

Oxides of nitrogen; Manufacture of —, C. Bosch, A. Mittasch, and C. Beck, Assignors to Badische Anilin und Soda Fabr., Ludwigshafen, Germany, U.S. Pats. 1,207,706, 1,207,707, and 1,207,708, Dec. 12, 1916. Date of appl., Feb. 25, 1915.

SEE Eng. Pat. 13,818 of 1911; this J., 1915, 799.

Hydrosulphites; Production of anhydrous — from aqueous hydrosulphite solutions, E. Marburg and G. Münch, Assignors to Chem. Fabr. Griesheim-Elektron, Frankfurt, Germany, U.S. Pat. 1,207,782, Dec. 12, 1916. Date of appl., June 9, 1911.

SEE Ger. Pat. 279,389 of 1913; this J., 1915, 355.

Carbon monoxide; Process of absorbing —, W. Meiser and C. Krauch, Assignors to Badische Anilin u. Soda Fabr., Ludwigshafen, Germany, U.S. Pat. 1,207,968, Dec. 12, 1916. Date of appl., Feb. 25, 1915.

SEE Eng. Pat. 9271 of 1914; this J., 1915, 861.

VIII.—GLASS; CERAMICS.

Chemical and medical glass, etc. Regulations for trading.

THE Minister of Munitions has ordered, under date 2nd January, that all persons engaged in the manufacture, purchase, sale or other dealings in chemical and medical glass or glass tubing and rod shall comply with the following regulations:—

(1) No person shall manufacture any chemical or medical glass or glass tubing or rod unless the purpose for which the glass is required has been approved. Such approval must be evidenced by one or other of the following which must be quoted by the ordering firm together with the purpose for which the glass is required:—

(a) Reference to and number of an Admiralty, War Office or Ministry of Munitions contract for which the glass is necessary, or

(b) A certificate authorising the supply issued on behalf of the Minister of Munitions by the Director of Optical and Glassware Munitions.

(2) Manufacturers are required to render to the Director of Optical and Glassware Munitions, at regular intervals, full and accurate returns of their manufacture and output of chemical and medical glass and glass tubing and rod in accordance with the directions from time to time given by the said Director.

(3) No person shall buy, sell, or deal in any chemical or medical glass or glass tubing or rod situated or to be manufactured outside the United Kingdom unless a certificate authorising such purchase, sale or dealing has been issued on behalf of the Minister of Munitions by the Director of Optical and Glassware Munitions.

(4) For the purpose of this Order chemical and medical glass shall include resistance, chemical and bacteriological glassware, carbons, thermometers, glass for miners' safety flame lamps, glass for X-ray apparatus, hospital glassware and glass vessels (graduated or otherwise) manufactured for the purpose of containing reagents, drugs, medicines, pharmaceutical or biological substances or preparations; and glass tubing and rod shall include all glass tubing and glass rod made by the process of drawing.

(5) All applications in reference to the above Order should be made to the Director of Optical and Glassware Munitions, Ministry of Munitions of War, 117, Piccadilly, London, W.

NOTE.—Certificates will be granted to dealers to order reasonable quantities of chemical and medical glass and glass tubing and rod for the purpose of stock and/or export, provided that such orders are not considered by the Minister of Munitions as likely to interfere with the execution

of orders required for war purposes. No further authorisation to dispose of such stocks will be required, provided that in the case of articles, the export of which is prohibited, the usual permit to export be obtained.

Magnesite and magnesite products. Restrictions on use.

THE Minister of Munitions has prohibited, as from 10th January, the use of magnesite and magnesite products for or in connection with (a) the construction or repair of any building (other than a furnace) or any flooring or deck, or (b) the manufacture of any insulating or non-conducting material, except under and in accordance with the terms of a permit granted by the Minister of Munitions. All applications in reference to this order should be addressed to the Director of Steel Production (W.J.J. 342), Armament Buildings, Whitehall Place, London, S.W.

Zirconia objects; Preparation of —. O. Ruff and G. Lauschke. *Z. anorg. Chem.*, 1916, 97, 73—112. *Z. angew. Chem.*, 1916, 29, Ref., 503—501. (See also this J., 1914, 593, 647.)

By addition of small quantities of other oxides, zirconia objects can be made which, after burning in an exhausted carbon tube resistance furnace, in a reducing atmosphere, are sufficiently non-porous to be used in such a furnace. The most suitable additions are 1% of alumina for objects burnt at 2000° C., 1% of thorium for objects burnt at 2200° C., and 1—3% of yttria earths for objects burnt at 2400° C. Larger quantities of the oxides mentioned increase the porosity, as also do beryllium (glucinum) oxide and magnesia even when used in small quantities; silica also acts unfavourably. —A. S.

PATENTS.

Glass surfaces; Joining together —. F. Twyman, R. G. Parker, and A. J. Dalladay, Assignors to A. Hilger, Ltd., London. U.S. Pat. 1,206,177, Nov. 28, 1916. Date of appl., May 23, 1916.

A PROCESS of joining together glass surfaces without distortion consists in cleaning the surfaces, placing them in direct contact and then heating them sufficiently to cause them to unite firmly, yet without distortion. (See also Parker and Dalladay, this J., 1917, 32.)—A. B. S.

Transfers for earthenware, china, glass, and enamelled goods; Process for the production of —. L. Brindley, Burslem, Staffs. Eng. Pat. 15,142, Nov. 2, 1915.

THE designs are printed on tissue paper in one or more colours by means of engraved copper plates or rollers in the customary manner. The tissue paper is then applied, with the printed surface innermost, to the gummed surface of a sheet of duplex paper. A softening medium such as a mixture of linseed oil and oil of turpentine is applied to the tissue paper, which is then removed, leaving a perfect print on the duplex paper ready for application to the article to be decorated.—A. B. S.

Abrasive wheels; Process of making —. C. R. King, Assignor to Norton Co., Worcester, Mass. U.S. Pat. 1,208,330, Dec. 12, 1916. Date of appl., May 28, 1914.

A porous abrasive wheel is dipped in a cold solution of a synthetic resin and then heated so

as to transform the resin into a hard, tough, supplementary bond which will not be melted if the wheel becomes heated when in use.—A. B. S.

Carbon bricks and ceramic bodies containing carbon; Manufacture of —. Chem. Fabr. Dr. K. Albert, and L. Berend. Amöneburg. Ger. Pat. 291,661, Aug. 10, 1913.

CARBON, or a mixture of ceramic raw materials, is intimately mixed with an aqueous emulsion of an organic substance with an organic emulsifying agent, both of which yield finely divided carbon on carbonisation, and the mixture is heated until the constituents of the emulsion which are not volatilised are carbonised. Concentrated sulphite-cellulose waste lye is recommended as emulsifying agent, and tar, tar oils, or fatty oils, as substances to be emulsified. The raw mixture, before carbonising, may be used for lining furnaces, etc.—A. S.

Kiln or oven [for bricks]. U.S. Pat. 1,206,547. See IX.

IX.—BUILDING MATERIALS.

Concrete; Testing hardened —. F. Hart. *Chem.-Zeit.*, 1916, 40, 1032.

To ascertain the proportion of cement and sand in hardened concrete, it is necessary to examine the cement and aggregate from which the concrete was made. The sample of the roughly ground and air-dried concrete is further ground in a porcelain mortar until it will pass through a sieve with 120 holes per sq. cm. (It must not be too fine.) The aggregate is similarly treated and the cement is examined by the usual method. The loss on ignition, the proportion of matter insoluble in hydrochloric acid, the soluble silica, alumina, iron oxide, lime, magnesia, and sulphates are determined in the concrete, aggregate, and cement respectively, and the results are calculated to percentages on the calcined samples. Thus, if the aggregate consists of 96.20% insoluble residue and 3.80% soluble matter, and the concrete contains 80.27% insoluble matter, then the concrete contains $80.27 + 3.14$ (the corresponding quantity of soluble matter) = 83.41% aggregate and $100 - 83.41 = 16.56\%$ cement, and corresponds to a mixture of 1:5.04. When two different aggregates are used in the concrete, the probable proportions in which they have been mixed may be estimated in a similar manner. If the raw materials used for the concrete are not available, some of the particles of aggregate should be picked out of the crushed concrete and tested for calcium carbonate and other substances soluble in hydrochloric acid. If this is present, a further estimation of the amount of limestone, pumice, or clay ironstone present is impossible. If the aggregate is almost pure quartzose, the proportion present is calculated by assuming that the insoluble matter in the concrete is derived wholly from the aggregate and the soluble matter from the cement. As a check, the soluble ingredients should be compared with the analysis of normal Portland cement. If they agree, it is probable that the estimation of the composition of the concrete will be sufficiently correct; otherwise, it may be impossible to estimate the latter. If the manufacturer of the cement can be ascertained, it will usually be sufficiently accurate to obtain a sample of cement from him and to use this as the basis for calculation. In some cases, it is sufficient to substitute the analysis of an average cement. The estimation of the volumes of sand and cement used in the

manufacture of a given sample of hardened concrete is far less reliable than that of their percentages by weight.—A. B. S.

[Reinforced] concrete; *Cracking of—by salt water.* J. L. Harrison. Bull. Bureau of Public Works, Philippine Islands, Oct., 1916. Eng. and Min. J., 1916, 102, 1019–1020.

The cracking of numerous structures of reinforced concrete was traced to the presence of sodium chloride introduced by the use of brackish water or unwashed beach sand and gravel in the concrete mixture or by the use of salt water for wetting down the freshly set material. The failures were caused apparently by the bursting action of iron oxide formed in continuously increasing quantity around the embedded metal, this being rendered possible by the alternate production and decomposition of ferric chloride under the prevailing climatic conditions.—W. E. F. P.

Wood; *New method of fireproofing—* Engin. Rec., 1915, 72, 717. Bull. Agric. Intell., 1916, 8, 1166.

The following method of fireproofing shingles has been tested at the Forest Products Laboratory, Madison, Wis., U.S.A.:—The air-dry shingles are first impregnated with a solution of borax and dried in the stove until their moisture-content does not exceed 10%. Subsequently they are impregnated with a solution of zinc chloride, which forms a deposit of zinc borate in the pores, and again stove-dried. The zinc borate, being insoluble, resists exposure to running water and exerts a fireproofing effect by fusing at a high temperature and covering the wood fibres with a protective coating. The treatment can only be applied by means of a costly plant, including provision for impregnating the wood under high pressure, and consequently is only available on a large scale. In a fierce fire the treated shingles burn, but without flame, thus avoiding the danger of spreading the fire by falling sparks.—J. F. B.

PATENTS.

Refractory bricks and cement; Manufacture of— T. Twynan, Redcar. Eng. Pat. 102,386, Jan. 3, 1916. (Appl. No. 2 of 1916.)

MAGNESITE or dolomite is mixed with 3–5% of neutral slag wool preferably high in alumina, and then ground, or it may be ground dry in a ball mill and afterwards mixed with the slag wool and then made into bricks in the customary manner. Owing to the slag wool, the shrinkage of the bricks is very small and they remain true to shape. Bricks of lesser porosity are produced by adding 20–30% of highly shrunk magnesite to the ground mixture, or the porous bricks may be ground and then re-made into bricks. A mixture of magnesite or dolomite with 5–10% of slag wool makes a good cement for repairing the interior of metallurgical furnaces. The use of the slag wool avoids the necessity of burning the magnesite or dolomite at such high temperatures as are otherwise required. (Cf. Eng. Pats. 15,163 and 16,237 of 1915; this J., 1916, 1261.)—A. B. S.

Compositions for paving and building purposes. J. Gibb, Glasgow. Eng. Pat. 102,522, July 3, 1916. (Appl. No. 944 of 1916.)

SAWDUST free from large chips is soaked in water for 24 hours and mixed with at least half its volume of Portland cement and sufficient water to produce a consistency similar to that of mortar. Small stone chips or sand may be added if desired. The material may be moulded into blocks or laid

in situ. The product forms a durable, heat-resisting and resilient paving and building material of great strength and homogeneity and capable (when used for paving) of reducing skidding and slipping and of decreasing the noise of traffic. It is lighter than granolithic or concrete, yet equally durable; it does not "sweat," and nails can be driven into and held by it.—A. B. S.

Plastic binding composition; Process of preparing a— J. G. Vail, Chester, Pa. U.S. Pat. 1,206,656, Nov. 28, 1916. Date of appl., June 29, 1915.

AN emulsion of an alkaline solution of a silicate and a bituminous product is formed by equalising the viscosities of the substances and then mixing. The viscosity of the sodium silicate may be increased by incorporating stone screenings therewith; the viscosity of the bituminous product may be lessened with a suitable solvent.—T. H. B.

Building material; Artificial— and method of producing the same. L. Kern, Hamburg, Germany. U.S. Pat. 1,206,515, Nov. 28, 1916. Date of appl., June 22, 1914.

WET infusorial earth and fusible clay are mixed in such proportions that the product melts at 650°–950° C. The mixture is moulded and pressed into bricks, which are dried in a current of air, burned, and then cooled quickly. The bricks produced are porous, fireproof, and of low specific gravity.—A. B. S.

Diatomaceous earth; Process for producing articles from— L. Kern, Hamburg, Germany. U.S. Pat. 1,206,516, Nov. 28, 1916. Date of appl., May 15, 1915.

DIATOMACEOUS earth "and its compounds" are mixed with hydrochloric acid so as to convert any metallic compounds present into chloride, the product being moulded, partly dried, and then burned so as to convert the metallic chlorides into oxides.—A. B. S.

Kiln or oven [for bricks]. L. Kern, Hamburg, Germany. U.S. Pat. 1,206,517, Nov. 28, 1916. Date of appl., Jan. 4, 1916.

A TRIPLE stage vertical oven is provided with perforations in each of the three crowns, so that heat from a furnace in the lower part of the oven may rise vertically through it and pass out at the top. The lowermost stage forms the combustion chamber, the ones above contain the goods to be burned. Dampers are provided to divert some of the heat to the sides of the burning chambers.—A. B. S.

Furnace-lining material and process for preparing same. C. J. Barr, Birmingham, Ala., Assignor to A. S. Davison Co., Pittsburgh, Pa. U.S. Pat. 1,206,771, Nov. 28, 1916. Date of appl., Dec. 26, 1914.

GRAINS of non-fusible refractory material, such as dolomite, are roasted in a rotary kiln and a less refractory material, such as pulverised slag, is blown into the discharge end of the kiln, the temperature maintained at that end being such as will cause the pulverised material to fuse and coat separately the grains of dolomite with a non-cohesive envelope, so that when the product is formed into a granular lining of a furnace, the fusible coating serves to bind together the grains of refractory material to a permanent mass on exposure to the heat of the furnace.—J. F. B.

Building material; Manufacture of— T. Gürtler, Kleinzschachwitz. Ger. Pat. 295,013, Apr. 7, 1914.

BURNT clay, kaolin, or other material containing

alumina and silica, is mixed with a calcareous binding medium, and hardened by treatment with steam under pressure.—A. S.

Coating composition [for concrete]. U.S. Pat. 1,189,550. See XIII.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

German iron industry in 1915—1916. Z. angew. Chem., 1916, 29, Wirtschaftl. Teil, 697.

IN the period July 1, 1915, to June 30, 1916, the production of pig iron in Germany was 12,756,000 metric tons, as compared with 10,633,000 tons in 1914-15, an increase of 20%; the 1915-16 production amounted to 67% of that of 1913-14, the highest previously recorded. The steel production was 14,790,016 tons in 1915-16, as against 11,752,627 tons in 1914-15, an increase of 25.8%, and 82.6% of the highest production previously recorded. The total coal production was 87.8 million tons in 1915-16, as against 77 million tons in 1914-15, and the available supply, after deducting that consumed at the mines, was 68.4 and 60.6 million tons in 1915-16 and 1914-15 respectively. The amount of steel rolling mill products fell from 3,393,537 tons in 1914-15 to 3,279,632 tons in 1915-16. The year was a very profitable one for the companies concerned. In nearly all cases the profits were higher than any previously recorded—twice and in many cases three times as much as in the previous year. Dividends were increased and large sums were applied to writing off capital and providing special reserves in preparation for the severe competition anticipated after the war. The high profits were due largely to increased prices. Female labour and workers from occupied enemy territories have been used in an increasing degree during the past year.

Nickel in iron ores; Determination of—. P. Covitz. Met. and Chem. Eng., 1916, 15, 682—683.

THE following method, using dimethylglyoxime, is accurate and reasonably rapid, and the removal of other elements is not necessary. One grm. of finely powdered ore (100—120-mesh) is dissolved in 10 c.c. of nitric acid (sp.gr. 1.42) and 10 c.c. of hydrochloric acid (sp.gr. 1.2), quantities to be varied to suit the nature of the ore; sufficient nitric acid must be used to oxidise all reduced metals, particularly ferrous iron. After cooling, 10 c.c. of sulphuric acid (sp. gr. 1.81) is added, and the solution evaporated till copious white fumes appear. The nitric acid must be completely expelled or it will interfere in later stages. The solution is cooled, treated first with 30 c.c. of water, then with 2 to 3 c.c. of hydrochloric acid, heated for 10 to 15 minutes, and 5 grms. of citric or tartaric acid added. The solution is filtered, the filtrate diluted to 125 c.c., and neutralised with ammonia. If on passing the neutral point the solution is brown, enough citric acid is added to produce a green colour. After adding a few drops of hydrochloric acid to make barely acid, and heating to 70°—85° C., the nickel is precipitated by adding 20 c.c. of dimethylglyoxime reagent (8 grms. dimethylglyoxime in 1 litre ethyl alcohol); the solution is stirred constantly and allowed to boil. The precipitate is collected in a weighed Gooch crucible, and dried in an oven at 110° C. for 45 minutes; the dried precipitate contains 20.31% Ni.—T. H. B.

Cobalt ores; Occurrence and utilisation of—. Bull. Imp. Inst., 1916, 14, 417—437.

THE chief cobalt minerals are enumerated and particulars given of the distribution of cobalt ores throughout the world. In the Cobalt district of Ontario, Canada, the chief producing centre, cobalt and nickel occur in association with rich arsenical silver ore. During 1904—1914 the total production of cobalt in this district was 8007 tons, valued at £425,273; and, prior to the outbreak of war, sufficient ore was produced to provide over 1500 tons of cobalt oxide annually, the world's consumption of the oxide being then estimated at only 300 tons per annum. In the form of smalt, Thénard's and cerulian blues, Rinnmann's and turquoise greens, Indian yellow, cobalt brown, etc., cobalt compounds are employed as pigments, and in ceramics and other arts and industries, while the soluble salts form the basis of sympathetic inks. Until recent times metallic cobalt was not employed industrially to any extent, but the researches of Kahnus, instituted by the Canadian Department of Mines in 1912 and still in progress, have already resulted in a better knowledge of the properties and possible applications of the metal (see this J., 1914, 253, 261; 1915, 180, 619; 1916, 1113). Cobalt has been employed with success in the preparation of high speed steels, the latter containing 4% Co in addition to tungsten and chromium. Cobalt-chromium alloys of the "stellite" type (Co 75, Cr 25%) are much used for "stainless" cutlery on account of their hardness and resistance to acids; the hardness is further increased, and the alloys rendered suitable for high-speed tools, by the addition of tungsten and molybdenum. "Cochrome," an alloy similar to nichrome but containing cobalt instead of nickel, is in some respects superior to nichrome for electric heating elements, being less readily oxidised and having a higher melting point. Light alloys of aluminium and cobalt (Co 9—10%) have a coarsely crystalline structure and a tensile strength little more than that of aluminium; by the addition of 0.8—1.2% of tungsten or molybdenum the structure is refined and the strength increased to 2 or 3 times that of aluminium. Such alloys work and polish well, are very stable in air, and have a specific gravity between 2.8 and 2.9. An amalgam of cobalt is used in dentistry.—W. E. P. P.

Antimony ores; Occurrence and utilisation of—. Bull. Imp. Inst., 1916, 14, 389—417.

PARTICULARS are given of the occurrence of antimony ores throughout the world, together with statistics of imports into the United Kingdom during 1912—1915 and of the world's production of antimony ore and metal during 1911—1914. Prior to the war most of the antimony ore imported into this country came from Australia and China, whilst large quantities of crude antimony metal and regulus were imported from Mexico and China. Thus, in 1911, 2711 and 4367 tons of ore, valued at £38,704 and £33,911, were imported from Australia and China respectively, while 1294 and 1513 tons of crude antimony and regulus, valued at £21,857 and £46,500, were imported from China and Mexico respectively. During 1915 considerable amounts of ore, crude metal, and regulus were also imported from other countries, of which Algeria, Peru, Chile, Bolivia, Argentine Republic, Victoria, New South Wales, and Canada were the chief producers. The total imports of ore and of metal plus regulus in 1915 were 22,569 and 4691 tons, valued at £542,631 and £215,109 respectively; the corresponding figures for 1914 were 9179 and 3515 tons, valued at £90,760 and £85,371 respectively. For the production of metal for munition purposes, the

purchase of stibnite ores is conducted—by agreement with the Ministry of Munitions—on the basis of 11s. per unit per ton for an antimony content of 60% or over, 10s. 9d. for 55–60% Sb, and 10s. 6d. for 50–55% Sb; these gross prices are subject to a discount of 2½%, and the antimony content of an ore is calculated on the net dry weight received at the buyer's works, less a deduction of 12 lb. per ton draft. Ore containing less than 50% Sb is unsaleable under present circumstances if higher grade stibnite is available. Lead, bismuth, arsenic, copper, and zinc are considered objectionable impurities and penalised as follows. For each 0.1%, or part, of lead above 0.3 and up to 1.5% (the maximum permissible), a deduction of 5s. per ton is made; 7s. 6d. per ton is deducted for each 0.1%, or part, of arsenic or copper above 0.1 and up to 0.5%; if zinc or bismuth is present in more than traces the ore is subject to heavy deductions depending largely on the other constituents of the gangue. Siliceous ores are preferred to those of a pyritic character. Oxidised ores containing less than 50% Sb would probably be saleable, but the deductions from the price of 10s. 6d. per unit payable for 50% stibnite would be 1s. for each unit below 50 down to 45, and 2s. per unit below 45%. Brief descriptions are given of the concentration of stibnite ores by lixiviation, smelting by the English and the sublimation processes, and the refining of the crude metal, together with analyses of four brands of refined antimony. These latter contained 98.856–99.760% Sb, the impurities being Pb 0.402–0.718, Sn nil–0.012, As 0.090–0.210, Cu 0.012–0.016, Fe 0.004–0.007, Zn 0.023–0.034, Ni and Co nil–0.028, and S 0.078–0.201%. Metallic antimony as such has few uses; it is mainly employed industrially in the form of alloys, of which antifriction or "white" metal, type metal, hard lead, and Britannia metal are the chief types.—W. E. F. P.

Monazite and other thorium minerals in Ceylon; Recent work on —. Bull. Imp. Inst., 1916, 14, 321–369.

THE work of the Mineral Survey of Ceylon during 1911–1915, of which a summary is given, was devoted mainly to searching for thorium-bearing minerals on the west and south coasts and in various inland districts. Along the coast, most of which is bordered by shallow water, "nambu" — a natural concentrate of heavy minerals (mainly ilmenite and magnetite associated with monazite, garnet, zircon, rutile, etc.) varying from a film to several feet in thickness and from a foot to several yards in width — was found at many points. From Colombo to Dutch Bay Point and from Puttalam to Kudremalai the monazite content of these deposits was generally under 3%; but nambus containing 7, 9, and 12% respectively were found at the mouth of the Maha Oya, near Marawila, and near Welaboda, while a similar deposit near Kudremalai contained 22%. Between Colombo and Hambantota the nambus were black or red according as ilmenite or garnet predominated; although nearly always present in the former, monazite was seldom found in the latter. The nambu richest in monazite (17.5%) was found near Bentota; this material contained ThO₂ 4.15, Ce₂O₃, etc., 29.91, and U₃O₈ 0.18%, and on further concentration yielded a high-grade monazite sand comparing favourably with that now largely exported from Travancore and containing 9%–10% ThO₂. The alluvial deposits and gravels of the Ratnapura, Kelani Ganga, and Sitawaka Ganga districts were investigated by boring, etc., and although many of the samples were found to contain monazite, thorianite, gold, and gemstones the amounts were too small to permit of profitable extraction. On the Moon Plains in the Nuwara Eliya district, the source of a nambu rich

in monazite, xenotime, corundum, and zircon (the first two containing uranium) was traced to a pegmatite dyke the richer parts of which were found to contain 310 grms. of monazite per metric ton. An acid rock of the granulite type, containing a small proportion (20 grms. per ton) of monazite, was also found in this district; and it is considered probable that the granular monazite so widely distributed in the alluvial gravels of Ceylon is derived from similar rocks of the granulite series and not from the pegmatite intrusions. From a close examination of the Bambarabotuwa, Denawak Ganga, and Walawe Ganga districts, from which thorianite and thorite were formerly obtained as by-products in native gemming operations, it is concluded that the production can be renewed only by exploiting the thorianite-bearing lodes in these localities. Various thorianite-bearing veins at Niragama and Maddegama were investigated, and generally found to be unremunerative or unworkable under prevailing conditions; the Yalkumbura district was also prospected for thorium minerals with similar results.—W. E. F. P.

Use of pulverised fuel. Muhlfeld and Fuller. See 11A.

PATENTS.

Iron and steel; Method of changing the composition of —. B. Ford, Philadelphia, Pa. U.S. Pat. 1,205,611, Nov. 21, 1916. Date of appl. Aug. 3, 1909.

A mass of metal is melted and completely decarburised, and a second mass is "super-carburised to saturation," the masses being then mixed in predetermined quantities to give iron or steel of a definite carbon content.—B. N.

Iron ores; Preventing disintegration of — on smelting. "Phoenix" A.-G. für Bergbau und Hüttenbetrieb, Abt. Hoerder-Verein, Hoerde. Ger. Pat. 295,322, Mar. 11, 1916.

THE tendency of many iron ores, especially oolitic ores, to disintegrate when treated in the blast-furnace, etc., can be inhibited by slow drying of the ore, e.g., by heating, or by means of a current of warm air or gas; the heating may be continued until the combined hydrate-water is also removed.—A. S.

Furnaces; Crucible — and art of firing the same. J. and G. Keith, London. Eng. Pats. 17,902, Dec. 22, 1915, and 8793, June 22, 1916.

THE furnace, which has a stand for the crucible that can be raised or lowered, or an inner lining that can be raised or lowered, is heated by a mixture of gas and air which is preheated during its passage through a pipe placed in the waste gas flue. The gas burns from a number of tangential nozzles inclined upwards, which project into a circumferential channel of increasing cross-section at the upper part of the furnace; the hot products of combustion impinge on the cover of the furnace and are reverberated on to the crucible and pass down between the latter and the furnace liner to the waste gas flue below. The space between the furnace liner and the crucible is made as narrow as possible to economise fuel. To prevent overheating of the gas nozzles, the latter are thermally connected to the exterior wall of the furnace.—W. H. C.

Metals from liquids; [Electrolytic] process and apparatus for recovering —. C. E. Holland, New York. Assignor to Metals Electro-Recovery Co. U.S. Pat. 1,205,207, Nov. 21, 1916. Date of appl., Dec. 10, 1913.

THE liquid is passed from a tank into a receptacle,

open at the top, containing a series of plates near the bottom as electrodes, and an electric current is passed through the liquid, the current being intermittently reversed by a suitable pole changer. Hydrogen is liberated, and the minute particles of metal are carried by the gas to the top of the liquid, the flow of the latter also carrying the particles of suspended metal which have been released from the electrodes by the reversal of the current. The liquid overflows into a trough at the side of the tank and thence flows into a settling tank, in which the metal is separated, and the sediment is passed into a leaching tank. This is also in connection with a cyanide tank. The sediment is treated with cyanide solution, and the solution is passed into a recovery tank, provided with a series of anodes and cathodes in baffle formation, where it is subjected to electrolytic action. The slime is separated from the electrolytic deposit, and the liquid portion from the slime is returned to the cyanide tank for recovery of the cyanide solution.—B. N.

Ores and other products; Leaching——. J. E. Rothwell and H. B. Lowden, Assignors to Colorado Iron Works Co., Denver, Colo. U.S. Pat. 1,205,936, Nov. 21, 1916. Date of appl., June 3, 1912.

In a continuous leaching process a mixture of solids and solvent is agitated in a suitable vessel, a portion of the mixture being continuously withdrawn during agitation and passed to a following vessel, whilst a substantially clear solution is continuously passed to a preceding vessel.—B. N.

Sintering fine ores, flue-dust, purple ore and the like; Process for——. C. Giesecke, Bad Harzburg, Germany. U.S. Pat. 1,205,944, Nov. 21, 1916. Date of appl., Aug. 30, 1916.

FINELY-DIVIDED material containing iron is sintered by first mixing and agglomerating the material with a finely-divided fuel, and with slimes containing a high proportion of clay, and the agglomerated material is subjected to pressure to form it into more or less regular bodies. Fuel is distributed in the form of small lumps over the bodies, and in the interstices between them, in a sintering furnace, and the material is rapidly heated and cooled.—B. N.

Ingot; Method of making——. J. E. York, New York. U.S. Pat. 1,206,188, Nov. 28, 1916. Date of appl., Mar. 21, 1913.

METAL in "piece form" is inserted into the zone of the ingot, where "pipes" and segregations occur, whilst the metal in the interior is mobile, and the metal is gradually displaced to fill the "pipes," at the same time expelling the portion containing the segregations to the exterior. Metal is fed in to compensate for the portion flowing into the cavities, and the extruded metal is heated at the issuing point to maintain its mobility.—B. N.

Pickling process (for copper). E. F. Hitch, Assignor to Western Cartridge Co., East Alton, Ill. U.S. Pat. 1,206,220, Nov. 28, 1916. Date of appl., Aug. 25, 1916.

COPPER and metals containing copper are cleansed by pickling in a bath containing sodium bisulphate and an oxidising agent, such as sodium bichromate.—B. N.

Vanadium ores; Lixiviation of——with alkali sulphide solution. G. Fester, Breslau. Ger. Pat. 394,932, June 23, 1914.

THE ore is treated, in a counter-current apparatus,

with an aqueous solution of alkali sulphide, polysulphide, or hydrosulphide, with or without the application of heat and/or pressure. The resulting alkali vanadate solution is purified by treatment with chlorine or other similar oxidising agent, and then treated in the usual way.—A. S.

Rabbling appliances for mechanical ore roasting furnaces. J. Harris, Sheffield. Eng. Pat. 102,591. Aug. 17, 1916. (Appl. No. 11,650 of 1916.)

Metallic deposits; Process of producing——. F. A. Roux, Assignor to Soc. L'Aluminium Français, Paris. U.S. Pat. 1,207,218, Dec. 5, 1916. Date of appl., Jan. 19, 1911.

SEE Fr. Pat. 464,721 of 1913; this J., 1914, 599.

Silvering or gilding metal articles; Preparation for——. A. Dalby, London. U.S. Pat. 1,208,597, Dec. 12, 1916. Date of appl., July 22, 1916.

SEE Eng. Pats. 8866 and 8867 of 1915; this J., 1916, 1117.

Ores, slimes, and the like; Apparatus for the water concentration of——. W. M. Martin, Redruth. U.S. Pat. 1,207,312, Dec. 5, 1916. Date of appl., June 22, 1915.

SEE Eng. Pat. 15,442 of 1914; this J., 1915, 620.

Ores or the like; Apparatus for the water concentration of——. W. M. Martin, Redruth. U.S. Pat. 1,207,967, Dec. 12, 1916. Date of appl., Jan. 24, 1916.

SEE Eng. Pat. 2845 of 1915; this J., 1915, 876.

Concentration of ores. H. Lavers, Camberwell, H. H. Greenway, Melbourne, and A. H. P. Lowry, Prahran, Victoria, Assignors to Minerals Separation American Synd. (1913), Ltd., London. U.S. Pat. 1,208,334, Dec. 12, 1916. Date of appl., Sept. 14, 1916.

SEE Fr. Pat. 469,677 of 1914; this J., 1915, 35. No frothing agent other than sodium carbonate is added.

Cupola-furnace. W. Wagner, Lodz, Poland. U.S. Pat. 1,208,416, Dec. 12, 1916. Date of appl., Feb. 17, 1913.

SEE Eng. Pat. 5452 of 1913; this J., 1913, 1016.

Manufacture of briquettes of coal, coke, turf, iron or other ores, or the like. U.S. Pat. 1,207,180. See 11A.

Continuous heating furnace. U.S. Pat. 1,205,503. See 11B.

XI.—ELECTRO-CHEMISTRY.

Batteries; Pocket lamp——. K. Arndt, Chem.-Zeit., 1916, 40, 1017—1019.

THE dry batteries for pocket electric lamps are made almost exclusively on the principle of the Leclanché cell. A battery of three cells joined in series, gives initially a voltage of about 4.5, and will yield 3 watt-hours of energy at a continuous discharge rate of 0.2 amp. The capacity of individual batteries varies according to the purity of the materials used. Impurities tend to cause local chemical action and short circuiting. The following measurements were made on different

varieties of carbon powder after compressing at (25 atm. (1875 lb. per sq. inch).

Nature of carbon	Ash content.	Density.	Specific conductivity (in reciprocal ohms).
Acheson (electric furnace) ..	(0.2 2.1 5.7 7.7 20.0	1.61 1.47 1.59 1.73 1.79	93 85 53 93 52
Natural graphite			
Acetylene black	0.0	0.61	4

On mixing with manganese dioxide, the conductivity is greatly lowered. A determination of the amount of zinc and manganese dioxide entering into chemical reaction during the production of a measured amount of current, showed that the amount of chemical change is about twice that calculated from the current. The difference represents the loss through local chemical action. In the practically exhausted cell, about two-thirds of the manganese dioxide and of the zinc remains unaffected. It is estimated that, in Germany, 30 millions of these batteries are manufactured annually, representing a consumption of 300 tons of the constituent materials.—J. N. P.

Electrolytic oxidation of sulphurous acid. Thompson. See VII.

Catalytic decomposition of formic acid by rhodium. Haas. See VII.

PATENTS.

Electric arc furnace. C. W. H. von Eckermann, Ljnsne, and I. Rennerfelt, Djursholm, Sweden. U.S. Pat. 1,206,057, Nov. 28, 1916. Date of appl., July 15, 1915.

AN electric arc furnace with a horizontally elongated crucible, is provided with several systems of electrodes, each system being located in a plane perpendicular to the longitudinal axis of the furnace; means are provided for connecting the electrodes to a three-phase alternating current so as alternately to produce arcs between the electrodes of each system, by connecting each system in one phase of the circuit, and between the electrodes and the charge in the furnace by connecting the electrodes in Y-connection with the charge as neutral point.—T. H. B.

Furnace control apparatus; Electric—. J. A. Seede, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pat. 1,206,663, Nov. 28, 1916. Date of appl., Apr. 12, 1916.

IN an apparatus for regulating furnace electrodes, the electrode is mechanically connected to, and moved by, a reversible electric motor, an electromagnetic device, responsive to variation of energy in the electrode supply circuit, being provided for controlling and reversing the motor. A dynamic braking means is interlocked with the relay magnet to close the armature circuit of the motor through a resistance, in order to brake the motor when the supply circuit is open, and an electromagnet cut-out is provided for de-energising the motor when the voltage of the current in the electrode circuit falls below a predetermined value.—B. N.

Accumulators; Electric—. M. and A. Fetscher, Mergentheim. Ger. Pat. 294,860, Jan. 14, 1914.

THE electrodes consist of a mixture of lower

manganese oxides and of manganese dioxide, respectively, whilst the electrolyte is a slightly alkaline solution of potassium nitrate. The manganese oxides may be used in the form of compressed blocks or in combination with metallic fillers. In these accumulators the metallic portions are not attacked by the electrolyte and the formation of active oxygen is prevented.—W. P. S.

Ultra-violet rays; Method of obtaining—by spark discharge. J. von Kowalski-Wierusz, Fribourg, Switzerland. U.S. Pat. 1,207,347, Dec. 5, 1916. Date of appl., Apr. 10, 1914.

SEE Fr. Pat. 168,215 of 1914; this J., 1914, 971.

Manufacture of sodium perborate. Eng. Pat. 100,153. See VII.

Manufacture of alkali perborates. Eng. Pat. 102,359. See VII.

Utilisation of aluminium chloride residues [from oil refining]. U.S. Pat. 1,206,874. See VII.

XII.—FATS; OILS; WAXES.

Arachis oil; Detection of—in admixture with olive oil. R. Biazzo and S. Vigdoreik. Annali Chim. Appl., 1916, 6, 179—185.

A SOLUTION of the fatty acids from 20 grms. of the oil under examination in 200 c.c. of ether is shaken vigorously for 5 mins. with 50 c.c. of a 30% aqueous solution of normal lead acetate. The lead soaps of the liquid fatty acids dissolve in the ether, whilst the insoluble lead soaps of the solid acids form an intermediate layer between the aqueous solution and the ether. If a persistent emulsion forms in the aqueous layer, the latter is filtered through a wet filter and the particles of insoluble soap on the filter returned to the separating funnel. The clear ethereal solution is decanted through a dry filter, the residual insoluble lead soap washed with 75 c.c. of ether, then transferred to the filter and again washed with ether. The residue on the filter is transferred to a separating funnel with 200 c.c. of ether, treated with two successive quantities of 100 c.c. of 20% hydrochloric acid, the ethereal solution of the liberated fatty acids washed with water, dried, filtered, evaporated, and the residue tested for arachidic acid by one of the known methods. For the detection of arachidic acid the authors use the method of Kreis and Roth (this J., 1913, 201) slightly modified, and for its determination the method of Tortelli and Ruggeri (this J., 1898, 876).—A. S.

Rape oil; Detection of—in admixture with olive oil. R. Biazzo and S. Vigdoreik. Annali Chim. Appl., 1916, 6, 185—195.

THE method proposed depends upon the concentration of erucic acid by means of the process of Fachini and Dorta (this J., 1912, 397), its conversion into behenic acid by hydrogenation, and identification of the behenic acid. The fatty acids from 20 c.c. of the oil under examination are dissolved in 180 c.c. of anhydrous acetone, and the solution is heated nearly to boiling and treated with 20 c.c. of N/1 potassium hydroxide solution. After cooling, the precipitated acid potassium soaps are filtered off, washed four times with cold acetone (10 c.c. each time), then dissolved in water, decomposed with hydrochloric acid, and the fatty acid, dissolved in ether. The

etheral solution is shaken with lead acetate solution and the insoluble lead soaps treated for the detection of arachidic acid (see preceding abstract). The lead soaps remaining dissolved in the ether are decomposed with hydrochloric acid, and the liberated fatty acids in etheral solution are hydrogenated in presence of palladium prepared by Loew's method (this J., 1890, 550). The hydrogenated fatty acids are subjected to fractional crystallisation as in the method of Kreis and Roth (this J., 1913, 201) for the detection of arachidic acid: if the least fusible fraction has a melting point higher than 71° C. the presence of rape oil is indicated.—A. S.

"*Solvines*" (Turkey-red oils); *Biological valuation of the so-called* —. R. Kobert and W. Grönel. Collegium, 1916, 261—266, 305—311. Z. angew. Chem., 1916, 29, Ref., 505.

EXPERIMENTS have shown that indications of the strength and action of commercial Turkey-red oils can be obtained from experiments with blood corpuscles. When exposed to the action of Turkey-red oil, blood corpuscles dissolve to a red liquid, and then after a very short time the blood colouring matter is decomposed into glutin and hæmatin, and a turbidity is produced. The constituents of Turkey-red oil producing the effects described are the same as those to which its value in the dyeing and tanning industries is due. The sodium salts of polycinnoleic acids resemble saponins in many respects, and it is not improbable that saponins could be used as substitutes for Turkey-red oil in the tanning industry.—A. S.

Water content of margarine prepared from hydrogenised fats. Brauer. See XIXA.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

PATENTS.

Titanic oxide products [pigments]; Method for producing composite —. L. E. Barton, Niagara Falls. Assignor to The Titanium Alloy Manufacturing Co., New York. U.S. Pat. 1,205,144, Nov. 21, 1916. Date of appl., Apr. 23, 1915.

A SOLUTION of titanic sulphate is treated with a base, such as calcium hydroxide, giving an insoluble sulphate, and the mixture heated to produce a mixed precipitate of this sulphate with basic titanic sulphate. Sulphuric acid may be added to the titanic sulphate solution before adding the base.—B. V. S.

Paints. A. J. Rossi, Niagara Falls, and C. M. E. Schroeder, Rutherford, N.Y., Assignors to The Titanium Alloy Manufacturing Co., New York. U.S. Pats. (A) 1,205,267, (B) 1,205,268, and (C) 1,205,269, Nov. 21, 1916. Dates of appl., (A) Nov. 19, 1912, (B) and (C) May 7, 1915.

(A) AMORPHOUS white titanic oxide (TiO_2) is incorporated, without chemical combination, with other substances to form a white paint. It may also be mixed, in a proportion of not less than 96%, with iron oxide to form a yellowish or buff paint. (B) An addition of white lead may be made to paints prepared as in (A). (C) Zinc oxide may form a constituent of the paints claimed in (A). —C. A. M.

Composition; Binding and coating —. C. Ellis, Montclair, N.J., Assignor to Ellis-Foster Co. U.S. Pat. 1,189,519, July 4, 1916. Date of appl., Mar. 29, 1910.

A SLOW-DRYING "pitchy" paint for iron and

steel-work is made up of guayule resin, 80; benzol, 40; Japan drier, 20; and red iron oxide (or other pigment), 100 parts. Another paint-composition is made by boiling guayule resin with 0.5 to 1.0% of litharge, manganese borate, or similar drier, and thinning with turpentine, benzol, etc. Guayule resin is advantageously used where ordinary paint is affected by the liquids with which it comes in contact. Another paint consists of guayule resin, 75; linseed oil or other drying oil, 10; Japan drier, 20; turpentine, 45; and red iron oxide, 100 parts. An elastic paint consists of linseed oil, 4; guayule resin, 4; copal resin, 1; and turpentine, 3 parts, coloured with white or sublimed lead, zinc oxide, lithopone, etc. A paint for cement is made up of Pontianak resin, 3; guayule resin, 1; benzine, 4; and benzol, 2 parts, together with pigment, and Portland cement as a thickener. Guayule resin may be stiffened by heating it with 3 to 5% of hydrated lime or zinc oxide, for the production of hard surfaces. A shingle stain is prepared from guayule resin, 20; copper oleate (or copper oxide dissolved in guayule resin at 140° C.), 1; benzol, 15; and Japan drier, 5 parts, and pigment. For reinforced concrete protection, a paint may be prepared by adding guayule resin, 50, to melted Pontianak resin or ordinary resin, 25, then thinning with benzol, 50, and adding Portland cement 50 parts. A steel protective dubbing is obtained by dissolving chromium sesquioxide, 1, in guayule resin, 10 parts, and thinning with benzol; or the resin may be treated with 5—8% of its weight of caustic soda in aqueous solution and precipitated with chrome alum. A priming for cement work is made by mixing guayule resin, 10; Pontianak resin, 20; fatty acids from linseed oil, 5; and benzol, 15 parts.—E. W. L.

Coating composition [for concrete]. C. Ellis, Montclair, N.J., Assignor to Ellis-Foster Co. U.S. Pat. 1,189,550, July 4, 1916. Date of appl., July 25, 1911.

THE composition consists essentially of a substantial proportion (20—35%) of unsaponifiable, resinous, finish-forming material, such as Pontianak or Jelutong resin, together with a thinner, such as coal-tar naphtha, and a colloidal "bodying" agent such as vulcanised oil (e.g., vulcanised tung oil). For example (1) Pontianak resin, 1 part, is melted and thinned with light coal-tar naphtha, 2 parts; (2) Pontianak resin, 4; ceresin or montan wax, 1; and naphtha, 8 parts; (3) Pontianak resin, 8; spindle oil, 1; tung oil, 1; and naphtha, about 16 parts. (1) For a glossy finish, Pontianak resin, 8; kauri resin, 2; boiled tung oil, 1; fish oil, 1; and naphtha, 6 parts. The Pontianak resin may be either raw or heat-treated (e.g., for one hour at about 320° C., 15 hrs. at about 200° C., or 12 hrs. at about 230° C.). In the former case the coal-tar naphtha may be replaced by petroleum naphtha to the extent of 10—20%. As thickeners, polymerised tung and other oils, aluminium tungate, the aluminium soap of fish oil, rubber, and certain waxes are serviceable. The following formula is illustrative of a thickened composition for general purposes:—Jelutong resin, heat-treated, 25; ceresin, 2; oil-soluble compound from cotton-seed oil and sulphur chloride, 8; tung acids, 10; Japan drier, 1; benzol, 30; and petroleum benzine, 24 parts. Pigments fast to cement alkali may be used to colour the composition.—E. W. L.

Preparation [artificial resin] for treating teeth. J. A. Albrecht, Frankfurt, Germany. U.S. Pat. 1,205,957, Nov. 28, 1916. Date of appl., Jan. 4, 1913.

A SOLUTION of a phenol (resorcinol) in formaldehyde is diluted with a viscous retarding agent (glycerin), and mixed with a condensing agent, to

obtain a preparation which will readily penetrate into the smallest cavities in the teeth, and slowly harden there, at the temperature of the body, without liberating any objectionable amount of heat.—C. A. M.

Elastic compositions for printing rollers. Usher Walker, Ltd. and C. E. Soane. Fr. Pat. 480,909, Feb. 5, 1916.

SEE Eng. Pat. 2167 of 1915; this J., 1916, 368.

Manufacture of an insoluble azo dyestuff [for preparation of lakes]. Ger. Pat. 295,025. See IV.

Process of treating resinous woods. U.S. Pat. 1,206,283. See V.

Process of making abrasive wheels. U.S. Pat. 1,208,330. See VIII.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Ceara rubber from Nigeria. Bull. Imp. Inst., 1916, 14, 382—384.

Two samples of Ceara rubber, prepared from latex tapped by the Lewa system from trees growing in the Government plantation at Ankpa, Bassa, Northern Provinces, Nigeria, consisted of rough sheets, and were valued at 2s. to 2s. 1d. per lb. and 2s. 4d. to 2s. 6d. per lb. respectively in London (with plantation Para crêpe at 2s. 1d.—2s. 4d. and 3s. 4d. per lb. respectively). The physical properties of the samples were satisfactory and the analytical results were: loss on washing 5.3, and 8.0%; on original sample; and caoutchouc, 83.1, 84.7; resins, 5.3, 6.3; protein, 9.9, 7.7; and ash, 1.7, 1.3%, on the dry washed rubber. A comparison of the second sample with plantation Para sheet, with regard to their behaviour on vulcanisation gave the following results: time of cure at 50 lb. steam pressure, Ceara 50 min., Para sheet 70 min.; tensile strength, 2330, 2300—2400 lb. per sq. in.; elongation 847, 875%. The ages of the trees from which the two samples were obtained were, respectively, 3 years and 3—4 years, their average girth being 15 in. and 18—20 in. at 3 ft. from the ground.

—E. W. L.

Vulcanisation tests. L. E. Campbell. Bull. Dep. Agric., Ceylon, 1916, No. 24. India Rubber J., 1916, 52, 831—832. (Cf. this J., 1916, 1226.)

AN investigation has been carried out at the Imperial Institute, on the effect of the form of raw plantation rubber, the method of drying, and the effect of "overworking" the freshly-coagulated rubber, upon time of vulcanisation, tensile strength, elongation, and permanent set. The results show that the conversion of the freshly-coagulated rubber into crêpe, lengthens the time of vulcanisation, but that, a further, even excessive, "working" of the rubber has little effect. The effect upon tensile strength and elongation is very small. Permanent set was satisfactorily low (1.00—3.44%) in each case. The method of drying—in air at ordinary temperature, in hot air, in a vacuum dryer—has very little effect upon tensile strength or time of vulcanisation. The average tensile strength of all samples examined was fully equal to that of specimens of best hard Para; the average elongation at break was only very slightly lower.—E. W. L.

Vulcanised rubber; Relationship of mechanical to chemical properties of. D. Spence. India Rubber J., 1916, 52, 861. (Cf. this J., 1916, 550.)

EXPERIMENTS made during the past few years

indicate that the combined sulphur at "optimum cure" in the case of *Hevea* plantation rubber is a remarkably constant quantity, equal on the average to approximately 2.8—3.0%. Where more than this amount of combined sulphur has been found, either the method of vulcanisation is at fault, or the means of determining the "optimum cure" is inaccurate. Where the time of cure is prolonged, higher combined sulphur at the "optimum" point will probably be found: depolymerisation, requiring an increase in cure to bring the rubber up to the apparent physical optimum, leads to an increase in combined sulphur over the amount given above. The rubber is nevertheless over-cured. The constancy of the value for combined sulphur leads the author to regard the relation between rubber and sulphur as stoichiometric. It has been observed that the physical properties of pure balata undergo, on vulcanisation, a sudden change in the direction of those of rubber, at a combined sulphur content of about 3%.—E. W. L.

PATENT.

Rubber composition and art of manufacture: Dental.—S. G. Supplee, E. Orange, N.J., and C. J. R. Engstrom, Los Angeles, Cal. U.S. Pat. 1,201,609, Nov. 14, 1916. Date of appl., Feb. 19, 1916.

A PLASTIC composition consisting of a mixture of finely-divided vulcanised, and unvulcanised rubber, is vulcanised, when, it is claimed, the expansion of the one ingredient is off-set or counteracted by the shrinkage of the other.—E. W. L.

XV.—LEATHER; BONE; HORN; GLUE.

Tanning; Theory of vegetable.—H. R. Procter and J. A. Wilson. Chem. Soc. Trans., 1916, 109, 1327—1334.

TANNINS give colloidal sols with water, each tannin particle having a negative charge. The surface layer of solution immediately surrounding the particles has therefore a certain concentration of positive ions bound electrochemically to the tannin; this concentration is called $[M^+]$. If some of the electrolyte MN be added to the solution, there will be now some unbound M^+ in the surface layer, so that in this layer $[M^+]$ and $[N^-]$ will be unequal, though necessarily equal in the bulk of the solution. This is a case to which Donnan's results on membrane equilibria are applicable, and it can consequently be shown that

$$[M^+]_s \times [N^-]_s = [M^+]_b \times [N^-]_b,$$

s and b denoting the concentrations in the surface layer and in the bulk of the solution respectively. The equation refers to diffusible ions. Let x represent the concentration of positive or negative ions in the bulk of the solution, y the concentration of negative diffusible ions, and z that of bound ions in the surface layer, then $y+z$ is the concentration of positive ions, and

$$x^2 = y(y+z).$$

The difference in distribution of ions in the bulk of the solution and in the surface layer gives rise to a potential difference according to the equation

$$E = \frac{RT}{F} \log \frac{1}{\lambda}, \text{ where } \lambda = \frac{y}{x}, \text{ and therefore}$$

$$E = \frac{RT}{F} \log \frac{2x}{-z + \sqrt{4x^2 + z^2}} = 0 \text{ when } x = \infty.$$

Thus E diminishes with increasing concentration of electrolytes in the solution, and when sufficiently small, establishes a condition favourable to the coalescence of tannin particles and their precipitation. Similarly between a colloid

jelly such as hide, and an acid solution, in which it is immersed, a potential difference will exist, which is opposite in sign to that existing in the case of tannin. Thus when hide is immersed in a slightly acid tannin solution, electrical neutralisation and co-precipitation of the two colloids follows their mutual approach. This is the fundamental action in vegetable tanning. Tannins for which z is higher than for others will give the greatest potential difference between surface layer and bulk of solution, will combine most rapidly with hide, and will give the most stable leather. A table giving the values of z for various tannins under uniform conditions would be of great value. The rate of tanning for a given tannin concentration is a maximum when the potential differences are of opposite sign and the absolute value of each is a maximum. With increasing concentration of electrolyte, the potential differences diminish, until the tannin must precipitate alone, and the collagen shrink to a hard mass. In alkaline solution, when both colloids have negative charges, there is no combination. The above reasoning is applicable to many other colloid problems, such as those involved in dyeing.—F. C. T.

Alkali sulphides [in tannery lime liquors]; Determination of—D. McCandlish and J. A. Wilson. J. Amer. Leather Chem. Assoc., 1916, 11, 598—602. (See also Bennett, this J., 1916, 1124.)

The presence of ammonia in standard zinc sulphate solutions is useful for the titration of solutions of sodium sulphide alone, but not when lime is also present, even though the precipitation of zinc hydroxide is prevented. Zinc hydroxide is less soluble than zinc sulphide, and the titration would be impossible but for the more complete ionisation of the hydroxide. When the titration is nearing the end point, the solution is saturated with zinc sulphide, and the following relations hold:

(1) $[Zn^{++}] \times [S^{--}] = K_1$ (solubility-product constant)

(2) $[Zn^{++}] \times [OH']^2 = K_2[Zn(OH)_2]$

and therefore (3) $[S^{--}] = \frac{K_1[OH']^2}{K_2[Zn(OH)_2]}$

and with a solution saturated with zinc hydroxide, $[Zn(OH)_2]$ is fixed, and (3) may be expressed in the form:

(4) $[S^{--}] = K_3[OH']^2$

which gives the minimum value for $[S^{--}]$, which is necessary for the end point, the denominator in (3) being at a maximum. Any further addition of zinc ions will cause a precipitation of both zinc sulphide and hydroxide in such proportion as to satisfy (4). Any increase in $[OH']$ increases $[S^{--}]$ and also the error of titration, as is readily shown by the addition of sodium hydroxide. Ammonium chloride diminishes $[OH']$. Experiments showed that 25—40 c.c. of concentrated ammonia per litre in $N/10$ zinc sulphate solutions, with or without ammonium chloride, caused a slight increase in small titrations, owing to the retention of zinc as zinc ammonium ions. This increase becomes indefinitely large by the addition of more and more ammonia. The zinc solution without ammonia is thus not unworkable as Bennett states, though on the other hand no form of zinc solution gives correct results in all cases, strong solutions causing especial difficulty. With regard to Bennett's criticism of the authors' copper method, it is maintained that the equation

$4CuSO_4 + 4H_2S = 2CuS + Cu_2S + S + 4H_2SO_4$ sometimes held to represent the action of hydrogen sulphide on copper sulphate, shows an exact relation between copper and sulphur. Further Schirpf maintains that the action of sodium sulphide on an acid solution of copper sulphate

(as in the authors' method) invariably gives cupric sulphide. It should be remembered that the unprecipitated copper is estimated.—F. C. T.

Biological valuation of the so-called "solvinces" (Turkey-red oils). Robert and Greuel. See XII.

PATENTS.

Tanning substances; Manufacture of—H. Wade, London. From Deutsch-Koloniale Gerbu-Farbstoff Ges. m.b.H., Karlsruhe, Germany. Eng. Pat. 18,174, Dec. 30, 1915.

TANNING substances are obtained by the action of formaldehyde or a substance capable of yielding formaldehyde on aminonaphtholsulphonic acids or dihydroxynaphthalenesulphonic acids, as such or in the form of their salts, in aqueous or slightly acid solution.—F.W. A.

Leather; Composition for finishing and dressing—T. Sandlant, Masterton, New Zealand. Eng. Pat. 17,702, Dec. 7, 1915.

A COMPOSITION for finishing and dressing leather for furniture, etc., consists of three parts each of hard drying elastic varnish, methylated spirit, and petroleum, one part of boiled linseed oil, and six parts of benzine and/or benzol. Pigments may be added as desired. The composition may also be used for the renovation of old and worn leather.—F. C. T.

Composition of matter [hydrolysed glue] for sizing and dyeing. Composition of matter and method of making the same. U.S. Pats. 1,206,189 and 1,206,190. See VI.

XVI.—SOILS; FERTILISERS.

Committee on supplies of fertilisers.

THE Food Controller has appointed a Committee to make such arrangements as may be necessary and expedient for the increase of supplies of fertilisers in the United Kingdom, and for controlling so far as may be necessary their output and distribution. The following are the members of the Committee:—Capt. Charles Bathurst, M.P. (chairman); Mr. H. R. Campbell; Sir James J. Dolbie, F.R.S.; Mr. R. R. Enfield; Capt. R. B. Greig; Mr. T. H. Middleton, C.B.; Mr. W. Anker Simmons; Professor W. Somerville; Mr. G. J. Stanley, C.B., C.M.G.; Mr. R. J. Thompson; and Professor T. B. Wood. Mr. H. Chambers will be the secretary to the Committee.

Evaporation of moisture from the soil; Factors affecting the—F. S. Harris and J. S. Robinson. J. Agric. Res., 1916, 7, 439—461.

To ascertain the effect on evaporation of the initial amount of water present in a soil, small or large shallow vessels made of metal or glass were charged with loam, sand, clay, or muck (vegetable mould) soil, with definite water contents, and allowed to dry for periods varying from 13 to 51 days. Weighings were mostly taken daily, and after each weighing water was added to restore the original moisture content. It was found that evaporation increased with the initial water content of the soil, that the increase was relatively less when the original water content was high, and that in most cases more evaporation took place from soils containing more than 20% of moisture than from pure water itself. The evaporation curves showed the presence of various critical points where the

rates of loss changed rapidly. Evaporation diminished greatly when the humidity of the air was increased and when the intensity of sunshine was reduced. The influence of wind velocity was determined by driving air-currents, produced by electric fans, over soils contained in copper vessels of 6 in. diameter, placed in alleys 70 in. long by 8½ in. wide, one alley receiving no air current. Evaporation increased *pari passu* with increased wind velocity up to 10 miles per hour, but above that velocity the increased evaporation was very slight. Experiments made with quartz sand of five different grades of fineness and placed in copper vessels 1–3 cm. above a free water surface, showed that evaporation was somewhat greater for the finer particles. The effect of mulches of varying depths was ascertained by placing quartz sand or river sand on wire-gauze covered with cheesecloth about 1 cm. above the surface of some water in the same vessel, thereby eliminating capillary action. A ½-inch mulch reduced the evaporation by about 63%, a 1-inch layer by about 66%. Dry mulches composed of fine particles are apparently less effective than others containing coarse particles. Slight changes in temperature exerted a marked effect upon evaporation; compacting the surface soil also increased it but only to a depth of 4 inches. Evaporation was reduced by adding dissolved salts in high concentration.

—E. H. T.

Nitrification in semi-arid soils. W. P. Kelley, J. Agric. Sci., 1916, 7, 117–137. (See also this J., 1915, 808; 1916, 61.)

LABORATORY tests on a light sandy loam soil containing 1% of dried blood showed that nitrification proceeded actively in the virgin soil, manured, and control plots, but that little or no nitrification took place except in the presence of manure. On the other hand, the nitrogen of dried blood was actively nitrified under field conditions where relatively very much less fertiliser was added. Subsequent laboratory experiments proved that when dried blood was added to the soils in amount approximating to that used in the open, the nitrogen was readily converted into the nitric state. Comparative tests with bone meal, ammonium sulphate, and dried blood, on soil from the same plots, showed that the concentration of the fertilisers had a very marked effect upon nitrification. Thus 1% of dried blood in certain soils remained unnitritified when 1% of bone meal and 0.2–0.3% of ammonium sulphate were actively nitrified; but 0.06% of dried blood was readily converted. This inability to nitrify 1% of dried blood was found to apply to widely different soil types of southern California. When bone meal and ammonium sulphate were applied in amounts containing the same quantity of nitrogen as 1% of dried blood, they too remained largely unnitritified. The period of incubation was also shown to have a marked effect upon the rate of nitrification, in fact directly contradictory results could be obtained by varying the period of incubation; in the above tests a period of 4 weeks was selected. The nitric nitrogen was determined by the phenolsulphonic acid or by the aluminium reduction method, but the former is untrustworthy when large amounts are present, and the latter method fails in presence of much nitrite. The conclusion is drawn that much of the laboratory work hitherto done on rates of nitrification is invalidated by the neglect of the two factors—concentration of fertiliser and period of incubation. Investigation of the nitrification in a dark-coloured clay loam soil showed that, given adequate aeration, this process could take place down to 5 ft. below the surface, and the results also emphasised the importance of using the fertilisers in low concentrations. The influence of added

sodium carbonate or sulphate varied greatly with the concentration of the nitrogenous fertiliser employed. Thus 0.05% of the carbonate inhibited the nitrification of 1% dried blood, but 0.04% did not affect the conversion of 0.1% of the fertiliser. Similarly, 0.1% of sodium carbonate was toxic to the nitrification of 0.15% of ammonium sulphate, but stimulated the oxidation when 0.0625% only of ammonium sulphate was present. Under artificial and abnormal conditions, e.g., excess of nitrogenous fertiliser, presence of considerable amounts of alkali salts, nitrite accumulates in field soils, and in certain cases oxidation may not proceed beyond the stage of nitrite, although nitrifying organisms may be present in abundance. Nitric nitrogen is best determined in presence of nitrite by the phenol-sulphonic acid method, after the nitrite has been decomposed by evaporating the soil-extract with 10 c.c. of a 1% ammonium sulphate solution.

—E. H. T.

Phosphoric acid: Conversion of soluble — into insoluble phosphoric acid in the soil under the influence of physical, chemical, and biological factors. S. Skalkij, Agric. Gaz. of Southern Russia, 1915, 17, Bull. Agric. Intell., 1916, 8, 1081–1086.

THE fixation of water-soluble phosphoric acid depends on the chemical, physical, and biological factors of the soil; the intensity of total fixation of the acid is in direct relation to the cultural conditions of the soil and increases with the addition of potassium nitrate. The fixation proceeds with greater intensity in natural soil than in soil in which bacterial life has been destroyed by addition of chloroform. The total intensity of fixation and the physical and chemical fixation of water-soluble phosphoric acid are less in the arable layer (from 0 to 17.7 cm. depth) than in the layer lying immediately beneath (from 17.7 to 35.5 cm.), whilst the intensity of the assimilation of phosphorus is greater in the arable layer than in that immediately beneath. The number of bacteria increases with improvement of the cultural condition of the soil and there is, possibly, a relation between the quality of the bacterial flora and the intensity of assimilation of phosphorus.—W. P. S.

Sodium salts: Effect of — on the absorption of plant food by wheat seedlings in water cultures. J. F. Breazeale, J. Agric. Res., 1916, 7, 407–416.

HARD wheat (*Triticum vulgare*) was grown in a nutrient solution containing, in parts per million: 200 NO_3 as sodium nitrate, 200 K_2O as potassium chloride, 130 P_2O_5 as sodium phosphate, and an excess of calcium carbonate. About 1000 seeds were germinated in 2500 c.c. portions of this solution, and after 2 days the chloride, sulphate, or carbonate of sodium, was added in concentrations varying from 50 to 1000 parts per million. After 21 days' growth the green and dry weights, the nitrogen, phosphoric acid, and the potash contents of 100 representative plants from each culture were determined. When present in concentrations up to 1000 p.p.m., none of the sodium salts affected the absorption of nitrogen by the plants. Sodium chloride up to 1000 p.p.m. had no effect on the P_2O_5 -intake, but decreased slightly that of the potash. The sulphate (1000 p.p.m.) caused the absorption of potash and phosphoric acid to fall to about 70% that of the controls, when expressed as percentage of dry weight of the plants. The depressing effect of sodium carbonate was apparent when only 100 p.p.m. were present; with 1000 p.p.m. the potash absorption fell to 20%, and the phosphoric acid absorption to 30% that of the control. The

inhibiting action of the chloride and sulphate may have been due to their interaction with calcium carbonate to form sodium carbonate.—E. H. T.

Sodium nitrate and ammonium sulphate; Comparison between the effects of manuring potatoes with —. A. Zasukhin. *The Farm (Russia)*, 1916, 11, 297—304. *Bull. Agric. Intell.*, 1916, 8, 1114—1116.

PLOTS manured with ammonium sulphate (264 lb. per acre) yielded larger crops than did similar plots treated with sodium nitrate (396 lb. per acre), and larger crops were obtained by applying the ammonium sulphate directly to the tubers during planting than by spreading it before planting. When the sodium nitrate was applied to the tubers, the development of the potato in its first period of growth was considerably retarded, but as regards the crop, the effect appeared to be equal whether the nitrate was applied to the tuber or spread before planting. By giving half of the nitrogen in the form of sodium nitrate to the tuber, and the other half in the form of ammonium sulphate to the soil, no advantage was secured as compared with manuring the potato with ammonium sulphate alone.—W. P. S.

Dicyanodiamide; Determination of — in nitrolim [crude calcium cyanamide]. A. Stulzer. *Z. angew. Chem.*, 1916, 29, 417—418.

THE error attendant on the determination of dicyanodiamide in crude calcium cyanamide (see Hager and Kern, this J., 1916, 974) may be minimised by extracting with ten times the weight of 94% alcohol, instead of with water, whereby only small quantities of unchanged cyanamide, either free or as the calcium salt, pass into solution along with the dicyanodiamide present, and only traces of the latter are then carried down with the subsequent small precipitate of silver cyanamide. The error due to decomposition of dicyanodiamide by the sodium hydroxide added to reprecipitate its silver salt from the ammoniacal solution is more difficult to obviate, but by keeping the concentration of the alkali within prescribed limits, it does not exceed 5% of the total dicyanodiamide present. It is immaterial whether the ammoniacal liquid is evaporated after addition of sodium hydroxide or not. The modified procedure is as follows:—10 grms. of nitrolim is extracted for 2 hours with 100 c.c. of 94% alcohol, and after filtration, the total soluble nitrogen is determined in 20 c.c.; and to another 50 c.c., 180 c.c. of water is added, followed by 10 c.c. each of 10% silver nitrate and 10% ammonia. The precipitate represents the alcohol-soluble cyanamide in 5 grms. of sample, and 200 c.c. of the undiluted filtrate, representing 4 grms. of sample, is treated with 50 c.c. of 10% sodium hydroxide, and without heating, the precipitate of silver dicyanodiamide filtered off, washed, and determined in the usual way.

—G. F. M.

Fertilisers; Effect of large applications of — on carnations. G. D. Beal and F. W. Muncie. *J. Amer. Chem. Soc.*, 1916, 38, 2784—2804.

THE effect upon carnations of large applications of dried blood, sodium nitrate, ammonium sulphate, acid calcium phosphate, disodium phosphate, and potassium sulphate, and in some cases also sodium chloride and sodium sulphate, to the soil in which they were grown has been determined, the injurious effect characteristic of excess of each fertiliser being recorded. The rapidity with which the plants became affected was, in general, in the order of the solubilities of the fertilisers employed. Determinations of dry weight and of ash made on the foliage of the plants showed an increase in

both values with increased applications of the fertilisers, whilst analysis of the mineral constituents of the foliage showed an increased content of the fertilising salt after large applications. Osmotic pressure determinations made on the sap showed that the degree of injury varied with the osmotic pressure, the increase of osmotic pressure being accompanied by an increase in the total solids and ash of the sap and in the amount of the fertiliser taken up by the plant, but the injury is not a result of increased osmotic pressure exclusively.—T. C.

Boron; Influence of — on plant growth. J. A. Voelcker. *J. Roy. Agric. Soc.*, 1915, 76, 317—351. *Bull. Agric. Intell.*, 1916, 8, 1100.

POT experiments were made as to the effect of boric acid and borax on wheat and barley; the quantities of boron compounds added were equivalent to 0.0001—0.10% of the element, calculated on the whole content of each pot. Germination was retarded by the presence of more than 0.003% of boron and even 0.001% of boron, especially when added in the form of borax, appeared to have some effect. Quantities of more than 0.001% of boron, whether added as boric acid or borax, prevented the plants from developing and forming grain. A toxic influence was noticed with 0.0005% of boron, but quantities not exceeding 0.00025% had a slight stimulating action. The effects generally were more marked in the case of borax than with boric acid. (See also Cook, this J., 1916, 319.)

—W. P. S.

Humic substances in decomposing leaves; Amount of —. A. C. Trusov. *Agric. and Sylvicult.*, Petrograd, 1916, 76, 339—361. *Bull. Agric. Intell.*, 1916, 8, 1096—1098.

THE quantity of soluble humic substances in decomposing leaves varies according to the stage of decomposition; for instance, maple leaves after 4 days' decomposition contain 1.93% of water-soluble humic substances and this is about 50% of the total humic substance present. During the decomposition, the quantity of water-soluble humic substances at first increases and then decreases; this shows that humic substances are formed during the first brief period of decomposition of vegetable detritus and that the humic substance itself subsequently undergoes decomposition. The ratio between the quantity of water-soluble humic substance and that soluble in ammonia varies with different leaves and with the degree of decomposition. When leaves are subjected to repeated desiccation, the quantity of humic substance decreases. The quantity of humic substances formed does not increase after 8 days, and after 156 days its solubility in water disappears completely. (See also this J., 1915, 808; 1916, 132, 616.)—W. P. S.

Relationship between the wetting power and efficiency of nicotine sulphate and fish oil soap sprays. Smith. See XIXB.

PATENTS.

Peat; Treatment of — for manurial and other purposes. W. B. Bottomley, London, Eng. Pat. 16,658, Nov. 25, 1915. (See this J., 1913, 878.)

IN the aerobic treatment of peat previously described, the resulting fertiliser owes its efficacy to the presence of auxinones, and not directly to that of ammonium humates. The initial neutralisation of the peat is much accelerated by sprinkling it in a 6-inch layer with sodium carbonate, in amount equal to about 3% of the weight of

anhydrous peat, dissolved in about five times its weight of water. Further acceleration is effected by then breaking down the cellular tissue with live steam at about 60 lb. pressure in a tank containing perforated steam pipes and covered loosely. This action takes about 30 mins. per ton of peat. After the material has been spread on a heated floor in a 1 ft. layer, water containing ammonifying and nitrifying organisms is sprinkled over it, and then the product is maintained at 26°—28° C. for about three days.—E. H. T.

Fertilisers. G. Defries, London, Eng. Pat. 17,381, Dec. 11, 1915.

NATURAL guano is successively treated with sulphur dioxide and ammonia, or is treated with a solution of ammonium sulphite, and the ammonium sulphite oxidised to sulphate by exposure to air.—B. V. S.

Fertiliser [from molasses]; Process of producing a stable——. L. Wilkening, Hanover, Germany. U.S. Pat. 1,205,829, Nov. 21, 1916. Date of appl., Jan. 14, 1915.

A DRY, stable, non-hygroscopic fertiliser is obtained by the fermentation of a mixture of residues of molasses and an absorbent fibrous material such as peat. The fermentation may be produced by the addition of decomposed stable

acetate. The author recommends treatment with lead acetate and alcohol, as proposed by Chauvin (this J., 1912, 197) for the determination of gum in syrups. A solution of 20 grms. of the sample in 110 c.c. of water is treated with a mixture of 70 c.c. of 95% alcohol and 10 c.c. of basic lead acetate solution, added gradually, with agitation. After standing for about 1 hour, the mixture is diluted to 200 c.c., allowance being made for the volume of the precipitate, and filtered. 100 c.c. of the filtrate is neutralised with a few drops of acetic acid, evaporated to expel most of the alcohol, then diluted to 100 c.c., the excess of lead precipitated with a small quantity of alum. the solution filtered, and the sugar determined in the usual manner. Sucrose and dextrose can be determined accurately in presence of gum arabic by this method; the results are not quite so good in presence of invert sugar, but are better than those given by the ordinary method and are sufficiently accurate for most purposes.—A. S.

Calcium sulphite; Solubility of—— in water and in sugar solutions. T. van der Linden. Deutsche Zuckerind., 1916, 41, 815. Chem.-Zeit., 1916, 40, Rep., 397.

THE following figures express the quantity of calcium sulphite ($\text{CaSO}_3 \cdot 2\text{H}_2\text{O}$) in mgrms. dissolved by 1 litre of the solvents mentioned at various temperatures between 30° and 100° C.

Solvent.	30° C.	40° C.	50° C.	60° C.	70° C.	80° C.	90° C.	100° C.
Water.....	64	63	57	61	45	31	27	11
15% sucrose solution.....	103	83	73	80	56	41	36	41
Solution of 15% sucrose and 1.5% invert sugar.....	104	81	85	71	60	47	40	29
In presence of excess of calcium sulphate:—								
Water.....	31	29	25	19	12	9	8	6
15% sucrose solution.....	35	32	22	16	21	17	20	21
1 Solution of 15% sucrose and 1.5% invert sugar ..	32	27	22	20	16	19	19	28

manure mixed with peat, and air and carbon dioxide may be mixed with the fermenting mass; the fermentation is stopped by the addition of dilute acid.—B. V. S.

Fertiliser; Manufacture of——. C. F. Pennewell, Sacramento, Cal. U.S. Pat. 1,208,499, Dec. 12, 1916. Date of appl., Aug. 18, 1914.

STABLE manure and a carbohydrate are placed in a container with a perforated base, situated immediately above a second container charged with soil containing nitrifying organisms. About every third day, water is added to the upper vessel at the rate of 2 galls. per ton of the manurial mixture and per ton of soil, and the liquid filters through from the upper to the lower container. The wetted soil is stirred at intervals of about three days, and the moistening and stirring are continued for about ninety days.—E. H. T.

XVII.—SUGARS; STARCHES; GUMS.

Sugars; Determination of—— in presence of gum. G. Savini. Annali Chim. Appl., 1916, 6, 250—255.

THE official Italian and German methods for the determination of sugar in presence of gum, in which the solution is treated with basic lead acetate and the excess of lead precipitated with sodium sulphate, phosphate, or carbonate, do not give accurate results, as the gum is not completely removed by the treatment with lead

The slight solubility of calcium sulphite in water is thus increased by sugar and greatly reduced by calcium sulphate.—A. S.

Zymase and carboxylase in the storage organs of the potato and sugar beet. Bodnar. See XVIII.

PATENTS.

[Sugar] syrup or massecuite; Device for examining a sample of——. Device for taking a sample of syrup or massecuite. W. A. Baldwin, Haiku, Hawaii. U.S. Pats. (A) 1,205,837 and (B) 1,205,838, Nov. 21, 1916. Date of appl., May 17, 1916.

(A) A MICROSCOPE tube is mounted movably in a holder provided with means for trapping a definite quantity of syrup or massecuite between two transparent plates, one of which is fixed in the holder and the other is movable with the microscope tube. The holder may be of tubular form, projecting through the wall of a vacuum pan into the massecuite, and fitted inside with an electric lamp between the inner end, which is closed, and the fixed transparent plate, to illuminate the massecuite between the plates. (B) A plate with a hole in the centre is interposed between, and in close contact with, two transparent plates, one of which is mounted to permit a sliding motion relative to the middle plate for the purpose of opening and closing the central pocket.—J. H. L.

Apparatus for revivifying char. U.S. Pat. 1,207,178. See IIb.

Process of producing a stable fertiliser [from molasses]. U.S. Pat. 1,205,829. See XVI.

XVIII.—FERMENTATION INDUSTRIES.

Zymase and carboxylase in the storage organs of the potato and sugar beet. J. Bodnar. Math. és Termész. Ertesítő, Budapest, 1915, 33, 591—610. Bull. Agric. Intell., 1916, 8, 1092—1093.

Zymase was isolated from stored potatoes and ripe sugar beet; in some cases bacteria were present in the liquid obtained but they did not ferment dextrose in the presence of 2% of toluene. Diseased potatoes yielded an enzyme which produced alcohol from dextrose, but the alcohol thus formed was converted into acetic acid by the action of the soil bacteria present. These bacteria had entered as spores into the enzyme extract of the diseased tubers. As with yeast zymase, the presence of carboxylase was detected in potato and sugar beet zymase. The carboxylase of the potato and sugar beet is much less sensitive than are other enzymes to the effects of high temperatures and various antiseptics.—W. P. S.

Fermentation; Influence of small and short elevations of temperature upon the progress of ———. C. Richet and H. Cardot. Comptes rend., 1916, 163, 954—959.

THE influence of brief exposures to high temperatures on lactic acid fermentation was studied; the progress of the fermentation was judged by the acidity of the solution, the acidity of a fermentation mixture under normal conditions being taken as 100. On exposure for 5 mins. at 57°—58° C. there was a reduction of 53% in the acidity of the solution, and this was maintained during the whole fermentation. Small increases in the length of time for which the raised temperature was applied, had a progressive retarding effect on the fermentation. Thus, in the case of a vigorously fermenting mixture, after an exposure of 1 min. at 58° C. the acidity was 93%, after 1½ min. 74%, after 2 min. 72%, after 2½ mins., 57%, and so on up to 5 mins., when the acidity was only 5%. At a lower temperature, 51° C., applied at the beginning of the fermentation, after an exposure of ½—1 min. the acidity was 86.5%, 1—2 mins. 81.7%, 2—3 mins. 78%, 7—8 min. 65.8%. Repeated exposure of the same fermentation to the elevated temperature caused almost a complete stoppage of the action. Thus, at 54° C., tubes heated once for 5 mins. had an acidity of 77% after 62 hrs. fermentation, while tubes heated five times during that period, had an acidity of only 9%. The human skin, which is the most sensitive part of the body, can bear a temperature of 54° C. for a half-minute, and the experiments indicate that the treatment of wounds with water at 54°—58° C. would delay or prevent pathogenic fermentation.—J. H. J.

Ifines; Analytical discrimination between fermented sweet ——— and mistelles. W. I. Baragiola and C. Godet. Z. anal. Chem., 1916, 55, 561—577.

FROM an investigation of a number of mistelles (wines made by adding alcohol to unfermented musts) and fermented wines, the authors conclude that it is impossible to discriminate between the two classes of products by present analytical methods. Among the values determined were the contents of ether-soluble acids (cp. Blarez, this J., 1903, 928), ammonia and volatile acids, the

lævulose-dextrose ratio (cp. Gautier and Halphen, this J., 1903, 811), and the contents of lactic acid and glycerol.—J. H. L.

Citric acid in wine; Detection and determination of ———. F. Schaffer and E. Gury. Mitt. Geb. Lebensmittel. Hyg., 1915, 6, 247. Chem.-Zeit., 1916, 40, Rep., 425.

THE authors have modified Denigès' method (this J., 1898, 802) so that it can be used for the quantitative determination of citric acid in wine. 25 c.c. of the wine is treated with a slight excess of ammonia, concentrated at least to 10 c.c. on the water-bath, treated with 10 c.c. of a 7% solution of copper sulphate, and again concentrated to 10—15 c.c. After cooling, the solution is diluted to 25 c.c., filtered through a dry filter, and 10 c.c. of the filtrate is treated with 1 c.c. (or 1.5 c.c. in the case of wines with a high content of total solids) of Denigès' mercuric sulphate reagent (5 grms. HgO, 20 c.c. H₂SO₄, and 100 c.c. H₂O), and heated to boiling. The solution is then cooled, filtered, the filter washed with a few c.c. of water, and the solution heated to boiling and oxidised by adding a 1% permanganate solution, drop by drop, until a faint brown coloration is formed, which is destroyed by addition of a few drops of 1% solution of hydrogen peroxide. The precipitated mercury acetonedicarboxylate is separated in a graduated tube by centrifuging for 5 mins. at a speed of 1000—1200 revolutions per minute; the volume of the precipitate in c.c., multiplied by 0.021, gives the quantity of citric acid, in grms., in 1 litre of wine. The precipitate may be identified by washing it with a little cold water, dissolving in 2—3 c.c. of a 10% solution of sodium chloride, and adding a few drops of dilute ferric chloride solution, when a red coloration due to the iron salt of acetonedicarboxylic acid is produced. It was found, in agreement with Kunz (this J., 1915, 974), that natural wines may contain citric acid, and indeed in considerably larger quantities than the 0.008% given as the maximum by Kunz.—A. S. J.

Industrial retting of textile plants by microbiological action. Rossi. See V.

PATENTS.

Temperance stout; Manufacture of ———. E. W. Kuhn, London. Eng. Pat. 12,441, Aug. 30, 1915. (See also Eng. Pats. 1622 of 1908; 18,216, 18,218, and 18,219 of 1909; 11,121 of 1913; this J., 1908, 826; 1910, 1126, 1127; 1914, 659.)

WORT of gravity not exceeding 1016, prepared by ordinary methods, is boiled with hops, cooled, and then fermented in a closed vat so that the pressure of carbon dioxide rises to about 1 atm. by the time the desired alcohol-content (about 0.9%) has been attained. The fermented liquid is chilled to 0°—2° C., filtered, bottled, and pasteurised.—J. H. L.

Brewing of beer. A. Floto, La Serena, Chile. Eng. Pat. 102,470, Aug. 19, 1916. (Appl. No. 11,790 of 1916.)

FERMENTED beer produced from a wort containing a high proportion of extract (c.g., about 12° Balling) and twice the usual quantity of hops, is mixed with an equal volume of unfermented wort of low gravity which has been boiled without hops and cooled. The mixture is subjected to a slow secondary fermentation at a low temperature, to produce a beer of low alcohol-content.—J. H. L.

Spirits; Apparatus for refining potable grain ———. Z. Aronowitz, New York. U.S. Pat. 1,206,495, Nov. 28, 1916. Date of appl., Jan. 11, 1916.

THE apparatus comprises a mixing reservoir and

a feed reservoir and means for supplying spirit from the latter to any one of a series of charcoal filters each of which is so connected with the adjacent ones, and the last with the first, that the spirit can pass through all in turn whichever is made the first in operation. From the last charcoal filter in operation the spirit may be led through a sand filter. Means may be provided for testing the continuous flow of spirit between the filters and for controlling the flow from the last filter in operation. The charcoal filter consists of a metallic vessel fitted with a supporting screen in the lower part, liquid-proof doors for the introduction and removal of charcoal, steam-conducting pipes, inlet and outlet pipes for spirit, an outlet pipe for the passage of spirit to a sand filter, a vapour outlet pipe leading to a condenser, and an air relief pipe; all the outlet pipes are provided with screens to retain solid particles.—J. H. L.

Manufacture of nitrogen compounds [from distillers' spent wash]. U.S. Pat. 1,207,116. See VII.

XIXA.—FOODS.

Amylase in potato tubers: The part played by the —. J. Bodnár and G. Doby. Kiserlet Közlemények, Hungary, 1915, 18, 789—795; 956—968. Bull. Agric. Intell., 1916, 8, 1093—1094.

It was found that no regular relation existed between the sugar content of stored potatoes in a state of rest and the activity of the amylase present; the quantity of reducing sugar (dextrose) did not increase in proportion with the activity of the amylase. On the other hand, a certain relation existed between the activity of the amylase and the proportion of non-reducing sugar (sucrose) and also between this activity and the total quantity of sugar. Thus, with an increase in the activity of the amylase, the proportion of total sugar and of non-reducing sugar also increased. The activity of the amylase is, therefore, of importance, since a high activity indicates that the tubers are rich in sugar or that their respiration is more intense; potatoes with a high sugar-content are liable to rot, and in those having a more intense respiration a greater quantity of the starch is decomposed. (See also this J., 1915, 568, 677.)—W. P. S.

Margarine prepared from hydrogenised fats: Water-content of —. K. Brauer. Z. öffentl. Chem., 1916, 22, 209—216. Z. angew. Chem., 1916, 29, Ref., 492.

HYDROGENISED fats possess the property of "holding" a greater quantity of water than do ordinary fats and oils, and the water in the emulsion is not readily expelled by working the mixture. Margarine prepared from hydrogenised fats frequently contains as much as 20% of water. —W. P. S.

Cocoa powder: Determination of fat in —. Keller. Apoth.-Zeit., 1916, 31, 330. Z. angew. Chem., 1916, 29, Ref., 493.

EXTRACTION with ether in a Soxhlet apparatus for 16 hours is sufficient to extract the whole of the fat from cocoa powder. There is no need to mix the cocoa with sand previous to the extraction, and the addition of sand has the disadvantage that the crude fibre cannot then be determined in the extracted powder. Attention is directed to the fact that theobromine is extracted together with the fat and forms a white deposit on the wall of the extraction flask; the quantity of theo-

bromine thus extracted is small and in most cases may be neglected. If desired, the fat, after weighing, may be dissolved out of the flask with ether and the flask containing the deposit of theobromine re-weighed. In addition to theobromine, the ethereal extract of cocoa contains another basic substance; this yields a gold salt which differs from theobromine-gold chloride in m pt. and gold-content.—W. P. S.

Theobromine and caffeine in cocoa and chocolate: Determination of —. G. Savini. Annali Chim. Appl., 1916, 6, 217—250.

TWELVE grms. of the sample is heated for 10 mins. with 70 c.c. of light petroleum spirit in a 500 c.c. flask, the hot solution is decanted through a filter, and the process repeated twice. The filter paper is transferred to the flask and the residual substance is boiled with 250 c.c. of water and 5 c.c. of 10% sulphuric acid for 1 hour under a reflux condenser. The hot solution is poured off and the flask rinsed with hot water. The acid solution is cooled to about 30° C., made up to 300 c.c., and filtered, 250 c.c. of the filtrate (=10 grms. of sample) is mixed with 10 grms. of sand and excess of magnesia, evaporated to a syrup, and then mixed with a further 8—10 grms. of magnesia which converts it into a dry powder. This is transferred to a flask and treated with 100 c.c. of chloroform, the evaporating dish, etc., being rinsed twice with 2.5 c.c. of hot water, which is added to the chloroform in the flask. After adding 0.25 c.c. of strong ammonia solution, the chloroform is boiled for a $\frac{1}{4}$ hour under a reflux condenser, then decanted through a filter, and the residue again extracted with 100 c.c. of pure chloroform, this operation being repeated until altogether 500 c.c. of chloroform has been used. The chloroform solution is evaporated, and the residue is washed twice, with 5 c.c. of petroleum spirit each time, the liquid being passed through a filter. The residue is then dissolved in a small quantity of boiling water, the solution filtered through the same filter, the insoluble matter washed three times with boiling water, the solution evaporated, and the residue of theobromine and caffeine dried for 1 hour at 100° C. and weighed. —A. S.

Zymase and carboxylase in the storage organs of the potato and sugar beet. Bodnár. See XVIII.

PATENT.

Cooling and drying nuts, cubes and similarly shaped pieces of material for use as food for cattle and other animals, and grain, seed and other materials in bulk: Apparatus for —. G. R. Schueler. Kingston-upon-Hull, Eng. Pat. 102,460, July 26, 1916. (Appl. No. 10,521 of 1916.)

THE apparatus comprises a casing, preferably longer than wide, and open at the top, into which the material is delivered from a hopper. A swinging motion may be imparted to the hopper, to ensure uniform distribution of the material throughout the length of the casing. In the lower part of the casing, and extending throughout its length, are two partitions, sloping downwards from the two longer walls to the floor, and constructed of a number of parallel, overlapping slats, spaced apart. Air pumped into the spaces behind these two partitions escapes between the slats into the main body of the casing and passes upwards through the material. Openings in the floor of the casing, which may be covered and uncovered at will by means of slides, enable the material to be discharged after treatment, and shoots may be provided below the openings.—J. H. L.

XIXB.—WATER PURIFICATION; SANITATION.

Water supply; Decolorisation and removal of manganese from a— H. Klat. Mitt. K. Land. Wasserhyg., 1916, 21, 262—276. Z. angew. Chem., 1916, 29, Ref., 493—494.

THE water supply of the town of Neisse (Silesia) is submitted to the following treatment in order to remove iron and manganese compounds, the presence of the latter rendering the water unfit for use in its natural condition. The water is pumped from the wells into a tank and alum is added in the proportion of 80 grms. per cb.m. of water; the treated water then flows over weirs, where it is aerated, into a series of settling tanks from which the clear water is pumped through gravel filters to remove iron compounds. It is then passed through manganese-permutite filters to remove manganese compounds. The latter filters are regenerated from time to time by means of 2% potassium permanganate solution, and means are provided for washing the gravel and permutite filters. The whole treatment diminishes the quantity of organic matter in the water, besides removing the iron and manganese compounds, and does not increase the hardness. A subsequent filtration through permutite filters containing marble removes any free dissolved carbon dioxide from the water.—W. P. S.

Bac. coli in potable waters; Enumeration of— L. Bourdet. J. Pharm. Chim., 1917, 15, 5—12.

IN France the isolation of *B. coli* from water is effected in phenol broth of varying concentration and at a varying temperature. The various methods are reviewed, and it is considered that a strength of phenol of 1 per 1000 and a temperature of 37° C. are the best conditions. It was found that if more than one tube was inoculated with the same quantity of water, all of them would not necessarily give the same result, owing to the tendency of the *B. coli* to be distributed through the water, not singly, but in groups. When *B. coli* was present, the positive tubes from each quantity of water varied from 66% to 90%. Consequently in making a test, several tubes inoculated with the same quantity of water are examined, the numbers increasing from 3 tubes for 100 c.c. of water to 10 tubes for 1—0.05 c.c. Before any result is taken as indicative of *B. coli*, at least 70% of the tubes for each quantity of water should be positive. The results so obtained are confirmed by taking the positive tubes yielded by the smallest quantity of water, sub-culturing twice in phenol broth, and then making cultures in lactose-peptone-water, peptone-water, and gelatin. In the lactose cultures the indicator is not added until after incubation, when the same number of drops is added to the inoculated tube and to a control uninoculated tube.—J. H. J.

Nicotine sulphate and fish-oil soap sprays; Relationship between the wetting power and efficiency of— L. B. Smith. J. Agric. Res., 1916, 7, 389—399.

THE killing power of the sprays was investigated under field conditions upon peas, spinach, and strawberries against the pea aphid, the spinach aphid, and the red spider, the number of insects being counted before application and two hours afterwards. The peas were sprayed five times and the spinach and strawberry plants once each. The relative wetting powers were determined by the method of Cooper and Nuttall (this J., 1915, 1029). The proportions of the two constituents were varied and in every case 50 gallons of spray was prepared. The results showed that certain concentrated solutions were less satisfactory than weaker solutions, probably owing to chemical

interaction between soap and nicotine resulting in diminished efficiency and wetting power. The proportional efficiency of the mixtures against the three kinds of insects was almost identical. The addition of nicotine sulphate decidedly increased the toxicity of the soap, and *vice versa*, but when more than 4 lb. of soap was used with 10 oz. of the nicotine sulphate to 50 galls. of water, the efficiency fell off from the maximum, 90.8%. The best results were obtained by using 6½—8½ oz. of nicotine sulphate to 5 lb. of soap, and when the amount of sulphate was increased both efficiency and wetting power diminished. With 10 oz. of the sulphate and 1 : 50 soap solution, the maximum efficiency was 75%; and the same figure was obtained for a pure soap solution containing not more than 8 lb. of soap per 50 gallons.—E. H. T.

Influence of small and short elevations of temperature upon the progress of fermentation. Richet and Cardol. See XVIII.

PATENTS.

Sterilisation of liquids and especially of water supplies. L. Linden, London. Eng. Pat. 7205, May 13, 1915.

SEE Fr. Pat. 478,797 of 1915; this J., 1916, 1129.

Regulating and proportioning the feed of chemicals or like substances to water or other fluids. G. G. Earland A. B. Wood, New Orleans, La. Reissue No. 14,230, Dec. 12, 1916. of U.S. Pat. 1,200,324, Oct. 3, 1916. Date of appl. Nov. 1, 1916.

SEE this J., 1916, 1233.

Silicon compound [for water softening] and process of making same. U.S. Pat. 1,205,509. See VII.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Jambul; Some constituents of— M. C. Hart and F. W. Heyl. J. Amer. Chem. Soc., 1916, 38, 2805—2813.

JAMBUL seeds from *Syzygium jambolana* after air-drying contained 8.0% moisture, 40.3%—41.4% starch, 2.3% crude fibre, 2.1% pentosans, 6.3% protein, 2.9% ash, 2.1% dextrin, and 6.0% tannin, the alcohol-soluble carbohydrates consisting of 0.23% sucrose, 2.3% levulose, and 2.1% dextrose. The material obtained by extracting the seeds with wood alcohol at ordinary temperature, when examined by similar methods to those used by Power and Callan (see this J., 1912, 1051; 1913, 849.) for the examination of the hot ethyl alcohol extract, gave very similar results.—T. C.

Lemon grass oil from India. Bull. Imp. Inst., 1916, 14, 381—382.

LEMON grass oil shipped from Cochin is occasionally found to be "insoluble" when submitted to the usual test with 70% alcohol. A sample of oil distilled from "white-stemmed" lemon grass (*Cymbopogon flexuosus*, Stapf), examined in 1913, resembled citronella oil rather than a true lemon grass oil (this J., 1914, 805). A further specimen has therefore been obtained, and its source identified as *C. flexuosus*, Stapf, f. *albescens*, a colour variety of ordinary Cochin lemon grass. The following are the constants determined for this specimen, and for the earlier specimen respectively:—Sp.gr. at 15/15° C., 0.915, 0.909; refra

tion (100 mm., 22° C.), too dark, $-10^{\circ} 50'$; aldehydes, 81.9%; solubility (80% alcohol) sol. in 0.7 vol., turbid in 4.5 vols., sol. in 0.8 vol., turbid in 4 vols.; (70% alcohol), not sol. in 5 vols., at but 15° C., sol. in 2.5 vols., at 20° C., not sol. in 5 vols. The new sample is therefore a normal lemon grass oil, and hence "insolubility" is not due to inclusion of other grasses. It is probably due to distillation being carried too far.—E. W. L.

Essential oil of Sherungdu tubers. II. Bull. Imp. Inst., 1916, 14, 378—381. (Cf. this J., 1915, 511.)

A CONSIGNMENT of tubers from the Transvaal, weighing 235 lb., was received in August, 1915. These contained moisture, 74.7%, as compared with 42.2 and 25% in earlier samples. Distillation in the laboratory, and also under factory conditions, gave respectively 0.55 and 0.45% of oil calculated on original tubers. Examination of the factory-distilled oil gave:—Spgr. at 15°/15° C., 0.924; rotation (100 mm.) at 22° C., $+26^{\circ} 42'$; acid value, 1.0; ester value, before acetylation, 11.5, after acetylation, 33.6. On re-distillation the following fractions were obtained: 160°—195° C., 44; 195°—270° C., 26; residue (chiefly ketone and sesquiterpene), 30%. The odour of the oil as obtained by distillation is unpleasant, that of the refined oil was not much valued by perfumers, etc. At best the oil would only be useful as a substitute for spike lavender oil, and its production would therefore be unprofitable. The high-boiling constituents are comparatively odourless, and the perfume of the oil therefore lacks persistence.—E. W. L.

Cassia oil; Removal of lead from—. Ber. von Schimmel und Co., Apr. to Oct., 1916. Z. angew. Chem., 1916, 29, Ref., 518.

100 GRMS. of the oil is shaken vigorously and repeatedly with 1 gm. of powdered tartaric acid, and filtered from the flocculent precipitate. The colour of the oil is improved by the treatment, and practically no separation of crystals occurs at the zone of contact of the aqueous and oily layers in the subsequent determination of the aldehydes.—A. S.

Ionone; Manufacture of—. H. F. Slack. Perf. and Essent. Oil Rec., 1916, 7, 389—391.

WHEN lemongrass oil is distilled with steam the early and later fractions contain only a small percentage of citral, whilst intermediate fractions contain up to 91% and are much more suitable for the manufacture of ionone than the unrectified oil. The condensation agent, used in condensing, the citral with acetone should be in solution, as insoluble condensation agents, such as sodamide, cause local overheating with consequent production of tarry and resinous matters. The yield and quality of the condensation product are much improved by carrying out the condensation in presence of a diluting agent, the best result being obtained by employing excess of acetone as diluting agent; five parts of acetone to one part of citral is a suitable proportion. Sodium ethoxide is a much better condensation agent than either sodamide or barium hydroxide, the best proportion being one part of a 5% solution of sodium ethoxide in absolute alcohol to two parts of citral. During condensation the temperature must be kept as low as possible, and prolonged contact with the alkaline condensation agent must be avoided. Immediately after condensation the excess of acetone is removed by rapidly washing with water, and the unchanged citral removed by distilling with steam. The residual pseudo-ionone is converted into ionone by boiling 100 parts with 15 parts of concentrated sulphuric acid, 500 parts of

glycerol, and 500 parts of water for six hours. The use of 50% sulphuric acid in the cold instead of dilute acid leads to increased amounts of tarry products. The product requires to be repeatedly rectified to give ionone of the highest grade, the distillation being carried out as rapidly as possible to avoid loss by resinification. The final product is greatly improved by passing a rapid current of steam through it, followed by a current of air for several hours.—T. C.

Acetic ester of tribromo-tertiary-butyl alcohol or brometone acetic ester. Studies on derivatives of trihalogenotertiarybutyl alcohols. I. T. P. Aldrich and C. P. Beckwith. J. Amer. Chem. Soc., 1916, 38, 2740—2746.

TRICHLORO- and tribromo-tertiary butyl alcohols ("chlorotone" and "brometone") are known to possess pronounced sedative, hypnotic, and anæsthetic properties, both local and general. Brometone is considered to have more marked sedative, but less pronounced hypnotic and anæsthetic properties. From their reactions they may be regarded as trihalides of ortho- α -hydroxy-isobutyric acid. The acetic ester of tribromo-tertiary butyl alcohol can be prepared from acetyl chloride or bromide and the alcohol, or by means of acetic anhydride and fused sodium acetate. When recrystallised from alcohol it melts at 43—44° C. (uncorr.), is extremely soluble in most organic solvents but practically insoluble in water. It is not readily saponified by boiling water or dilute acid. When saponified the alcohol is decomposed. Saponification takes place quickly with hot concentrated nitric acid. The ester is volatile in the air and in steam, but less readily than chlorotone or brometone. Unlike the parent alcohols, the ester is stable to warm 5—10% caustic alkali solutions. An account is given of the pharmacological action of this and other esters of chlorotone or brometone. (Compare Woffenstein and others, this J., 1916, 328.)—F. C.

Amidines; Synthesis of— from cyanamides by means of the Grignard reagent. R. Adams and C. H. Beebe. J. Amer. Chem. Soc., 1916, 38, 2768—2772.

DIBENZYL-CYANAMIDE on treatment with the Grignard reagent yields first a magnesium halide addition compound, which on treatment with dilute acid is converted into a salt of a substituted amidine. Thus dibenzylcyanamide with ethyl, phenyl, and tolyl magnesium halides and subsequent treatment with hydrochloric acid, yields the hydrochlorides of dibenzylpropionamidinium, m.p. 204°—204.5° C., of dibenzylbenzamidinium, m.p. 211.5° C., and of dibenzyltoluylamidinium respectively. The free amidines obtained by treating these salts with alkalis are very soluble oils or low melting solids which can only be purified with difficulty.—T. C.

PATENT.

Ethylenglycol; Production of—. A. Hough, Lavigne, Quebec. U.S. Pat. 1,206,222, Nov. 28, 1916. Date of appl., Feb. 21, 1914.

ETHYL alcohol vapour is brought into contact with thin layers of aluminium sulphate upon inert material, at a high temperature (350°—400° C.) and in the absence of air, so as to remove the combined oxygen without forming aldehydes. The resulting ethylene is converted into ethylene dichloride, and the chlorine in the latter is replaced by hydroxyl by means of ferric oxide. The ferric chloride formed in the reaction is oxidised, and the resulting ferric oxide and chlorine are used for the treatment of further quantities of ethylene.—C.A.M.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

PATENTS.

Cinematograph film; Renovated —. A. P. H. Trivelli, The Hague, Netherlands. U.S. Pat. 1,205,822, Nov. 21, 1916. Date of appl., Aug. 3, 1916.

A RENOVATED cinematograph film consists of a film coated with a closely adherent layer of transparent flexible varnish containing a salt of a resin acid, a cellulose ester, and a drying oil, and having practically the same coefficient of refraction as the original film. (See also Eng. Pat. 7956 of 1915; this J., 1916, 751.)

Colour photography; Multicolour screens for —. I. Kitsee, Philadelphia, Pa. U.S. Pat. 1,206,000, Nov. 28, 1916. Date of appl., Apr. 8, 1915.

MINUTE coloured particles, suitable for the formation of multicolour screens, are obtained by spraying a coloured solution of a suitable solid through an atmosphere containing a substance, such as formaldehyde, which coagulates the solid and prevents coalescence of the particles.—B. V. S.

XXII.—EXPLOSIVES; MATCHES.

Explosives; Simple tests for —. A. Stettbacher. Z. ges. Schiess- u. Sprengstoffw., 1916, 11, 249—251. Z. angew. Chem., 1916, 29, Ref., 495.

IN order to make rapid tests of the properties of an explosive by means of simple apparatus, it is a great advantage to have an arrangement whereby explosive force and scattering or detonating effect can be measured simultaneously. The method suggested is to pack tightly about 50 grms. of the explosive in a thick-walled nickel crucible which is placed on a plate of soft iron, 6 to 8 mm. thick, and supported on a stand. After bringing about explosion, the detonating effect is measured by the depth of the impression made in the iron plate by the crucible, by the disintegration of the surface, and the amount of scaling. The total energy of the explosion is measured by the bulging and the distortion of the metal plate.—J. N. P.

Pentaerythritol and its nitric ester. A. Stettbacher. Z. ges. Schiess- u. Sprengstoffw., 1916, 11, 182—181. Z. angew. Chem., 1916, 29, Ref., 495—496.

PENTAERYTHRITOL $C(CH_2OH)_4$ gives on nitration a compound which combines the explosive properties of nitromannitol and nitroglycerin, while being free from the disadvantages of these. A method of preparation described by Tollens enables pentaerythritol to be produced in large quantities and purified cheaply. In the form of its tetranitrate the compound is suitable for use in primers, percussion caps, and detonators. In consequence of the linking of the ester groups to a central carbon atom, the nitrate is particularly stable, less sensitive than nitromannitol, but more sensitive than tetranitromethylaniline. As shown by calorific measurements, it possesses a greater decomposition energy than the materials hitherto used for initiating explosions. The preparation of the compound is described in Ger. Pat. 245,025. (See also Eng. Pat. 20,281 of 1891; this J., 1895, 66.)—J. N. P.

Ammonium chlorate; Stability of —. J. Gelhaar. Z. ges. Schiess- u. Sprengstoffw., 1916, 11, 166—167. Z. angew. Chem., 1916, 29, Ref., 496—497.

AN investigation was made of the properties of

ammonium chlorate in the solid state and in aqueous solution. At ordinary temperatures, 3 grms. of the salt exposed in a thin layer to air lost 80% of its weight as gaseous products in 7 weeks. The nitrogen was partly oxidised to nitric acid. At 40° C., spontaneous decomposition took place after 11 hours. 0.5 gm. heated to 70° C. decomposed after 45 mins., 0.1 gm. heated to 90° C. after 10 mins., and at 100° C. after 3.5 mins. In solution, the decomposition took place somewhat more slowly. The dry salt was detonated by a hammer of 2 kilos, falling from a height of 15 cm. In the lead block test, an indentation of 25 t. c.c. was obtained on detonation.—J. N. P.

PATENTS.

Blasting cartridges. W. Weber, Hayingen, Germany. Eng. Pat. 12,463, Aug. 10, 1915. Addition to Eng. Pat. 8606, June 10, 1915.

BLASTING cartridges made as described in Eng. Pat. 8606 of 1915 (see U.S. Pat. 1,157,270; this J., 1916, 276) may contain several combustible metallic powders instead of a single powder, the mixture being placed in a bag, with or without the addition of amorphous carbon or an organic substance, which may have great absorptive capacity for liquid air.—C. A. M.

Explosive containing nitroglycerin. W. Cospy, San Francisco, Cal. U.S. Pat. 1,205,516, Nov. 21, 1916. Date of appl., July 8, 1916.

NITROGLYCERIN (80%) is incorporated with tetrachloroethene (tetrachloroethylene) or a mixture of tetrachloroethene with 20% of tetrachloromethane (carbon tetrachloride).—C. A. M.

Glycol dinirate; Process of making — for explosive uses. A. Hough, Choisy, Quebec. U.S. Pat. 1,206,223, Nov. 28, 1916. Date of appl., Oct. 22, 1911.

GLYCOL (1 part) is nitrated with a mixture (7 parts) of nitric and sulphuric acids containing not less than 93% nor more than 96% of total acids. The nitration mixture may contain from 35 to 36% of nitric acid and 58 to 59% of sulphuric acid, and special claim is made for a mixture containing 35.1% of nitric acid, 59% of sulphuric acid, and 5.85% of water.—C. A. M.

Explosive charge for shells and the like. E. Stern, Hanover. Ger. Pat. 291,811, Aug. 1, 1915.

A FILLING recommended for shells and other projectiles consists of silicon chloride in conjunction with explosives. A violent reaction takes place between the silicon chloride and the water vapour which is produced by some explosives.—J. N. P.

Match and process of making the same. D. A. Venot and L. P. Chasseigne, Pantin, France. U.S. Pat. 1,208,111, Dec. 12, 1916. Date of appl., Aug. 4, 1911. Renewed May 1, 1916.

SEE Fr. Pat. 430,711 of 1910; this J., 1911, 1111.

Manufacture of nitro compounds. Eng. Pat. 102,216. See 111.

XXIII.—ANALYSIS.

Sulphonaphthalein series of indicators and the quinone-phenolate theory. H. A. Lubs and S. F. Acree. J. Amer. Chem. Soc., 1916, 38, 2772—2784.

SULPHONEPHTHALEINS (see this J., 1915, 1226;

1916, 980) containing no negative bromo or nitro group in the phenol residues, when in solution as free acid or as monobasic salt, are yellow to orange in colour, the colour and conductivities indicating that they exist largely in the quinonoid form. On titration with alkali there is an intense colour change when 0.85 mol. to 0.98 mol. of alkali has been added, with formation of the dibasic salt. Solutions of sulphonephthaleins containing negative bromo or nitro groups in the phenol residues have high molecular conductivities and low P_H ranges, indicating considerable ionisation of the phenol residue, and these solutions exhibit more or less the colour of the dibasic salts. Addition of mineral acids to such solutions suppresses the ionisation of the phenol group and changes the intense colour characteristic of the dibasic salts into the fainter yellow or orange of the quinone group. The free sulphonephthaleins and the monobasic salts give absorption spectra containing a yellow band characteristic of the quinones, whilst the dibasic salts have a deep band in place of the yellow band, indicating that the quinone group as such disappears due to combination with the phenolate anion to form a complex quinone-phenolate group. By substituting bromo, nitro, methyl, isopropyl, amino and other groups in the benzenesulphonic acid group and especially in the phenol residue, the ionisation constants of these groups may be greatly changed and indicators of a wide range may be thus obtained. The phenol-, thymol- and cresol-sulphonephthaleins and their bromo derivatives are highly satisfactory indicators.—T. C.

Chemical method of detecting deterioration of wool. Sauer. See V.

Characteristics and basis of valuation of kapok fibre. Cross and Bevan. See V.

Volumetric determination of zinc in its chloride, nitrate, and sulphate. Sjöström. See VII.

Testing hardened concrete. Hart. See IX.

Determination of nickel in iron ores. Covitz. See X.

Detection of arachis oil in admixture with olive oil. Biazzo and Vigdoreik. See XII.

Detection of rape oil in admixture with olive oil. Biazzo and Vigdoreik. See XII.

Determination of alkali sulphides [in tannery lime liquors]. McCandlish and Wilson. See XV.

Determination of dicyanodiamide in nitrolin [crude calcium cyanamide]. Stutzer. See XVI.

Determination of sugars in presence of gum. Savini. See XVII.

Analytical discrimination between fermented sweet wines and mistelles. Baragiola and Godet. See XVIII.

Detection and determination of citric acid in wine. Schaffer and Gury. See XVIII.

Determination of fat in cocoa powder. Keller. See XIXa.

Determination of theobromine and caffeine in cocoa and chocolate. Savini. See XIXa.

Enumeration of Bac. coli in potable waters. Bourdet. See XIXb.

Simple tests for explosives. Steltbacher. See XXII.

PATENTS.

Pyrometer. E. L. Clark, Lakewood, Ohio, Assignor to National Carbon Co., Cleveland, Ohio. U.S. Pat. 1,205,325, Nov. 21, 1916. Date of appl., Dec. 19, 1912.

A GALVANOMETER, a thermocouple, a resistance having a positive temperature coefficient located close to the cold junction of the thermocouple, and a second resistance are connected together in series in a closed circuit. A source of E.M.F. and a variable resistance in series are connected in a closed circuit to the ends of each of the resistances in the first mentioned circuit.—W. F. F.

Gas-calorimeter: Continuous ——. F. G. Breyer, Palmerton, Pa., Assignor to The New Jersey Zinc Co., New York. U.S. Pat. 1,205,701, Nov. 21, 1916. Date of appl., Mar. 31, 1915.

SUPPLIES of gas and air are maintained in tanks under pressure of water columns of constant height and open to the atmosphere. The gas and air are delivered to an open combustion chamber at constant relative rates, and an indicating and recording thermometer is provided with its sensitive element in position to indicate temperature variations in the combustion chamber.—W. F. F.

Method of determining sulphur dioxide. U.S. Pat. 1,205,724. See VII.

Device for examining a sample of [sugar] syrup or massecuite. Device for taking a sample of syrup or massecuite. U.S. Pats. 1,205,837 and 1,205,838. See XVII.

Trade Report.

Prohibited exports. Order in Council, Jan. 15, 1917.

THE following headings have been removed from the Royal Proclamation of May 10th, 1916 (see this J., 1916, 620): ¹Alcohol, methylic. ¹Amyl acetate. ³Barium sulphate. The following headings are added: ³Bone black. ¹Alcohol, methylic, and its esters. ¹Amyl acetate and other amyl esters. ²Barium sulphate.

Chemical and medical glass, etc. Regulations for trading. See VIII.

Book Received.

THE CENTRAL. Vol. XIII. No. 39. SPECIAL CHEMICAL DEPARTMENT NUMBER. Percival Jones, Ltd., Birmingham.

THIS issue of "The Central," which is the journal of the old students of the Central Technical College, contains a brief record of some of the work done in the College under the leadership of Professor Armstrong during the years 1884 to 1914. The subjects dealt with are "Stereochemistry and crystallography," by W. J. Pope. "A reform in education," by W. M. Heller. "Early physico-chemical work at the Central," by H. Crompton. "On chemical change," by T. M. Lowry. "The chemistry of camphor," by A. Lapworth. "Crystallography," by H. A. Miers. "The naphthalene research," by W. P. Wynne. "Biological investigations," by J. V. Eyre. The number concludes with some notes on the origin and development of the chemical school at the Central, by Prof. Armstrong, and a brief account of the careers of the students who have worked under him at the College.



J. B. Jones

Journal of the Society of Chemical Industry.

No. 3. VOL. XXXVI.

FEBRUARY 15, 1917.

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Official Notices.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY.

Owing to unforeseen delays in the receipt of the manuscript of certain sections of these Reports, it is regretted that the publication of the first volume is unavoidably postponed until March.

CROSS AND BEVAN ESSAY PRIZE OF £20 AND LATHAM RESEARCH GRANT OF £300.

The Council have pleasure in announcing that a gift of £20 has been made by Messrs. Cross and Bevan as a prize for an essay on "The Inter-connection of Economic Botany and Chemical Industry."

A further sum of £300 has also been presented by their friend, Mr. T. P. Latham, of Weybridge, to be paid in three annual instalments to such one of the competing essayists as may be judged to be of conspicuous ability, as a grant towards his expenses, on the condition that he apply himself, during three years, to research of approved character on a subject cognate with that discussed in his essay.

The immediate object of the donors is to promote the study of economic botany with special reference to its bearing on chemical industry, giving the widest possible interpretation of the relationship.

They desire, under the auspices of the Society, to assist in forming public opinion in this direction and to discover and further the career of a student of promise who may wish to devote himself to work in such a field.

The Essay Prize will be open to all members of the Society who are British subjects. The Research Grant will be limited to competitors under 25 years of age at the time of sending in the essay.

Essays are to be submitted to the Council of the Society not later than the close of the year 1917. The awards will be made promptly. Neither the prize nor the first grant will be given unless the essayist or essayists shall be deemed to have real merit. The Latham Research Student will be required to submit a report at the close of each year, to satisfy the Council that he has made and is likely to make proper use of the grant.

London Section.

Meeting held at Burlington House on Monday, January 15th, 1917.

MR. A. B. LING IN THE CHAIR.

A NEW METHOD OF EXTRACTING THE VAPOROUS CONSTITUENTS FROM COAL GAS.

BY R. LESSING, PH.D.

The recovery of benzol from coal gas is a problem which has engaged the attention of the carbonising industry for the last 50 years. A good account of its early development, in which men like Cusiter, H. Caro, J. Hardman, G. E. Davis, and F. Carvès appear as pioneers, is given in Lunge's "Coal Tar and Ammonia."

The process was first practised in the English "carbonising" works, then taken up by the by-product coke oven industry, and reintroduced into this country by Continental coke-oven builders.

The gas industry became interested in the recovery of benzol from gas a few years ago as a

means of augmenting the supply of motor fuel, but the statutory requirements of illuminating power stood in the way of its adoption on an appreciable scale.

Whilst the way had been paved, by the fixing in a few individual cases of a calorific standard—the more rational one in view of the growing importance of coal gas as a heating agent—it took the stern demands made by the present War to sweep away old traditions and idiosyncrasies and to make the valuation of gas on a calorific basis more general, or, at any rate, indemnify gas undertakings against deficiencies in illuminating power where they are caused by the extraction of benzol and toluol for munitions purposes. Under these conditions, created by the War, benzol extraction was taken up by many gas undertakings and to an increased extent by coke-oven works which had not previously practised it.

The principle of the process is practically the same in all plants although they may differ in details of design and working. It consists of scrubbing or washing the gas with an absorbent oil and subsequently distilling the absorbed hydrocarbons from the "benzolised" oil and returning the "debenzolised oil," after cooling, to the scrubbers or washers. The scrubbers used are in the main of three types: tower scrubbers filled with more or less efficient packing material; mechanical washers of the horizontal or vertical type; and bubbling washers of the Livesey type. As to stills, a great many varieties of design are in use, many of which are capable of improvement by the application of a more thorough study of the physico-chemical laws involved. Oils from coal tar, blast furnace tar, shale, and petroleum are being used as absorbents, the most important ones being creosote oil, green oil, and gas oil. Undistilled tar is also used as originally proposed by Fricllaender and Quaglio (Eng. Pat. No. 4888, April 1, 1887) and in that case the distilling plant can be dispensed with as fresh tar is produced at the works and the benzolised tar is worked up by the tar distiller. As the boiling range of tar is a very wide one it may act at the same time as a scrubbing and carburetting agent, and to low absorbing efficiency, on account of high water or carbon contents, is frequently added the risk of the gas picking up additional naphthalene from the tar.

The adoption of a process which dispenses with a distilling plant in preference to the more efficient method of washing with oil in a continuous cycle, exemplifies a certain justifiable reluctance on the part of managers of small or medium-sized gas works to add the duties of chemical manufacturers to their manifold responsibilities. It was, therefore, considered desirable to devise a process of benzol recovery which should combine extreme simplicity in design and working of the plant with a fair degree of efficiency.

The use of a "dry" scrubber filled with a solid absorbent material which would strip benzol from the gas without the employment of running wash oil and from which the volatile products could be removed by steam distillation *in situ*, appeared to offer a solution of the problem.

I had observed a number of years ago in the analysis of spent oxide that it was difficult to obtain constant figures when endeavouring to estimate its moisture by passing a current of dry coal gas over it. I explained these results, even at that time, by the absorption of hydrocarbons and carbon disulphide in the gas by the free sulphur and particularly by the tarry matter in the spent oxide. On searching the literature I find that a similar observation had been made

with American spent oxide by Goodno (Gas World, 1893, 18, 296). However, I did not consider spent oxide a suitable material either for the absorption or for the distillation phase of the process. This opinion has since been confirmed with regard to the absorption of carbon disulphide on the practical scale by Teune in experiments carried out at the Amsterdam Gas Works (J. Gas Lighting, 1915, 130, 331).

It appeared to be necessary to find a material of greater and more definite absorptive power, and one which should offer considerably less back pressure than spent oxide would do and not be subject to chemical side-reactions.

It was found that the illuminating power of coal gas could be greatly reduced by passing it through a tube charged with pitch crushed to the size of a pea. It was, however, observed that the sharp-edged pieces became rounded, and that the pitch started "squatting" and finally "running" as soon as its viscosity had decreased sufficiently by the absorption of its solvents from the gas. This showed that it would be impossible to pack a scrubber with it, as it would tend to consolidate

allowing it to remain quiescent, and indeed to behave as a solid, as far as contact with the gas and the production of back pressure is concerned. The absorbed compounds can be liberated from their solution in the oil, *in situ*, by steam distillation, and to this phase of the steaming process apply the same considerations regarding the exposure of a large surface and avoidance of back pressure, as to the scrubbing period.

On this basis the following process was devised:—The gas is passed through a closed vessel which contains porous material soaked in a suitable oil—for instance, green oil or gas oil. The inert material may consist of broken highly porous brick or, preferably, of moulded pieces of definite shape, volume, weight, and available surface. The vaporous compounds in the gas in which the oil is soluble, *i.e.*, the hydrocarbons and organic sulphur compounds, which when isolated, are liquid at ordinary temperature, are absorbed. When the oil has taken up the required amount of the substance to be extracted, which will depend on the quantity and surface of the absorbing agent, the velocity and volume of the

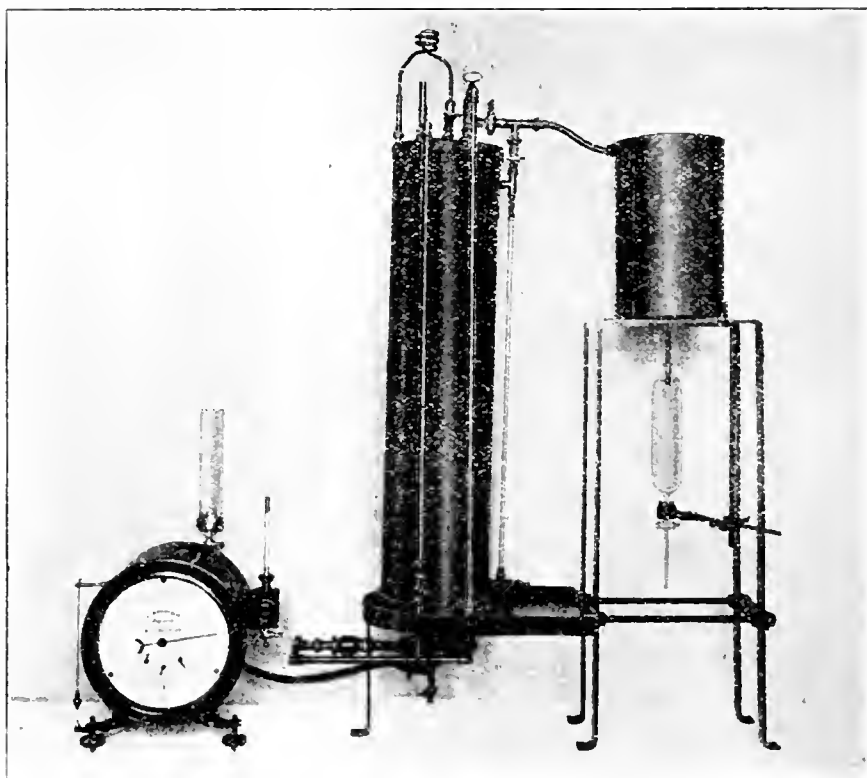


FIG. 1.

and block the passages, even if the temperature were kept low enough for the original pitch to remain rigid.

It was, therefore, necessary to supply a rigid support for the absorbent material. Whilst pitch had been selected on account of the high viscosity, both of itself and its solution in carbon disulphide, benzol, toluol, etc., it was found in the course of further experiments that oils of fairly low viscosity could be incorporated into highly porous inert materials without being unduly thinned or washed out by the solvent vapours from the gas. Whilst, therefore, in the usual methods of washing or scrubbing gas with oils the gas is caused to bubble through a body or pass through a shower or rain of washing liquid, it was found possible to charge scrubbers with oil carried on an inert and rigid support,

gas, the temperature and degree of its saturation, the mutual solubility of the vapours and the absorbing oil, and the vapour pressure of the solution formed, the gas inlet and outlet valves are closed, the gas current being directed into the second vessel of the series. Steam is then blown through the material, carrying the vapours of the absorbed compounds with it to the water-cooled condenser and finally to a receiver fitted with overflow pipes for water and crude benzol respectively. It is advisable to provide the "scrubber-still" with a jacket to avoid the condensation of steam, particularly on the walls. It is, however, not necessary to raise the whole of the inert carrying material to the temperature of distillation. As the oil forms a very thin film and is, therefore, completely exposed to the passing steam, the

volatile matter dissolved in it is distilled off before the non-conducting support is raised throughout its mass to the same temperature.

When the distillation is finished the steam is shut off and the vessel is cooled by passing water through the jacket, and is then ready for the next scrubbing period.

By employing three or more sets of "scrubber-stills" they can be worked in rotation, a definite schedule being arranged for the three periods of scrubbing, steaming, and cooling.

It will be seen that the labour involved is restricted to the manipulation of valves for changing over from gas to steam and *vice versa*, and to the collection of the distillate. As there are no pumps or other moving parts involved in the process, nor adjustments of the flow of oil, the plant does not require any attention except for the change-over from one period to another. The steaming is to be done only once in 24 hours, or at even longer intervals, and occupies only a fraction of the time available for scrubbing. The ground-space required is, if anything, smaller than that occupied by the usual combination of scrubbing and distilling plant. Losses of oil are restricted to the portion distilled off with the steam, particularly if superheated steam is used. In places where the crude benzol is fractionated this oil can be returned in the form of residue. Elsewhere it is replaced by fresh oil, which is occasionally introduced through the top of the scrubber and is allowed to soak into the material on its way to the bottom, where any excess is drawn off through drain-cocks.

The efficiency of scrubbing or washing in the customary manner depends upon constantly breaking up the oil into small drops or thin films, in order to expose new surfaces, and likewise upon deflecting the gas currents at short and frequent intervals to avoid the formation of inactive cores in bubbles or streams. In the proposed method all the oil is exposed in a thin film into the body of which the gas can readily diffuse and which, therefore, does not require breaking up or turning over.

Thickening of the wash oil in ordinary scrubbers is a disadvantage on account of the less intimate contact caused by a rise in viscosity. In this process, provided the solubility is not impaired, the thickening of the oil is rather an advantage, as a more viscous oil is more readily retained by the porous material than a thinner one; whilst the area of the oil film exposed to the gas and steam respectively remains unaltered.

The interaction of gas and oil further depends on time-contact. Assuming equal rates of gas passage and equal scrubbing surfaces of a "dry" scrubber and an "irrigated" scrubber a certain volume of gas would remain in contact with oil for about the same time in both cases. On the other hand the oil in the "dry" scrubber will remain in contact with gas throughout the whole scrubbing period, whilst the contact of each particle of oil passing through the "irrigated" scrubber or through a washer depends on the rate of flow, which varies in wide limits with different constructions, but it is always considerably shorter than that of the quiescent body of oil locked up in the "dry" scrubber. Consequently the oil in the latter has a chance to saturate itself with the vapours from the gas to the maximum limit of the permissible vapour pressure of the solution formed. The latter is more concentrated near the gas inlet than towards the outlet, and if the vessel is divided into compartments, or several vessels are arranged in series, one will be completely saturated whilst the following ones act as check vessels and it is only necessary to steam the completely saturated vessel whilst the second and third become Nos. 1 and 2 respectively, in the series.

Pending the elaboration and thorough testing of the process on a works scale, I have constructed an experimental apparatus for analytical and

research purposes based on the same principle, which has proved useful in this class of work during the last two years. The need for a simple and reliable method of controlling oil washing operations has been expressed on various occasions lately, and I have, therefore, been encouraged by the Ministry of Munitions to publish the details.

None of the purely chemical methods which have been proposed from time to time has been found satisfactory for the control of benzol extraction plants in gas and coke works. The most accurate physical method is probably the freezing out of the condensable hydrocarbons. This was proposed by St. Claire Deville (J. des Usines à Gaz, 1889), who extracted benzol and its homologues by passing from 10 to 20 cub. ft. of gas through glass coils placed in a freezing mixture at -22°C . and weighing the condensate. He also determined the quantity of benzol required to saturate the gas at that temperature by further cooling it to -70°C .

Lebeau and Damiens (Comptes. Rendus, 1913, 156, 144, 325) devised a method for the fractional distillation of liquefied coal gas on the lines of the researches of Ramsay and Travers. This method was amplified by Burrell, Seibert, and Robertson (U.S. Bureau of Mines Tech. Paper 104, 1915).

Whilst exceedingly useful for the estimation of the permanent gases and the total quantity of vapours—if that distinction be permitted—these methods deal with quantities too small to allow of a separation of the vapour mixture into its components. These are, therefore, lumped together into one figure representing "compounds having an inappreciable vapour-pressure at -78°C ." and their volume in uncondensed form amounts to only about 1.5% of the total. Their further treatment is, therefore, out of the question.

H. F. Coward and F. Bailey (Manchester Lit. and Phil. Soc., 1916, XXIV.) pass a current of gas through a tube immersed in a mixture of solid CO_2 and ether for the purpose of estimating the illuminating power of the stripped gas on the lines of St. Claire Deville's experiments.

Whilst all these methods are very valuable for purely research purposes the apparatus is complicated and costly, and requires skilled manipulators; besides, the quantities of liquid hydrocarbons obtainable in reasonable time are too small for practical purposes.

The method most widely adopted for works purposes is the passage of gas through a train of wash bottles charged with tar oils or petroleum oils of various description. The gas is passed at the rate of about 1 cub. ft. per hour. The first bottle in the series is emptied twice a day, charged with fresh oil and placed at the end. The oil from all the bottles is collected and distilled in a metal retort, with the aid of steam for the fractions above 130°C . On account of the back-pressure caused by the oil and the low scrubbing efficiency of most types of wash bottles, the rate of gas cannot be increased, and a complete test of 100 cub. ft. of gas consequently takes practically 5 days.

On account of the bubbling the stream is not constant, and if the gas is to be tested for calorific value or illuminating power it has to be collected in a holder to obtain a steady flame. At best, absorption in wash bottles is attended by the drawbacks of rubber connections and leaks in stoppers.

The method described below overcomes these difficulties. Figure 1 is a photographic view, and Figure 2 is a diagrammatic section of the apparatus. The container, A, is filled with the oil-soaked inert material, C, which rests on a perforated bottom, B, and exerts only a negligible back-pressure to the gas. The gas to be tested enters through stop-cock, D, passes downwards through the material, and through the gas outlet, E, into the gas meter. I prefer to arrange the

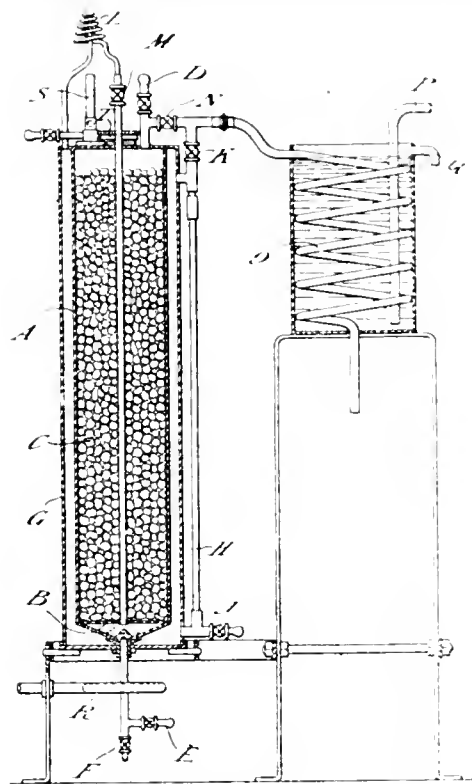


FIG. 2.

gas meter after the scrubber in order to avoid condensation or extraction of vapours in the meter. In most cases it is also more convenient to relate the results to totally extracted gas as a basis. The use of rubber tubing should be avoided as far as possible.

After leaving the meter the gas may be used for any further chemical or physical examination required. Or else it may be burned and then indicates, by its almost entirely blue flame, the satisfactory working of the scrubber. It burns with a perfectly steady flame, and if the burner is arranged on the lines of a jet photometer the length of flame, when compared with that of the unstripped gas, will give a direct, though somewhat empirical, measurement of the extracted hydrocarbons. Only the inner cone of the flame shows a small amount of luminosity, which is due to the non-condensable illuminants, such as ethylene, propylene, and acetylene, and to the small amount of vapour due to the vapour pressure of the solution formed, which is constant for any given temperature.

The container, A, is surrounded by a jacket, G, which is provided with a gauge, H, and drain-cock, J, and is filled with water during the scrubbing period. The gas is passed through the apparatus at the rate of about 5 cub. ft. per hour, and about 100 cub. ft. are used for one experiment. This will, therefore, cover a period of 20 hours, during which the apparatus does not require any attention at all.

Stop-cocks, E and D, are then closed, K is opened and the water run out through drain-cock, J, until it fills only about one-third of the jacket. A gas ring burner, R, is then lit and steam is raised in the jacket, the excess steam escaping through the condenser O. When the water is well boiling K is shut and stopcocks, M and X, are opened, the pressure having been relieved from time to time through X. At the same time the Bunsen burner,

S, is lit. The steam raised in the jacket passes now through the super-heater coil, L, and stop-cock, M, to the bottom of the inner container and up through the absorbent material. The steam and vapours pass through X and condenser, O, and are collected in a graduated separating funnel clamped to the stand under O. P is the inlet for the cooling water and Q its overflow. The charging hole, T, through which the material is put into the apparatus, is closed by a screw-cap. Any water condensing in the vessel or surplus oil is drawn off through drain-cock F.

The steam distillation, including heating up, takes from 1 hour to 1½ hours, and is usually carried on until the absorbed naphthalene is distilled over. To avoid blockages in the condenser it is advisable to allow the cooling water to get hot before the naphthalene stage is reached.

By drawing off the hot water and running cold water through the jacket the apparatus cools rapidly and is then ready for scrubbing again; so that the complete cycle of operations can be carried out within 24 hours and therefore daily tests can be made.

According to the vapour contents of the gas being tested, from 100 to 200 c.c. of steam distillate is obtained. This is separated from the water, measured, and further examined by distillation. In most cases the estimation of benzene and toluene is the principal object. For this purpose H. G. Colman's method of fractionation and final distillation of mixtures with pure benzene, toluene, or xylene is followed.

Apart from the estimation of benzene and toluene considerable interest attaches to the examination of the lower and higher fractions. Even one day's product yields a fair amount of material for the closer examination of the extract from the gas, and a week's supply will suffice for quite considerable research.

It should be remembered that the term "benzol" in this connection refers to a mixture of a number of hydrocarbons and sulphur compounds, and may include paraffins, di-olefines, and naphthalene. Whilst at the moment the production of pure benzene and toluene is in the focus of interest on account of the supply of raw materials for explosives and dyestuffs, the identification and quantitative relation of the other components of the mixture of vapours in coal gas is of the highest importance.

The extraction of condensible hydrocarbons from coal gas has probably come to stay, and will form a valuable source of raw materials for chemicals and motor fuel purposes. As long as the present policy of gas undertakings—of supplying a more or less considerable percentage of inert gases with their product—continues, this deadweight must be compensated by enriching the gas with compounds of greater molecular weight and higher carbon: hydrogen ratio, and consequently higher calorific and illuminating value.

By a study of the compounds of this kind "naturally" present in the gas when leaving the retorts—or the superheater in the case of water gas—it will be found which of them are, economically, the most and which the least important. It will probably pay to extract the gas exhaustively, and re-incorporate with it the hydrocarbons having a lower value for others purposes; or else replace the extract or part of it by cheaper-grade petroleum distillates or cracked spirits.

However, signs are not wanting which point to the possibility of obtaining high makes of gas from coal without the necessity of dilution with nitrogen or carbon dioxide, in the not far distant future. If this comes to pass it will be possible to extract all condensible compounds from the gas and still supply a commodity which in calorific value is far superior to that of the present day.

But even now the detailed examination of the condensible hydrocarbons, beyond their customary

inclusion in " C_nH_m " or "illuminants," of which they form the smaller portion, is essential.

It should be realised that the value of coal gas as a commodity depends in the first instance on its chemical composition. The expression of the aggregate of its constituents and their properties, merely by a composite physical value such as the heating or illuminating power, may be convenient and necessary for the business relations of gas works with their consumers. But, for the study of the mechanism of carbonization and after-treatment of the gas and the wider aspects of the fuel problem a more extensive application of analysis to coal gas, and particularly to its smaller but not less important constituents, is highly necessary.

It is hoped that this method will be found useful in this connection. In the control of benzol extraction plants it has been found capable of discriminating between the hydrocarbons present before and after scrubbing. As is only to be expected it has been found that a large proportion of the naphtha scrubbed out from the gas consists of higher fractions which are of less immediate importance than benzene and toluene, which are frequently allowed to go forward with the gas. The daily control of the extracting efficiency and a closer study of oils and solutions (benzolised oils) at the temperatures concerned is highly desirable.

It should be added that conversely the method is adaptable for the comparative testing of various oils against gases carrying known percentages of vapours both as regards their absorbing capacities and their behaviour on steam distillation.

In conclusion I wish to express my thanks to the Ministry of Munitions for their permission to publish this paper, and to Messrs. Alexander Wright & Co., Ltd., the makers of the apparatus.

THE VULCANISATION OF RUBBER BY AGENTS OTHER THAN SULPHUR.*

BY HENRY P. STEVENS, M.A., F.I.C.

A remarkable series of papers has recently been published by I. I. Ostromyslenski,† in certain of which he claims to have substituted successfully certain nitro compounds and peroxides for sulphur in the vulcanising process. The work, however, is of a superficial character, regarded from the standpoint of the rubber technologist. The proportions are given of a number of mixes containing the above-mentioned substances. These were cured in an autoclave or steam press at various pressures for varying periods. The vulcanisate is variously described as incompletely, completely, or over vulcanised, but there is little or no indication of the physical properties of the product, nor are figures given which would enable a comparison to be

drawn between the physical properties of the rubber vulcanised with these agents and that vulcanised with sulphur in the ordinary manner. Should it be possible to obtain results with nitro compounds or peroxides of the same order as those obtainable with sulphur, we have to deal with a discovery not only of scientific interest but possibly of great technical importance and worthy to rank with those of Goodyear and Parkes.

The first attempts to obtain vulcanisation with nitrobenzenes were unsuccessful. I was unable to obtain any indication of vulcanisation using a mixture of plantation crepe with 2 per cent. of dinitrobenzene (Le Caoutchouc et la Gutta-Percha, May 15, 1916, p. 880), and similar experiments by B. D. Porritt (this Journal, 1916, p. 988), using 1-methyl-2,4,6-trinitrobenzene, showed that this substance acts neither as a vulcaniser nor as an accelerator. However, I found later that a very considerable degree of vulcanisation can be obtained under suitable conditions and, having regard to the importance of the subject, I propose to describe in this preliminary paper some of the more important experiments which I have made.

Vulcanisation with nitrobenzenes. The failure to obtain positive results with nitrobenzenes appears to be due, to some extent at least, to the fact that complete translations of the original Russian were not available (*loc. cit.*). Ostromyslenski claims that complete vulcanisation can be obtained with 0.5% of nitrobenzene whereas 6% of sulphur would be required. He also states that metallic oxides, especially litharge, facilitate the process. But in the actual details of his vulcanisation experiments he only quotes two in which rubber was compounded with nitrobenzenes (in these cases 1,3,5-trinitrobenzene) without the addition of litharge or magnesia. In the first of these experiments crepe rubber was compounded with 0.8% of trinitrobenzene and he states that he obtained "complete" vulcanisation. In the second "Permian" with 20% of trinitrobenzene and 12% of linseed oil were heated together but vulcanisation did not take place. It is therefore plain that the evidence brought forward by Ostromyslenski that "vulcanisation" can be obtained with mixes of rubber and nitrobenzenes alone is of a contradictory nature. I have repeated the first experiment using the proportions given but with negative results, nor did the addition of 0.8% of "accelerene" (*p*-nitrosodimethylaniline) help to produce a "vulcanised" product. Having regard to Porritt's failure and my own to obtain vulcanisation under these conditions, Ostromyslenski's claim cannot at present be accepted.

On the other hand I have obtained the effect of vulcanisation with mixes of rubber with di- or trinitrobenzene in the presence of bases such as litharge or magnesia without the least difficulty. In agreement with Ostromyslenski's statements I find that trinitrobenzene is far more efficient than dinitrobenzene. With mononitrobenzene I have not so far been able to obtain a satisfactory result.

The figures given in Table I were obtained with 100 parts pale sheet rubber, 8 parts litharge, and

TABLE I.

	(1)	Trinitrobenzene, (2)	(3)	(4)	Dinitrobenzene, (5)	(6)
Parts of vulcanising agent	4	4	1	1	1	1
Cure in minutes	5	10	60	90	90	120
Colour of vulcanised rubber	Black	Black	Brown	Brown	Black	Black
Breaking load (grms. per sq. mm.)	954	876	376	318	56	53
Final length (original = 100)	8.56	7.80	8.69	8.56	5.36	5.60
Tensile product*	82	68	33	27	3	3
Acetone extract %	2.12	2.20	1.48	1.05	1.36	—
Nitrogen in same, calculated on rubber, %†	0.24	0.10	0.04	0.06	0.06	0.06

* For an explanation of this term see this Journal, 1916, p. 872.

† It must not be forgotten that the acetone extract of raw rubber usually contains a little nitrogen.

the quantities of *m*-dinitrobenzene and sym.-trinitrobenzene indicated. The specimens were cured in a steam vulcaniser at a temperature of 135°C. for the periods stated.

The original raw rubber gave an acetone extract of 1.8%. Comparing this with the figures for the acetone extracts of the vulcanised rubber, the figures are similar to what would have been obtained with a rubber and sulphur mix—after allowing for the free sulphur simultaneously extracted. That is to say, the acetone soluble constituents of the raw rubber are either somewhat higher or lower than those of the "vulcanised" rubber. The figures for nitrogen indicate that very little of the nitrobenzenes survived the "vulcanisation" or remained in a condition in which they were soluble in acetone. The only exception is the sample containing 4 parts of trinitrobenzene and vulcanised for 5 minutes. Fortunately in the case of the sym.-trinitrobenzene we have a delicate colour reaction by which it may be detected. With a trace of alkali this substance develops a deep red coloration. Examination of the acetone extracts showed an appreciable residue of the trinitrobenzene in (1), a trace in (2), and none in (3) and (4). This test can probably be applied colorimetrically to estimate the "uncombined" sym.-trinitrobenzene, which therefore becomes a very suitable vulcanising agent for quantitative experimental work.

The results of the physical tests show that the products so far obtained possess relatively poor physical qualities. The best results were obtained with the larger proportion of trinitrobenzene, but even in this case the strength as measured by the tensile product is not much more than half that obtainable with a properly vulcanised rubber and sulphur compound.

For comparative purposes, control figures are given in Table 2, (7) and (8), for a mix composed of

mix was also made with 30 parts of magnesia which gave fairly good figures. The results are given in Table 2 and apply to mixes containing 100 parts rubber and the stated proportions of the other ingredients, cured for the stated period at 140°C.

The colour of rubber vulcanised with nitrobenzenes is brown to black (see Table 1). Viewed by transmitted light in a thin stretched sheet, it is yellow-brown and translucent or almost transparent. The dark colour is discharged by treatment with hydrochloric acid after swelling with ether, with the liberation of a trace of hydrogen sulphide, so that there is little doubt but that the colour is due to the formation of a trace of lead sulphide during vulcanisation. This points to the presence of sulphur, possibly arising from traces of sulphur compounds which always hang about a vulcaniser. The amount of lead sulphide would appear to be too small to influence appreciably the reaction with the nitrobenzene or account for the "vulcanised" properties of the vulcanisate. Moreover, litharge can be replaced by magnesia (see Table 2) and probably by other basic oxides with similar results. A comparison of (9) and (10) with (7) and (8) illustrates the effect of trinitrobenzene on an ordinary rubber and sulphur mix.

Vulcanisation with benzoyl peroxide. The discovery of peroxides as vulcanising agents to replace sulphur was announced by Ostromyslenski (J. Russ. Phys. Chem. Soc., 1915, 1453—1461, and 1467—1471). Of the peroxides employed, most of the experiments were made with benzoyl peroxide and I therefore chose this substance for the purpose of controlling the published results. As in the case of the nitrobenzenes, Ostromyslenski's results are of a superficial nature and the vulcanisate is only very roughly characterised by stating whether the vulcanisation was complete and whether the product was dark or transparent.

TABLE 2.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Vulcanising agent.										
Parts of same	4	4	1	1	4	4	10	10	1	1
Other ingredients.										
		Litharge.			Magnesia.				Trinitrobenzene and sulphur.	
Parts of same	30	30	30	30	30	30			10	10
Cure at 140°C. in minutes	5	60	60	75	40	60	90	105	60	90
Breaking load (grms. per sq. mm.)	226	104	419	359	1067	1006	1238	1590	889	1223
Final length (original=100)	5.15	2.74	7.3	7.13	5.42	5.36	10.14	9.36	10.89	9.7
Tensile product	12	3	31	26	58	54	126	149	97	119
Acetone extract %	2.16	2.22	2.11	—	1.58	2.63				

rubber 100 parts and sulphur 10 parts. With a view to obtaining higher figures some experiments were made with larger proportions of litharge (30 parts) but the results were less satisfactory than with the smaller proportion (8 parts) previously used. A

As is well known, benzoyl peroxide, like other peroxides, is very explosive and consequently cannot be handled in the dry state. For these experiments it was used in the form of a paste with about its own weight of water. In this condition

TABLE 3.

	(1)	(2)	(3)	(4)	(5)	(6)
	A.		B.		C.	
Cure (minutes) at 130°C.	60	30	60	30	15	10
Benzoyl peroxide %	0.33	0.33	1.33	1.33	6.67	6.67
Breaking load (grms. per sq. mm.)	34	21	35	57	412	389
Final length (original=100)	228	181	219	339	1025	1006
Tensile product	8	5	8	19	42	39
Acetone extract	1.17	3.04	2.00	2.01	2.13	3.81

it presents no difficulty when added to the rubber on the mixing rolls and the small amount of water added is lost by the time the mixing is complete.

In the first series of experiments three mixes were made of the same plantation crepe rubber with the following percentages of benzoyl peroxide (reckoned dry):—A, 0.33%; B, 1.33%; C, 6.67%. Small portions of the sheeted rubber were cured for various periods to ascertain by simple hand tests the cure most likely to suit the particular mixing. With mixings A and B it was found impossible to prepare an even moderately strong rubber, but with mixing C a fairly satisfactory result was obtained. The figures for the tests are given in Table 3.

It will be noted that mixings A and B give very weak rubbers. Nevertheless, the influence of even 0.33% of benzoyl peroxide is clearly marked, as the raw rubber heated alone under the conditions under which these samples were cured would have given a weak, sticky mass whereas the vulcanised samples A, although very weak and adhesive between cut surfaces, were nevertheless superior in physical properties to what would have been produced had the rubber been heated without the benzoyl peroxide. Mix C gave the best results, the vulcanised samples having approximately one-third the strength of a similar rubber vulcanised with sulphur in the heat. Freshly cut surfaces are rather adhesive and the rubber has the feel of being somewhat undercured. Yet on the whole there is a very marked difference between these samples and those containing the smaller proportions of benzoyl peroxide. Samples from mix B occupy an intermediate position. All the vulcanised samples are very pale in colour, quite as pale as the original raw rubber. Those of mix C have indeed a very attractive appearance. They are quite transparent and resemble some of the palest cold cured sheet prepared from plantation crepe rubber.

The samples were acetone extracted a few days after curing and the figures for acetone extract are given in the table. These compare with an acetone extract of 3.0% for the original raw rubber.

The behaviour of the vulcanised specimens to solvents was also noted. In this respect they exhibit a gradual change in properties according to the proportion of benzoyl peroxide in the mix. Thus the vulcanised mix A "dissolves" in a few hours in benzene in a similar manner to a raw crepe rubber. Mix B swells enormously but does not "dissolve." It remains a soft, shapeless, gelatinous lump in the solvent. Vulcanised mix C behaves in the same manner as an ordinary vulcanised rubber, that is to say, it swells considerably but retains its original form. It may therefore be said that the change brought about by heating with benzoyl peroxide is exactly similar to that produced by sulphur and that the products formed have similar properties. The proportion of benzoyl peroxide required to give a fairly complete vulcanising effect is similar to the proportion of sulphur which would be required for the same purpose, but the vulcanisation with benzoyl peroxide is brought about in a much shorter time. Thus, in the above experiments and also in those published by Ostromyslenski, vulcanisation is fairly complete in ten or fifteen minutes at 130°—135°C. with 4–6% of benzoyl peroxide, whereas vulcanisation would have hardly begun with a mix containing 5–6% of sulphur and would require 2–3 hours for completion. On the other hand, attempts I have made to obtain satisfactory vulcanisation with smaller proportions of benzoyl peroxide, but vulcanising for longer periods, have not been successful. Thus it will be seen that with 1.33% of benzoyl peroxide better results were obtained when vulcanising for 30 minutes than for 60 minutes. Further experiments are in progress.

Manchester Section.

Meeting held at Grand Hotel on Friday, December 1st 1916.

MR. J. H. ROSEASON IN THE CHAIR.

SPONTANEOUS IGNITION TEMPERATURES OF LIQUID FUELS FOR INTERNAL COMBUSTION ENGINES.

BY HAROLD MOORE, M.Sc. TECH.

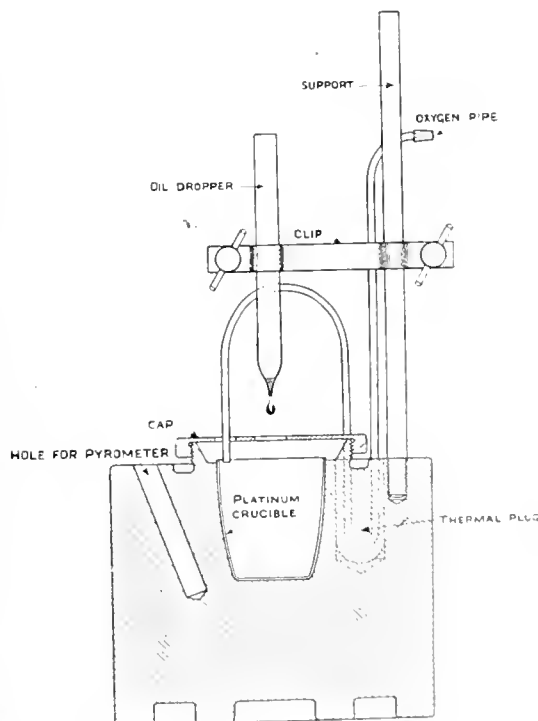
Determinations of the temperature of spontaneous ignition or ignition point of liquid fuels were first made by Holm in 1913*, and their importance as a test is not yet fully realised.

Flash points and burning points are common tests used for both liquid fuels and lubricating oils. The flash point is the temperature at which an oil will give off sufficient vapour to burn momentarily when a small flame is held close to the surface of the oil. The burning point is the temperature at which vapour is given off by the oil at a sufficient rate to maintain a continuous flame.

These properties provide a measure of the danger from fire which is encountered in the handling and storage of liquid fuels and illuminants. They are of little use as an indication of the behaviour of a fuel in an internal combustion engine. The temperature of spontaneous ignition is the temperature at which a substance surrounded by oxygen or air at the same temperature will burst into flame without the application of any spark or other local high temperature.

Holm made several determinations of spontaneous ignition in a tube furnace whilst Constam and Schläpfer investigated the properties of a large number of fuel oils for Diesel engines in a simple apparatus consisting of a small platinum crucible

* Z. angew. Chem., 1913, 273.



placed in a larger crucible, the intervening space being filled with sand. No means of preheating the incoming air or oxygen was employed, and the experimenters concluded that the error was $\pm 30^\circ\text{C}$.

Some time ago the author required to know the temperature of spontaneous ignition of several fuel oils with which he was experimenting on a Diesel engine, and as no existing apparatus was sufficiently delicate to differentiate between these oils it was determined to make a special instrument for this purpose. The result was the device shown in the accompanying figure.

The instrument consists of a diffusion block of 4 in. diameter mild steel bar $3\frac{1}{2}$ in. deep, the base of which has been turned in order to afford a greater heating surface. The upper end of the bar has been machined so as exactly to fit the platinum crucible used for the estimation of the coking values of oils (dimensions, upper diameter 35 mm., diameter of base 22 mm., height 37 mm.).

A screwed-on cover protects the upper end of the crucible from draughts. This cover is provided with two holes, one for oxygen or air inlet and one for oil inlet. The oxygen or air is preheated to the temperature of the experiment, passing through a thin copper coil situated in a chamber inside the block.

A thermometer and a thermocouple pyrometer are fitted into the diffusion block as close as possible to the base of the platinum crucible and serve to show the temperature of the experiment.

The method of operation when determining values in oxygen is to pass the gas through the apparatus at a speed of three bubbles per second. The quantity of oxygen is observed by means of a wash bottle filled with sulphuric acid, which also serves as drying agent. When the temperature of the block is constant at a desired temperature, one drop of the fuel under examination is allowed to fall through the hole in the centre of the cover of the instrument. If the temperature is much higher than the ignition point a sharp explosion will occur almost immediately, if below the ignition point no explosion takes place. When only slightly above the temperature of ignition, the explosion follows some 10 to 12 seconds after the introduction of the oil.

By repeating the experiment the lowest temperature at which ignition takes place is rapidly determined. This temperature is the temperature of spontaneous ignition. The results obtained by different experimenters using the same instrument agree to within 3°C .

A similar procedure using air instead of oxygen will give the ignition temperatures in air, but in this case the explosion is much less violent and always follows one second after the introduction of the oil.

Spontaneous ignition temperatures are of importance for several purposes, but in this paper I will only deal with the application of this test in the examination of liquid fuels for use in internal combustion engines, in which respect I consider that they are of as much importance as the heat value.

Internal combustion engines, whether operating on 2 or 4 stroke cycles, may be divided into two classes:—

1. Engines which receive the fuel and air before the compression stroke, *e.g.*, petrol and gas engines.

2. Engines which compress the air alone and inject the fuel into the cylinder about the end of compression, that is immediately before inner dead centre, *e.g.*, Diesel engines.

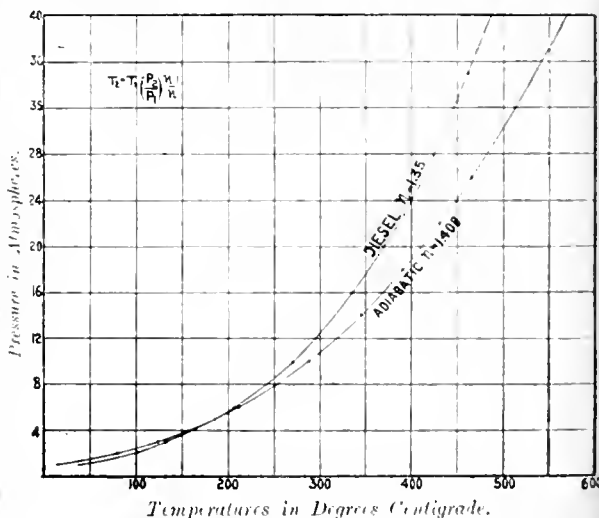
For the first type of engine it is generally desirable to employ high compressions in order to obtain high thermal efficiencies, but the compression allowable is limited by the liability to pre-ignition. Pre-ignition is most liable to occur when the temperature of the mixture due to the heat of

the cylinder walls and the heat of compression approaches the ignition point. Pre-ignition is accompanied by fall of power and loss in efficiency.

In Diesel engines there is no danger of pre-ignition as no fuel is present in the cylinder at the time of compression. No special means are adopted for igniting the charge in Diesel engines, firing being dependent upon the spontaneous ignition of the fuel immediately it enters the cylinder. In Diesel engines it is therefore necessary to employ high compression pressures in order to obtain a sufficiently high compression temperature to ensure the spontaneous ignition of the charge. Provided the temperature is attained it is generally advisable to keep the compression pressure low for mechanical reasons. From these facts it is seen that both for engines which receive fuel and air before the compression stroke and for Diesel engines the temperature at which the fuel will ignite spontaneously is of fundamental importance. In the first case, one is forced to employ a low compression pressure on account of danger of spontaneous ignition, whereas in the case of the Diesel engine this limitation does not appear, but a high compression is required in order to exceed the ignition temperature of the fuel. The temperature attained in the cylinder of an internal combustion engine during compression can be calculated by means of the formula—

$$T_2 = T_1 \left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}}$$

where T_2 and T_1 are respectively final and initial temperatures absolute, and P_2 and P_1 are final and initial pressures respectively; n is a constant



Press., in atmos.	Temp., abs.	Adiabatic temp. $^{\circ}\text{C}$.	Diesel temp. $^{\circ}\text{C}$.
1	288.0	15.0	38.0
2	352.0	79.1	103.0
3	396.0	123.0	133.0
4	430.0	157.0	162.0
5	459.0	186.0	186.0
6	485.0	212.0	207.0
8	526.0	253.0	242.0
10	561.0	288.0	271.0
12	—	—	295.0
14	619.0	346.0	—
16	—	—	336.0
18	664.2	391.0	—
20	—	—	369.0
22	705.2	432.0	—
26	739.0	466.0	—
28	—	—	426.0
32	786.1	513.0	447.0
40	880.5	567.0	487.0

which for air under adiabatic conditions equals 1.408.

On account of the leakage of gas past the piston and the cooling due to the cylinder walls the constant, n , in internal combustion engines approximates to 1.35, the conditions being between those of isothermal and adiabatic compression.

By means of this formula it is possible to calculate approximately the temperature which corresponds to any given compression. The graph of pressure-temperature here shown has been calculated by this means.

It is not at present possible to determine the temperature of spontaneous ignition under actual cylinder conditions, but the relative value can be accurately determined by the device described above. The influence of pressure upon the ignition temperature is a subject for further research.

By an experience of the difference between compressions which have been calculated from the determination of the spontaneous ignition in the instrument, and the experimentally determined point at which spontaneous ignition takes place in an engine, it is possible to build up tables showing the approximate relationship between the experimentally determined ignition point and the maximum compression practicable in a petrol engine. By a similar process it is possible to ascertain the minimum pressures which can be employed in a Diesel engine with any given fuel.

As an example of the influence of the ignition temperature of a liquid fuel we may take the case of alcohol. It has been found in practice that alcohol, though much lower than petrol in calorific power, when run in an engine can be made to yield approximately the same power per unit volume as the latter fuel.

The net calorific power of petrol is about 10,450 calories per gram or 7315 cal. per c.c. The net calorific power of commercial alcohol is about 5420 calories per gram or 4440 cal. per c.c. If both be burnt in an engine with the normal compression (i.e., compression adjusted to suit petrol) the consumptions per B.H.P. hour will be approximately in inverse proportion to the calorific powers of the fuels and over $1\frac{1}{2}$ galls. of alcohol is required to do the same work as one gall. of petrol. Now the spontaneous ignition temperature of petrol (in oxygen) is about 272° C., whilst that of commercial alcohol is 395° C., therefore alcohol will withstand a much higher compression.

The compression pressure of a petrol engine tuned to run on petrol is approximately 90 lb. per sq. in., but with alcohol this pressure may be raised to 200 lb. per sq. in., and by this means the overall thermal efficiency of the engine is raised from about 22% to 35%, when it is found that the volumetric consumption of alcohol per brake horse power hour is approximately the same as that of petrol. Thus though petrol possesses 65% greater calorific power than alcohol per unit volume, the advantages of this high heat value are entirely lost on account of its low ignition point. The ignition temperature is of general interest to chemists as it is a measure of the relative stability of the bodies towards heat. The accompanying table shows the spontaneous ignition temperatures of several fuels which have been determined with this instrument.

Temperatures of Spontaneous Ignition.

Lab. No.	Description.	Specific gravity.	Spontaneous ignition temp. in oxygen.	Spontaneous ignition temp. in air.	Difference.
521	<i>Petroleum Distillates.</i>		°C.	°C.	°C.
	Pratt's Perfection Spt. No. 1	0.710	272	383	+111
250	Petrol (Mex.)	0.718	279	361	+82
522	Pratt's Spt. No. 2	0.724	270	371	+101

Lab. No.	Description.	Specific gravity.	Spontaneous ignition temp. in oxygen.	Spontaneous ignition temp. in air.	Difference.
	<i>Petroleum Distillates.</i>		°C.	°C.	°C.
520	Taxibus Spt (A.A.O. Co., Ltd.)	0.720	272	390	—
26	Paraffin Oil from A.A.O. Co., Ltd.	0.807	251	—	—
350	Petrolite Kerosene	0.814	251.5	432	+180.5
	Empire Paraffin	0.782	253	365	+112
	Petrol from Anglo-American	0.735	—	392	—
	Lamp oil from Anglo-American	0.787	—	367	—
Gas oil.	Gas oil (A.A.O. Co., Ltd.)	—	254	358	—
	<i>Petroleum (crude and residue).</i>				
118	Crude Petroleum (Egypt)	0.851	260	—	—
121	Dijbel oil (Assam)	0.890	261	484	+223
124	Anglo-Persian Oil Co.'s Oil	0.894	254	408	+154
131	Crude Petroleum (Texas)	0.895	256	387	+131
8	Anglo-American Fuel Oil	0.900	260	430	+170
168	Anglo-Mexican Oil	0.908	259.5	417	+157.5
32	Crude Petroleum (Texas)	0.936	268.5	416	+147.5
129	Crude Petroleum (Borneo)	0.939	269	380	+111
111	Mexican Fuel Oil	0.948	259.5	424	+164.5
31	Crude Petroleum (Mexican)	0.949	258	425	+167
47	Crude Petroleum (Trinidad)	0.950	271	424	+153
61	Crude Petroleum (California)	0.952	264	—	—
167	Venezuelan Petroleum	0.955	275	420	+145
13	Crude Petroleum (California)	0.961	262	420	+158
	<i>Shale Oils.</i>				
513	Oil Engine Oil (Broxburn Oil Co., Ltd.)	0.768	253	333	+80
318	Lighthouse Oil (Broxburn Oil Co., Ltd.)	0.803	251	322	+71
	<i>Tar Distillates.</i>				
	Nyloe Commercial	0.860	484	—	—
237	Toluol 90%	0.863	516	—	—
140	Benzol 100%	0.875	566	—	—
	Premier Tarless Tar Oil	0.992	349	—	—
361	Creosote Oil (Hardman & Holden)	1.010	415	—	—
58	Water Gas Tar	—	—	—	—
	Cresote (Stainsby & Lyons)	1.036	473	—	—
71	Coke Oven Tar Oil (Simon Carvès)	1.046	478	—	—
	<i>Tars.</i>				
262	Tar (Product of low temp. carbonisation)	0.987	307	508	+201
371	C.W.G. Tar (Stockport Gas Works)	1.074	464	—	—
340	Oil Gas Tar (Beckton)	1.077	415	—	—
346	Horizontal Retort Tar (Heywood Gas Works)	1.114	445	—	—
335	Horizontal Retort Tar (Stockport Gas Works)	1.123	454	—	—
342	Coke Oven Tar (Simon Carvès)	1.132	494	—	—
363	Coke Oven Tar (Copper Co.)	1.140	488	—	—
362	Coke Oven Tar (Koppers Type Ovens)	1.145	495	—	—
267	Blast Furnace Tar (Carlton Iron Works)	1.172	498	—	—
274	Blast Furnace Tar (Wm. Baird & Co.)	—	410	—	—
	<i>Miscellaneous.</i>				
142	Alcohol	0.817	395	518	+123
	Turpentine	0.842	275	275	sum.
305L	"Mirreles-Diesel"	—	—	—	—
	Compressor Lubricating Oil	0.875	265.5	405	+139.5
239L	"Mirreles-Diesel" Engine Lubricating Oil	0.891	265.5	404.0	+138.5

Lab. No.	Description.	Specific gravity.	Spontaneous ignition temp in oxygen.	Spontaneous ignition temp in air.	Difference.
	<i>Miscellaneous.</i>		°C.	°C.	°C.
335	Whale Oil.....	0.924	273	170	197
	Ether.....	0.730	190	347	157
	Paraffin Wax.....	—	245	—	—
	Naphthalene.....	—	102	—	—
R26	Free Carbon from Tar.....	—	348	—	—
	Asphaltum from Oil.....	—	260	—	—

From general observations the author has concluded that:—

1. Compounds containing simple molecules have higher ignition points than similar compounds containing more complex molecules. This rule applies to all types of compounds.

2. The ignition points of aromatic compounds are much higher than those of aliphatic compounds.

3. Unsaturated hydrocarbons have lower ignition points than the corresponding saturated hydrocarbons.

4. Ignition points observed in air are higher than those observed in oxygen. This difference for petroleum products is generally 100 to 200 C.

DISCUSSION.

The CHAIRMAN observed that the percentage of hydrogen in the compounds appeared to have some effect upon the lowering of the ignition point.

Mr. J. DRUMMOND PATON said from investigations he had conducted in the United States with regard to gas producers for turbines for marine purposes it was discovered that the determining factor causing rapid ignition and pre-firing was the hydrogen content. It was then endeavoured to ascertain the time constant for ignition of fuel of various hydrogen contents and from the velocity of ignition the actual value was set. It was possible that according to the nature of the compound and the molecular tenacity of the hydrogen the tendency to free liberation would be the determining point, and this determined the linear velocity of ignition.

Mr. L. E. VILES remarked that the spontaneous ignition point of petrol was much lower than that of benzene. Motor car users were aware that even with the same compression better effect could be obtained from benzol than from petrol. He asked whether designers of explosion engines had taken this fact fully into account by producing an engine to run with benzol, which according to the evidence Mr. Moore had brought forward, should be more efficient than an engine indiscriminately used either with benzol or petrol.

Mr. DRUMMOND PATON said the most important heat loss occurred in the period of ignition. Had any investigation been made with a view to isolating the crown of the engine, so that at the actual ignition, the cooling effect and surface of the cylinder would be a minimum? For instance, cast iron was now used. Was it feasible to cover the crown and piston face with isolating material which would diminish heat loss?

Mr. T. O. MORGAN, speaking from the point of view of a motorist, said he had tried various mixtures of petrol and very light petroleum, and had even gone so far as to experiment with mixtures of naphthalene and benzol, without noticing any material difference in the pre-ignition or the overheating of the engine.

Mr. MOORE, in reply, said it was very noticeable that compounds with a high hydrogen content usually had a low spontaneous ignition temperature, but the rule did not apply in several cases, whereas the rules given at the end of the paper could always be applied. Petrol contained more

hydrogen than kerosene, but petrol possessed the higher ignition temperature. Paraffin wax had a still lower hydrogen content, but possessed the lowest ignition point on account of its complexity. Methane had a very high hydrogen content and high ignition temperature. It would be seen that hydrogen content was not a reliable indication of the ignition temperature. It was well known that benzol would stand a much higher compression pressure than petrol. The engine of a racing motor car running at 100 lb. compression would "knock" very badly on petrol. It would work much better on benzol. At the same time it was possible to have pre-ignition with any fuel at comparatively low compressions. There were two causes for pre-ignition. If the temperature of the engine were the same at all parts there would not be pre-ignition until the temperature of compression corresponded with the ignition temperature. If the engine were not perfectly even in temperature, as must always be the case in practice, a plug point or a valve top would get hot and act as a firing agent. This ignition was quite independent of spontaneous ignition, so that an engine might "knock" without the compression being excessively high. The adiabatic curve was calculated from the adiabatic formula, the formula of the other curve (for Diesel engine) being taken from the tangent on the compression curve of the indicator diagram of a Diesel engine. Mixtures with naphthalene had, of course, been largely used. The German army was now running its motor vehicles on mixtures of about 4 volumes of alcohol with one volume of a solution of naphthalene in benzol. The addition of naphthalene cheapened the mixture. The benzol raised the percentage of carbon in the mixture and increased the calorific power. Replying to a further question, Mr. MOORE said that there was a tendency for the spontaneous ignition temperature to vary inversely with the flash point, but these values were better considered as independent.

Newcastle Section.

*Meeting held at Bolbee Hall on Monday,
January 17th, 1917.*

MR. HENRY PEILE IN THE CHAIR.

UTILIZATION OF WASTE HEAT FROM COKE MAKING.

BY HENRY PEILE.

Up to comparatively recent years very little of the waste heat from coke making was utilized except for the purpose of raising steam for colliery purposes. This was usually done by installing Cornish or Lancashire boilers on the flues carrying the waste heat from the beehive ovens to the chimney. In this way only a small portion of the waste heat was utilized, only one lb. of steam per lb. of coal carbonized.

In 1901 when the patent ovens were erected at Blyth there was added a complete installation of water tube boilers which are fired by the waste heat and gas generated. The steam from 90 ovens is carried direct into an up-to-date power station. The whole of the power generated at this station is delivered into the mains of the Newcastle Electric Supply Company for general distribution in the Newcastle district. In this way the whole of our waste heat and waste gas is utilized to the best advantage as the station is kept running day and night.

At Rowlands Gill there is an installation of 200

beehive ovens. About eight years ago it was decided to utilize the waste heat from these ovens for the production of electricity. Nine Stirling water tube boilers were erected on the main flues which carry the waste heat from the ovens to the chimneys, and where it was found necessary steam driven fans were added to increase the draught on the ovens.

Economizers were also fitted at the back of the boilers so as to avoid any loss of waste heat. As the process of making coke in beehive ovens is more or less intermittent it was decided to erect two Bettington tubular boilers which are fired with a mixture of coal and coke ballast. The fuel is elevated into an overhead bunker from which it falls into a disintegrator where it is ground into a very fine powder. This powder is then blown into the boiler by hot air where it burns with a hot flame, combustion being very complete. Each boiler is capable of producing 15,000 to 20,000 lb. of steam an hour.

In addition to these two boilers a battery of four Stirling boilers was erected, fitted with underfired movable grates specially designed to burn ballast, one of the waste products from coke making. Burning coke ballast is one of the most economical methods of raising steam and at the same time getting rid of waste material from ovens which has otherwise to be disposed of at some cost. This ballast contains about 80% carbon and is therefore a very valuable fuel. From these six boilers it is possible to add to the steam from the coke ovens 60,000 lb. of steam an hour. The whole of the steam from these boilers is super-heated 200° C., and carried direct into the power station.

In the Whinfield Power Station at Rowlands Gill there are installed four Westinghouse turbines fitted with three phase alternators working at a voltage of 6000. All the semachines are interchangeable.

The electricity which is generated at 6900 volts is passed through specially designed transformers, being supplied to the Newcastle Alloy Company at varying voltages suitable for use in their electric furnaces.

As the station is run on a continuous load night and day it is found necessary to keep the transformers cool by means of oil and water. The output of the station approaches thirty million units a year. Special transformers are installed for supplying power to the colliery for pumping, hauling, and lighting purposes.

Electricity is also supplied for lighting purposes in the district.

Ferro-alloys.

The low tension current from the transformers is passed through the walls of the power station into the Alloy Company's works where it is utilised for the manufacture of ferro-alloys and other purposes.

In the early stages of the company experiments for the manufacture of ferro-silicon were carried out in a small electric furnace. On the strength of these experiments larger furnaces were erected until to-day there is a 2000 K.W. furnace producing from 10 to 15 tons of ferro-silicon a day. During the last four or five years the following grades of ferro-silicon have been successfully produced: 25%, 50%, 75%, and also ferro-silicon of exceptional purity, containing 95% of silicon. There is at present under consideration a scheme for the production of one to two thousand tons a year of this material for war purposes.

We have also produced carborundum in our furnaces, but up to now this has not been done on a large scale.

Before the war there was a furnace running on carbide which made one or two thousand tons of

this material, but owing to keen competition it was decided not to continue its manufacture.

The next alloy to be taken in hand was ferro-molybdenum. Considerable difficulty was experienced in making this alloy on account of its very high melting point and the difficulty of getting rid of objectionable impurities. These difficulties have been successfully overcome and an alloy of excellent quality, testing over 80% of molybdenum, is now being produced.

At the beginning of the war it was discovered that practically there were no stocks of ferro-chrome in the country. We were asked to make this alloy and within three or four weeks of war breaking out we were in a position to supply our customers. Since then we have made large quantities of all grades of ferro-chrome with carbon content ranging from $\frac{1}{2}$ % to 10%. The $\frac{1}{2}$ % carbon grade has a very fine crystalline fracture.

Two or three months after war breaking out a large demand for ferro-tungsten set in for the manufacture of high speed steel for munition works. To make this material we erected a specially constructed furnace house fitted with furnaces suitable for the manufacture of this alloy. We are now producing between 300 and 400 tons of ferro-tungsten a year, all of which is being supplied to steel makers in Sheffield. The alloy is sent out in a ground state or in small pieces as required. Considerable difficulty was experienced at first in breaking up this alloy. These difficulties have now been overcome.

Cuprous oxide. Before the war this oxide was all made electrically in Germany. At the present time we are producing between 300 and 400 tons a year.

Our objects in putting up these works were first to utilize the waste heat from our coking plant and second the production in this country of the various ferro-alloys which were all being supplied from abroad. The value of this policy has been fully justified since war broke out, as otherwise great difficulty would have been experienced in obtaining the necessary supplies of alloys to carry on munition work.

I think that perhaps I have said enough to show how a waste product from coke making can be turned to good account either in producing electricity for general purposes or for the production of alloys and for use in other processes in which electricity is employed. If we are to meet competition in the future, we must be prepared to see that there is no waste of any sort going on in our works.

Yorkshire Section.

Meeting held at Queen's Hotel, Leeds, on Monday, January 8th, 1917.

PROF. J. W. COBB IN THE CHAIR.

NOTE ON A DANGEROUS OIL USED IN A WOOLLEN MILL.

BY THOMAS FAIRLEY, F.I.C., AND B. A. BURRELL, F.I.C.

The oil which is the subject of the present note was being used as a wool oil by a firm manufacturing woollen goods. During the process of manufacture, it was observed that white wool when oiled in the usual manner rapidly began to

heat and would no doubt have eventually fired if it had been left unattended to. It was therefore desirable to determine the nature of the oil and its consequent risk of fire.

The oil gave the following numbers:

Free fatty acids (as oleic acid)	87.6
Unsaturation matter	1.0
Cotton seed oil	none
Iodine value	137.0
Yield of insoluble bromides (m.p. above 200° C.)	10.1
Saponification value	193.6
Yield of fatty acids by saponifying, decomposing the soap and drying at 100° C.	98.2
Iodine value of separated acids	137.0
Loss on heating for 1 hour at 340° F.	66.0
Flash point (open test), 268° F.	—
Ignition point, 406° F.	—

The oil therefore consisted of free fatty acids admixed with about 12% of neutral oil. It had a decided fishy smell and its fish origin was further confirmed by the yield of insoluble bromides and their behaviour on heating, as they did not melt at 200° C., at which temperature they began to blacken and decompose, whereas the hexabromides from linseed oil melt to a clear liquid at about 176° C.

The iodine value and the loss experienced on heating showed the oil to be quite unsuitable for use in a woollen mill and this deduction was completely confirmed in actual practice, as the use of this oil nearly involved a serious fire.

We have examined a large number of oils for the Insurance Companies but have not met with a similar oil.

DISCUSSION.

Mr. W. McD. MACKEY was surprised to find so much of the oil volatile at 340° F. He would like to know the composition of the distillate, and whether any water was present. He thought the use of such an oil would make the yarn sticky.

Mr. J. K. S. DIXON said there were large quantities of fatty acids of all kinds on the market at present, among them fish oil fatty acids. The glycerin was required for explosives, and the resulting fatty acids were being used for a variety of purposes, but this was the first time he had heard of fish oil fatty acids being used (except as an adulterant) as a wool oil, for they were undoubtedly dangerous. He was not altogether surprised at the loss on heating at 340° F. In his experience it was almost impossible to obtain a constant weight when drying fatty acids of any kind at a temperature above 140° C.

Mr. B. T. VICKERS did not think the iodine value a reliable criterion as to whether the oil would heat. It only showed the total possible absorption of oxygen and gave no indication of the rapidity with which oxygen was absorbed, which was the real cause of heating. An actual test in a Mackey's tester would be more satisfactory. He thought it possible that this oil might produce "gilding" which was quite different to heating.

Mr. J. F. BARNES said that in his opinion many cases of spontaneous heating were caused by the melting of oil with live steam in the casks; when the resulting oil and water were put on the wool it was more liable to heat than the oil by itself.

Mr. Wm. RUSSELL said that it was a common practice in the United States to use emulsions made of lard oil and water with a little borax. Hence it evidently was not a danger to have water present with oil on the wool-fibre.

Mr. BURRELL replied that the loss on heating was certainly abnormal; it was not due to the presence of water. He regretted that the small quantity of oil placed at their disposal did not permit of an investigation into the nature of the fatty acids present. He did not think, however, that there could be any notable proportion of either linolic or linolenic acids as the insoluble bromides from these acids melted about 175° C., whereas those obtained did not melt at 200° C., and on further raising the temperature began to decompose.

The oil was not distilled but heated in a flat-bottomed basin in an air oven kept at 340° F. This temperature had been selected because it was the minimum flash point allowed by the Insurance Companies for oils used in woollen mills. The loss of weight took place in a non-oxidising atmosphere, viz., the oil's own vapour; when a free current of air was passed through the oven it was not so great, as it was counterbalanced by the gain of oxygen in the residuum, which assumed a hard, varnish-like consistency. Oleic acid was usually regarded as a non-volatile substance and required a temperature of about 182° F. (250° C.) to distil in a current of superheated steam, but when heated in an air bath at 340° F. it lost about one-third of its weight. Some of the cloth oils which contained from 30%—50% of free fatty acids would lose at least a quarter of their weight when heated under similar conditions. He agreed with Mr. Dixon that it was very difficult to attain a constant weight when heating free fatty acids. A good illustration was the washed insoluble fatty acids from butter when dried at as low a temperature as 190° C.

The iodine value was of great use in determining the safety or otherwise of wool oils; it was the measure of the capacity of the oil for absorbing oxygen and therefore of its drying tendencies, and Gellatly had shown the intimate relationship which exists between drying oils and their tendency to spontaneous combustion when exposed to the air in a finely divided state, as when spread on wool. Woollen manufacturers rightly objected to such oils, as not only was there the tendency to spontaneous combustion but they spoiled the yarn by "gumming." With this oil the wool had not merely "gilded" but had actually charred and the mill itself might be regarded as the cloth oil tester.

In this country the use of emulsions or "creams" was still in its infancy, but no doubt the presence of water along with the oil would tend to increase the heating effect. On the other hand their experience of emulsions was that they were generally made from a safe non-drying oil such as olive oil.

NOTES ON THE WORKING OF A DUST FIRED BOILER.

By C. A. KING, M.S.C.

During recent years much discussion has taken place on the necessity for improved utilisation of fuel of every grade, and with this in view it may be of interest to note a recent appliance, which makes use of low-grade raw coal for steam-raising purposes.

It is well known that in ordinary boiler practice the coal lies on the grate in a fairly thick bed with irregular contact with air, so that immediately after firing, the supply of air is insufficient, resulting in incomplete combustion and the production of smoke, and later, when the volatile matter of

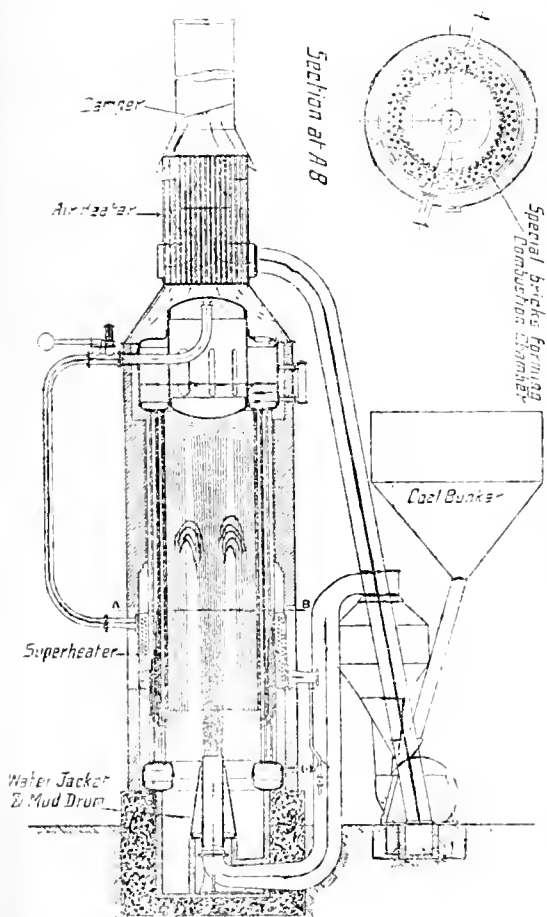
the coal has been distilled off, excess of air passes through the flue, both conditions giving rise to considerable loss of useful heat.

On the other hand, with gaseous firing, the combustible matter, in the form of gas, comes into intimate contact with the air supply and is fully burned without the necessity of a large excess of air to ensure complete combustion.

The method of firing the type of boiler to be described can be regarded as being intermediate between these two conditions, the better admixture of fuel and air being secured by grinding the coal to a very fine dust and blowing the required mixture of coal-dust and air together into the combustion chamber of the boiler. It will readily be seen that the particles of coal are brought into much more intimate contact with air than in standard steam boiler practice.

Commercially and scientifically it is important that fine coal, which is a positive source of danger when left in mines, and is unsalable at the present time by reason of its high ash content, and its lying too closely on boiler grates and in gas producers, can be successfully used.

The Bettington boiler (see fig.) is an example of



this type. Small coal is fed from a storage hopper by means of a variable worm gear, into a pulveriser which also acts as a fan, drawing heated air for the combustion of the coal from a

tubular air heater above the boiler. The pulverised coal, carried along by the air current through a separating chamber, across which is stretched a sieve to reject the coarser particles, is burned at the mouth of a water-cooled vertical nozzle. The heated air, in addition to regenerating some heat from the flue gases, to a certain extent dries the coal as it passes through the pulveriser, preventing clogging of the screen.

The dust as used is of such a fineness that 80% of it will pass through a sieve of 200 meshes per linear inch.

The boiler proper consists of concentric vertical rows of tubes terminating at the lower end in an annular metal chamber, and at the upper end in a drum, the combustion chamber being formed by firebricks of semicircular shape lining the innermost ring of tubes.

The flame and hot gases travel vertically up the central axis of the boiler until, nearing the drum, they are turned down and under the firebrick wall, passing again vertically amongst the water, superheater, and air-heater tubes, and finally to the chimney. It should be noted that in the vertical design the action of gravity causes the coal-dust to travel the combustion chamber a second time, whereas in a horizontal or slightly inclined installation the dust tends to fall out of the combustion zone under this influence.

The function of the firebrick lining, apart from acting as a boundary for the fused ash pellicles, is to retain a sufficient quantity of heat to re-ignite the fuel mixture after any temporary stoppage. Its use also prevents short circuiting of the gases around the tubes, and thus gives an increased length of contact for the combustion process to take place. The incandescence surface of the brickwork may also tend in the direction of more complete combustion.

The ash of the fuel in its passage through the furnace of the boiler is converted into a semi-liquid spray, which coalesces on the lining, slowly trickles down, and drips from the bottom edge into the ashpit, from which it is raked out at intervals. It is of obvious advantage to use a coal the ash of which has a low fusion point, or to modify a refractory ash by suitable addition to the coal. Many analyses show that this clinker contains no combustible matter, and theoretically this is excellent, but with furnaces of this type it is usual to find in practice that a certain proportion of the coal is not completely burnt to ash but passes out of the boiler as a coked dust containing up to 10% of fixed carbon and sometimes up to 5% of volatile matter. This is undoubtedly only a question of design, but at the present time a dust catcher may sometimes be usefully installed.

The ultimate test of the efficiency of a boiler, however, is its evaporative power. It has long been the custom to compare boilers upon the basis of the number of pounds of water evaporated by each, per pound of fuel, but this is likely to be deceptive, especially if, as seems probable, coals of much inferior quality are brought into use. The true efficiency of a boiler is represented by the number of heat units which are utilised in heating the water and converting it into steam compared with the total number of heat units supplied in the fuel used. In the results of the tests below both methods of expression are given.

On one day two tests were made. No interruption of the ordinary working condition was made except that the coal was weighed and the water measured. Temperatures and pressures at various points were also taken throughout the test. The boiler was run at about normal load for 5½ hours

common with all high temperature boilers, soft water should be used to avoid scaling and consequent overheating of the tubes. Full steam pressure (160 lb.) can be raised within thirty minutes from lighting off, and the manipulation is very simple, the firer only having to alter the mechanical regulation of the coal and water feeds according to the variation in load.

No inconvenience from floating coal dust has been observed, the boiler house being clean and tidy.

Acknowledgment is made to The Directors of the Farnley Iron Co. for permission to include the results of the tests, and to Messrs Fraser and Chalmers, Ltd., for the use of the diagram.

ADDENDUM.

The method of obtaining the balance sheet of heat in the various parts of the boiler depends on temperatures and analyses of the flue-gases being taken at the same time at various points. The relationship of these to a conventional temperature of combustion worked out by Bunte, gives the loss of heat in the flue-gas at that particular point as a percentage of the total heat of combustion of the fuel. Correlated with figures obtained from the total heat in the steam raised, all in terms of the percentage of heat in the fuel, a simple calculation then separates the heat retained in the various parts of the boiler.

Thus in the present example on normal load :

	Heat lost from.	Heat retained by.
	%	%
(A) Super-heater (calc. from super-heated steam tables)	—	6.8
(B) Boiler, super-heater, radiation (entering air heater)	18.6	81.4
(C) Boiler, super-heater, radiation, air heater (leaving air heater) ..	16.8	83.2
(D) Boiler, super-heater, air heater, (heat in steam)	—	76.0

Therefore :—

Loss by radiation = C—D	= 6.3
Retained by air heater = C—B	= 1.8
Retained by super-heater = A	= 6.8
Retained by boiler = B—(6.3+6.8)	= 68.3
Loss in flue gas = (100—C)	= 16.8

100.0

DISCUSSION.

The CHAIRMAN called attention to the economic importance attaching to the utilisation of small coal, and to the practical difficulties which were encountered in dealing with dust in boilers, gas-producers, and coke-ovens respectively.

Mr. Moss asked what was the horse-power of the pulveriser?

Mr. B. G. McLELLAN said that he had made some tests on a Bettington boiler a few years ago. With good coal it had been frequently observed that the cost of preparing coal, drying, grinding, etc., more than counterbalanced the increase of efficiency obtained. With low-grade coal, which was the rational fuel for this type of firing, there might be a greater margin, but then there was a tendency for the flame to go out, and for the combustion to be incomplete, as was shown by the clinker being accompanied by particles of coke.

For this type of boiler where the flame temperature was intense, the use of a soft water was imperative. In absence of a natural supply, this meant an efficient water softener under regular chemical supervision. As evaporation proceeded, concentration of salts took place in any boiler using softened water. In Lancashire boilers and water-

tube boilers, with tubes arranged to provide circulation of the water, this might be kept under control, but where there was no definite circulation of water, intense local concentration might occur with crystallisation of salts and as a result, burning or explosion of tubes.

The fact that there was not a definite course of circulation, constituted a distinct weakness in this boiler.

It would be interesting to know the author's experience on the life of the firebrick lining, also if any attempt had been made to employ a lining of the same type as the ash of the coal in use, *i.e.*, an acidic brick for coal with an acidic ash, and *vice versa*.

Mr. WILLIAM McD. MACKEY asked if the boiler was intended for a poor coal, *i.e.*, a coal high in ash, or was it intended that good coal should be ground. In the case of a poor coal he considered that it was better to wash it and then use it in the ordinary way as a boiler fuel, or grind and coke it. In pit practice about half the coal was sold at above cost price, and the rest, the small coal, below, and it was this that was wanted for coke making and ordinary boiler fuel; but the smallest, the fine slack and smudge, contained the bulk of the dirt or ash. The dirt came from the partings in the seam, from the roof, and from the floor, and could be readily washed out of the small coal, except in the rare cases in which the dirt was intergrown with the coal. He agreed with Mr. McLellan's remarks with reference to the action of the fine ash on the brickwork of the furnace.

Mr. C. P. FINN asked for a description of the disintegrator and also what amount of moisture caused this to clog. In coal washeries the fine dust washed away from the coal was allowed to settle out from the water; he wondered whether this would be of any use with these boilers.

Mr. F. MILLER said he understood that it was impossible to store coal dust owing to risk of spontaneous heating. In the present instance, however, the coal was ground immediately before use. He also had seen it stated that it was impossible to screen the coal if it contained more than 1% of moisture. What was the life of the firebrick lining?

Mr. DOUGILL asked if the boiler was adapted to fine coke breeze?

The AUTHOR replied that it was intended to show an improved method of steam-raising by using low-grade small fuel, though with good coal an increased efficiency over ordinary practice would be obtained. Fine coal, which was otherwise wasted, either in the mine itself or on washing plants, could be used if sufficiently dry. Coal containing up to 11% of moisture had been successfully burned though necessitating a rather larger excess of air to prevent clogging in the pulveriser. It was pointed out that air at 60° C could carry 19% of its volume of water vapour, much more than was contained in the coal, and the dust passing to the screen was found by direct determination to be perfectly dry. Coke breeze would have to be much more finely pulverised than coal to be satisfactorily used.

The pulveriser was of the "rotary" type, the blades lasting about three months. During the first test the power consumed by it was 29 EHP, which would correspond with approximately 3% of the steam raised, assuming 15 lb. of steam per kilowatt. No tendency for the flame to go out had been noticed during a period of two years' working.

Definite circulation of water in this boiler was doubtful, and the necessity for the use of soft water had been noted. The life of the brick lining was not a simple question of the acidity or basicity of the ash as compared with the firebrick, though that was important, the physical structure and previous treatment of the clay being also a prime factor.

Communications.

NOTE ON GHEE.

BY R. C. BROWNING, M.A., AND M. PARTHASARATHY
(Government Analyst's Laboratory, Colombo,
Ceylon).

In two papers (Analyst, 1910, p. 313, and 1911, p. 392) Bolton and Revis give figures for the Reichert-Meissl value of ghee. They state that it is usually approaching or even exceeding 30.

Kesava Menon (J. Soc. Chem. Ind., 1910, 1128) finds a Reichert-Meissl value of 25.7 for cow ghee and 18.21 for buffalo ghee. These samples were made at the author's home and were thus genuine.

K. H. Vakil (J. Soc. Chem. Ind., 1915, 320) finds that the Reichert-Meissl values vary from 20 to 25.

The writers of this note have frequently had samples of ghee which appeared to be genuine (from the analytical figures) but which had Reichert-Meissl numbers lower than those of Bolton and Revis.

They have therefore prepared samples of ghee in the laboratory, from cows and buffaloes milked under their personal supervision.

The following is a typical example:

Sample.	Origin.	Butyro- refracto- meter reading at 40° C.	Oleo- refracto- meter at 45° C.	m.p.	Acid value.	Reichert- Meissl value.
1	Buffalo	44°	-28°	43°	0.83	18.9
2	Cow	45.4°	-29°	38°	0.48	22.3

The Reichert-Meissl numbers of four buffalo ghees prepared in the laboratory were 18.9, 18.86, 27.0, and 30.2.

Reichert-Meissl numbers of cow ghees also prepared in the laboratory were 21.4, 22.3, 23.9, 20.9, and 20.9.

Ghees prepared from imported frozen Australian butter had Reichert-Meissl values 29.4 and 28.0 respectively.

It will thus be seen that it is quite possible for genuine ghees to have Reichert-Meissl values well below 30.

The writers' experience is that the oleo-refractometer is most valuable in the preliminary examinations of ghees.

ORGANIC VULCANISING ACCELERATORS.

BY D. SPENCE.

In view of the world-wide publicity given in recent times to the above subject it would seem to be no longer amiss, but, indeed, desirable to put on record a few facts in refutation of some of the very erroneous statements which have appeared in the literature of this subject. The various writers reviewing this subject, and in particular Dittmar,¹ Gottlob,² King,³ Penchey,⁴ have all, without exception, assumed that that which is not proclaimed from the house top is not known, and from these faulty premises have drawn certain equally erroneous yet sweeping conclusions which it has been my intention sooner or later to nullify and correct. I shall take the various references in the order in which they appear.

Dittmar¹ in that part of his article which deals with the subject of organic accelerators refers to the first patent application² on this subject as follows:—"The 16th of November, 1912, marks an important turning-point in the development of the rubber industry. For on the publication of this patent there began a systematic hunt in German, Russian,

Austrian, and in American rubber factories for organic vulcanising accelerators. The ice was broken: the practical value was recognised." This patent deals with the vulcanisation of natural or of synthetic rubber using piperidine or its homologues as accelerators.

In similar, if somewhat more modest, language Gottlob² describes the discoveries of the Elberfeld Farbenfabrik, and in all the subsequent patents dealing with the subject of the vulcanisation of natural or of synthetic rubber by this company the novelty as well as the scope of their discoveries are described in no uncertain terms.

In the article by King³ dealing with this subject it is stated that the use of organic accelerators dates from the discovery of synthetic rubber. "This product cannot be vulcanised without the addition of some of the organic catalysts." . . . "The first patent granted for an organic accelerator was to Bayer & Co. (German Patent 265,221, November 16th, 1912) for the use of piperidine."

According to all these authorities then the discovery of the principle of vulcanisation whether of natural or of synthetic rubber by means of organic catalysts dates from the disclosures of the Elberfeld Farbenfabrik in November, 1912. And by reason of the sources of the information I am inclined to believe that this is true so far as Europe in general and Germany in particular are concerned. But as one who has studied this aspect of vulcanisation, continuously, for the past several years, both scientifically and industrially, I must take exception to their generalisations as far as America is concerned. The "systematic hunt" which Dr. Dittmar refers to, took place in America not after but several years previous to the first disclosure in German patent literature to which he refers, and I hope to demonstrate that this field had been covered and the scope of the discovery determined long before the Elberfeld Farbenfabrik had even commenced to investigate this subject. All their claims as well as those of others to novelty in this connection can readily be disposed of, coming as they do at this late date.

Substantial proof of my assertion is indeed to be had from a careful analysis of my own previously published work on the subject of vulcanisation. In the *Kolloid Zeitschrift*⁶ of 1912, more than six months before the Elberfeld Farbenfabrik made application for their first patent on this subject I described certain experiments the significance of which passed apparently unobserved even by the chemists of the Elberfeld Farbenfabrik. In this communication I wrote as follows:—"More than a year ago we prepared samples of two carefully-chosen mixings. Both mixings were made from partially purified rubber with about 9% of sulphur. In order to make the investigation as comprehensive and complete as possible the two mixings were purposely chosen so that two quite distinct types of compound as different as possible in their properties were obtained. The first was a slow-curing compound deteriorating rapidly; the second, on the other hand, was a quick-curing mixing which we knew from experience would resist deterioration indefinitely. . . . Two compounds of the same general character as No. 2 were prepared; both these compounds contained about 9% of sulphur and were free from mineral compounds."

A moment's consideration of the statements italicised by any chemist of india-rubber familiar with his subject should at once make evident the fact that the acceleration of vulcanisation in the two compounds described must have been produced by novel methods, by substances organic in nature, for the use of litharge, magnesia, or of any of the accelerators then known is expressly precluded. As a matter of fact the first of these two compounds actually contained 1% of piperidine, the very substance referred to in the German patent of November 16th, 1912; the

formula for the mixing was as follows:—Plantation Para 100 pts., sulphur 10 pts., piperidine 1 pt. Without the use of piperidine in this mixing the results given in Table V. of the communication referred to would have been utterly impossible, as I knew full well before I made the test, while debating in my mind as to the best type of compound and accelerator to use for these experiments on vulcanisation at low temperatures.

Now in regard to the discovery of vulcanisation of synthetic rubber by means of organic accelerators, also accredited to the Elberfeld Farbenfabrik. The vulcanisation of these products by this means was actually carried out and successfully accomplished by me both for isoprene-caoutchouc and for the dimethylcaoutchouc from pinacone at a time when the large industrial concerns in Germany engaged in the study of the synthesis of india-rubber were in the dark as to their lack of success in the vulcanisation of their products. The proof of this assertion and the complete vindication of my position with reference to the subject in general I am content to leave over until a later date. At that time I will also bring evidence to show that even the reagents claimed by Peachey (English Patent 4263 of 1914) were known to me and had been used by me both scientifically and industrially several years before his application was applied for.

In conclusion, although it cannot be denied that Germany has taken the lead in many of the discoveries of science in its application to industry and in the present instance has again sought to establish her priority in invention, I believe that I have already brought out enough evidence to refute her claims in this instance and to show that, notwithstanding her silence, America has not been asleep but on the contrary took the lead in the discovery of this one fundamental principle of vulcanisation which has only now become universally recognised.

¹ Dittmar, Gummi-Zeitung, 29, [17], p. 425 (1915).

² Gottlob, Gummi-Zeitung, 30, [14], p. 303 (1916).

³ King, India Rubber Journal, 52, [12], p. 440 (1916).

⁴ Peachey, India Rubber Journal, 52, [18], p. 603 (1916).

⁵ Ger. Pat. 265,221, Nov. 16, 1912, Elberfeld Farbenfabrik.

⁶ Kolloid Zeitschrift, 10, 303—305 (1912).

Industrial Notes.

COMMITTEE ON GLASS AND OPTICAL INSTRUMENTS.

The Advisory Council of the Government's Department of Scientific and Industrial Research have added to the list of their technical Committees a Standing Committee on Glass and Optical Instruments. The membership of the Committee is as present as follows:—Professor H. Jackson (Chairman), Mr. Conrad Beck, Professor C. V. Boys, F.R.S., Mr. F. J. Cheshire, Mr. A. E. Conrady, Mr. A. S. Esslemont, Mr. J. W. French, Dr. R. T. Glazebrook, F.R.S., Sir Howard Grubb, F.R.S., Mr. E. B. Knobel, Dr. T. R. Merton, Professor J. W. Nicholson, Captain Cragh Osborne, R.N., Mr. H. J. Stohart, Mr. J. Stuart, Mr. M. P. Swift, Mr. William Taylor, Mr. F. Twyman, Lt.-Col. A. C. Williams, Mr. W. F. J. Wood.

The Committee met on December 11th, and, having regard to the urgency of the problems requiring investigation in respect of these essential industries, appointed a series of Sub-Committees to which various special problems were referred. Among these problems the more important are:—

- (A) Raw materials for glass and glass making.
- (B) Optical properties of a large range of glasses.
- (C) General physical and chemical properties of glass and glassware for scientific and industrial purposes.

- (D) Testing and standardising of glassware.
- (E) Workshop technique.
- (F) X-ray glass apparatus.
- (G) Optical calculations and lens designing.
- (H) Optical instruments.
- (J) Translation of foreign works on optics.

This brief description indicates certain lines of investigation which have been brought forward. The Standing Committee does not propose to limit itself to these subjects, but is prepared to consider and report upon the necessity for investigation in other directions, relevant to its terms of reference. Manufacturers who have experienced difficulties requiring investigations for their solution in connection with the subjects of glass and optical instruments or who desire to make suggestions for special researches on these subjects are invited to communicate in the first instance with the Secretary of the Research Department, Great George Street, Westminster, S.W., who will direct the correspondence into the appropriate channels for attention.

ELECTROMETALLURGY IN THE UNITED STATES IN 1916.

According to an article in the Jan. 1st issue of *Metallurgical and Chemical Engineering*, there was a greater commercial development of electrometallurgical industries in the United States during 1916 than at any time during recent years. The heavy consumption of alloy steels formerly made largely in the crucible, the increased demand for ferro-alloys caused by the greater production of alloy steels, the shutting-off of imports of ferro-alloys and other electrometallurgical products, like aluminium and magnesium, the high prices of metals permitting experimentation with new processes—all these are contributory causes of the recent industrial advance in electrometallurgy.

The installations of electric steel furnaces in America were approximately doubled in 1915, and the progress continued at almost undiminished rate in 1916. The chief trouble met with is a lack of experienced workers. High-speed tool steel is now being manufactured in 6-ton heats as a regular procedure, in contrast with the 100-lb. pour of the crucible. The heavy demand for high-speed tool steel and the difficulty of securing crucibles at any price has made the electric steel furnace an economic necessity.

A considerable number of electric furnaces have been installed in foundries for the manufacture of steel castings. More installations are contemplated involving the use of the electric furnace in a duplex process with the open-hearth or the converter. Several electric furnaces are melting ferromanganese before addition to steel.

In Germany—formerly the largest producers of electric-furnace steel—the heavy demand for tool steel has also resulted in an increased use of the electric furnace for steel making. In August the production reached 17,000 tons per month, or six times the monthly production at the outbreak of the war. On the other hand, the production of crucible steel in Germany has remained stationary, there being no new installations of any size. The monthly production of electric-furnace steel in Germany is now double the crucible output.

On a smaller scale there has been a heavy increase of ferro-alloy manufacture in the United States. Three new manufacturers of ferrosilicon started production during the year. At the outbreak of the war about half of the domestic ferrosilicon consumption was imported, but now practically all ferrosilicon needed for consumption is manufactured in the country, and a small amount is being exported. To provide part of the needed furnace capacity a calcium carbide plant in

Niagara was converted to ferrosilicon manufacture. During the period in question the domestic consumption of ferrosilicon has doubled and is now estimated at 45,000 tons annually.

The largest domestic producer of ferrochrome was able to supply the increased needs of the steel industry, but it is probable that if this producer had not held large stocks of foreign ore, there would have been a shortage of ferrochrome. The development of California mines has been slow and the average grade of the chromite was too low for alloy manufacture. With other alloys, such as ferrotungsten, ferrovanadium, ferrotitanium, and ferromolybdenum, there has been an increase of production and several plants have been established. There is now sufficient plant capacity in the country for filling all domestic requirements of ferrotungsten, and for the first time considerable quantities of the alloy are being exported. Exports of ferrovanadium have doubled since 1915. Most of the new producers are using the electric furnace. Ferrotitanium is produced at Niagara to the limits of plant capacity. A fair quantity of ferromolybdenum is being manufactured in the United States, and towards the end of the year there was a marked increase in demand for foreign shipment, which is believed to have to do with the lining of big guns. Ferro-uranium was produced commercially for the first time in the States, and may be added to the new products of the electric furnace.

Aluminium manufacture in the United States enjoyed in the past year maximum production and maximum prosperity in its history, the lead over European producers being increased. The North Carolina plant of the Southern Aluminium Company, which in 1915 passed into the hands of the Aluminium Company of America, is expected to start operation in the near future. Further large projects for increased plant capacity are under way. The imports dropped to about one-tenth of the normal quantity and exports doubled. There are no new producers besides the Aluminium Company of America, up to the present. J. W. Richards estimates that by 1925 aluminium will be third in importance among metals (measured by weight), and will be outranked only by copper and iron.

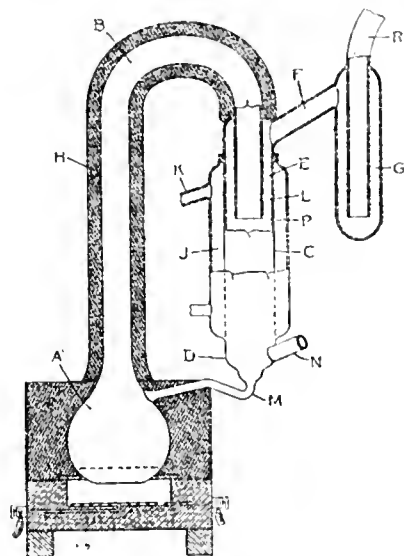
As a result of operations started in 1915 several plants are producing very pure metallic magnesium on a small but commercial scale by electrolysis.

Among new electrometallurgical enterprises electrolytic zinc looms large. There is the plant of the Anaconda Copper Company at Great Falls, Montana, with a production of 100 tons of electrolytic zinc per day, while as a result of the Bully Hill experiments of the General Electric Company a \$350,000 electrolytic zinc plant is being erected at the Mammoth smelter in California. As in 1915, there was in 1916 practically no development of electric-furnace smelting of zinc ore. It would seem that electrolytic zinc has the upper hand, and may be able to keep it, although in a measure its sudden development to a commercial process has probably been accelerated by the facilities of the Anaconda company available for placing an experimental development on a commercial basis.

The electrolytic copper refineries that were hit so hard at the start of the war have all been working to the limit of their capacity. Electrolytic refining has also been successful with tin; it has often been stated that Bolivian tin ores would always be out of question as the tin produced would be too impure; the success of the combined tin smelting and electrolytic refining plant of the American Smelting and Refining Company at Perth Amboy has proved that the additional refining cost is by no means prohibitive, and the only reason why enlargements have not yet been made is the present high cost of building materials.

HIGH VACUUM PUMPS.

In a recent issue of the *Journal of the Franklin Institute*, Dr. Irving Langmuir, of the General Electric Company, Schenectady, describes a new form of vacuum pump, which is characterised



Glass condensation pump.

by extreme speed and the high degree of vacuum attainable. In these pumps the gas is carried into a condenser by means of a blast of mercury vapour, the action being similar to that in a steam ejector and in a Gaede diffusion pump. The method by which the gas is brought into the mercury vapour blast in the new pump is based on a principle which differs essentially from that employed in the steam ejector or Gaede pump. In the new pumps, which are called "condensation pumps," the gas to be exhausted is caught by the blast of vapour and is forced by gas friction to travel along a cooled surface. By maintaining this surface at such a low temperature that the condensed mercury does not re-evaporate at an appreciable rate, it is possible to keep the mercury vapour from escaping into the vessel which is being exhausted. The action of the pump therefore depends primarily on the fact that all the atoms of mercury striking a mercury-covered surface are condensed, no reflection from the surface-taking place. The pumps can be worked at a very high speed (3000—4000 r.c. per second, or even more), and there is no lower limit, other than zero, to which the pressure may be reduced. By means of this pump, pressures lower than 10^{-6} bars have been produced and measured.

One form of the condensation pump, made entirely of glass, is illustrated here. Mercury vapour from the flask, A, is carried through the thermally insulated tube, B, to the nozzle, L. The vessel to be exhausted is connected to R. The gas from this vessel passes through the trap, G, and tube, F, into the annular space, E. At P this gas comes into contact with the mercury vapour blast issuing from L, and is thus forced outwards and downwards against the walls of the tube, C, and is finally driven down into the space, D, from which it escapes into the rough pump connection, N. The mercury which condenses on the sides of the tube, C, passes back through M into the boiler, A. This construction prevents the condensed mercury passing into the annular space, E, and thus the trouble arising from a mercury blast into the tube, F, is avoided. It is

essential that the end of the nozzle, L, should be below the level of the water in the condenser, J. The distance between L and D must be sufficiently great that no perceptible quantity of gas can diffuse back against the blast of mercury vapour, and so that a sufficiently large condensing area is furnished. The other dimensions of the pump are relatively unimportant. The pumps may be made of any size. The larger the pump the greater will be the speed of exhaustion. Such pumps have been constructed with the tube, B, and nozzle, L, in sizes varying from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inch.

In working the pump, the mercury boiler, A, is heated either by gas or electrically so that the mercury evaporates at a moderate rate. A thermometer in contact with tube, B, under the heat insulation, usually indicates a temperature between 100° and 120° C. when the pump is working satisfactorily. Under these conditions the mercury evaporates quietly, and no bubbles are formed, so that there is no tendency to bumping. With an electrically heated pump in which the nozzle, L, was $\frac{3}{4}$ inch diameter, the pump began to work satisfactorily when the heating unit delivered 220 watts, but the speed of exhaustion remained practically unchanged even when the heating current was increased to about 550 watts.

The back pressure against which the pump will operate depends, however, on the amount and velocity of the mercury vapour escaping from the nozzle. Thus with 220 watts the pump mentioned would not operate with a back pressure exceeding 50 bars (bar = 0.0075 mm. mercury pressure), whereas with 500 watts back pressures as high as 800 bars did not affect the working.

The condensation pump, like any other mercury pump, does not remove mercury vapour from the system to be exhausted. (The vapour pressure of mercury at room temperature is about 2 bars.) By the use of a trap such as that shown at G, this vapour pressure may be lowered, and mercury vapour can be entirely eliminated by the use of solid carbon dioxide or liquid air.

The condensation pump also lends itself to construction in metal, and two types of metal pumps are illustrated in the article referred to (J. Franklin Inst., 1916, 182, 719—743).

PLANT DEPRECIATION.

In a paper before the Institution of Electrical Engineers, Messrs. F. Gill and W. W. Cook discussed the principles underlying the computation of depreciation of plant. Neither the engineer, nor the financier, nor the accountant is competent to settle the question in any particular case, because to obtain correct results there must be co-operation among the three. The function of the engineer is to provide the information necessary regarding the plant, such as first cost, residual value, and life. The financier has to furnish information regarding the money, the amount available, the rate at which it can be borrowed, and the rate that can be obtained for the loan of it. The accountant has to provide accurate records based on the decisions arrived at, and to see that the real results are neither disguised nor hidden.

Considering that this common method can best be studied in the annual charges for plant, determined in advance of construction, these are analysed these into four principal parts:—(1) Return on capital outlay, treated as a charge, because no engineer is justified, except in special circumstances, in putting down plant that will not pay a return on its own capital; (2) depreciation, including "renewals" or provision for diminution in value of plant in place and working by reason of causes outside the owner's control, such as age,

wear, and accidents, and "improvements" to enable the owner to take plant out of commission before its physical life is exhausted in cases where, either from progress of the art or growth of the business, it is economically advisable to do so; (3) maintenance, or the cost of keeping plant in as good condition as is advisable, but not of renewing it; and (4) operation, the cost of working the plant. To determine the amount in the annual charges for depreciation it is thus necessary to estimate the first cost, residual values, and the physical and economic lives of the different classes of plant. The treatment of the capital account must also be fixed and the charge for return on capital estimated.

The reserves are preferably handled by means of two funds, for "renewals" and for "improvements." The calculation of the amounts to be contributed to these two funds must include the interest which should be earned by the money before it is required at the end of the life. The amount which should be in the renewals fund gives the correct diminution in value, when considering the value to the owner, of the plant in place and working, at any period in its history. The amounts annually put to the two funds, renewals and improvements, determine the correct charge against the undertaking for the purpose of assessing profits, fixing rates, and, under certain conditions, assessing the value of the undertaking as a going concern.

There are several methods of treating the provision for depreciation, but substantially they reduce to the following:—(1) Maintenance method, in which no regular sum is put aside, the plant being maintained and renewed out of revenue expenditure; (2) reducing balance method, in which a uniform percentage is deducted each year off the reduced capital cost; (3) straight line method, in which the annual charge is the ratio of one year to the total time or life; and (4) sinking fund and annuity method, in which value is given to the interest the fund will earn until it is wanted.

The first method affords no means of calculation, is bound to be irregular, and since no charge can be made until a renewal actually takes place, is always in arrear unless and until a complete renewal is effected. The second is very frequently employed to ascertain the amount to be allocated for depreciation at the end of a year, but it results in a relatively heavy charge in the early years and a very light one in the last years.

The third method, as generally used, is very simple. Assuming the first cost to be £100, the residual value £13, and the economic life 19 years, then £87 has to be found in that period, and therefore all that is required is £4.58 per annum for depreciation, the total charge, with £5 for return, being £9.58 per annum. But the present value of 19 annual payments of £9.58 at 5% is £115.77, instead of £94.86, and the method does not pass the test of total cost. If £4.58 be set aside annually, £87 will be accumulated at the end of 19 years, but since it is not prudent to leave money idle, interest ought to be and will be earned by the money set aside. If interest at 5% is added to the growing fund, there will be at the end of the 19 years not the £87 required, but £138.84; hence the yearly payments must be reduced below £4.58 until the amount is just sufficient to accumulate only the £87 required. This needs an annual payment of £2.85 for the 19 years.

If the earned interest be not added to the fund, but credited to the general revenue account, as is generally the practice of those who uphold the straight-line method, the effect is to increase the revenue, with the result that a higher return on capital is obtained, the interest earned by the depreciation fund not being required for the plant. This is a violation of the hypothesis that a stated return on capital is to be earned, no more and no less, and the present value of all the

payments exacted for the plant is too great, being £115-77.

If instead of accumulating a fund the capital is partly repaid each year, the present value is correct at £94-86, but the annual charges vary each year, and there is no condition as regards the plant which requires a varying annual charge.

In the annuity method a part of the capital is repaid each year and a return is paid on the capital outstanding, while in the sinking fund method the capital remains fixed at £100 and a fund is built up gradually against the end of life, at which time, and not till then, the money will be required either to repay the capital or to replace the plant. In both methods the total charge is uniform at £7-85 per annum, made up in the former case of the decreasing return component and an increasing depreciation component, and in the latter of uniform charges each year both for return and for depreciation. In both methods the present value of the series of components is £94-86. Thus they are both correct in amount, satisfy all real requirements demanded by the plant, and being uniform can be readily handled. In practice it is not usual to repay the capital fractionally each year; the money set aside for depreciation is generally accumulated until it is wanted, and the sinking fund method satisfies all requirements so far.

ELECTROLYTIC HYDROGEN AND OXYGEN.

In a recent issue of the *Engineering and Mining Journal* L. V. Curran gives an account of the operation of an electrolytic hydrogen and oxygen plant at the Copperhill property of the Tennessee Copper Co.

The principal equipment is as follows: One 25-kw. 60-volt direct current generator, direct-connected to one 30-h.p. 220-volt 60-cycle three-phase 900 r.p.m. slip-ring-motor; fifteen oxygen-hydrogen generating cells; two 59-cu. ft. capacity gasometers; two $6\frac{1}{2} \times 3 \times 5$ -in. two-stage tandem belt-driven compressors, 200 r.p.m.; one 15-h.p. 220-volt 60-cycle three-phase 1150 r.p.m. induction motor; ten 15×48 -in. drums, tested to 1000 lb. water pressure, fitted with right-hand connections; fifty-four 15×48 -in. drums, tested to 1000 lb. water pressure, fitted with left-hand connections; two 4×10 -ft. receivers tested to 300 lb. water

pressure. The plan of the plant is shown in the accompanying figure.

The cells consist of an iron tank $10 \times 6 \times 47$ in. high, forming the positive electrode, and two $\frac{1}{8}$ in. iron plates, $36 \times 39\frac{1}{2}$ in. high, forming the negative electrode, an asbestos fabric entirely inclosing the latter and preventing the gases from mixing. The cells are spaced on 9-in. centres and enclosed in a cellroom $18 \times 9 \times 8\frac{1}{2}$ ft. high. The water is kept charged with sufficient caustic soda to maintain a density of 26° B., about 75 lb. per cell being required at first filling.

The most economical rate of generation with these cells is reached when the current is 400 amp.; so the current is kept at that strength, 40 volts being required when cold and 36 volts at the running temperature, which is about 127° F. (51° C.). In order to minimise the danger of the gases getting mixed, the equipment for collecting the gases from the cell tops and for compressing into the drums and receivers is arranged entirely in duplicate, with no cross-connections, the scheme of left-hand and right-hand connections being carried out on the compressor discharges and drum connections, for hydrogen and oxygen respectively. Further precautions are taken by watching the polarity of the generator and by making frequent tests of the oxygen.

The gases are collected into $\frac{1}{2}$ -in. manifolds with rubber-hose connections to each cell, and are led into two gasometers which, as often as filled, are pumped down by the two compressors driven by the 15-h.p. motor through a lineshaft. The oxygen is pumped into drums and used for welding and cutting and for certain heavy lead work.

The hydrogen is pumped into the "hydrogen system," consisting of two 4×10 -ft. receivers, one at the gas plant and one at No. 1 sulphuric acid plant, approximately 800 ft. distant, the two receivers being connected by a $\frac{1}{2}$ -in. line. From the acid-plant receiver the gas is piped through the plant in $\frac{1}{2}$ -in. and $\frac{3}{4}$ -in. lines, being used at 4 lb. pressure. The pressure carried on the gas-plant receiver is 200 lb. and on the acid-plant receiver, 50 lb. Hydrogen is also compressed in drums for use on work at the other plants or in places isolated from the hydrogen system. Compressed air is used with the hydrogen for lead work except where there are no air lines or where the work is particularly heavy, when the oxygen is used. Hydrogen is also used with oxygen at the welding shop in cutting.

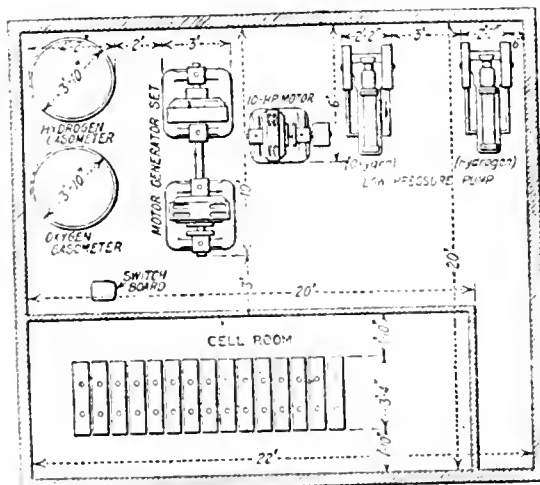
The output of the plant was found to be 12½ lb. of hydrogen and 97½ lb. of oxygen per 24 hr. The present hydrogen consumption is 14½ lb., 5½ days per week. It is therefore necessary to operate the plant 15½ hr. per week, or 91.4% of the time. The present demand for oxygen is 19½ lb. per day, six days per week. Current is bought at \$30 per h.p.-yr.; the power input of the plant is 26-25 h.p.

The first cost of the plant was \$6287.42. The present operating costs are:—

Yearly operating costs.

	\$
Power, 26-25 \times \$20 \times 91.4%	719.78
Engineers, 8007 hr. at 185c.	1487.68
Interest and depreciation, 12%	754.49
Inspector lines, 4536 hr. at 165c.	759.18
Total yearly expense	\$3721.43

At the present rate 6022.5 lb. of oxygen and 4086.9 lb. of hydrogen are used per year. The cost of replacing the service with bought oxygen and hydrogen generated with zinc and acid would be about \$17,000.



Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

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Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

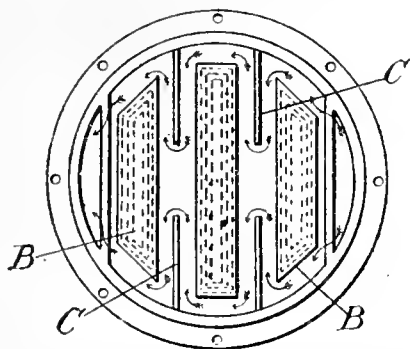
PATENTS.

Steam and similar bodies: Device for freeing — from impurities. C. Hülsmeier, Düsseldorf-Grafenberg, Germany. Eng. Pat. 8134, Mar. 31, 1914.

THE steam is passed in an upward direction through several separate spiral passages contained in a conical casing. The latter is enclosed in an outer casing and is provided at the top with an outlet for the purified steam. The inlets to the spirals are closed by ball valves of different weights, the lightest of which opens when only a little steam is passing, the next heavier when more steam is passing, and so on. The edges of the spirals have bent-over channels to facilitate the discharge of the oil or other impurities. The latter pass through openings in the conical casing into a common pipe for each vertical series of openings, and pass thence into the lower part of the space between the conical casing and the outer casing. An electric lamp is fitted in the purified steam outlet, which is also provided with a window so that the extent to which the steam is purified can be observed.—W. H. C.

Dephlegmator. J. E. Mitchell and H. Morfeys, Barnsley. Eng. Pat. 17,507, Dec. 16, 1915.

A DEPHLEGMATOR tray or section for connection with benzol and other stills is shown in plan in the figure. It is constructed with a number of



vapour outlets surmounted by caps or hoods, B, between which baffle plates, C, are interposed to cause the condensed liquid to travel in a circuitous route.—J. E. C.

Refrigerating apparatus: Absorption. F. T. Dunsford, and The Seay Syndicate Ltd., Manchester. Eng. Pat. 17,672, Dec. 17, 1915.

IN absorption refrigerating apparatus of the type in which ammonium nitrate is employed as an absorbent for ammonia. The absorbent is supported upon a corrugated or ribbed surface which contains the pipes or passages for the heating or cooling media; several such surfaces may be arranged in a tier.—W. F. F.

Grinding machinery. T. Breakell, Wirksworth, Derby. Eng. Pat. 102,631, Jan. 11, 1916 (Appl. No. 178 of 1916) and Apr. 6, 1916 (Appl. No. 5089 of 1916).

IN a mushroom type disc mill, a grinding disc is positively driven by a shaft having a universal joint, the disc co-operating with a controlling ring whereby a gyratory motion of the disc is produced. The grinding may be effected partly on the face of the disc and partly on a step or similar arrangement for giving an action corresponding to crushing on the edge of a roll.—J. E. C.

Crushing machinery. R. E. Ellis, London. From R. W. Pringle, Gatooma, South Rhodesia. Eng. Pat. 102,767, Feb. 17 and Aug. 11, 1916 (Appl. Nos. 2406 and 11,385 of 1916).

IN a crushing machine of the type in which the crushing members comprise two concentric rotating millers of inverted conical form, with the annular space between them converging towards the bottom, the lower ends of the millers are cylindrical and the outer miller has a flared extension at the bottom. A second inner conical miller is parallel to the flared end of the outer miller and is adjustable axially so as to vary the discharge space between the millers. The first inner miller may be raised and dropped periodically by a cam operated by the driving mechanism.—W. F. F.

Kiln: Recuperative. R. D. Pike, Richmond, Cal. U.S. Pat. 1,207,209, Dec. 5, 1916. Date of appl., June 1, 1915.

THE exhaust gases from the heating chamber pass through a number of openings in the hearth which register with rows of vertical flues through which the gases pass to a main waste gas flue below. The air to support combustion passes through rows of horizontal flues which alternate with the before-mentioned vertical flues, and heat exchange takes place between the gas and air. The air passes backwards and forwards through groups of horizontal flues and enters an annular flue in the wall of the heating chamber, from which it passes to the burners, which are spaced around the periphery of the heating chamber.—W. H. C.

Centrifugal machine and method. L. P. Sharples, West Chester, Pa. U.S. Pat. 1,207,230, Dec. 5, 1916. Date of appl., Apr. 27, 1915.

A SUSPENDED revoluble bowl is provided with a bottom inlet pipe, upper outlet pipes, and with a steadying device at the bottom. The lower inlet pipe is connected with a tank containing the liquid to be treated, which is drawn into the bowl by the suction produced by the discharge of the separated liquid through the outlet pipe.—W. H. C.

[Graphite] lubricants: Method of making — and products thereof. C. H. Bierbaum, Buffalo, N.Y. U.S. Pat. 1,207,813, Dec. 12, 1916. Date of appl., Apr. 7, 1915.

A WET mass of pulverised graphite freed from impurities is mixed with "petroleum," agitated, and diluted with oil and a solution of "petroleum." —W. F. F.

Graphite crucibles: Composition for preserving — J. B. Carmichael, Assignor to H. J. Harper, Seattle, Wash., U.S. Pat. 1,297,858, Dec. 12, 1916. Date of appl., Jan. 28, 1916.

THE composition consists of a mixture of 18 oz. of pulverised glass, 9 oz. of pulverised pumice, and one quart of a saturated solution of sodium silicate.—W. H. C.

Measuring the flow of fluids: Method and apparatus for — C. W. Humphrey, Chicago, Ill., U.S. Pat. 1,208,159, Dec. 12, 1916. Date of appl., Dec. 17, 1915.

THE flow is measured by observing the differences which occur in the ratio between the expansion of a measured quantity of gas enclosed in a chamber under atmospheric pressure and wholly surrounded by the liquid, the flow of which is to be measured, and the quantity of electric current passed through a resistance heater in the enclosed chamber, when the liquid is at rest and when it is flowing at various speeds.—W. H. C.

Mixing and distributing liquids: Apparatus for — O. Schutz, Assignor to Badische Co., New York, U.S. Pat. 1,208,670, Dec. 12, 1916. Date of appl., Feb. 9, 1916.

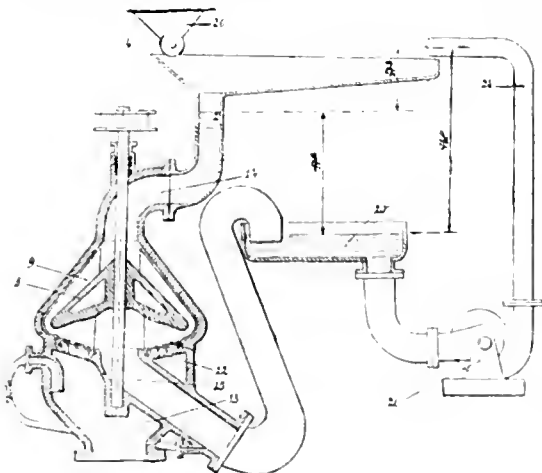
A TANK having a front wall lower than the other three walls is divided into compartments by cross walls of less height than the front wall and provided at alternate ends with openings. The liquid is fed into the compartment farthest from the front wall, circulates through the compartments, and is discharged by means of capillary material, which is suspended from a bar above the tank and after dipping into the liquid hangs over the front wall of the tank.—W. H. C.

Dryer: Mechanical — H. L. Julien, Fr. Pat. 480,106, Oct. 29, 1915.

THE material to be dried is moved by a conveyor substantially horizontally through the dryer. Air is drawn in by a fan at the top of the casing, near the outlet for the material, and passes transversely through the material to a heater at the bottom. The air is passed repeatedly through the dryer from top to bottom, being further heated at each stage, till it finally escapes near the inlet for the material.—W. F. F.

Separating uniform or mixed materials according to density or size of particles: Apparatus for — J. Bernard and C. Vibert, Fr. Pat. 480,376, Dec. 2, 1915.

THE material to be separated is fed from the hopper, 26, to the conduit, 11, supplied with water



by the pump, 21, and pipe, 21. The rotating shaft, 4, carries a member, 8, having blades, 9. By suitable adjustment of the relative actions of centrifugal force and of the current of water, material of any desired density or size of particle may be caused to escape by the holes, 12, to the collector, 13. The water passes on to the conduit, 15, and thence to the tank, 20, which supplies the pump. Several similar separating apparatus may be connected in series.—W. F. F.

Pulverisation of solid substances: Process for the — L. Boulade, Fr. Pat. 480,116, Dec. 9, 1915.

THE substance is melted and then sprayed from a nozzle by compressed air or an inert gas, so that it solidifies in a finely divided state.—W. F. F.

Pulsometer: Automatic — for raising liquids, especially acids. J. Cotellet, Fr. Pat. 480,861, Jan. 29, 1916.

LIQUID enters the bottom of a closed vertical vessel through a non-return valve. The top of the vessel is provided with passages communicating with the atmosphere and with a supply of compressed air, the openings being controlled by two vertical glass rods resting on the opposite ends of a pivoted lever at the bottom, so that the rods move simultaneously in opposite directions. A float surrounds the rod controlling the passage to the atmosphere and engages with stops at both ends of the rod. When the float is at the bottom, the atmospheric valve is open and the compressed air valve closed, and liquid fills the vessel and raises the float. When the vessel is full, the atmospheric valve is closed and the compressed air valve opened, so that the liquid is forced out through another pipe at the bottom and the float falls. The cycle is then repeated.—W. F. F.

Furnaces of the tilting type. I. Hall, Birmingham, Eng. Pat. 102,811, Feb. 15, 1916. (Appl. No. 2211 of 1916.)

Impregnating liquids with carbonic acid or other gases: Apparatus for — A. A. Pindstoffe, Copenhagen, U.S. Pat. 1,209,490, Dec. 19, 1916. Date of appl., Sept. 17, 1911.

SEE Eng. Pat. 19,769 of 1914; this J., 1915, 344.

Recovering solvents: Apparatus for — T. Baker, Assignor to E. I. du Pont de Nemours Powder Co., Wilmington, Del., U.S. Pat. 1,209,657, Dec. 26, 1916. Date of appl., Oct. 7, 1912.

SEE Eng. Pat. 10,351 of 1914; this J., 1915, 601.

Spray-producer or atomiser for liquids. D. H. Thomas, Morriston, Wales, A. D. Berk, London, and F. J. Morgan, Swansea, U.S. Pat. 1,210,232, Dec. 26, 1916. Date of appl., Dec. 29, 1915.

SEE Eng. Pat. 608 of 1915; this J., 1915, 1132.

Separating substances of different specific gravities, such as fine coal or ores and the like: Apparatus for — J. M. Draper, Manchester, U.S. Pat. 1,210,916, Jan. 2, 1917. Date of appl., Jan. 21, 1916.

SEE Eng. Pat. 1849 of 1915; this J., 1915, 1196.

Separation of liquids by centrifugal force: Process and apparatus for — L. P. Sharples, Fr. Pat. 480,726, Jan. 21, 1916. Under Int. Conv., Apr. 27, 1915.

SEE U.S. Pat. 1,207,230 of 1916; preceding.

Apparatus for continuous distillation. Fr. Pat. 480,558. See XVIII.

IIA.—FUEL; GAS; MINERAL OILS AND WAXES.

Ammonia recovery [from coal gas] and intensive scrubbing. W. S. Blauvelt. Gas Record, 1916. Gas J., 1917, 137, 63—64.

THE factors operative in washing gas by water for ammonia recovery are considered, and it is pointed out that an equilibrium between ammonia in the gas and in the wash liquor may limit the effectiveness of the process. Washers are classified under four types:—1. Washers in which the gas bubbles through the wash liquor. These may cause considerable back pressure. 2. Tower scrubbers, up which the gas ascends once meeting a descending stream of wash liquor. Time and area of contact are increased by fillings of coke, tiles, or wooden grids. The cost is relatively low, and back pressure is small. The large size required renders this type unsuitable for large works. 3. Mechanical washers containing moving internal parts which effect good contact between gas and liquor. They are usually multi-stage with gas moving counter to the liquor. 4. "Intensive scrubbers," comprising a number of towers or compartments in series, with grid fillings. The liquor passes repeatedly down each tower before proceeding to the next. Gas and liquor flow in counter currents. Types 3 and 4 are more adapted for use in larger works, and it is considered that the "intensive scrubber" has the advantage over the mechanical washer. In the latter a large portion of the contact surface is always submerged and out of action, in the former it is all in action. Installation costs, and over a long term of years maintenance costs also are lower, and ground space less, while the "intensive scrubber" also works better under overload conditions.—H. J. H.

Petroleum Supplies Branch of the Ministry of Munitions.

THE Minister of Munitions has established a Petroleum Branch in the Ministry, to be known as the Munitions Petroleum Supplies Branch, to deal with questions of the provision and distribution of petroleum and similar mineral oils for the purposes of the Ministry of Munitions. Mr. E. Houghton Fry will act as Director of the Branch. In connection with the investigation and development of hitherto unproved home sources of supply of mineral oils, the Minister will have the advantage of the services of Sir Boverton Redwood as Director of Munitions Petroleum Research. Sir Boverton Redwood will have charge of the Research Section, including the development of the British sources of supply. Professor John Cadman, C.M.G., President of the Institute of Petroleum Technologists, has assisted in the organisation of arrangements with the Scottish shale distilleries during the war, with a view to a considerable increase in their output. Sir George Beilby is also assisting in an advisory capacity.

Gas-oils: Cracking of— in various atmospheres. R. C. Downing and E. F. Pohlman. Amer. Gas Institute. Gas J., 1917, 137, 24—26.

THE atmospheres used were nitrogen, carbon dioxide, carbon monoxide, hydrogen, methane, blue gas, and a mixture of blue gas with 10 and 20% of steam respectively. The effect of each diluent on candle-power of the gas, candles per gallon, B.Th.U. per gallon, and the production of gas, tar, and carbon was studied. With nitrogen the calorific power of the gas per gallon of oil was 97,000 B.Th.U. at 1350° F. (about 730° C.). This is slightly better than is obtained in atmospheres of carbon monoxide, carbon dioxide, and methane, and lower than in hydrogen or blue gas. The

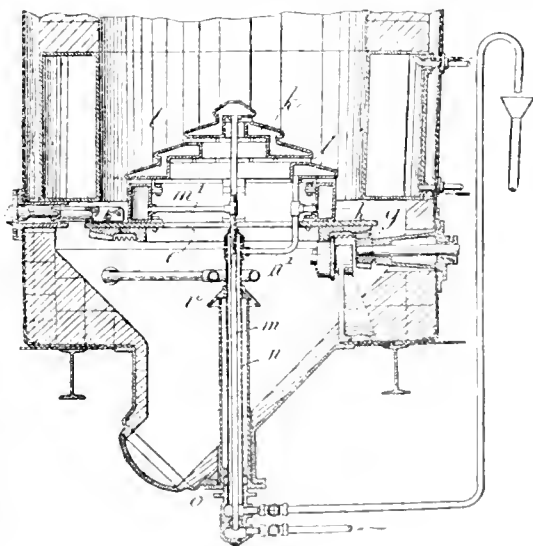
amount of tar and carbon produced was considerable, as is usually the case in inert atmospheres. The yield of oil-gas by weight was rather low. In an atmosphere of carbon dioxide the volume of the gas made was over 60 cu. ft. per gallon of oil, and it contained much hydrogen and methane. The production of carbon was much increased. The reaction $2\text{CO}_2 + \text{C}_2\text{H}_4 = \text{CO} + 2\text{H}_2$ probably occurs to a slight extent. With hydrogen, gas of high calorific power tends to be produced, owing to the production of saturated compounds. There is a decrease in the formation of tar and carbon. The production of illuminants is low; apparently some of the unsaturated compounds are hydrogenated. Methane acts very much like an inert atmosphere; much less methane is actually produced from the oil, but the production of hydrogen is larger, due probably to the decomposition of the methane. The effect of blue gas was studied in some detail. The conclusion is reached that no advantage is to be gained over blue gas by the use of any of the above-mentioned atmospheres alone. Blue gas gives much better candle-power results than either hydrogen or carbon monoxide. Tar formation is lowered and the deposition of carbon is about the average. Steam lowers the candle-power and candles per gallon, but raises the B.Th.U. per gallon of oil, possibly due to formation of hydrogen by partial decomposition of the steam. The appearance of the flames when the gas formed in the various atmospheres was burned in a Bray burner is also described. With carbon monoxide great loss of candle-power was noticed, due to the large proportion of carbon monoxide in the finished gas. The B.Th.U. results were the lowest obtained with any atmosphere except from oil used alone with a much longer time of contact. More tar was produced with carbon monoxide than in any other atmosphere. Carbon monoxide moreover seems to prevent the decomposition of the "illuminants." (See also this J., 1916, 917.)—F. C.

Combustion methods for use in the laboratory. [Determination of sulphur.] Hewett. See XXXII.

PATENTS.

Gas producers. F. Thuman, London. Eng. Pat. 102,597, Sept. 16, 1916. (Appl. No. 13,178 of 1916.)

THE bottom of the producer is provided with a base-plate, *c*, rotated by bevel gearing, *g*, and carrying a grate having water-circulating channels,



k. Cooling water is supplied by the pipes, *m, m'*, and withdrawn by the pipes, *n', n*. Steam is supplied through the sprayer, *v*, and passes with air to the fire through the openings, *l*. The water pipes are protected from the hot ashes by a surrounding sleeve carried by the stuffing-box, *o*.
—W. F. F.

Solidified hydrocarbons: Treatment of —for the manufacture of combustible blocks. A. C. B. Webb. Fr. Pat. 480,347, Nov. 29, 1915. Under Int. Conv., Oct. 30, 1915.

DEHYDRATED calcium sulphate, clay, or earth is mixed with wax, heavy mineral oil, or heavy vegetable oil to form a porous combustible mass which may be ignited by pieces of celluloid or cotton waste.—J. E. C.

Coal gas: Apparatus for manufacture of —. The Riter-Conley Manufacturing Co. Fr. Pat. 480,531, Dec. 6, 1915.

SEVERAL gas retorts are connected to a common stand-pipe, to secure a uniform temperature high enough to fix the lighter hydrocarbons in the gas (about 1000° F., 540° C.). The stand-pipes communicate with short mains, in which the gas is cooled by liquid sprays to about 110° to 125° F. (43° to 52° C.). The gas then passes to the general purification plant. Means of access to the stand-pipes and short mains are provided.
—J. E. C.

Gas: Manufacture of —. L. D. Carroll. Fr. Pat. 480,535, Dec. 7, 1915.

IN the manufacture of carburetted water-gas or similar gases, the primary and secondary air are controlled so as to give a constant volume of air per unit of time. The regulation may be effected by governors acting on the source of power driving the air blower and controlled by the differential pressure produced by a Venturi meter, perforated diaphragm, or Pitot tube.
—J. E. C.

Gas: Manufacture of —. L. D. Carroll. Fr. Pat. 480,536, Dec. 7, 1915.

IN a gas-producing system in which a gas with increasing content of carbon monoxide is produced, the secondary air is regulated in proportion by a throttle-valve in the air conduit and controlled by the rise and fall of a governor bell. The bell is actuated by a three-way cock alternately connecting the contents with the air conduit and the atmosphere. Means are also provided for counteracting the effect of increased pressure in the air conduit.—J. E. C.

Coal gas: Apparatus for manufacture of —. L. D. Carroll. Fr. Pat. 481,095, Mar. 1, 1916.

IN a vertical retort system for the manufacture of coal gas, one of the retorts communicates directly with a producer and supplies the necessary coke. Means are provided for regulating the pressure in this retort and in the producer to prevent the producer gas passing into the coal gas retort.—J. E. C.

Hydrocarbons: Extraction of —from coal gas. G. E. Darier. Fr. Pat. 479,997, Jan. 12, 1915.

HYDROCARBONS of the benzene and ethylene series are recovered by cooling coal gas to a temperature low enough to precipitate these bodies in a solid or liquid state. A recuperative system is provided by using two coolers alternately, in one of which the hydrocarbons are precipitated in a solid state, whilst in the other the solid products are liquefied by passing the uncooled gas through the chamber. The solid

products may also be extracted by solvents, or solvents solidifying with difficulty may be introduced prior to cooling. The hydrocarbons may be separated at higher temperatures by introducing porous substances, such as animal charcoal, coconut fibre, etc., whilst benzene compounds may be selectively separated, leaving ethylene compounds in the coal gas.—J. E. C.

Gaseous mixtures: Proportioning of —. A. C. Ionides, jun., London. Eng. Pat. 17,670, Dec. 17, 1915.

THE proportions of the constituents of a self-burning gaseous mixture are adjusted by observation of the lighting effect produced by combustion with an incandescent mantle under regulated pressure conditions. The illumination may be compared with a standard source of light or with a guide light using a mixture of known proportions.—J. E. C.

Producer-gas: Process for producing a diffused flame with —. H. L. Doherty, New York. U.S. Pat. 1,206,821, Dec. 5, 1916. Date of appl., May 15, 1911. Renewed Mar. 11, 1916.

THE flame is regulated to produce a uniform heating effect by mixing from 5 to 100% of combustion gases with the producer gas and burning it in a furnace chamber with pre-heated air, so that a slow burning flame of moderate temperature fills the chamber.—W. F. F.

Hydrocarbon oils: Method of dehydrating and refining —. E. I. Dyer, Oakland, Cal. U.S. Pat. 1,207,381, Dec. 5, 1916. Date of appl., Mar. 5, 1913.

THE oil is made to flow in a thin layer over heated surfaces in a closed vessel, and, after removal of the lighter vaporised portions, it is conducted, without cooling, into a second closed vessel, where it is again made to flow circuitously over heated surfaces at a higher or lower temperature and pressure than in the first vessel. Outside heating is used for one of the vessels, and the vapours generated therein are conducted through the other vessel as a heating medium for the oil. The oil in each vessel is agitated during the heating, and means are provided for condensing the vapours which have been used for heating one of the vessels.—C. A. M.

Petroleum: Apparatus for converting heavy products obtained from —. Process for the conversion of heavy products of petroleum. P. Roth and M. E. Venturino, Buenos Aires, Argentina. U.S. Pats. (A) 1,208,214 and (B) 1,208,378, Dec. 12, 1916. Date of appl., Oct. 16, 1916.

(A) PETROLEUM products are successively heated in a series of connected boilers, each of which is provided with means for discharging and condensing the vapours formed in the distillation. The heavy or middle hydrocarbons thus obtained are separated from water and impurities, and are sprayed under pressure into the vapour space of the lowest or converting boiler, which is also connected with a condenser to receive the vapours formed in the process. (B) Petroleum residues, asphalt, oils, or crude petroleum are sprayed into the vapour space of a still above a layer of similar material which has been heated to a temperature above that required to "crack" the heavy hydrocarbon or crude petroleum to be treated, whereby partial vaporisation of the sprayed liquid is effected, while the greater proportion of the volatilisation and cracking occur when the liquids come into contact. The resulting vapours are condensed.—C. A. M.

Petroleum oils; Process and apparatus for transforming heavy—into light oils. Simplex Refining Co. Fr. Pat. 480,447, Nov. 8, 1915.

HEAVY petroleum oil is made to circulate, with or without pressure, in a continuous cycle, *e.g.*, through serpentine tubes, which are heated to the "cracking" point of the oil, and means are provided for the continuous withdrawal of the resulting vapour and the addition of fresh oil to keep the circulating oil at a constant volume. A portion of the condensed light vapour is injected into the residue when it returns to the heating vessel. Advantages claimed for the process are regularity in working, and the prevention of overheating and formation of carbonaceous and viscous deposits within the tubes.—C. A. M.

Chemical reactions; Producing—in a single [gaseous] phase. [Cracking hydrocarbons.] Synthetic Hydro-Carbon Co. Fr. Pat. 480,653, Jan. 11, 1916.

A VERTICAL tube of refractory material heated electrically by a surrounding coil, is provided at the top with a plug of loose refractory material through which liquid hydrocarbon is supplied to be gasified and then cracked. The products, which vary with the temperature, pressure, and the rate at which the gasified material flows through the heated zone, pass through a condenser to a liquid-collecting vessel having a pipe leading to a pump for withdrawing the gas at the top. Light hydrocarbon oils are produced at temperatures of 600°–900° C. and pressures about 6 atmospheres. Permanent gases are produced in large proportion at a pressure of about 0.28 kilo. per sq. cm.—W. F. F.

Motor spirit suitable for high-speed internal combustion motor engines; Process of producing—. Hall Motor Fuel, Ltd. Fr. Pat. 481,066, Feb. 25, 1916.

THE fraction of kerosene oil boiling up to about 220° C., which must be practically free from petroleum spirit, is forced through very narrow interstices at a high pressure (70 to 200 kilos. or more, per sq. cm.), in the presence of hydrogen or a hydrocarbon gas, and at a temperature not exceeding 100° to 120° C. or that of the initial boiling point of the liquid. The resulting product burns much more rapidly than kerosene oil in motor engines.—C. A. M.

Petroleum or other hydrocarbons; Apparatus for the continuous fractionation and dephlegmation of the products of the distillation of— or of a mixture of volatile liquids, including products of the distillation of shale, coal, or both. H. L. Allan. Fr. Pat. 481,134, Mar. 8, 1916.

THE vapour from the first distillation is made to pass downwards through vertical tubes of a dephlegmator, which are exposed to the air, and may also be cooled by water which trickles over them and is collected in a tray. The condensed liquid which collects in the vessel below the tubes may be redistilled by means of a steam coil or the like, and the resulting vapour passed upwards through other vertical tubes into a box at the top connecting the series of tubes, and thence to a water-condenser. In this process the latent heat of the condensed fractions is utilised in the redistillation of the portions of lower boiling point. The fractions collected at each stage are of uniform quality.—C. A. M.

Coal gas retorts; Charging machines for use in operating—. A. E. White, London. From Riter-Conley Manufacturing Co., Leedsdale, Pa., U.S.A. Eng. Pat. 102,839, Jan. 19, 1916. (Appl. No. 857 of 1916.)

Coke-oven. E. Hinschmann, Essen, Germany. U.S. Pat. 1,208,781, Dec. 19, 1916. Date of appl. Nov. 24, 1914.

SEE Ger. Pat. 289,082 of 1913; this J., 1916, 527.

Vertical retorts; Discharging—. A. McD. Duckham, Ashted, U.S. Pat. 1,211,391, Jan. 2, 1917. Date of appl. May 19, 1915.

SEE Eng. Pat. 17,668 of 1911; this J., 1915, 215.

Gas; Burners and methods of burning—. W. K. Twomey, Toledo, Ohio, U.S.A. Eng. Pat. 18,092, Dec. 28, 1915.

SEE U.S. Pat. 1,167,447 of 1916; this J., 1916, 298.

Gas producers of the Mond type; Method of working—. J. B. Chadwick and P. Hollinshead, Runcorn, Assignors to The Salt Union, Ltd., Liverpool. U.S. Pat. 1,210,598, Jan. 2, 1917. Date of appl. July 12, 1912.

SEE Eng. Pat. 16,168 of 1911; this J., 1912, 975.

Gas producers. S. Glover and J. West. Fr. Pat. 480,249, Nov. 16, 1915.

SEE Eng. Pat. 5315 of 1915; this J., 1916, 297.

Coal gas; Process and apparatus for manufacture of—. A. Waddell. Fr. Pat. 481,050, Feb. 21, 1916. Under Int. Conv., Apr. 14 and Oct. 6, 1915.

SEE Eng. Pats. 5611, 11,112, and 11,143 of 1915; this J., 1916, 625, 1117.

Method of making [graphite] lubricants. U.S. Pat. 1,207,843. See I.

Method of producing granular carbon from [oil-] gas refuse. U.S. Pat. 1,207,694. See IIb.

Process for the production of ammonia from coke. Eng. Pat. 101,154. See VII.

Apparatus for the analysis of gas. Fr. Pat. 480,661. See XXIII.

IIb.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

PATENTS.

Carbon from [oil-] gas refuse; Method of producing granular—. R. D. Pike, San Francisco, Cal. U.S. Pat. 1,207,694, Dec. 5, 1916. Date of appl. Apr. 1, 1916.

LAMPBLACK from the refuse of oil-gas manufacture is heated to a relatively low temperature to expel water, and is then mixed with oil-gas tar to form a semi-plastic mass which is pressed into cakes. The cakes are heated to a high temperature to expel all volatile products and the residue finely ground and subjected to magnetic separation.—W. F. F.

Are light carbons, and method of manufacturing the same. R. D. Pike, Richmond, Cal., U.S.A. Eng. Pat. 102,645, Feb. 21, 1916. (Appl. No. 2541 of 1916.)

IN the production of are light carbons from the so-called lampblack refuse from the manufacture of illuminating gas from crude petroleum, the tar and soluble ash are removed from the refuse by washing. Volatile hydrocarbons are then removed by roasting, and the resulting product ground and incorporated with a suitable flux (such as boric acid) to produce a plastic body. Carbons are formed from the plastic mass in the usual manner.—J. E. C.

Arc device; Inclosed— and method of operating the same. G. M. J. Mackay, Schenectady, N.Y., Assignor to General Electric Co., U.S. Pat. 1,208,597, Dec. 12, 1916. Date of appl. Oct. 30, 1915.

A REFRACTORY cathode, such as tungsten, with a melting point exceeding 2000° C., is adapted to co-operate at incandescence with an anode within a sealed envelope, and the latter is filled with a monatomic gas, such as argon, with a pressure, at the operating temperature, of several millimetres of mercury, the gas being inert with respect to the electrodes and suppressing the electrical disintegration of the cathode. A drying material, inactive with respect to argon, is employed to remove the water vapour emitted from the electrodes and the walls of the envelope. The drying material is liberated in the form of vapour, by the operation of the arc, and forms compounds of negligibly low vapour pressure by combination with the water vapour.—B. N.

[*Tungsten*] *metal-filament manufacture.* O. Oberländer, London, Assignor to General Electric Co., U.S. Pat. 1,208,629, Dec. 12, 1916. Date of appl. Nov. 27, 1911.

A PLASTIC mass, for the manufacture of tungsten filaments, is formed by treating tungsten hexachloride with methylated ether, and then evaporating the resulting product to a paste of suitable consistency for further treatment.—B. N.

Electric incandescence bodies; Process for manufacturing—. C. O. Bastian, London, U.S. Pat. 1,209,247, Dec. 19, 1916. Date of appl. Sept. 21, 1914.

SEE Eng. Pat. 22,331 of 1913; this J., 1914, 1197.

Electron-emitting cathodes and process of manufacturing the same. A. McL. Nicolson, New York, and E. C. Hull, Montclair, N.J., Assignors to Western Electric Co., Inc. U.S. Pat. 1,209,324, Dec. 19, 1916. Date of appl. Dec. 26, 1914.

SEE Eng. Pat. 17,580 of 1915; this J., 1916, 828.

Carbons for arc lamps, and process of making them. R. D. Pike, Fr. Pat. 481,071, Feb. 26, 1916.

SEE Eng. Pat. 102,615 of 1916; preceding.

Process and [electric] fusion furnace for the manufacture of coherent ductile tungsten or other metal [for incandescence filaments]. Fr. Pat. 480,819, See X.

III.—TAR AND TAR PRODUCTS.

Aromatic base oil; Cracking of—. The temperature factor at constant rate under pressure. G. Egloff and R. J. Moore, J. Ind. Eng. Chem., 1917, 9, 10-12.

For the production of benzene and toluene from an aromatic base oil, the best results were obtained with solvent naphtha. The oil was passed through a steel tube, 11½ ft. long by 8 in. in diameter, at a pressure of 11 atmos. and at the rate of 15 galls. per hour, the temperatures used being 500°, 550°, 600°, 650°, 700°, 750°, and 800° C. In the recovered oil the maximum yield for benzene was 42.5% at 800° C., and for toluene 39.9% at 750° C.; or, calculated on the basis of the solvent naphtha used, 15.9% for benzene and 20.6% for toluene. The following table shows the maximum yields obtained under comparable conditions from a paraffin base oil and a naphthene base oil:—

	Paraffin oil.		Naphthene oil.		Aromatic oil.	
	by vol.	°C.	by vol.	°C.	by vol.	°C.
Benzene	6.6	750	7.2	650	15.9	800
Toluene	1.5	650	6.0	650	20.6	750

The course of the decomposition effected by the cracking of the solvent naphtha is of the same kind as the reaction produced by aluminium chloride on alkyl derivatives of benzene, which are converted successively into lower alkyl derivatives, toluene, and benzene (Ber, 1884, 17, 2816; this J., 1885, 270). The yield of recovered oil decreased from 100% at 500° C. to 98% at 650° and to 37.3% at 800° C. The greatest decomposition (25%) took place between 700° and 750° C. The sp.gr. of the recovered oils increased from 0.868 at 500° C. to 0.989 at 800° C., which indicated the formation of polycyclic aromatic hydrocarbons of high molecular weight.

—C. A. M.

Trinitrobenzene; Additive compounds of—. J. J. Sudborough, Chem. Soc. Trans., 1916, 109, 1339-1348.

POLY-NITRO compounds of the aromatic series possess the property of forming additive compounds with aromatic hydrocarbons, amines, phenols, phenolic ethers, and sulphur compounds. A large number of additive derivatives of *s*-trinitrobenzene have been prepared and analysed. In the majority of cases the compound is obtained by mixing theoretical proportions of the components and crystallising from a suitable solvent, usually alcohol, but occasionally benzene. In other cases the compound was only obtainable by using an excess of the hydrocarbon or base over the amount calculated to form the trinitrobenzene derivative. As a rule the colour of the additive compounds with hydrocarbons is not so marked as that of the corresponding amino- or hydroxy-derivatives; the colour of the hydrocarbon additive compounds is usually yellow, but anthracene gives a bright red compound. It would appear that the formation of these compounds is due to latent valencies of the nitro-groups and of the aromatic residues of the hydrocarbon; the hydroxy-, alkoxy-, amino-, and alkylamino-groups act mainly as auxochromes and tend also to increase the stability. As regards the combining proportions, it would appear that the number of trinitrobenzene molecules combining varies with the number of independent aromatic nuclei in the other component; in this connection, however, a condensed system of several benzene or benzene and heterocyclic rings counts as a single nucleus. Compounds in equimolecular proportions are formed with naphthalene, anthracene, phenanthrene, aniline, etc. Compounds of two mols. of trinitrobenzene and one mol. of the substance are formed with stilbene, diphenylamine, etc. There are, however, exceptions to the rule, and several substances form two types of additive compounds containing one and two mols. of trinitrobenzene respectively. Quite a number of substances containing two or more independent aromatic nuclei combine in equimolecular proportions; in a few cases one mol. of trinitrobenzene combines with two of the substance.

—J. F. B.

s-Trinitrobenzene; Additive compounds of— with amino-derivatives of complex aromatic hydrocarbons. S. T. Cadre and J. J. Sudborough, Chem. Soc. Trans., 1916, 109, 1349-1354.

As a rule the additive compounds (see preceding

abstract) obtained from naphthalene derivatives are more stable than those derived from corresponding benzene compounds. A series of compounds has been prepared from amino derivatives of phenanthrene, anthracene, acenaphthene, and fluorene. With the exception of aminofluorene all these compounds were formed by the union of equimolecular proportions of trinitrobenzene and the base. In this series, the colours of the additive compounds are relatively deep, being, as a rule, either black or deep brown, whereas those of the naphthalene series are mainly orange-yellow or red. The compounds are comparatively stable and can be crystallised from most solvents, but determinations of molecular weights showed that, in dilute benzene solution, dissociation into the components is almost complete. These compounds, on the whole, resemble the additive compounds from the naphthylamines, but several of them appear to be incapable of yielding acetyl derivatives.—J. F. B.

Benzoyl chloride; Catalytic decomposition of —. A. Mailhe and F. de Godon. Bull. Soc. Chim., 1916, 19, 419—452.

BENZOYL chloride when passed with a current of hydrogen over finely divided nickel at 270° — 280° C. furnishes to the extent of about 50% a mixture of benzene and toluene, and about 40% of diphenyl. The mechanism of the formation of the latter is obscure, but it appears to be conditioned by the formation of nickel chloride on the surface of the catalyst, and is not suppressed even when an excess of hydrogen is employed. With copper as catalyst benzoyl chloride is decomposed up to about 40% into benzoic anhydride, the remainder being unchanged. A similar conversion occurs at 420° — 450° C. with the chlorides of barium and thorium, with simultaneous deposition of carbon on the catalyst, and formation of carbon monoxide and hydrogen chloride. The manner of formation of the anhydride remains uncertain.—G. F. M.

Friedel-Crafts reaction; Observations on the —. [Decomposition of polyalkylbenzenes.] E. Brätker and O. M. Halse. Bull. Soc. Chim., 1916, 19, 411—449.

A REVERSAL of the Friedel-Crafts reaction can in general be brought about with more or less facility by the action of aluminium chloride on the alkylbenzene in presence of a large excess of benzene. In the case of the xylenes alone, this reaction does not succeed, but when polyethyl-, isopropyl-, butyl-, and amylbenzenes were boiled with aluminium chloride in presence of ten times their weight of benzene, quantities of the monoalkylbenzene, varying in each case were formed according to the scheme:—



Of the greatest interest however was the formation in excellent yield of toluene and cumene from cymene, which is available in large quantities as a by-product of the sulphite-cellulose process. Ninety grms. of cymene in 900 grms. of benzene gave, on boiling for 10 hours with 4.5 grms. of aluminium chloride, a yield of 11 grms. of toluene and 68 grms. of cumene, corresponding to 80% of that theoretically possible, leaving a residue of only 3—4 grms. of gummy material. The polyhalogen derivatives of benzene could not be decomposed by the action of aluminium chloride and benzene in this manner.—G. F. M.

Determination of naphthalene by picric acid. Knudlauch. See IX.

Combustion methods for use in the laboratory. [Determination of sulphur.] Hewett. See XXIII.

PATENTS.

Aromatic hydrocarbons: Improving the colour and odour of crude —. J. M. Weiss, Assignor to The Barrett Co., New York. U.S. Pat. 1,206,962, Dec. 5, 1916. Date of appl. Jan. 22, 1913.

THE oil to be purified is intimately mixed with an aqueous solution of a metallic salt, such as copper sulphate, in the proportion of 1 to 3 lb. of the hydrated salt to 100 galls. of oil, and the reaction allowed to proceed at a temperature below the point at which distillation of the volatile ingredients of the mixture occurs. The mixture is settled, the aqueous liquor drawn off, and the remaining oil distilled.—B. N.

Sulphonic acids: Process of manufacturing sodium salts of —. A. P. Sachs and O. Byron. Carnegie, Pa. U.S. Pat. 1,207,798, Dec. 12, 1916. Date of appl. Apr. 6, 1916.

A MIXTURE of a sulphonic acid forming a water-soluble calcium salt, sulphuric acid, and water is neutralised with lime to obtain a mixture of calcium sulphate and the calcium salt of the sulphonic acid. This mixture is agitated, without previous filtration, with sodium sulphate, and then filtered.—F. W. A.

Aromatic amino-hydroxy compounds: [Electrolytic] manufacture of —. O. Inrady, London. From Soc. of Chem. Ind. in Basle, Switzerland. Eng. Pat. 18,981, Dec. 28, 1915.

IN the electrolytic reduction of aromatic nitro-compounds, the formation of the amino-hydroxy compound is favoured and that of the amine reduced, by the use of a cathode of two or more metals. The cathode is obtained either by the use of a suitable alloy, the surface of which remains of practically constant composition during the reaction, or by making the cathode of one metal and placing the other, either as such or as salt, in the electrolyte, or by using an indifferent substance such as carbon and depositing the metals thereon during the electrolysis. It is possible to reduce the amount of acid to very little more than is necessary to combine with the base which is formed. Details are given of the reduction of nitrobenzene using a copper cathode, with lead, or lead and arsenic, in the electrolyte, and with a lead cathode with bi-smuth in the electrolyte. Other suitable combinations of metals are copper with mercury, and copper with tin and arsenic. A plain lead cathode under these conditions would give *p*-aminophenol and aniline in the proportion of about 2 to 3, while this method gives them in the proportion of 5 or 6 to 1.—B. V. S.

Monochlorobenzene: Manufacture of —. G. Contagne. Fr. Pat. 480,151, Feb. 17, 1915.

MONOCHLOROBENZENE is formed by the action of chlorine on benzene, in the presence of a catalyst such as iron, the process being so conducted that strong chlorine vapour comes into contact only with fresh benzene. A stream of benzene flows through a vertical series of basins exposed to a stream of chlorine passing in the same direction as the benzene. The formation of higher chlorine compounds is further reduced by mixing with the chlorine vapour hydrochloric acid previously formed by the reaction. Cooling appliances are used for maintaining the benzene at a temperature of 15° C.—B. V. S.

Binding compound from coal tar, &c., and process of making same. A. C. Evans, Hampton Wick, and P. J. Mitchell, London. U.S. Pat. 1,209,692, Dec. 26, 1916. Date of appl. Sept. 7, 1915.

SEE Eng. Pat. 19,933 of 1911; this J., 1915, 899

Dephlegmator [for benzol stills]. Eng. Pat. 17,567.
See I.

Apparatus for the continuous fractionation and dephlegmation of the products of the distillation of petroleum and other hydrocarbons. Fr. Pat. 181,131. See II.A.

IV.—COLOURING MATTERS AND DYES.

Indigo in Bihar: Third report on the improvement of— A. and G. L. C. Howard. Bull. No. 67, 1916. Agric. Research Inst., Pusa. (See also this J., 1915, 952.)

THE indigo plant can assimilate nitrogen either through the agency of *B. radiclecola* present in its root nodules or from nitrates present in the soil. The nodules are numerous and functionally very active in poor, well-aerated soils, but their development and activity are arrested and inhibited in rich ground, the nitrogen in this case being derived from nitrate. The formation of indican is dependent upon the activity of the nodules and is greatest in the high-lying areas; in the rich low-lying swamp tracts and in fields treated with *seeth*, the nitrate cycle predominates, the plants yield heavy leaf crops, but their indican content is low and they afford only a dye of inferior quality. The indican may be regarded as representing the difference between the total nitrogen assimilated and that consumed in growth. The essence of successful indigo cultivation is adequate soil-aeration. Saltpetre soils dressed with potsherds (*thikra*) or brick-refuse (*sarkhi* and *roras*) grow remarkably fine indigo, and the value of adding such aerating agents to other soils is now being investigated; so far, it has been ascertained that they are best applied in comparatively small fragments. All the evidence to hand points to the conclusion that wilting is a starvation effect due to inhibited development of the nodules and fine roots; it cannot well be cured, but it may be prevented by cultivating early plants which grow rapidly and which have shallow roots, all weak, late-flowering plants being exterminated, and by adequate drainage. The introduction of new seed from Java would be useless, as the cultivation in that island is now in the hands of natives who do not select the seed carefully; they grow chiefly deep-rooting, late types. The Java plant, however, does not breed true, and if the early, quick-growing forms were selected and cultivated continuously, the old type of Java plant which formerly flourished in Bihar could be recovered. Both Javan and Sumatran varieties can be cultivated during the hot season, thorough weeding and the formation of a surface mulch of several inches being effected with the Canadian lever-harrow. When the first crop is gathered, a branch should be left to maintain the transpiration current, thereby causing the quick growth of shoots for a second cut; after the latter, the plants should be dug out and the land prepared for *rabi* crops, as it does not pay to grow the old stumps for a seed crop. The value of a good drainage system cannot be over-emphasised: an improved system for northern Bihar is *sine qua non* of the re-establishment of the indigo industry. A special seed crop, well spaced, should be sown early in August and kept for leaf afterwards. Should floods intervene, the soil must be aerated by deep cultivation, and the application of *thikra* and the provision of sub-soil drainage would also assist. Storage of seed is also to be recommended. Attempts to grow Sumatran indigo for seed have not been encouraging, as although the seed was good in quality the yield was small; possibly selection might lead to improvement. Java indigo

from Natal is unsuitable for cultivation in Bihar. The Java plants are fertilised by bees, and cross-pollination is the rule. Artificial self-fertilisation is difficult, and leads to degeneration. The mixed types composing the ordinary crops vary greatly, the late slow-growing kinds yielding the most indican. The chief means of improvement consists in controlling natural crossing. To this end, the seeds of a large number of good, early plants are collected and sown, the best plants are picked out and the weakest removed. The seeds of the former are mixed and sown on a large scale, and again the undesirable individuals are eradicated. Alternatively, the selection may be started from a single plant. Improvement by selection on the basis of indican content would be difficult and probably unsuccessful in Bihar, for those plants which contain most are late, deep-rooting sorts and are liable to wilt. Attempts to improve Sumatran indigo from Madras by selection did not succeed, but the possibility of crossing a high-yielding Java type with a good strain of Cawnpore Sumatran needs investigation. As regards indirect means of improvement, Java indigo might be rotated with *rakar* (rice), as this tends to conserve the soil organic matter and to open up the sub-soil; the rice is also improved by the rotation. The value of wheat as a cover crop was demonstrated by a very successful test with the rapid-growing Pusa 4 wheat; the flour produced was of the finest quality and, after the stubbles had been thoroughly harrowed, the next crop of indigo developed well.—E. H. T.

Indigo. Rept. Agric. Res. Inst., Pusa, 1915-16, 94-96.

THE success or failure of indigo manufacture depends largely upon the nature of the bacterial inhabitants of the steeping vats. Two distinct types of fermentation have been identified, one involving the evolution of nitrogen (usually in large excess) and carbon dioxide, and the other producing hydrogen, nitrogen, and carbon dioxide in about equal proportions. These fermentations do not give rise to methane. Numerous species of bacteria have been isolated and some of them have been classified definitely as beneficial or deleterious. The presence of one bacterium has been correlated with the unfortunate production of "green vat" which occurs sometimes in the "heating" or oxidising process. It is hoped that the manufacture may be improved by artificially controlling the bacteria in the vat.—E. H. T.

Indian indigo crop.

THE final general memorandum on the 1916-17 indigo crop, issued by the Department of Statistics, India, and based upon reports received from provinces containing practically the whole area under indigo in British India, states that the total area is estimated at 756,400 acres, which is 114% in excess of the acreage (353,100 acres) of last year. All the provinces show an increase in the area sown, the largest increases being in the United Provinces and in the Punjab. The total yield of dye is estimated at 95,500 cwt., as against 55,100 cwt., last year, or an increase of 73%. The present estimate of yield, as against the final figures of last year, shows an increase of 267% in the Punjab, 252% in the United Provinces, 117% in Bombay and Sind, 53% in Bihar and Orissa and 46% in Madras. The season has not, on the whole, been favourable for the crop except in the Punjab and Bombay and Sind. Heavy rainfall and floods adversely affected the crop in the United Provinces and in parts of Bihar and Orissa and Madras. The exports by sea to foreign countries in each of the last five years have been (in cwt.): 1911-12, 19,155; 1912-13, 11,857; 1913-14, 10,939; 1914-15, 17,142; 1915-16,

41,942 cwt. The imports of synthetic and natural indigo into the United Kingdom in the last five calendar years are stated below. Of the total amount of natural indigo (25,157 cwt.) thus imported 1915, 22,322 cwt. was imported from India, 824 cwt. from Java, and the rest from other countries.

	Synthetic indigo.	Indigo.	Total.
	cwt.	cwt.	cwt.
1911	24,287	4,917	29,204
1912	28,302	7,073	35,375
1913	23,889	4,174	28,063
1914	15,517	5,314	20,831
1915	6,542	25,157	31,699
1916 (10 months)	—	28,245	28,245

Flavine and Brilliant Green: new and powerful antiseptics. Browning and others. See XX.

Preparation of dyes for the colour sensilising of photographic plates. Harrison and Boitounley. See XXI.

Production of dyes for colour-sensilising [photographic plates]. Pope. See XXI.

PATENTS.

Anthraquinone dyes and process of making same. M. H. Isler, Mannheim, Assignor to Badische Anilin und Soda Fabrik, Ludwigshafen, Germany. U.S. Pat. 1,207,762, Dec. 12, 1916. Date of appl., Feb. 4, 1913.

AN oxidation product of dibenzanthrone is heated with *p*-toluidine and boric acid. The products dye cotton from a blue hydrosulphite vat brilliant olive-green shades of excellent fastness to soap and very good fastness to chlorine.—F. W. A.

Sulphur dyes. W. Herzberg and O. Scharfenberg, Assignors to Actienges. für Anilinfabr., Berlin. U.S. Pat. 1,209,580, Dec. 19, 1916. Date of appl., Mar. 22, 1913.

SEE Fr. Pat. 432,440 of 1911; this J., 1912, 119.

[Azó] dyestuffs; Orange to red—able to be chromated, and process of making same. C. Jagerspacher, Assignor to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,210,808, Jan. 2, 1917. Date of appl., Dec. 31, 1915.

SEE Eng. Pat. 16,916 of 1915; this J., 1917, 78.

Process for utilising osier-bark. Fr. Pat. 480,637. See V.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Cotton stalks; Paper pulp from—. W. B. Nanson. Paper-making, 1916, 35, 371—374.

It has long been known that an excellent fibre suitable for paper pulp or for spinning purposes can be produced from the mature stalks of the cotton plant, although the matter has not been developed beyond the experimental stage. The Southern States of America produce 52 million tons of cotton stalks annually, sufficient for 21 million tons of bleached fibre, but the collection of these for industrial utilisation would require some organisation. So far as laboratory trials go, it would appear that the stalks should be chopped in a fodder-cutter into pieces from 2.5—3 ins. long; such a machine would chop 2 tons per hour. The material would then be conveyed to digesters holding 5000—7000 lb. of stock and digested with 4000—5000 galls. of caustic soda liquor at 7°—10° B. (sp. gr. 1.052—1.072) for 10—12 hours;

it is most advantageous to employ a high steam pressure for the digestion, e.g., up to 120 lb. per sq. in. The treatment of the digested pulp would be similar to that of wood pulp. If the fibre is to be treated for spinning purposes, the digested stalks should be washed and passed between steel rollers, such as are employed in cottonseed oil mills, to crush the stalks and separate the fibres. The cotton-stalk pulp is particularly adapted for the permanganate bleaching process, the material being steeped overnight in a solution of sodium permanganate of 0.5°—2° B. (sp. gr. 1.003—1.011); this liquor should be run off and the stock boiled, without washing, in a 5% solution of soda ash for 6—8 hours; the permanganate treatment may be repeated, and the material steeped in sodium carbonate solution before being finally cleared in a bath of sulphurous and sulphuric acids.—J. F. B.

Friedel-Crafts reaction. [Decomposition of poly-alkylbenzenes.] Baedeker and Halse. See III.

PATENTS.

Wool and other fibrous materials or the like; Machinery for washing—. T. Rhodes, Shipley, Yorks. Eng. Pat. 17,613, Dec. 17, 1915.

IN a wool-washing machine in which the material is carried forward through a trough by means of prongs, inverted funnels closed at the top are attached at their small ends to the cross-members of the rake frame, being either secured to an extension at the base of the prongs or substituted for prongs; valves may be provided in the funnels to regulate the pressure of the enclosed air. The vertical reciprocating motion of the funnels agitates the liquid and air, forcing and sucking them through the goods.—J. F. B.

Artificial silk, yarns, tow, rope, etc. [from casparlo]; Manufacture of—. L. N. Trigos. Fr. Pat. 480,606, Jan. 3, 1916.

ESPARTO is treated in a boiler with steam or boiling water in presence of 1—6% of its weight of soda or potash until the material becomes soft and pliable. It is then treated in a pressing machine which squeezes out the excess of liquid and separates the fibres from each other, converting the material into a kind of tow which is washed, dried, and combed. The fibre may be bleached with sulphur dioxide and applied to various textile uses.—J. F. B.

Osier-bark; Process for utilising—. N. V. Stoom-Touwslagerij en Spinnerij, voorheen onder J. M. Van der Lely. Fr. Pat. 480,637. Jan. 8, 1916. Under Int. Conv., Nov. 16, 1915.

OSIER bark is boiled in a solution of sodium carbonate until the bast tissues are separated into filaments; the latter are washed and dried, with or without bleaching, then combed and spun like hemp or employed as a stuffing for mattresses, cushions, etc. The solution, which contains the tannic acid of the bark, may be employed for tanning or mordanting, and a brown colouring matter may be prepared therefrom.—J. F. B.

Cellulose and its derivatives; Manufacture of—, and application of the same in various chemical and other industries. A. C. Vournasos, Athens. Eng. Pat. 17,318, July 22, 1911.

CELLULOSE of fine staple and superior in absorbent power to ordinary cotton may be produced from the fibres of *Hibiscus cannabinus* and its various species of the order *Malvaceae*. The green stems are retted, e.g., by immersion in running water for 30—40 days, and the fibres are opened, scutched, and combed, bleached for 30—40 hours in a solution yielding chlorine, e.g., of potassium hypochlorite, washed free from chlorine, and finally dried in sunlight.—F. Sr.

Cellulose ; Process of manufacture of— and utilisation of the waste liquors of the manufacture. C. Harist. Fr. Pat. 177,895, July 6, 1914.

RAW cellulose material is treated with boiling water to expel the air; the vessel is then closed and connected with a supply of ammonia gas; a quantity of ammonia is introduced equivalent to one-sixth of that necessary to form the ammonium sulphite it is desired to have in the final exhausted lye, which is generally 2–5% of the weight of the liquor. Ebullition is maintained by indirect heating for $\frac{1}{2}$ –1 hour under a pressure of 2–4 atmos. At this stage a preliminary removal of organic matter may be effected, e.g., recovery of tannins, resins, etc., by precipitation, on neutralising with sulphur dioxide. After separating the precipitate, the liquor is treated with a further quantity of sulphur dioxide equal to two-sixths of the desired total and digestion of the material continued for 2 hours at 2–1 atmos. The liquor is gradually strengthened with five-sixths of the total ammonia and after one hour this is neutralised with three-sixths of the total sulphur dioxide, and digestion completed in 4–6 hours at 6–8 atmos. The waste liquors are treated for recovery of the reagents or for use as a fertiliser. J. F. B.

Luminous [cellulose] product. Soc. Anon. de Traitements Chimiques. Fr. Pat. 480,230, Nov. 13, 1915.

A FINELY powdered luminous (phosphorescent) substance is suspended in a "collodion," either nitrocellulose, cellulose acetate, or viscose, etc., in appropriate solvents, and the solution is converted into the form of sheets or threads, which can be used for the manufacture of luminous devices. As luminous substances, phosphorescent zinc sulphide, calcium sulphide, barium platino-cyanide, etc., may be employed, either with or without the addition of a salt of radium, mesothorium, or other radioactive substance.—E. W. L.

Pulp ; Process of treating—. G. Moore, Joplin, Mo. U.S. Pat. 1,207,978, Dec. 12, 1916. Date of appl., Jan. 23, 1915.

FOR recovering paper pulp from water containing the particles in suspension, a filter cell is submerged in the water and the latter is passed through the submerged cell until a layer of pulp solids has been deposited thereon; the coated cell is exposed to the atmosphere and air is drawn through the coating into the cell; the cell is again submerged and the layer of pulp discharged from it. The paper pulp suspended in the water may be thickened by the means described and the thickened pulp delivered to a body of similar pulp from which a cake is formed on a screen by a difference in pressure on opposite sides; the cake thus formed is moved into the atmosphere, held in position and drained on the screen by the difference in pressure, and discharged from the screen beyond the body of thickened pulp by reversing the difference of pressure. Water containing pulp in suspension may be treated to thicken the pulp and then aerated to cause the pulp to float by means of bubbles.—J. F. B.

Waterproofed material and method of producing same. A. O. Tate, Montreal, Assignor to Tate Electrolytic Waterproofing Co., Inc., New York. U.S. Pat. 1,208,100, Dec. 12, 1916. Date of appl., Dec. 31, 1911.

FIBROUS material is impregnated with a saponaceous liquid and a metallic sulphate, e.g., aluminium sulphate, and then subjected to the action of an electric current passed between electrodes one of which is soluble, whereby a metallic "palmitate" and metallic hydroxide are electrolytically incorporated in the fibres, and co-act therein to make them non-capillary.—J. F. B.

Paper and the like ; Manufacture [sizing] of—. C. W. Fish, Rawcliffe, Yorks. Eng. Pat. 16,742, Nov. 27, 1915.

PAPER pulp is treated with resin size and 0.5–1.0% of an aluminium salt calculated on the dry weight of pulp. When the mixture is thoroughly incorporated, nitre cake is added in quantity about equal to the aluminium sulphate which would be required if the nitre cake were not employed. The order of adding the size and aluminium salt is immaterial, but it is essential that the nitre cake or sodium bisulphate be added last. J. F. B.

Wool and other textile fibres and textile or other materials ; Machines for washing—. F. B. Petric. Fr. Pat. 480,412, Dec. 8, 1915. Under Int. Conv., Dec. 10, 1911.

SEE Eng. Pats. 23,837 and 23,838 of 1911; this J., 1916, 172.

Artificial silk ; Machine for spinning—. H. de Chardonnnet, Paris. U.S. Pat. 1,209,133, Dec. 10, 1916. Date of appl., July 16, 1915.

SEE Eng. Pat. 10,857 of 1915; this J., 1916, 533.

Sizing paper ; Process of—. R. Clavel, Basle, Switzerland. U.S. Pat. 1,211,288, Jan. 2, 1917. Date of appl., Aug. 12, 1916.

SEE Eng. Pat. 101,855 of 1916; this J., 1916, 1215.

Paper and paper pulp ; Process for treatment of— by means of foam. Soc. de Teinture et d'Apprêt ci-dev. A. Clavel, and F. Lindemeyer. Fr. Pat. 480,736, Jan. 22, 1916.

SEE Eng. Pat. 101,855 of 1916; this J., 1916, 1215.

Process of producing nitrocellulose. Eng. Pat. 9547. See XXII.

VI.—BLEACHING ; DYEING ; PRINTING ; FINISHING.

Dyeing of wood ; Theory and practice of the—. F. Moll. Z. angew. Chem., 1916, 29, 405–409.

OWING to the cells in wood being kept together by a layer of hemicelluloses, the dyeing of wood is not the same as the dyeing of cotton cellulose, in which the cells are completely separated; the process also differs from the impregnation of wood with preserving agents, which must be soluble to be effective as antiseptics, whereas the aim in dyeing is to convert the dyestuffs into an insoluble form. By immersing wood in a solution of the dyestuff in a solvent, such as water, alcohol, turpentine, benzene, or acetone, and allowing the solvent to evaporate, the colour penetrates to a depth of 0.5 to 2 mm. This process is not satisfactory for oak, but by continued immersion in aqueous solutions pinewood is penetrated to a depth of 5 to 20 mm. in 8 days; the penetration may be accelerated by using warm solutions, and the wood may be steamed before dyeing. Maple, lime, and poplar give good level light shades; pear tree wood is used for making imitation ebony; oak is shaded to resemble "old oak," or green; walnut, mahogany, and birch are "aged" by such a process. For technical purposes red beech is generally used on account of the readiness with which it is penetrated. A veneer only requires quite a small pressure; beech and pine require about 5 atm.; oak and similar wood is only penetrated to a depth of 1 mm. even at 100 atm. For complete penetration of pieces of larger cross-section, the filtration (Boucherie) process is used, in which the dye solution is introduced under pressure in the direction of the wood fibre to replace the sap in freshly hewn wood, after steam-

ing until the condensed water is clear. The air in the interior is considered to dissolve when a certain pressure is attained. The structure of wood is considered in relation to the dyeing process. It is preferable to use dyestuffs of a colloidal character that are readily coagulated; the greater their colloidal nature, the less the diffusibility, but the greater the fastness to water and, generally, to light. Additions may be made to the dyebath in order to accelerate diffusion by increasing the colloidal condition of the cell walls; this may also be done by steaming, which does not, however, penetrate sufficiently in the case of hard woods. In order to prevent coagulation, acids are added to solutions of acid dyestuffs and ammonia to those of basic dyestuffs. After treatment in the dyebath, the wood is allowed to stand for 6—12 hrs. to allow the dyestuff to coagulate, and is then allowed to dry or is steamed. Basic dyestuffs of low molecular weight are not fast to light, and coagulate too rapidly on the fibre, so that it is difficult to obtain level shades.—F. W. A.

Dyeing and cleaning; Studies in—D. B. Lake. *J. Phys. Chem.*, 1916, 20, 761—808.

WHEN a dyed material is treated with a solution of another dyestuff, the colour of the first dyestuff may, under suitable conditions, be masked by that of the second dyestuff, but the apparent displacement is due merely to the solvent or peptising action of the water and is independent of the second dyestuff. Probably on account of coagulation of the dyestuff, dyeings made at a high temperature do not bleed so readily as those obtained at a lower temperature. Examples are given of selective adsorption by wool from mixtures of dyestuff solutions at different temperatures. Probably due to the coagulating effect of acid, acid dyestuffs (on wool) bleed less in hot water if dyed from an acid bath. The laws of adsorption of an acid dyestuff in various acid baths as suggested by Bancroft (this J., 1914, 197, 349) hold when the "saturation capacity" of the fibre has been so decreased that the "cutting down" effect of the various anions can be manifested. In the case of the dyestuffs examined, the more the dyestuff is irreversibly adsorbed the less completely and readily is that dyestuff adsorbed at a low temperature, and the less it will bleed, other factors being the same.

The methods used for the removal of stains have been classified as follows: (1) mechanical removal; (2) solution in a liquid; (3) peptising in a liquid, e.g., removing dyes with hot water; (4) peptising with a solution, e.g., removing dyes with sodium carbonate solution; (5) peptising with peptised colloid, e.g., removing stains with soap; (6) peptising in two stages, e.g., removing paint by treatment first with oil and casein and then with soap; (7) adsorption by solid, e.g., in removing grease with fullers' earth or blotting paper, which is considered of special interest; (8) peptising with a liquid and adsorption by solid; and (9) change of substance forming the stain. A large number of examples of practical importance are tabulated, e.g., the removal of soot from cotton by dilute caustic soda is explained as due to the peptisation of the soot by the preferentially adsorbed hydroxyl ions forming a caustic soda-soluble colloid of soot.—F. W. A.

PATENTS.

Cotton fabrics; Production of figured effects on—Heberlein et Cie. First Addition, dated Nov. 30, 1915, to Fr. Pat. 468,642, Feb. 19, 1914 (this J., 1914, 960). Under Int. Conv., July 6, 1915.

The cotton fabric, previously mercerised, is submitted in places to the action of sulphuric acid above 50–55° B. (1.54 sp. gr.) in strength, then washed and again mercerised.—B. N.

Weighting, fixing, mordanting, dyeing and bleaching natural silk, artificial silk, cotton, linen, and other textile materials [by means of foam]; Process for—Soc. de Teinture et d'Apprêt ci-dev. A. Clavel, and F. Lindenneyer. Fr. Pat. 480,761, Jan. 25, 1916.

For the production of foam by means of acid, neutral, or alkaline liquids, saponins, agglutinants, tannins, resins or other analogous substances are added to the liquids.—B. N.

Silk; Protective treatment of weighted—in order to increase its strength and elasticity. Schadd & Korteling. Fr. Pat. 480,206, Nov. 12, 1915. Under Int. Conv., Nov. 23, 1914. (See also Fr. Pat. 478,007, Mar. 12, 1915; this J., 1916, 1167.)

SILK, after weighting with tin phosphosilicate, for instance, is treated with organic compounds containing nitrogen or sulphur, or both, which are non-volatile and which are oxidised more readily than the fibroin but do not stain nor injure the feel and appearance of the silk; the compounds employed may be fixed in the fibre by precipitation in an insoluble form. Suitable substances are choline, betaine, and the alkaloïds; for example, the silk after weighting is treated with a solution containing 5% of choline and hydrazine hydrochloride.—J. F. E.

Finishing materials dyed with vat colours; Process of—A. Kertesz, Mankur, Germany, and E. Kur, Manchester. U.S. Pat. 1,297,414, Dec. 5, 1916. Date of appl., Mar. 18, 1915.

THE dyed fabric is treated with a finishing paste containing dextrin and an oxidising salt.—F. W. A.

Mercerised fabrics; Apparatus for leaching and rinsing—and recovering the lye. J. Matter, Laaken, Assignor to J. P. Bemberg A.-G., Barmen-Rittershausen, Germany. U.S. Pat. 1,209,465, Dec. 19, 1916. Date of appl., Jan. 28, 1915.

SEE Eng. Pat. 1633 of 1913; this J., 1913, 908.

Dyeing and like apparatus; Perforated beam for—J. T., and E. Brandwood, Bury. U.S. Pat. 1,211,068, Jan. 2, 1917. Date of appl., Oct. 27, 1914.

SEE Eng. Pat. 17,355 of 1914; this J., 1915, 26.

Foam for the treatment of textiles; Production of—at any desired temperature. Process for treating textiles, at any desired temperature, with oxidising, reducing, or inert gases in the form of foam. Soc. de Teinture et d'Apprêt ci-dev. A. Clavel and F. Lindenneyer. Fr. Pats. 480,397 and 480,398, Dec. 6, 1915.

SEE Eng. Pat. 102,310 of 1916; this J., 1917, 80.

Process for utilising osier-bark. Fr. Pat. 480,637. See V.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Sulphuric acid from copper-smelting gases. E. L. Larison. Eng. and Min. J., 1916, 102, 1121–1125.

FIVE important American copper smelting works manufacture acid from furnace gases. The Mount Copper Co. (Mococo, Calif.), the Anaconda Copper Co. (Anaconda, Mont.), and the Garfield plant (Utah) use gas from McDougall furnace-roasting sulphide ores. The Tennessee Copper Co. (Copperhill) and the Ducktown Sulphur, Copper, and Iron Co. (Isabella, Tenn.) use gas from blast furnaces in which pyritic smelting is carried out with addition of 1–6% of coke on undressed ores carrying about 30% of pyrrhotite, 6 of pyrite.

and 8 of chalcopryrite. The normal composition of the gas from the blast furnaces is SO_2 8–9, CO_2 6–7, CO 0.8–1, and N 84%. Air is admitted at several points in the acid plant by low-pressure blowers to furnish the necessary excess of oxygen without unduly diluting the sulphur dioxide. Much skill and attention is required at the furnaces, especially in charging, to keep the quality and quantity of the gas as uniform as possible. The nitre consumption in the two plants is 6–8%. All the smelters use the chamber process because it is cheaper and the gas too impure for the contact process; the use of the latter would involve the removal of moisture, arsenic, and dust.—W. R. S.

Phosphoric acid evolved in the volatilisation method of treating phosphatic rock; Use of the Cottrell precipitator in recovering—, W. H. Ross, J. N. Carothers, and A. R. Merz. *J. Ind. Eng. Chem.*, 1917, 9, 26–31.

In the Cottrell precipitator (this J., 1911, 1037) used in the authors' experiments on a manufacturing scale (this J., 1916, 1154) the sheet iron pipes were replaced by glazed terra-cotta tile pipes, within which were suspended wires of Monel metal or nichrome wires weighted at the ends. The exhaust-fan for drawing off the fumes was made of antimonial metal, the surface of which was protected from the action of the phosphoric acid by a coating of Bakelite enamel. Air was admitted to the furnace through openings round the electrodes, whilst the charge was introduced through openings round other electrodes. The rock used in the experiments was unground Florida land-pebble phosphate, containing 32.44% of phosphorus pentoxide and 2.33% of fluorine. The amount of moisture in the charge and in the admitted air was sufficient to convert the phosphorus pentoxide into phosphoric acid, and by increasing or reducing the moisture in the air, acid of any degree of dilution could be obtained. When the fumes were passed through a baffle tower so that the precipitation was made at a low temperature, the acid first collected from a charge containing about 1% of moisture had a concentration of about 60%, but by reducing the flow of air the concentration was increased to about 80%. By omitting the baffle tower and passing the fumes directly into the precipitator, precipitation of the phosphoric acid took place at about 100° C., and the solutions obtained either with a maximum or minimum flow of air were more concentrated than those obtained under corresponding conditions at a lower temperature (e.g., 90–82 and 95–23% as compared with 63.07 and 80.23% respectively). The extreme limits of impurities found in samples of phosphoric acid (about 63%) collected in the precipitator were as follows:—Sulphuric acid, 0.01 to 0.21; hydrofluoric acid, trace to 0.40; hydrochloric acid, *nil* to 0.01; silica, 0.03 to 0.26; calcium oxide, *nil* to 0.03; ferric oxide and alumina, trace to 0.06; arsenic, trace; heavy metals, none; and residue on ignition, 0.11 to 0.85%. Under the conditions of the precipitation the greater part of the hydrofluoric and sulphuric acids present passed through the precipitator in the form of gas. The phosphoric acid collected when the baffle tower was omitted contained a larger amount of suspended matter and was somewhat coloured probably by carbonaceous matter carried over with the air.

—C. A. M.

Hydrogen bromide: The absolute density of gaseous —, C. K. Reiman. *Comptes rend.*, 1917, 164, 44–46.

DETERMINATIONS of the density of gaseous hydrogen bromide prepared by three different methods gave as the result of a large number of experiments a mean value of 3.6432 grms., ± 0.002 as the weight of a litre under normal conditions.—G. F. M.

Salt; Removal of barium [chloride] from brines used in the manufacture of —, W. W. Skinner and W. F. Baughman. *J. Ind. Eng. Chem.*, 1917, 9, 18–26.

SAMPLES of the brine from different wells in the Ohio River District contained from 61.73 to 85.13 grms. of sodium chloride, 0.28 to 0.60 grm. of barium chloride, and 0.01 to 0.11 grm. of ferrous bicarbonate per litre. The brine, which has a density of 8.5 to 10° B., is concentrated in an evaporator to about 19° B., and is then passed through filters into settling tanks containing copper steam pipes, whence, after concentration to about 20 to 21° B., it is run into a "draw settler." Here a little salt is allowed to crystallise to remove the last traces of iron in suspension, and the clear brine is then drawn off to the crystallising tanks, or "grainers," which contain a system of copper steam pipes. As the salt crystallises more brine is run in until the concentration reaches about 30° B. From these grainers, in which No. 1 or "Table and Dairy Salt" is made, the brine is drawn off into the "bitter water grainer," where it is concentrated to 38° or 40° B. and yields No. 2 or "off-grade" salt, whilst the final mother liquors are drawn off and treated for the recovery of bromine, and calcium and magnesium chlorides. Samples of No. 1 salt contained from 0.02 to 0.23% of barium chloride (calculated on the anhydrous salt), whilst "off grade" salt contained from 1.02 to 18.52%. The "off-grade" product constitutes from 7 to 12% of the total salt produced by a works, and is sold for the manufacture of ice, salting of hides, etc., but notwithstanding its dangerous character, it has not infrequently been substituted for the No. 1 salt. Experiments on the precipitation of the barium by means of sodium sulphate showed that by the addition of the equivalent quantity of the reagent only 81.9% of the total barium was precipitated from the brine, whilst by the addition of 30% in excess 93.7% of barium was removed. The presence of the ferrous bicarbonate, the iron in which was partially precipitated on aeration or boiling, promoted the subsidence of the barium sulphate, and for this reason the sodium sulphate solution was added to the brine before heating. In practice the sodium sulphate (salt-cake free from arsenic or lead) was dissolved in water and its acidity neutralised by the addition of slaked lime which had been rubbed to a paste. The calculated quantity of solution was added to the brine, which was then agitated by the admission of compressed air for an hour, until the ferrous bicarbonate was decomposed. After standing for 16 hours practically the whole of the barium sulphate had deposited, and the brine was ready for the evaporator. After 3½ months' work scale due to calcium sulphate began to form on the pipes in the grainers, and it was therefore decided to reduce the proportion of sodium sulphate to the amount equivalent to the barium. Under these conditions No. 1 and No. 2 salts were whiter than before owing to more complete removal of the iron, and they crystallised more rapidly in the grainers. The highest proportion of barium found in No. 2 salt was 0.06%, whilst a sample of the mixed No. 1 and No. 2 salts contained only 0.02% of barium sulphate. The cost of treatment is estimated at about 1 cent per barrel, and the increased value of the product more than compensates for this. In the works which adopted this treatment about 400 lb. of barium sulphate per day was obtained as a by-product.—C. A. M.

Ammonium salts: Exportation of —.

AN Order in Council, dated January 1916, orders that the Proclamation of May 10th, 1916, prohibiting the exportation of certain articles from

the United Kingdom, be altered as follows:—The heading “²Ammonia and its salts, whether simple or compound (except ammonium nitrate, perchlorate, and sulphocyanide),” is deleted and replaced by the headings “²Ammonia and its salts, whether simple or compound (except ammonium nitrate, perchlorate, sulphate, and sulphocyanide)” “³Sulphate of ammonia.”

(Note: The effect of this order is to permit the exportation of ammonium sulphate to France and its possessions, Russia, Italy and its possessions, Spain, and Portugal, and to any other destination not in Europe nor on the Mediterranean and Black Seas.)

Ammonium nitrate solutions of any desired strength; Tables for the preparation of —. C. Gautsch, Chem.-Zeit., 1916, 40, 1049—1050.

TABLES are given showing the quantities, by weight and by volume, of ammonia solution of concentration from 9.91 to 30.37% NH_3 (sp.gr. 0.960—0.894 at 15° C., 16°—27° B. at 12.5° C.) and of nitric acid of concentration from 10.68 to 98.90% HNO_3 (sp.gr. 1.060—1.514 at 15° C., 8.17—48.99° B. at 15° C.) to furnish 1 gram. of ammonium nitrate. The following figures have been selected from the tables:—

Ammonia solution.

Sp. gr., 15° C.	0.960	0.950	0.940	0.930	0.920	0.910	0.900	0.894
Amount required for 1 gram ammonium nitrate {	grms. 2.1489	1.8716	1.6255	1.4425	0.9791	0.8522	0.7517	0.7012
	c.c. 2.285	1.7596	1.4495	1.2285	1.0542	0.9365	0.8352	0.7843

Nitric acid solution.

Sp. gr., 15° C.	1.060	1.120	1.180	1.240	1.300	1.360	1.430	1.480	1.514
Required for 1 gram ammonium nitrate {	grms. 7.3693	3.8905	2.6789	2.0555	1.6573	1.3671	1.1276	0.9146	0.7058
	c.c. 6.9522	3.4736	2.2702	1.6577	1.2749	1.0052	0.7941	0.6180	0.5256

Seaweeds [; Japanese —]. K. Miyama. Kōgyō-Kwagaku-Zasshi, 1916, 19, 1044—1065.

IN Yezo different species of *Laminaria* and *Arthrothamnus* are collected for use as edibles and in large quantities as raw material for iodine manufacture; potassium salts are also obtained as a by-product. The cost of potassium chloride from seaweed is less than £1 per ton. Some of these seaweeds are rich in iodine, e.g., *A. bifidus*, Rupr. contains 0.6% on the dry weight. Near the coast of Saghalin seaweeds are as abundant as in Yezo and equally rich in iodine. Other varieties commonly used as a source of iodine are *Ecklonia cava* and *E. bicyclis*. Kelp made from seaweed in Japan is not porous, but obviously over-roasted. According to experiments, the seaweed may lose 12.5% of its iodine-content by unsuitable roasting. Japan produces 1700 tons of potassium salts per annum, or about one-fourth of the total consumption, but the proper utilisation of the seaweed gathered should afford over 6000 tons.

—J. F. B.

Cyanides [of the alkali and alkaline-earth metals]; Synthesis of — in the electric pressure-furnace. IV. Reactions at high pressures. A. Stähler, Ber., 1916, 49, 2292—2291.

MIXTURES of alkali carbonate and carbon, heated in the presence of nitrogen, at 60 atmos. pressure, in the author's high-pressure electric furnace (this J., 1913, 789), furnished a product containing at least 74% of alkali cyanide (yield 95%), and lithium cyanide was obtained by the same method in 80% yield, whilst a product containing about 74% of barium cyanide, with no appreciable proportion of cyanamide, was similarly prepared from barium oxide, the yield of cyanide being over 80%.

Attempts to prepare magnesium cyanide and glucinum (beryllium) cyanide were unsuccessful; and, as regards yield, the synthesis of aluminium nitride was unaffected by working under high pressure, no cyanide being formed.—F. SODX.

Ammonium silicate. R. Schwarz, Ber., 1916., 49, 2358—2361.

HYDRATED silica was slowly dissolved by 3 N ammonia solution at 18° C. until a maximum concentration representing about 1/50th of that required for the conversion of all the ammonia into metasilicate was reached. On heating, the silica dissolved more rapidly, but the solutions obtained were opalescent, and the solubility varied with the degree of hydration and character of the silica used. The formation of ammonium silicate was however proved by the steady rise in electrical conductivity which accompanied solution. Ammonia solution had no appreciable effect on finely powdered quartz at the ordinary temperature, but anhydrous amorphous silica underwent slow hydration and therefore dissolved. Tetraethylammonium metasilicate was obtained as a white amorphous hygroscopic mass by dissolving hydrated silica at 80° C. in a 10% solution of tetraethylammonium hydroxide and evaporating the solution in a vacuum desiccator.—F. SODX.

Iron ammonium alum; Hydrolysis of —. W. N. Rae, Chem. Soc. Trans., 1916, 109, 1331—1339.

THE precipitate, formed by hydrolysis, which separates on keeping a solution of iron ammonium alum, has been shown to have the composition $2\text{Fe}_2\text{O}_3 \cdot \text{SO}_3$. The intensity of the colour of iron ammonium alum solutions, alone and in the presence of other substances, such as sulphuric acid, ammonium sulphate, sucrose, potassium chloride, and alcohol, has been measured, and is shown to be in agreement with the supposition that the colour is due to the presence of a soluble form of the above basic sulphate. On adding concentrated sulphuric acid to a solution of the alum, a white precipitate is formed which is found to be the anhydrous alum. Several density determinations of aqueous iron ammonium alum solutions are recorded.—B. N.

Compounds formed by the interaction of glacial acetic acid and ferric chloride; Constitution of —. R. Weiland and K. Kessler, Tübinger Chem. Ges., June, 1916, Chem.-Zeit., 1916, 40, 1002.

ON dissolving ferric chloride in a small amount of glacial acetic acid the compound $\text{Fe}(\text{CH}_3\text{COO})_2 \cdot \text{Cl} + 2.25\text{H}_2\text{O}$ is formed, whereas when much acetic acid is present the product has the composition, $\text{Fe}(\text{CH}_3\text{COO})_2 + 0.25\text{CH}_3\text{COOH} + 0.75\text{H}_2\text{O}$. In both compounds the complex hexa-acetato-dihydroxyferric cation is present (Ber., 1909, 42, 3881) since the concentrated aqueous solutions yield the characteristic platinum-chloride of that cation. Treated with alcohol both salts yield a new red rhombohedral compound, $[\text{Fe}_2(\text{CH}_3\text{COO})_4(\text{OH})_2] \cdot (\text{FeCl}_3) + 5 \text{C}_2\text{H}_5\text{OH} + \text{H}_2\text{O}$, whilst when crystallised from a little water both

form the chloride of the hexa-acetato-ferrie base $[\text{Fe}_3(\text{CH}_3\text{COO})_6(\text{OH})_2]\text{Cl} + 7\text{H}_2\text{O}$. An analogous compound also separates from a concentrated aqueous solution of 1 mol. of ferric chloride and 1 mol. of sodium acetate, while a solution of 1 mol. of ferric chloride and 2 mols. of sodium acetate yields the above-mentioned chloride of the hexa-acetato-ferrie base. C. A. M.

Refractory oxides. R. B. Sosman, J. Ind. and Eng. Chem. 1916, 8, 985-990.

THE author quotes the melting points of silica, alumina, magnesia, lime, and ferrosilicic oxide previously determined by C. W. Kanolt (this J., 1913, 1155) and reproduces the phase rule diagrams of all possible two and three-component systems made from the foregoing oxides and ferric and ferrous oxides. He concludes that the stable compounds of the oxides with each other are all made up of these oxides in simple proportions, usually 1:1 or 2:1 and that the stable compounds are molecular compounds of the oxides (Werner's compounds of the second and third order). He suggests that certain compounds which exist in the crystalline state may be entirely dissociated when converted into the liquid or glassy state. "The maximum melting points in all of the systems are those of the pure stable compounds, and the highest melting points are those of the pure oxides, Al_2O_3 , CaO , and MgO , so that the addition of any substance to a refractory oxide will lower its melting point. Kaolinite $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$, is not the hydrate of any high temperature compound and when heated it breaks up into a mixture of Al_2SiO_5 and SiO_2 with a softening point below that of either constituent, i.e., below 1625°C . If alumina is added to a pure kaolin to make a mixture equivalent to Al_2SiO_5 , sillimanite will form and will not melt below 1815°C . The formation of this compound is the basis of the manufacture of Marquardt porcelain. Magnesia spinel, $\text{MgO} \cdot \text{Al}_2\text{O}_3$, is a similar product; it melts at 2135°C . and its eutectics with MgO and Al_2O_3 melt respectively at 2030°C . and 1925°C . Fused silica or "quartz glass" is only stable above the melting point of cristobalite (1625°C). Below this temperature it tends to crystallise (devitrify), but as the high temperature form of cristobalite has the same density as the glassy form, the material remains transparent and homogeneous and only breaks up into the familiar devitrified mass when passing the $\alpha - \beta$ inversion point at $200^\circ - 275^\circ\text{C}$. Future progress in the use of refractory oxides must follow two principal lines: (1) control of the purity of the materials and (2) accurate control of high temperatures.

—A. B. S.

Hydrogen-oxygen mixtures: Catalysis of— at the ordinary temperature by moist contact substances. K. A. Hofmann and R. Ebert, Ber., 1916, 49, 2369-2389.

THE catalysis of a gaseous mixture of oxygen and hydrogen brought about by the action of contact substances moistened with aqueous solutions (see Hofmann and Schneider, this J., 1916, 45) is shown to be an electrochemical process, similar in character to that taking place in a Groves' gas battery. It is supposed that parts of the contact surface (of palladised or platinised earthenware) are converted into oxygen electrodes and parts into hydrogen electrodes by contact with the gases. With surfaces of platinum, iridium, or palladium, the activity of the oxygen develops very slowly as compared with that of the hydrogen, and hence, since the rate of catalysis depends on the product of these activities (that is, on the E.M.F. of the system), the maximum effect is only reached by employing more than one contact substance, so as to secure rapid activation both

of oxygen and hydrogen. The best results were obtained by using a palladium film (on earthenware) in conjunction with small quantities of finely divided palladium (reduced by hydrogen from palladium chloride solution), in presence of sodium bicarbonate solution. With such combined catalysts, the extent of the action is far greater than with both catalysts working singly. Under the most favourable conditions, about 70 c.c. of gas was catalysed in 10 minutes with 15 sq. cm. of contact surface. A palladium film alone gave the highest figures in an acid solution, which raises the oxidation potential of the oxygen, and the effectiveness of the catalyst was increased by charging it with oxygen, but no rise in activity was induced by adding an oxygen-carrier.

—P. SODN.

Metallographic investigation of the system, antimony sulphide and cuprous sulphide. Chikashige and Yamauchi. See X.

Ionisation of sulphuric acid and normal potassium sulphate in aqueous solutions of medium concentration. Muller. See XI.

Remarks on certain electrolyses. Muller. See XI.

Use of diphenylamine and diphenylbenzidine for colorimetric determinations. Smith. See XXIII.

PATENTS.

Hydrochloric acid: Process for the manufacture of pure— M. Lucron and C. E. Riche, Fr. Pat. 480,217, Nov. 16, 1915.

THE impurities of ordinary commercial hydrochloric acid, consisting of iron, arsenic, antimony, sulphurous acid, and anhydride, can be removed by treatment of the acid with persalts, notably permanganates. The impurities are thus converted either into insoluble compounds, or into non-volatile compounds not carried away under the conditions of operation. The process can be applied in the ordinary course of manufacture so as to yield, directly, a pure acid.—J. B. C. K.

Sulphuric acid: Manufacture of— L. Laufer, Fr. Pat. 481,131, Mar. 7, 1916.

THE gases escaping from the Gay-Lussac towers are treated with water sprays or the like to absorb acid fumes, etc., and the water containing the recovered products is introduced into the acid-making system.—T. H. B.

Ammonia from coke: Process for production of— J. G. Aarts, Dongen, Holland, Eng. Pat. 101,154, Aug. 8, 1916. Under Int. Conv., Aug. 9, 1915. (Appl. No. 11,202 of 1916.)

A HOT mass of coke, after its discharge from the carbonising chamber, is exposed over its whole length and at both sides, to jets or streams of steam, preferably superheated, directed towards the middle of the mass, under constant conditions of quantity, velocity, and temperature, both for the steam and coke. The ammonia is recovered in any known manner by the aid of hoods, connected if desired with suction apparatus. The velocity and quantity of the steam should be regulated in accordance with the velocity and temperature of the coke, so that a sufficient quantity of nascent hydrogen is formed to give the maximum yield of ammonia, and that the temperature of the coke is reduced sufficiently to prevent as far as possible decomposition of the ammonia formed. In many cases, especially when the coke is moving slowly, the steam is introduced intermittently.—J. B. C. K.

Sodium bicarbonate and ammonium nitrate; Process of manufacture of—F. Ricard. Fr. Pat. 480,082, Oct. 20, 1915.

THE process is based upon the reaction between ammonium bicarbonate and sodium nitrate, and yields sodium bicarbonate and ammonium nitrate. One-third of the sodium nitrate is left undecomposed in the mother liquor, together with ammonium nitrate. The patent covers several alternative methods and apparatus for carrying out the reactions, and for separating the salts from the mother liquor. The ammonium bicarbonate and sodium nitrate may be allowed to react under pressure at 50° C. in the presence of only a small amount of water, or a saturated solution of the one salt may be allowed to act under the same conditions as regards temperature and pressure, upon the other salt in the dry state. The dried salt mixture obtained from the mother liquor is treated with hot water, which dissolves ammonium nitrate in preference to sodium nitrate, and the refined salt obtained by recrystallisation of this solution, is extracted with cold water, to remove sodium nitrate. The residual ammonium nitrate can be separated and dried by filtering under pressure of hot air. In order to facilitate the extraction of the raw or refined mother liquor salt by cold water, the latter is passed repeatedly through the salt by means of a pump, a jet of compressed air, or some mechanical form of agitator. —J. B. C. K.

Ammonium nitrate; Manufacture of—P. L. Hulín. Fr. Pat. 480,150, Feb. 11, 1915.

AN aqueous solution of calcium nitrate obtained, e.g., by the electric arc process of fixing atmospheric nitrogen, is allowed to react with ammonium sulphate at a temperature of 120° C. or higher. The solutions are preferably raised to this temperature separately, and the preliminary heating and the reaction are effected under pressure in a series of autoclaves. The apparatus may be applied to other reactions at high temperatures under pressure, notably those producing a precipitate of calcium sulphate. —J. B. C. K.

Ammonium chloride; Direct process of manufacture of—from chlorine, nitrogen, and hydrogen. C. L. Mayer. Fr. Pat. 480,232, Nov. 15, 1915.

A MIXTURE of hydrogen, nitrogen, and chlorine gases in definite proportions by volume, is submitted to the action of the silent electric discharge. In order to facilitate the reaction and to remove the products before decomposition can occur owing to its reversal, water or steam is injected under pressure into the chamber in which the reaction occurs. The following proportions are given as suitable for the process:—nitrogen 1 vol., hydrogen 4 vols., chlorine 1 vol.—J. B. C. K.

Sodium perborate; [Electrolytic] manufacture of—Deutsche Gold- und Silber-Scheideanstalt vorm. Roessler, Frankfurt, Germany. Eng. Pats. (A) 100,154, Mar. 2, 1916. Under Int. Conv., Mar. 10, 1915. (Appl. No. 3181 of 1916.) (B) 101,620, Mar. 2, 1916. Under Int. Conv., Sept. 24, 1915. (Appl. No. 3186 of 1916.) Additions to Eng. Pat. 100,153 of 1916 (this J., 1917, 83.)

(A) IN the preparation of sodium perborate by electrolysis of a solution of alkali carbonate and alkali borate, the solution, which may be saturated or not with borax, is kept saturated with alkali carbonate by maintaining the latter as a "bottom substance" (solid phase). (B) During electrolysis under the above conditions, a substance or mixture is added which will produce on the cathode a precipitate lowering the reducing action. Chromic acid may be used for this

purpose, and such of its salts the base of which does not decompose alkali perborate, e.g., chromates of alkali and alkaline earth metals, including magnesium, aluminium, beryllium (glucinum), etc. Other alkaline earth salts may also be used. With chromic acid 0.5 gm. per litre, and with calcium chloride 1 gm. per litre may be used. Protective colloids, e.g., albumin, starch, gum arabic, &c., may also be introduced to increase the action of the added chromic acid or salts.—T. H. B.

Iodine; Direct method of extraction of—from green sea-weed. V. Vincent. Fr. Pat. 480,014, Oct. 16, 1915.

GREEN sea-weed is extracted in the undried state with a solution of aluminium sulphate, preferably in sea water, and slightly acidified, which has the property of dissolving the alkali iodide from the weed, while leaving undissolved the gelatinous organic matters. The solution of alkali iodide is treated with copper sulphate and with sulphur dioxide or sulphites, and the precipitated cuprous iodide is separated from the solution by centrifugal force. An alternative method of extraction is to use a solution of iron sulphate for lixiviating the dried sea-weed.—J. B. C. K.

Sulphur dioxide; Synthetic manufacture of—R. P. Pietet. Fr. Pat. 480,294, Nov. 22, 1915.

SULPHUR or pyrites is burnt in a special furnace by means of pure oxygen, and to prevent the formation of products other than sulphur dioxide, the oxygen is mixed with sulphur dioxide before coming in contact with sulphur, and cooling coils are embedded in the walls of the furnace to moderate the temperature. A baffle-plate is fixed longitudinally in the furnace to divert the gaseous stream in a suitable manner. A compressor and exhauster are used to work an injector for mixing the oxygen with the sulphur dioxide produced in the process before bringing it in contact with the sulphur. Sulphur is kept in slight excess during the process so that all the oxygen is consumed. —T. H. B.

Zinc sulphate; Production of—from zinciferous minerals. E. Ferraris. Fr. Pat. 480,499, Dec. 21, 1915. Under Int. Conv., Dec. 7, 1915.

THE roasted and desulphurised ore or natural zinc oxide is treated with sulphur dioxide produced, e.g., by the roasting of a sulphide ore, and the precipitated zinc sulphite is treated with moist air to convert it into sulphate, which is dissolved by lixiviation with pure or acidulated water. The two stages of the process may be combined in one operation, treating the roasted ore with sulphur dioxide, together with air and moisture (or steam) in such a way as to produce directly zinc sulphate, the residue being afterwards extracted with acidulated water. —T. H. B.

"Mixed cream of tartar" [potassium and sodium bitartrates] and "soda cream of tartar" [sodium bitartrate]; Industrial preparation of—T. Gladysz. Fr. Pat. 480,620, Mar. 12, 1915.

CRUDE tartar is treated with hydrochloric acid, the acid solution is partially neutralised with lime or calcium carbonate, the precipitate of potassium and calcium bitartrates is separated and boiled with sodium carbonate solution, the resulting solution is decolorised with animal charcoal, and treated with a mineral acid to precipitate a mixture of sodium and potassium bitartrates ("mixed cream of tartar"). By exact neutralisation of the first mother-liquors with calcium carbonate, decomposition of the precipitated calcium tartrate by sodium carbonate, and treatment of the lye as described above, a crystalline precipitate of sodium bitartrate ("soda cream of tartar") is obtained.—T. H. B.

Carbon dioxide: Process for absorption of — from gaseous mixtures. Naaml. Vennootschap Anton Jurgens' Vereenigde Fabrieken. Fr. Pat. 480,774, Jan. 26, 1916. Under Int. Conv., Nov. 8, 1915.

The gaseous mixture is led into a solution capable of absorbing carbon dioxide, and which can be afterwards regenerated by boiling. The solution is one of alkali carbonate in which magnesium hydroxide, or a highly basic carbonate of magnesia or a mixture of these compounds, is held in suspension. This solution is obtained by adding an excess of a solution of an alkali carbonate to one of a magnesium salt, and afterwards boiling for some time.—T. H. B.

Alumina and hydrochloric acid: Simultaneous production of—. L. G. Patrouilleau. Fr. Pat. 481,106, Mar. 2, 1916.

SILICO-ALUMINIUM, produced by reduction of siliceous bauxite in an electric furnace, is heated to dull redness in a refractory vessel, and chlorine is brought into contact with it. A mixture of the chlorides of aluminium and silicon results, which is led into suitable condensers, the excess of chlorine which accompanies it being led away and used again. Subsequent treatment of the chlorides is based on the facts that silicon chloride decomposes in aqueous solution into silica and hydrochloric acid, whilst the very soluble aluminium chloride decomposes only after total evaporation of its solution and roasting of the residue at a red heat, then becoming converted into alumina and hydrochloric acid.—T. H. B.

Oxygen compounds of metals or metalloids and carbonaceous substances; Manufacture of an intermediate product for use in processes based on heating together — [e.g., in production of calcium carbide]. Alby United Carbide Factories, Ltd., and K. Hylland. Fr. Pat. 480,020, Oct. 18, 1915. Under Int. Conv., Oct. 31, 1914.

SEE Eng. Pat. 11,186 of 1915; this J., 1916, 963. The process may be applied to other oxygen compounds of metals or metalloids, besides lime, and the product may be used in the manufacture of metals, alloys, nitrates, silicates, cyanides, and cyanamides, as well as of carbides.

Sulphuric acid: Process and apparatus for the manufacture of—. L. P. Bassot, Paris. Eng. Pat. 100,597, May 31, 1916. Under Int. Conv., May 31, 1915. (Appl. No. 7724 of 1916.)

SEE U.S. Pat. 1,197,331 of 1916; this J., 1916, 1058.

Carbon dioxide: Process of absorbing — from gaseous mixtures. Naaml. Vennootschap "Ant. Jurgens' Vereenigde Fabrieken," Oss, The Netherlands. Eng. Pat. 102,138, Feb. 16, 1916. Under Int. Conv., Nov. 8, 1915. (Appl. No. 2331 of 1916.)

SEE Fr. Pat. 480,774 of 1916; preceding.

Ammonium phosphate: Manufacture of acid —. W. Wollenweber, Bochum, Germany. U.S. Pat. 1,208,877, Dec. 19, 1916. Date of appl. Oct. 19, 1915.

SEE Eng. Pat. 8037 of 1915; this J., 1916, 737.

Ammonia: Apparatus for condensing —. L. Block, Manhattan, N.Y. U.S. Pat. 1,210,111, Dec. 26, 1916. Date of appl. Dec. 2, 1912.

SEE Fr. Pat. 411,688 of 1912; this J., 1912, 1113.

Alkaline compounds: Method of producing soluble —. P. Radmann, Godegard, Sweden. U.S. Pat. 1,209,201, Dec. 19, 1916. Date of appl. May 23, 1911.

SEE Eng. Pat. 12,136 of 1911; this J., 1915, 138.

Nitrogen compounds: Apparatus for production of —. C. Krauss, Cologne-Braunfeld, and P. Stähelin, Knapsack, Germany. U.S. Pat. 1,211,181, Jan. 2, 1917. Date of appl. Mar. 20, 1915.

SEE Fr. Pat. 461,750 of 1913; this J., 1914, 549.

Zinc sulphate or other zinc compounds: Manufacture of — from zinc ores. R. B. Llopert. Fr. Pat. 480,848, Feb. 2, 1916. Under Int. Conv., Apr. 2, 1915.

SEE U.S. Pat. 1,112,795 of 1915; this J., 1915, 834.

Sulphur: Recovering elemental — from sulphur gases. W. F. Lamoreaux, Isabella, Tenn., U.S.A. Eng. Pat. 16,513, Nov. 23, 1915. Under Int. Conv., Feb. 8, 1915.

SEE U.S. Pat. 1,169,726 of 1916; this J., 1916, 309.

Sulphur: Recovery of — from sulphurous gases. W. F. Lamoreaux. Fr. Pat. 480,315, Nov. 29, 1915. Under Int. Conv., Feb. 8, 1915.

SEE U.S. Pat. 1,169,726 of 1916; this J., 1916, 309.

Oxygen from air: Apparatus for extraction of —. H. Filippo, P. Schoonenberg, and Naaml. Vennootschap Philips' Gloeilampenfabriek. Fr. Pat. 480,915, Feb. 10, 1916. Under Int. Conv., Oct. 16, 1915.

SEE Eng. Pat. 101,860 of 1916; this J., 1917, 32.

Automatic pulsometer for raising liquids, especially acids. Fr. Pat. 480,861. See I.

Process for producing a water-softener. U.S. Pat. 1,207,826. See XIX.

VIII.—GLASS; CERAMICS.

Bricks: Yellow —. L. A. Keane. J. Phys. Chem., 1916, 20, 731—760.

It has been found that the yellow colour of bricks is due to ferric oxide in a very finely divided form (not to compounds of the latter with lime or silica): when the ferric oxide is in a coarser condition the colour of the bricks is red. Alumina appears to be the important peptising agent in bricks, which are yellow when the ratio of free alumina to iron is high; lime acts indirectly by setting free alumina. Anhydrous yellow ferric oxide has never been obtained in the pure state, but it is stabilised by other substances. The buff colour of the product obtained by igniting aluminium hydroxide containing a small percentage of ferrous hydroxide is undoubtedly due to ferric oxide, as also is the yellow colour of slightly impure quicklime. Clay deposited in the presence of organic matter, and therefore likely to contain very finely divided iron oxide, may burn to a buff colour without the lime or alumina content being high. As agglomeration increases with the temperature, yellow bricks might be expected to turn red if heated sufficiently; but the peptising action of alumina also increases with the temperature, and the latter appears to be the predominating factor, since red bricks become paler or even buff when reheated. The changes of colour which result from the heating of yellow bricks are complicated by the dissociation of the contained ferric oxide, and heating in oxygen is suggested as a means of eliminating this factor. —W. E. F. P.

Committee on Glass and Optical Instruments. See page 119.

Refractory oxides. Sosman. See VII.

PATENTS.

China clay: Apparatus for drying —. C. A. Battiscombe and N. O. Walker, London, and G. L. Bates, Playden, Sussex, Eng. Pat. 102,781, May 11, 1916. (Appl. No. 6747 of 1916.)

THE soft clay paste passes through a hopper and forms a film, $\frac{1}{16}$ in. to $\frac{1}{8}$ in. thick, on an absorbent endless band, made of canvas, which conveys it through a shallow tunnel heated by steam-pipes fixed beneath the upper part of the band. After reaching the further end of the tunnel, the clay is loosened by a scraper and falls on to another band, similarly heated, which conveys it again through the tunnel and discharges it in a dry state.—A. B. S.

Refractory materials resistant to corrosion: Manufacture of —. Mineral Products Co. Fr. Pat. 480,491, Dec. 18, 1915. Under Int. Conv., Dec. 21, 1911, and Aug. 9, 1915.

SEE Eng. Pat. 17,447 of 1915; this J., 1916, 692. The proportion of finely divided carbon specified is from 10 to 30% of the weight of alumina. A material resisting the action of hydrofluoric acid is obtained by heating the products at a high temperature.

Abrasives: Manufacture of — for cleaning and polishing. Naamlooze Vennootschap West Borneo Cultuur Maatschappij. Fr. Pat. 481,099, Mar. 1, 1916. Under Int. Conv., Mar. 4, 1915.

AN abrasive, cleaning, or polishing material is made of acid salts of the heavy metals, such as ferric titanate or chromate (ferro-titanic sand or chrome iron ore), which have been freed from coarse impurities by sifting and then mixed with corundum, charcoal, rouge or other abrasive and with a bond such as rubber, oil, grease, cement, or clay. If great strength is required (as in the manufacture of grinding wheels), the mixture may be moulded and then burned.—A. B. S.

Recuperative kiln. U.S. Pat. 1,207,209. See 1.

IX.—BUILDING MATERIALS.

Theory and practice of the dyeing of wood. Moll. See VI.

Sources of rosin in Germany. [Artificial seasoning of wood.] Besemfelder. See XXI.

PATENTS.

Paving composition, and method of producing same. E. H. Staber, Calcutta, India. Eng. Pat. 13,753, Sept. 27, 1915.

A PAVEMENT composition consists of grains of a mineral aggregate of different sizes, graded so as to give the maximum density, and not less than 4% of bitumen. The softening temperature of the bitumen is increased by mixing it with an impalpable powder so that the paving material does not soften under the highest sun temperature. Details of the method of grading, with graphs of seven mixtures, are given.—A. B. S.

Metallic coating on artificial stones and articles of artificial stone mass; Process for the production of a thick or compact —. H. Wette, Znaim, Austria. Eng. Pat. 17,862, Dec. 21, 1915. Under Int. Conv., Apr. 10, 1915.

THE surface of the unset mass is strewn with a powdered metal, such as lead, tin, zinc, aluminium, or their alloys, preferably composed of globular or angular particles, before being subjected to the final pressure in the mould by which the desired shaping is produced. A soft and a less soft metal powder may be used in succession, or a mixture

of powdered metals or alloys may be employed, with or without a small proportion of graphite in either case.—W. E. F. P.

Artificial stones; Manufacture of —. J. Voisembert and F. H. Keudel. Fr. Pat. 480,285, Apr. 7, 1915.

ARTIFICIAL building stone is made by crushing or grinding natural stone, adding 1–4% of a bond such as felspar, clay, ground glass, or quartz, and sufficient water to make a stiff paste. The latter is pressed hydraulically or mechanically into the desired shapes and the blocks produced are burned in an electric or gas-fired kiln. The blocks are laid in a mortar made of the same materials together with cement or lime.—A. B. S.

Magnesian cement. E. Ruch. Fr. Pat. 480,338, Nov. 27, 1915.

MAGNESIAN cement is made by adding sufficient dilute hydrochloric acid to calcined magnesia and inert materials such as stone, sawdust, etc., to form a paste, and then stirring the mixture vigorously.—A. B. S.

Wood; Bleaching exotic —. P. E. Simon. Fr. Pat. 481,155, June 15, 1915.

ROSE-WOOD, violet-wood (palisander wood), or other exotic wood is soaked in dilute nitric acid, for about a fortnight if cold acid is used or four days if the acid has a temperature of 40° C. It is then washed in a stream of water for a fortnight or more until all traces of nitric acid have been removed.—A. B. S.

Lumber: Treatment of — to increase its density. F. Pfeumer, Dresden, and H. Pfeumer, Loschwitz, Germany. Eng. Pat. 100,792, June 24, 1916. Under Int. Conv., June 25, 1915. (Appl. No. 8916 of 1916.)

SEE Ger. Pat. 291,945 of 1915; this J., 1916, 843.

Cement: Process and furnace for manufacture of — for preparing concrete of great strength. E. Longan. Fr. Pat. 480,542, Dec. 9, 1915. Under Int. Conv., Dec. 11, 1914.

SEE Ger. Pat. 293,121 of 1914; this J., 1916, 966.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Gold in copper matte: Assaying —. R. E. Chase, jun. Eng. and Min. J., 1916, 102, 1139.

THE method is especially adapted for mattes rich in gold. One-quarter assay-ton is divided between two 3 in. scorifiers containing 35 grms. of test lead and 2 grms. of silica, and a second sample of the same weight is divided between a second pair of scorifiers, the assay being run in duplicate. The contents of the scorifiers are mixed and each charge is covered with 35 grms. of test lead and 2 grms. of borax glass. The lead buttons are combined two and two, made up to 65 grms. with test lead, and re-scorified with 2 grms. of silica. The silver beads are combined two and two and the assay finished in the usual way.—W. R. S.

Mineral and metal production of the United States. Eng. and Min. J., Jan. 6, 1917.

THE subjoined tables show the estimated amounts of certain important metals and minerals produced in the United States in 1916, together with the figures for 1914 and 1915:—

Metals.

Metal.	Unit.	1914.	1915.	1916.
Copper (a)	Pounds	1,158,581,876	1,423,698,160	1,941,900,586
Ferromanganese	Long tons	185,118	226,957	355,356
Gold (b)	Dollars	94,531,800	101,035,700	92,315,363
Iron	Long tons	23,147,226	29,016,213	39,484,000
Lead (c)	Short tons	538,735	535,922	583,498
Nickel (c)	Pounds	30,067,064	44,139,826	61,675,438
Quick-silver	Flasks	16,300	(f) 21,033	28,912
Silver (b)	Troy ounces	72,455,100	67,485,600	72,883,748
Zinc (d)	Short tons	362,261	492,495	672,500

(a) Production from ore originating in the United States. (b) The statistics for 1914 and 1915 are the final and those for 1916 are the preliminary statistics reported jointly by the directors of the Mint and the U. S. Geological Survey. (c) Production of refined lead from ore and scrap originating in the United States; Antimonial lead is included. (d) Total production of smelters, except those treating dross and junk exclusively; includes spelter derived from imported ore. (e) Imports; for 1914, 1915 and 1916 first 10 months only. This nickel is refined in the United States for the production of metal, oxide and salts. (f) As reported by U. S. Geological Survey.

Mineral and chemical substances.

Substance.	Unit	1914.	1915.	1916.
Coal, anthracite (a)	Short tons	90,821,507	88,912,000	88,500,000
Coal, bituminous (a)	Short tons	422,703,970	432,500,000	509,000,000
Coke (a)	Short tons	34,555,914	41,600,000	51,300,000
Iron ore	Long tons	42,911,897	58,843,804	81,035,000
Petroleum (a)	Barrels	265,762,535	281,104,194	292,300,000

(a) The coal and coke and petroleum statistics are the estimates of the U. S. Geological Survey.

Brass: The failure of —. I. *Microstructure and initial stress in wrought brasses of the type Cu 60, Zn 40%.* P. D. Merica and R. W. Woodward. U. S. Bureau of Standards, Technical Paper No. 82. J. Franklin Inst., 1916, 182, 803—805.

As the result of examining some 250 samples of used and unused wrought brass of the above type, the initial stresses in rods and bolts were found to vary greatly in distribution and magnitude. Average stresses of 1000—30,000 and fibre stresses of 0—80,000 lb. per sq. in. were obtained (mainly by the Heyn method; see this J., 1914, 596); and whereas the outside layers of extruded and forged rods were found to be under compressional strain, those of drawn rods were in tension. Some of the results obtained for typical materials are given in the following table: samples 85, 136, 172, 174, and 205 were new, 3 and 160 had season-cracked in service, while 187 and 189 had been in service under moderate stress for months without showing signs of failure.

5000—10,000 lb. per sq. in., an average initial stress value of 500 lb. per sq. in. is a safe stress limit for rods and bolts of usual size; and failure is likely to occur in cases where the initial stress value, or the sum of initial stress in tension and the tensional service stress, approaches the elastic limit of the material. The initial stress in rods is relieved by annealing for 1—2 hours at 300°—400° C., at which temperature the physical properties are not appreciably affected.—W. E. P. P.

Zinc, cadmium, and mercury; Vapour pressures of —. A. C. Egerton. Phil. Mag., 1917, 33, 33—48.

The method employed by Knudsen (Ann. Phys., 1909 (4), 29, 179) for determining the vapour pressure of mercury (depending on the kinetic flow of molecules through small apertures and tubes) was adapted to the requirements of the present investigation, the original procedure being simplified by the use of tubes having accurately circular holes the diameters of which

No.	Material.	Percentage composition.				Tensile strength (lb. per sq. in.).		Percentage elongation in 2 ins.	Initial stress (lb. per sq. in.).		Stress in outer layer.
		Cu.	Zn.	Sn.	Fe.	Ultimate strength.	Proportional limit.		Average stress.	Maximum fibre stress.	
3	Manganese bronze	60.0	38.6	0.78	0.5	70,000	17,000	33	25,000	44,000	Tension
85	Naval brass	59.8	39.3	0.61	—	61,000	16,000	46	2,000	7,000	Tension
136	Manganese bronze	59.1	39.3	0.78	0.70	72,000	27,500	44	22,000	34,000	Tension
160	Manganese bronze	57.3	40.7	0.94	1.08	61,000	14,000	28	30,000	81,000	Tension
								(on 3 ins.)			
172	Muntz metal	59.4	40.2	—	0.62	61,000	36,000	40	4,000	8,000	Compression
174	Manganese bronze	56.9	40.1	1.63	1.18	81,000	36,000	22	4,000	9,000	Compression
187	Naval brass	60.0	39.6	0.10	—	61,600	28,700	33	6,000	14,000	Compression
189	Manganese bronze	56.6	40.8	1.00	1.50	61,600	21,000	—	8,000	12,000	Compression
205	Manganese bronze	58.8	39.6	0.39	1.06	81,600	52,000	22	5,000	9,000	Tension

Failures by fracture or fissure were found to have occurred as the result of (1) the presence of initial stresses of large magnitude, (2) service over-stress due, for example, to the drawing up of bolts too tightly, and (3) improper and faulty practice in forging bolt heads, flanging plates, etc. Under normal service conditions, in which the service stresses are themselves not greater than

could be measured by a micrometer; the condensed metal was weighed instead of measured. The vacuum was obtained by means of a charcoal tube kept in liquid air, and also by the use of a Rose oil pump. The apparatus was standardised by means of mercury; and details of the observations made with all three metals are given in a series of tables. The values of log. p. for cadmium

and zinc were found to be $10.5979 - 0.5 \log. T - \frac{6060}{T}$ mm. and $10.9443 - 0.5 \log. T - \frac{7176}{T}$ mm., respectively; the corresponding value for mercury, as found by Knudsen, being $10.5721 - 0.817 \log. T - \frac{3342.26}{T}$ mm. The angle of slope of the vapour pressure curve for mercury was slightly less than half that of the slopes of the zinc and cadmium curves, which were very similar. The values of $\frac{dp}{dT}$ at the melting points of the elements were: Zn 4.11×10^{-3} , Cd 3.70×10^{-3} , and Hg 2.81×10^{-7} mm.; while at a point of equal pressure, 2.0×10^{-6} mm., the corresponding values were 1.25×10^{-7} , 1.39×10^{-7} , and 2.81×10^{-7} mm. at the absolute temperatures 502° , 436° and 231° respectively. At the melting points, the vapour pressures of zinc and cadmium were nearly equal (Zn 1.13×10^{-1} , Cd 1.0×10^{-1} mm.). The physical constants of these two elements are closely similar, but those of mercury have a much smaller value throughout. The results obtained so far show the method to be capable of general application.—W. E. F. P.

Aluminium; Official price of —.

THE selling price of aluminium ingots of ordinary commercial purity of 98–99% has been fixed by the Ministry of Munitions at £225 per ton, carriage paid to consumers' works. The maximum selling price of re-melted aluminium scrap and swarf ingots of 98–99% purity has been fixed at £210 per ton, carriage paid to consumers' works. The maximum price must not be exceeded, but a lower one may be fixed by agreement between the seller and the buyer, based upon the metallic aluminium content. These prices are to take effect as from 1st January, and permits under Regulation 30 A of the Defence of the Realm Regulations will be granted only for such dealings in the above-mentioned materials as are in accordance with the above prices. The above prices are subject to alteration, at any time, as may be directed by the Minister of Munitions.

Gallium; Electrolysis of —. H. S. Uhler, Amer. J. Sci., 1917, 43, 81.

THE electrolytic deposition of gallium by the process described recently (this J., 1916, 1221) is considerably retarded by the presence of nitrates. Chlorides, on the other hand, appear to have no effect on the rate of deposition.

Antimonial lead; Analysis of —. C. R. McCabe, J. Ind. Eng. Chem., 1917, 9, 42–44.

THE following modification of Demorest's method (J. Ind. Eng. Chem., 1913, 8, 842) obviates the error caused by occlusion of antimonious sulphate by the precipitated lead sulphate:—One gram. of the alloy is dissolved in 50 c.c. of strong sulphuric acid, and the solution boiled for 5 mins. to oxidise the tin, and allowed to cool. It is then diluted with 50 c.c. of water, boiled for 10 mins., allowed to cool somewhat, and a further 50 c.c. of water added. The precipitated lead sulphate is washed twice by decantation with 25 c.c. of water, the washings being passed through an asbestos filter in a Gooch crucible, and it is then dissolved in a solution of 10 grams. of ammonium acetate in 50 c.c. of water. The solution is treated with 25 c.c. of strong sulphuric acid, the flask shaken, and the lead sulphate left to settle for 5 mins. and then collected in the Gooch crucible, in which, after being washed with water, it is dried at 120°C ., ignited for 5 mins. over a Bunsen flame, cooled in a desiccator, and weighed. The antimony in the two filtrates is separately determined by adding a large excess of N/10 potassium permanganate

solution (standardised on pure antimony dissolved in sulphuric acid) and titrating the excess with standard ferrous sulphate solution. The total amount of permanganate used, less 0.3 c.c., the quantity consumed in a blank test, corresponds with the amount of antimony. Tin is determined in the first filtrate by reduction with iron, filtration of the liquid through cotton wool, which is then washed with dilute (1:5) sulphuric acid, and titration of the filtrate with standard iodine solution.—C. A. M.

Burma's wolfram output. U.S. Commerce Reports, No. 303, Dec. 27, 1916.

COMPLETED figures for 1915 show that the total production of wolfram from all sources in Burma amounted to 46,293 cwt., compared with 43,752 cwt. in 1914, 32,991.5 in 1913, 32,224.5 in 1912, and 25,357 in 1911. These figures do not include production from the southern Shan States, where wolfram is worked in conjunction with tin, and separate statistics are not recorded.

Hitherto the greater portion of the wolfram ore produced in Burma was taken up by Germany, but English smelters are now in a position to handle all the ore coming forward. Late figures show that from January 1 to October 7, 1916, 2702 tons of wolfram was exported, compared with 1844 tons in the corresponding period of 1915. (See also this J., 1916, 119.)

Silver-tellurium; Metallographic investigation of the system —. M. Chikashige and I. Saito. Mem. Coll. Sci., Kyoto Imp. Univ., 1916, 1, 361–368.

MIXTURES of silver and tellurium in varying proportions and, in each case, of a total volume of 2.5 c.c., were melted in an atmosphere of hydrogen in a porcelain tube contained in an electric furnace. During the progress of cooling, temperature readings were taken by means of a calibrated thermo-element. An allowance was made for the volatilisation of tellurium, which was found to be appreciable when the proportion present in the mixture exceeded 40%. The formation of homogeneous crystals and eutectoids was followed by maxima and constant temperature points in the cooling curves, and by microscopic examination of the reguli. Formation of the compounds Ag_2Te and Ag_7Te_4 was established. Ag_2Te is a brittle, greyish-white, crystalline substance melting at 957°C ., which is immiscible with silver in the solid state and thus forms an eutectoid with this metal, but reacts with tellurium in the molten condition at 443°C . to form $\beta\text{-Ag}_7\text{Te}_4$, which, at 403°C ., changes into the α -form. Ag_7Te_4 was found to be insoluble in Ag_2Te but remains mechanically mixed with the latter, and immiscible with tellurium in the solid state, so forming an eutectoid when separating together. Regulii containing 70% of silver give an alloy of fine structure which may have technical importance.—J. N. P.

Metals; Emulsions and suspensions with molten —. H. W. Gillett. U.S. Bureau of Mines. J. Phys. Chem., 1916, 20, 729–733.

FROM a consideration of numerous cases in practice where emulsions or suspensions of molten metals or alloys with solids, liquids, or gases are produced unavoidably, as in the refining of aluminium chips, "floured" or "sickened" mercury, dirty molten sodium, and "blue" zinc powder, or intentionally as in sherardising and in the production of the lead-copper mixture used for packings, bearings, etc., it is suggested that, if procurable, many stable emulsions of metals normally immiscible in the liquid state might prove of use industrially. Although useful emulsions of gases with metals are rare, it is known that lead made porous by an indirect method is

much more efficient than solid lead plate for storage batteries; and it is probable that other metals, if rendered uniformly porous by emulsification with gas while in the liquid state, would find many industrial applications. Investigation of the colloid chemistry of molten metals and alloys would doubtless yield much valuable information.

—W. E. F. P.

Antimony sulphide and cuprous sulphide; Metallographic investigation of the system—. M. Chikashige and Y. Yamauchi. Mem. Coll. Sci., Kyoto Imp. Univ., 1916, 1, 341—347.

AN investigation was made of the crystallisation of mixtures of antimony and cuprous sulphides. Mixtures of varying proportions were melted by means of an electric furnace in tubes of Jena glass or porcelain. Temperatures during the gradual cooling were read by a platinum-platinum-rhodium thermo-element and an atmosphere of nitrogen was maintained round the tube containing 30 grms. of the mixture. Maxima in the cooling curves were obtained with a mixture corresponding to the composition $4\text{Cu}_2\text{S} \cdot 5\text{Sb}_2\text{S}_3$ and with $3\text{Cu}_2\text{S} \cdot \text{Sb}_2\text{S}_3$ (orthothioantimonite). Metallographic examination showed that homogeneous crystallisation took place at these compositions, and the compounds gave no mixed crystals with each other or with either of their components. Indications were obtained of the separation of $\text{Cu}_2\text{S} \cdot \text{Sb}_2\text{S}_3$ (metathioantimonite), but this formation remained uncertain as the crystallisation was accompanied by the separation of a eutectoid containing $3\text{Cu}_2\text{S} \cdot \text{Sb}_2\text{S}_3$, which gave a heterogeneous structure to the regulus. On account of the uncertainty of this crystallisation, the composition of chalcostibnite still remains unsettled. An analysis of the mineral gives 46.81% antimony, while $\text{Cu}_2\text{S} \cdot \text{Sb}_2\text{S}_3$ contains 48.5% and $4\text{Cu}_2\text{S} \cdot 5\text{Sb}_2\text{S}_3$, 45.9%.—J. N. P.

Sulphuric acid from copper-smelting gases. Larison. See VII.

Overvoltage tables. IV. Theories of overvoltage and passivity. Newbery. See XI.

PATENTS.

Tool-steel alloy. R. Furness, Jenkintown, and R. H. Patch, Assignors to The Midvale Steel Co., Philadelphia, Pa. U.S. Pats. (A) 1,206,833, (B) 1,206,834 and (C) 1,206,902, Dec. 5, 1916. Dates of appl., Dec. 11, 1915, Jan. 19, 1916, and Sept. 16, 1915.

High speed tool steels are claimed containing (A) Cr, 2.5—5 (4); Mo, 4—11 (8); Co, 2—20 (5); C, less than 1% (1); (B) Cr, 2—6; W, 9—15 (less than 15); Co, 5—20 (not less than 10%); (C) Cr, 15—20 (19.5); C, about 1.35%.—W. E. F. P.

Iron for castings; Method of preparing—. W. G. Kranz, Sharon, Pa., Assignor to The National Malleable Castings Co., Cleveland, Ohio, U.S. Pat. 1,206,861, Dec. 5, 1916. Date of appl., Nov. 17, 1915.

A PORTION of the molten iron, high in carbon, manganese, and silicon, is treated in a Bessemer converter to reduce the amounts of these elements, and the molten iron is then mixed with the remaining portion of the charge, whereby the amounts of the elements are reduced and equalised, though the carbon remains above 1.5%. The metal is refined in an electric furnace, without further substantial reduction of the carbon.—B. N.

Ferrotungsten; Process of treating—. P. M. McKenna, Washington, D.C. U.S. Pat. 1,208,596, Dec. 12, 1916. Date of appl., Aug. 11, 1916.

FERRO-TUNGSTEN alloy obtained by smelting is treated for the removal of non-metallic impuri-

ties, such as sulphur, by grinding the mass and subjecting it to the action of hydrochloric acid of approximately 20° B. (sp.gr. 1.16). The acid does not combine with the metallic tungsten alloy, but forms hydrogen compounds, such as hydrogen sulphide, with the impurities. The excess of acid is removed by washing, and the finely-divided product dried.—B. N.

Tin from cassiterite and oxidation products of tin; Process for facilitating the extraction of—. G. Michaud and E. Delasson, Montreuil sous Bois, France. Eng. Pat. 17,743, Dec. 18, 1915. Addition to Eng. Pat. 611, Jan. 14, 1915 (this J., 1916, 313).

THE reduced metal, obtained as a concentrate or fine powder or in the form of "carbo-metallic plates," by the original process, is dissolved in a solvent composed of hydrochloric acid (40 litres), water (60 litres), and stannous chloride (20 kilos.) at a temperature between 50° and 70° C. The solution is electrolysed for the production of metallic tin, and the spent electrolyte used for dissolving a further quantity of the crude metal. The stannous chloride for the solvent is obtained by treating the partly exhausted carbo-metallic plates with hydrochloric acid and evaporating the solution.—W. E. F. P.

Roasting furnace. F. Fouarge, Swansea, Eng. Pat. 102,595, Sept. 4, 1916. (Appl. No. 12,491 of 1916.)

THE furnace has superimposed hearths with openings at the ends so disposed that the material travels along a sinuous path. Each roasting chamber is provided with lateral shelves or flanges which do not extend quite to the ends of the chamber. Reciprocating rakes are carried by rods extending across the chambers and their ends slide upon the inwardly projecting flanges or below these. The rakes on alternate hearths work in opposite directions, pushing the material towards the shoot leading to the next lower floor as well as to one side. Dust-chambers communicating with the upper hearth are situated at the top of the furnace. Additional side shoots may be provided to prevent the channel from getting clogged.—W. R. S.

(A) *Furnace and allied structure*. (B) *Furnace*. (C) *Feeding device for furnaces*. (D) and (E) *Metallurgical furnace*. U. Wedge, Ardmore, Pa. U.S. Pats. (A) 1,208,216, (B) 1,208,247, (C) 1,208,248, (D) 1,208,249, and (E) 1,208,250, Dec. 12, 1916. Dates of appl., (A) Jan. 12, 1914, (B) Feb. 11, 1914, (C) Feb. 28, 1914, (D) Nov. 21, 1914, and (E) Mar. 1, 1915. All renewed Apr. 27, 1916.

(A), IS a furnace having a series of superposed annular hearths, each hearth is provided with an inner and an outer charge-receiving surface, side by side, each having a separate outlet. A charge is fed to each surface independently and moved over the surface towards the outlet. The outlets of alternate hearths are at the outer periphery, and midway between the outer and inner peripheries respectively. (B) Two concentric cylindrical walls are provided with superposed annular hearths projecting into the annular space towards one another. A girder rotating in a horizontal plane about a central pivot carries depending from its outer end a series of annular hearths intermediate with the fixed hearths and projecting equally between the members of the two series. (C) In a furnace as in (B) the outer end of the girder carries a feeding hopper above a circular pivoted distributing plate over the hearths. The plate engages with fixed members on the furnace as the girder revolves, and is caused to rotate upon its own axis to distribute the

material (ore) on to the uppermost hearth from which it passes to the lower hearths. (D) In a metallurgical furnace a tubular vertical shaft is surrounded by a hearth having a treating chamber above it. A hollow rabble arm with a return passage therein communicates at one end with the tubular shaft and at the other end with a concentric tubular member within the shaft. An air distributing arm projects into the working chamber from one of the tubular members independently of the rabble arm. It is provided at its inner end with a valve to regulate the flow of air to the working chamber, the air being supplied to the other tubular member. (E) A rabble blade is supported by its enlarged head in jaws projecting downwards from a hearth or equivalent support. A rib or flange on the support bears upon the rear face of the rabble blade. A filling body occupies the space in the support above the rabble blade.—W. F. F.

Metal articles; [Preventing] scaling, and annealing of — F. Perry, and Metalloids, Ltd., Tipton, Staffs. Eng. Pat. 102,660, Mar. 25, 1916. (Appl. No. 4445 of 1916.)

IN the treatment of metal articles in a muffle or other annealing chamber containing an atmosphere of Mond gas or similar gas for reducing or preventing the formation of scale, the gas is freed from water vapour, sulphur, and unsaturated and saturated hydrocarbons before admission to the muffle. The saturated hydrocarbons (e.g., methane) are eliminated by passing the gas through an iron tube, or a chamber containing loose pieces of iron, heated to about 250° C., after removal of the other impurities by known means.—W. E. F. P.

Metals [copper] from ores; Process for the recovery of — C. S. Vadner, Butte, Mont. U.S. Pat. 1,207,243, Dec. 5, 1916. Date of appl. May 23, 1916.

THE oxide or roasted sulphide ore mixed with a hot chloride solution is treated with sulphur dioxide. The clear liquor is freed from the excess of sulphur dioxide, partially neutralised, and iron and arsenic are precipitated by introducing air in presence of a carbonate. After completely neutralising, the copper is precipitated as cuprous chloride by heating. Sodium sulphate is recovered from the liquor.—W. R. S.

Copper and nickel ores; Treatment of — by electrolysis. V. Garin, Fr. Pat. 481,079, Feb. 29, 1916.

ALBUMINOUS or gelatinous materials, such as albumin, gelatin, dextrin, etc., are employed in the electrolytic deposition of copper and nickel from poor impure solutions, charged with sulphurous acid, particularly those obtained by the lixiviation of copper ores. Filaments of albumin, gelatin, etc., are applied by rubbers of soft fibrous wood, obtained from the cotton plant, coconut palm, etc., covered with organic material, such as skins, etc., in order to remove the hydrogen bubbles from the rotating cylindrical cathodes, or the albuminous or like material may be employed as pieces floating in the electrolyte. The formation of copper sulphide is prevented, and a sound and compact deposit is maintained, even up to the point at which the bath is exhausted.—B. N.

Zinc, copper or other metals; Electrolytic production of — Soc. de Métallurgie Electrolytique. First Addition, dated Sept. 21, 1915, to Fr. Pat. 472,764, May 28, 1914 (this J., 1915, 497).

SEVERAL rotary mandrel-cathodes, of small diameter but great length and supported on bearings so that they may be easily removed, are arranged in a shallow rectangular tank, each cathode being partly surrounded by a perforated lead anode in

the form of an open trough. Adjacent anodes are bound together by rivets, and they rest on supports fixed to the bottom of the tank. Impregnated wiping pads, of soft supple animal membranes, prepared from skins, bladder, etc., rendered insoluble by immersion in aldehyde, acetone, etc., are employed to remove bubbles of hydrogen from the cylindrical cathodes, and the action of the gelatin, added to the bath to improve the deposit, is thus made more regular. The animal membranes may be replaced by vegetable materials impregnated with insoluble gelatin. The pads, resting lightly on the upper surface of the cathodes, are displaced by an irregular reciprocating motion. The electrolyte, filtering between the rotating shafts of the cathodes and their supports, is collected in a receiving vessel, and led off from the bottom of the latter, to prevent the liquid coming into contact with the turning mechanism.—B. N.

Melting metals [copper, bronze, and cuprous metals] which fuse at high temperatures; Process for — in iron or steel ladles. J. Cookerley, Inglenook, Ala., Assignor to E. Shelton, Birmingham, Ala. U.S. Pat. 1,208,717, Dec. 12, 1916. Date of appl. Feb. 21, 1916.

THE metal is melted, in contact with a bath of fused sodium chloride, in an iron or steel ladle or crucible, the inner surface of which has been previously coated with the fused sodium chloride.—W. R. S.

Brass surfaces; Process of crystallising — O. R. Hasenohr, Assignor to J. Debeck, Terre Haute, Ind. U.S. Pat. 1,207,910, Dec. 12, 1916. Date of appl. Oct. 14, 1914.

THE brass is immersed for 5–10 secs. in a solution containing 1 part of nitric and 2 of sulphuric acid, then washed in cold water and immersed for 5–10 secs. in an aqueous solution of potassium cyanide (8 oz. per gall.), again washed in cold water and placed for 1–5 mins. in sawdust impregnated with a solution made by dissolving 10 oz. of ammonium chloride and 2 oz. of copper sulphate in $\frac{1}{2}$ gall. of water, and subsequently washed in cold water and dried after immersion in boiling water.—W. E. F. P.

Gold; Process of recovering — J. H. Alling, Columbia, Cal., Assignor to F. M. Wright, San Francisco, Cal. U.S. Pat. 1,207,261, Dec. 5, 1916. Date of appl. Oct. 18, 1910. Renewed Aug. 18, 1911.

THE ore pulp is mixed with a solution of common salt, and a continuous supply of the mixture passed once only through a series of alternate electrolytic and non-electrolytic cells. The stream of mixture is thus repeatedly subjected to electrolytic action at intervals sufficiently long to permit combination of the gold with the liberated chlorine: the gold is deposited on the cathodes.—W. R. S.

[Zinc] retorts; Method of recovering clay and slag from used — C. C. Conover and A. N. Detweiler, Springfield, Ill. U.S. Pat. 1,207,503, Dec. 5, 1916. Date of appl. June 27, 1916.

OLD clay retorts, which have been used for zinc distillation, are coarsely crushed, and the powder is subjected to a weak magnetic power which separates the more magnetic constituents of the slag. The coarse powder, after re-crushing, is treated by strong magnetic power to separate the less magnetic constituents of the slag from the clay. The material is subjected to the process before the magnetic properties of the slag constituents have been materially altered through oxidation.—W. R. S.

Zinc: Manufacture and condensation of volatile metals, more especially — in the electric furnace. A/S Metallforedling. First Addition, dated Nov. 6, 1915, to Fr. Pat. 478,770, Jan. 27, 1915 (see Ger. Pats. 289,493, 290,499, 290,690, and 291,492 of 1914; this J., 1916, 427, 606, 695).

THE gaseous products from the treatment of the slag, as described in the main patent, are conducted into the condensation chambers, thus enriching the vapour in zinc and facilitating the condensation in liquid form.—B. N.

Metal: Process of carbonising and hardening —. N. H. Bray, San Francisco, Cal. U.S. Pat. 1,207,818, Dec. 12, 1916, Date of appl. Apr. 29, 1914.

METAL is heated to a high temperature by direct application of an oxyacetylene flame containing an excess of acetylene. Potassium cyanide and a solution of salt and copper sulphate are then applied to the metal.—W. E. F. P.

Ores: Process of smelting metallic —. H. L. Doherty, New York. U.S. Pat. 1,207,881, Dec. 12, 1916. Date of appl. June 22, 1909.

A MIXTURE of ore and flux is heated in a rotating chamber, by direct contact with a flame of combustible gas and preheated air, until combination is effected between the gangue and flux; it is then transferred to a rotating reducing chamber in which an atmosphere of carbon monoxide is maintained by the partial combustion of carbonaceous matter in aerial suspension. The charge is mixed with solid reducing material at the point of entry into the second chamber, in which the heating is continued until complete reduction and fusion are effected. The hot reducing gases from the second chamber are employed in admixture with preheated air for heating the first chamber.—W. E. F. P.

Galvanising wire: Furnace for —. G. L. Meaker, Joliet, Ill. U.S. Pat. 1,208,485, Dec. 12, 1916. Date of appl. June 27, 1913.

IN an apparatus having a fire-box at one end and a shallow container for the coating metal (zinc) at the other, the container is provided with a long side tube to serve as an annealing bath; this extends through a horizontal flue to above the fire-box and is then bent upwards to prevent escape of the molten metal and provide an outlet for the treated wire. One end of the horizontal flue communicates with the fire-box and the other with a flue beneath the container, the arrangement being such that the annealing bath is cooled externally by a downward current of air at that part adjoining the container, and heated most strongly at the exit end.—W. E. F. P.

Tinning, tading, and galvanising [small articles]: Mechanical process for —. C. Ziegler. Fr. Pat. 479,970, Oct. 8, 1915.

THE articles to be coated are placed in or upon a perforated vessel or horizontal grid support adapted to be rotated about a vertical axis and, after immersion in the molten metal, drained and whirled to remove excess of the latter. The coated articles are then separated from each other before solidification of the coating metal occurs.—W. E. F. P.

Metals: Method of separating fusible — [from alloys] by fractional distillation. J. Thomson, New York. Assignor to John Thomson Press Co., Jersey City, N.Y. U.S. Pat. 1,208,237, Dec. 12, 1916. Date of appl. Feb. 8, 1916.

THE alloy is heated in one compartment of a container to eliminate the metal having the lowest vaporising point; the residue is displaced by additional charges of alloy, and made to flow

into an adjacent compartment where it is vaporised by a higher temperature. The fumes of the different metals are condensed separately.—W.R.S.

Soldering composition. H. Hess. Fr. Pat. 480,197, Nov. 11, 1915. Under Int. Conv., Oct. 15, 1915.

A PASTE composed of soldering metal powder 85.616—90.97, ammonium chloride 2.53—2.59, glycerin 5.43—5.85, and glue (aqueous) 0.59—1.16%. The glue is prepared by soaking 1 part of glue in 2 parts of water, heating to about 50° C., and mixing the jelly with 1½ times its quantity of glycerin.—W. E. F. P.

Bronze powder: Process of manufacturing —. M. J. Fuchs. Fr. Pat. 480,504, Dec. 23, 1915.

THE coarse alloy is pulverised by stamping in a mill consisting of a series of compartments arranged at successively lower levels. The weight of the stamps decreases in successive compartments, and in each of the latter the dies or anvils are arranged in steps, down which the charge is caused to travel by the vibration produced.—W. E. F. P.

Metal [aluminium]: Manufacture of powdered or granulated —. H. J. Jack and A. G. Løbley. Fr. Pat. 480,563, Dec. 29, 1915. Under Int. Conv., Dec. 6, 1915.

A VERTICAL stream of the molten metal is subjected to the action of a horizontal blast of air or other gas under high pressure, whereby subdivision and solidification of the material is effected.—W. E. F. P.

Tungsten or other analogous metal [for incandescence filaments]: Process and [electric] fusion furnace for the manufacture of coherent ductile —. Soc. Anon. ci-dev. Gimur et Cie. Fr. Pat. 480,819, Jan. 31, 1916. Under Int. Conv., Jan. 15 and July 11, 1914.

COHERENT ductile tungsten is obtained by fusing the metal, and then rapidly cooling by directing a current of air on to the crucible containing it. The fusion furnace is composed of a crucible resting on a fixed base-plate forming one electrode, and surrounded by two concentric heating jackets connected to a common electrode. The tuyères for the cold air are arranged outside the heating jackets along the whole length of the crucible, and within an external insulating jacket. The heating jackets may be raised out of the furnace, a commutator, bound to the lifting arrangement, automatically cutting off the current at the same time, whilst the valve for the air is opened simultaneously.—B. N.

Bronze: New —. E. A. de Lisle and N. A. Hélois. Fr. Pat. 480,928, May 5, 1915.

COPPER-VANADIUM alloy, containing 4 to 5% of vanadium, reduced from the oxides by aluminium, is mixed with electrolytic copper and aluminium to give an alloy containing 0.1 to 0.3% of vanadium and 1% of aluminium, and, when melted, 4% of aluminium is added. The copper-vanadium may be replaced by copper-uranium, or preferably, copper-uranium-vanadium, so as to introduce into the copper, 5 to 7% of aluminium, 0.1 to 0.3% of vanadium, and 0.2 to 0.4% of uranium; a hard resistant alloy is produced, capable of taking a high polish.—B.N.

Metals [aluminium and silicon]: Process and apparatus for obtaining — [from clay, etc.]. Weaver Co. Fr. Pat. 481,056, Feb. 25, 1916.

A MIXTURE of clay, etc., with carbon is heated in an electric furnace in a stream of chlorine and the volatilised aluminium and silicon chlorides are separated by fractional condensation, all the

operations being conducted in an atmosphere free from moisture. The silicon tetrachloride produced is decomposed by intimate contact with molten aluminium with formation of aluminium chloride and silicon; the aluminium chloride is electrolysed in molten sodium chloride, the chlorine liberated in the latter operation being used for treating a further quantity of clay. The process is continuous, the apparatus consisting of a closed system comprising furnace, condenser, receiver, electrolytic vat, and gas reservoir (for chlorine) connected in series, the gas reservoir also communicating with the furnace inlet. The condenser consists of two parts adapted to be cooled to different temperatures; and the interior of the receiver is maintained above atmospheric pressure.—W. E. F. P.

Zinc; Extraction of —. E. S. Berglund. Fr. Pat. 480,633, Jan. 7, 1916. Under Int. Conv., May 31, 1915.

In a process for smelting zinc ores by electrical means, the bulk of the zinc vapour is condensed as liquid metal and the remainder as zinc dust which is subsequently volatilised out of contact with air and re-condensed in the same system. The condenser has two communicating compartments, the first connected with the outlet and the second with the inlet of the electric furnace. Liquid metal is condensed in the first compartment, zinc dust being deposited in the second and conducted therefrom to the interior of the furnace, out of contact with air, by means of a screw conveyor.—W. E. F. P.

Furnaces; Tilling or rolling —. D. F. Campbell, London, and Soc. Electro-Métallurgique Française, Froges, France. Eng. Pat. 102,902, Aug. 9, 1916. (Appl. No. 11,250 of 1916.)

Welding composition. J. A. Hope, Montreal, Canada. U.S. Pat. 1,209,841, Dec. 26, 1916. Date of appl., Apr. 10, 1916.

SEE Eng. Pat. 102,237 of 1916; this J., 1917, 38.

Iron from scrap of zincd sheet iron; Process of manufacturing —. O. Schleimer, Assignor to K. Albert Chem. Fabr., Neuss, Germany. U.S. Pat. 1,209,628, Dec. 19, 1916. Date of appl., Nov. 13, 1914.

SEE Ger. Pat. 280,414 of 1913; this J., 1915, 497.

Alloy for arc welding. D. H. Wilson, Franklin Township, N.J., and S. Rodgers, Pittsburgh, Pa., U.S.A. Eng. Pat. 18,115, Dec. 29, 1915. Under Int. Conv., June 16, 1915.

SEE U.S. Pat. 1,187,411 and 1,187,412 of 1916; this J., 1916, 849.

Copper; Extraction of —. Metals Research Co., Assignees of E. R. Weidlein, Thompson, Nev., U.S.A. Eng. Pat. 101,339, Aug. 2, 1916. Under Int. Conv., Aug. 31, 1915. (Appl. No. 10,933 of 1916.)

SEE U.S. Pat. 1,201,899 of 1916; this J., 1916, 1223.

Zinc; Electrolytic recovery of — from ores and other zinc-bearing materials. U. C. Tainton, Johannesburg, S. Africa. U.S. Pat. 1,210,017, Dec. 26, 1916. Date of appl., Aug. 10, 1915.

SEE Eng. Pat. 11,335 of 1915; this J., 1916, 969.

Roasting-furnace; Mechanical —. W. Schefczik, Hamburg, Germany. U.S. Pat. 1,210,852, Jan. 2, 1917. Date of appl., May 22, 1914.

SEE Fr. Pat. 473,310 of 1914; this J., 1915, 557.

Crucible furnace; Recuperative — for fusion of metals and alloys. A. Hermansen. Fr. Pat. 480,636, Jan. 8, 1916.

SEE Eng. Pat. 15,887 of 1915; this J., 1917, 36.

Tin; Extraction of — from cassiterite and from oxidation products of tin. G. Michaud and E. Delasson. Fr. Pat. 481,062, Dec. 10, 1915. Under Int. Conv., Jan. 14, 1915.

SEE Eng. Pat. 611 of 1915; this J., 1916, 311.

Production of a thick or compact metallic coating on artificial stones and articles of artificial stone mass. Eng. Pat. 17,861. See IX.

Treatment of waste tins in a dust destructor. Eng. Pat. 102,693. See XIX.

XI.—ELECTRO-CHEMISTRY.

Overvoltage tables. Part IV. The theories of overvoltage and passivity. E. Newbery. Chem. Soc. Trans., 1916, 109, 1359—1368. (See this J., 1916, 1265; 1917, 38.)

ELEMENTS in the same group of the periodic system show the same overvoltage, and when the overvoltage of a metal changes in such a way as to correspond with the typical overvoltage of another group, compounds of that metal are generally known in which the metal has the valency characteristic of the new group. Overvoltage is therefore stated to be probably due to the high solution potentials of compounds of the electrode material with the discharged ion, or with a product of the discharged ion. These compounds tend to form solid solutions in the electrode substance, and are usually stable only under the influence of high pressures or high temperatures. A slight fall of overvoltage is probably due to physical forces, such as the inductive action of escaping ionised gas at high current densities, whilst greater diminution of the overvoltage is more probably due to chemical forces, resulting in the breakage of the electrode surface, the release of internal pressures, and subsequent decomposition of the compounds present. It is probable that compounds of the nature described play a considerable part in the production of thermionic currents. Passivity is stated to be due to the insolubility and good electrical conductivity of the above compounds, which form a protective coating either over the whole surface or over the more easily soluble amorphous phase only. The coating may consist of the pure compound, or of a solid solution of the compound in the electrode substance. The chemical stability of the higher oxides or hydrides formed on the surface of the electrode is of greater importance than the overvoltage, when dealing with substances which are only slowly oxidised or reduced.—B. N.

Sulphuric acid and normal potassium sulphate; Ionisation of — in aqueous solutions of medium concentration. J. A. Muller. Bull. Soc. Chim., 1916, 19, 438—441.

By the electrolysis of dilute sulphuric acid in a divided cell in which the anode was surrounded by a solution of barium chloride, it was shown that the amount of barium sulphate formed in the anode compartment compared with the hydrogen liberated at the cathode corresponded to a molecule of the former to 2 atoms of the latter. This points to the ionisation of the sulphuric acid at the dilution employed (2N) into SO_4'' and 2H^+ , and not into $\text{SO}_4\text{H}'$ and H^+ , since in this latter case the formation of 1 mol. of barium sulphate, according to the equation, $\text{SO}_4\text{H}' + \text{BaCl}_2 =$

$\text{HCl} + \text{BaSO}_4 + \text{Cl}$ would be accompanied by the liberation of only 1 atom of hydrogen, unless the complete electrolysis of the hydrogen chloride were postulated, which however was shown not to be the case by suspending barium carbonate in the anodic solution in a second experiment, when although no free hydrochloric acid could be formed, still the same volume of hydrogen was liberated at the cathode. By a similar method potassium sulphate was shown to be ionised into SO_4' and K' to the exclusion of KSO_4' ions.

—G. F. M.

Electrolyses; Remarks on certain ——. J. A. Muller. Bull. Soc. Chim., 1916, 19, 111–114.

ALTHOUGH in the electrolysis of the system sulphuric acid, barium chloride (see preceding abstract), no barium passes into the cathode compartment, and sulphuric ions equivalent to all the hydrogen liberated are found in the anode compartment, when potassium hydroxide is substituted for the barium chloride a complete interchange of ions is observed, and a considerable difference exists between the hydrogen liberated and that corresponding to the migration of potassium and sulphate ions; this is attributed to an ionisation of the hydroxide into both K' and OH' and also H' and OK' ions. The electrolysis of the system sulphuric acid, hydrochloric acid, gives chlorine at the anode until the concentration of the hydrochloric acid falls below $N/100$, when principally oxygen is liberated. In this case the discrepancy between the observed and calculated volumes of hydrogen liberated is due to the formation of oxygen compounds of chlorine. When a molar solution of auric chloride is placed in the anode compartment, with sulphuric acid in the cathode compartment, neither chlorine nor gold is liberated at the electrodes, and the process resolves itself into an electrolysis of water, catalysed by the auric chloride. This may be due to the formation, decomposition, and re-formation of small quantities of hydroxychlorides of the type $\text{AuCl}(\text{OH})_2$. It is otherwise when a solution of auric chloride alone is electrolysed; in this case gold is deposited and, at the commencement, ozonised oxygen liberated at the anode, accompanied later by chlorine as soon as the concentration of free hydrogen chloride exceeds $N/100$.

—G. F. M.

Synthesis of cyanides in the electric pressure-furnace. Stähler. See VII.

Catalysis of hydrogen-oxygen mixtures at the ordinary temperature by moist contact substances. Hofmann and Ebert. See VII.

PATENTS.

Electrolytic apparatus. R. L. Whitehead, Perth Amboy, N.J., Assignor to American Smelting and Refining Co., Maurer, N.J. U.S. Pats. (A) 1,206,963, and (B) 1,206,965, Dec. 5, 1916. Dates of appl., (A) Feb. 19, 1913 and (B) Apr. 17, 1916.

(A) ELECTRODES are suspended from a bar of conducting material which extends across an electrolytic refining tank, the bar being supported at the ends by suitable members. Contact is made between these members and the bar, and between the bar and electrodes, or between electrodes, by means of a ridge on the one and a recess on the other, the walls of the recess coming into wedging contact with the sides of the ridge. (B) Several electrolytic vats are each provided with sets of anodes and cathodes, the set of anodes having lateral projections for supporting them on

the walls of the vat, whilst the cathodes are each provided with a lateral projection extending beyond the wall of the vat, and making direct contact with an anode in an adjacent vat by bearing thereon by gravity. The set of cathodes may be raised vertically out of the vat, and thus disconnected electrically from the anodes.—B. N.

Separator for storage batteries. W. L. Bliss. Assignor to U.S. Light and Heat Corporation, Niagara Falls, N.Y. U.S. Pat. 1,206,983, Dec. 5, 1916. Date of appl., Mar. 27, 1914.

A FINELY-DIVIDED acid-resisting material, such as asbestos fibre, and a finely-divided soluble material, are mixed with a phenolic condensation product, such as bakelite. The mass is hardened under the combined action of heat and pressure, and treated to dissolve the soluble material.—B. N.

Electrolytic cell. D. Shaw, New York. U.S. Pat. 1,208,722, Dec. 12, 1916. Date of appl., June 22, 1915. Renewed Oct. 11, 1916.

A RECEPTACLE, forming an electrode, is provided with a flange extending laterally from its upper edge; a support, with a central opening closed by a cover plate, is mounted upon the receptacle serving partly to close it, and the support is secured by suitable means to the flange. A sleeve, depending from the edge of the opening of the support, is secured to the top of a porous bag-shaped flexible diaphragm, and an electrode secured to the cover but insulated therefrom, is disposed within the diaphragm. Both the support and the cover plate are provided with gas outlets, for conducting gas from the interior of the receptacle externally of the diaphragm, and from the interior of the diaphragm respectively.—B. N.

Furnaces; Combined plug and cooler for electric arc — working under high pressure. Norsk Hydro-Elektrisk Kvaestofaktieselskab. Fr. Pat. 480,302, Nov. 23, 1915. Under Int. Conv., Dec. 10, 1914.

IN electric arc furnaces working under a high pressure, a hollow plug is attached directly to the outlet tube of the furnace, and is connected with an arrangement for producing an external pressure, and for cooling. For example, the plug may form the flame tube of a steam boiler, whilst in an alternative arrangement, the upper part of the furnace is cooled by a water jacket connected to, and serving as a preheater for, the boiler.—B. N.

Resistance of carbon electrodes; Reducing the ——. Soc. Franç. des Electrodes. Fr. Pat. 480,803, May 3, 1915.

THE resistance of carbon electrodes is diminished by incorporating with the electrode material powdered metals, such as copper, aluminium, etc., or metallic oxides and salts which will yield nascent metals under determined conditions, or natural mineral substances, such as graphite, or a mixture of these.—B. N.

Electrode for electrolytic purposes; Wire ——. M. Huth, Charlottenburg, Assignor to Siemens and Halske A.-G., Berlin. U.S. Pat. 1,209,710, Dec. 26, 1916. Date of appl., July 7, 1916.

SEE Eng. Pat. 100,739 of 1916; this J., 1916, 931.

Electrolytic cells for the decomposition of solutions. C. I. (1914) Syndicate, Ltd. Fr. Pat. 480,127, Nov. 1, 1915. Under Int. Conv., Nov. 6, 1913, and Nov. 21, 1914.

SEE Eng. Pats. 25,415 of 1913 and 22,867 of 1914; this J., 1914, 1096; 1916, 55.

[*Electrolytic*] manufacture of aromatic amino-[hydr]-oxy compounds. Eng. Pat. 18,081. See III.

Electrolytic manufacture of sodium perborate. Eng. Pats. 100,151 and 101,620. See VII.

Direct process for the manufacture of ammonium chloride from chlorine, nitrogen, and hydrogen. Fr. Pat. 480,232. See VII.

Process and apparatus for softening water. Fr. Pat. 480,108. See XIXE.

XII.—FATS; OILS; WAXES.

Olive pomace; Utilisation of —. W. V. Cruess and A. W. Christie. J. Ind. Eng. Chem., 1917, 9, 45—47.

It is estimated that about 1000 tons of residue ("pomace") are left each year after expression of the oil from olives in California, and at present most of this is wasted. Pomace from eighteen olive factories contained from 7.89 to 20.23%, or 20.98 to 53.81 galls. of oil per ton of the fresh product. This oil could be best extracted by four extractions with petroleum spirit (gasoline), the minimum yield from air-dried pomace being 25.5 galls. per ton. Oils thus extracted from two samples had sp. gr. 0.903 and 0.890 and saponification value 173.8 and 163.2, and contained 11.77 and 64.63% of free acids (as oleic acid) respectively. For soap-making they compared favourably with pure olive oil. Distillation by direct heat removed practically the whole of the solvent from the residual pomace, but it could not be completely separated by distillation with steam. Air-dried samples of the fresh and extracted pomace contained:—Potassium oxide, 0.24 and 0.26; phosphoric acid (P_2O_5), 0.12 and 0.11; and nitrogen 0.86 and 1.00%, respectively. The nitrogen was shown by practical tests to be "unavailable," whilst the amounts of potash and phosphoric acid were no greater than are present in average California soils. Hence the pomace is of no commercial value as a fertiliser.—C. A. M.

Utilisation of cherry by-products. Rabak. See XIXA.

Combustion methods for use in the laboratory. [Determination of sulphur.] Hewett. See XXIII.

PATENTS.

Oil from whale blubber; Process and apparatus for extracting —. Myrens Verksted. Fr. Pat. 479,962, Oct. 8, 1915. Under Int. Conv., Oct. 10, 1914.

WHALE blubber, preferably cut into small pieces, is heated for a short time to coagulate and separate the blood, prior to the expression of the oil. The heating is effected partly by direct and partly by indirect means, to prevent condensation of the steam. For this purpose the vessel is provided with two series of steam conduits, one of which is perforated to allow the steam to escape into the interior of the vessel, whilst in the other the steam is not allowed to escape. After heating, the blubber is conveyed to a press by means of a screw conveyor or the like.—C. A. M.

Oils and fats; Apparatus for purifying industrial —. L. J. Noël, Epernay, France. U.S. Pat. 1,209,180, Dec. 19, 1916. Date of appl. May 14, 1914.

SEE Fr. Pat. 458,019 of 1913; this J., 1913, 1021.

Preparation of solutions of vulcanised oils, obtained by the action of sulphur chloride, in amyl acetate. Fr. Pat. 480,939. See XIII.

Process of making [fatty] food products. U.S. Pat. 1,206,951. See XIXA.

Disinfectant, antiseptic, deodorant, and detergent materials. Eng. Pat. 16,110. See XIXE.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Copying ink pencils and the examination of their pigments in writing. C. A. Mitchell. Analyst. 1917, 42, 3—11.

THE following table gives the composition of the pigments of representative copying-ink pencils as sold from 1907 to the present time:—

	Description.	Origin.	Date.	Moisture (Loss at 100° C.)	Residue insoluble in alcohol.	Dye-stuff.	Loss on ignition (Graphite, etc.).	Ash (Kaolin, etc.).
1	American Pencil Co., Duplex, Blue	U.S.A.	1911	2.35	76.45	21.20	27.09	47.36
2	American Pencil Co., Duplex, Violet	U.S.A.	1916	3.06	59.28	36.76	27.36	31.92
3	American Pencil Co., "Ink Eau," No. 169	U.S.A.	1916	7.48	71.53	40.99	25.48	26.36
4	American Pencil Co., Venus, No. 167	U.S.A.	1916	2.30	60.89	36.81	56.84	4.05
5	Eagle Pencil Co., Atlas, No. 823	London	1907	4.86	66.69	28.15	35.78	30.91
6	Eagle Pencil Co., Copying Eagle Ink	U.S.A.	1911	4.53	67.77	27.70	11.66	50.11
7	Eagle Pencil Co., Copying Eagle Ink, No. 824	U.S.A.	1911	3.75	63.95	32.30	13.99	50.05
8	Eagle Pencil Co., Leads, No. 119	U.S.A.	1911	3.55	57.14	36.84	22.18	34.06
9	Faber Copying	Bavaria	1907	3.72	61.48	31.80	11.86	52.85
10	Faber Copying	Bavaria	1911	2.61	71.27	26.09	23.50	47.77
11	Faber Blue, No. 2251	Bavaria	1907	1.82	58.68	39.50	20.31	29.34
12	Hardtmuth "Mephisto"	Austria	1907	3.56	47.14	49.94	41.14	3.09
13	Hessin, No. 74	Bavaria	1911	3.74	72.92	23.34	68.12	4.80
14	"Ink and Copying"	U.S.A.	1911	5.36	61.49	33.24	52.64	8.76
15	Kurz	Bavaria	1907	3.82	57.59	38.58	49.01	17.58
16	"Lapis Tinta"	—	1911	2.04	69.36	28.60	64.86	4.59
17	Rowney	Britain	1911	4.53	73.05	22.12	69.17	3.88
18	Swan Copying, No. 1039	Bavaria	1907	6.35	59.83	33.84	7.61	52.22
19	Swan Copying, No. 1039	Bavaria	1911	2.05	46.43	51.52	5.50	40.93
20	Wolf's "British Preference"	London	1916	2.72	65.48	31.80	62.08	3.40
21	Wolf's "Royal Sovereign"	London	1916	2.91	65.35	32.74	62.56	2.79

The dyestuff was determined by treating the dried powdered pigment with successive small quantities of warm 95% alcohol, and drying the insoluble residue in the water oven. In all the pigments of violet colour the extracted dyestuff gave the reactions of Methyl Violet. The soluble blue pigment in No. 1 was an aniline dyestuff, whilst the pigment of No. 11 contained Prussian blue and Methyl Violet. As part of the ash is derived from impurities in the graphite it is only possible to make an approximate estimation of the relative proportions of graphite and kaolin from the analyses. Impure graphite may contain only about 50 to 70% of carbon, but the better kinds used for pencils generally contain not more than 3 to 4% of impurities (iron oxide, silica, etc.). When the ash is less than 5% (Nos. 4, 12, 13, 16, 17, 20, and 21), it is probable that the mineral matter was derived solely from the graphite. The ash of No. 14 (8.76%), consisting largely of ferric oxide, was also probably due to the graphite. By attributing about 5% of the mineral matter (calculated on the original pigment) to the graphite, and adding this to the loss on ignition, a result approximating to the proportion of impure graphite originally used would be obtained. These pigments may therefore be classified into four main groups, viz.: (1) Those composed of graphite and dyestuff only; (2) those in which the dyestuff has been mixed with approximately equal proportions of graphite and kaolin (Nos. 2, 3, 5, and 8); (3) those in which the kaolin is largely in excess (Nos. 1, 6, 7, 9, 10, 18, 19); and (4) one case (No. 15) where the graphite predominates. Some of the pigments contained alumina (0.59% in No. 3, to 19.37% in No. 18). This affected the extraction of the dyestuff with alcohol, and caused the pigments containing it to give poor copies in copying tests. The copying properties appear to depend on the proportion of the dyestuff, and on the nature of the graphite, as well as on the character of the kaolin. The best copying results were obtained with No. 3 "Ink Eau" and No. 12, Hardtmuth's; the worst with No. 16 "Lapis Tinta" and Nos. 18 and 19 (Swan). The behaviour of the written characters on treatment with a drop of water, or, in other words, their copying properties in miniature, may be used as a means of differentiating between the pigments in writing. Solution tests with drops of acetic acid and of ether may also be applied to the writing, whilst chemical tests with nitric acid and various reducing and oxidising agents will also enable the writings done with the different pigments to be distinguished. A further test with potassium ferrocyanide solution depends on the fact that the iron oxide in these pigments may range from nil to upwards of a third of the total ash. Writing done with these pencils upon wood was sufficiently permanent to resist immersion for over two months in strong salt water, which was frequently shaken and exposed to sunlight.—C. A. M.

Rosin; Sources of — in Germany. [Artificial seasoning of wood.] E. R. Besenfelder. Chem.-Zeit., 1916, 40, 997—1000.

The total production of utilisable conifer wood in 1913 in Germany is estimated at 12,462,000 metric tons, whilst 5,840,563 tons of resinous wood in various forms was imported. By the general adoption of the rapid method of seasoning timber, and by the extraction of sawdust, waste wood, etc., it would be possible to render Germany independent of imported rosin and oil of turpentine. In Schilde's rapid seasoning process (*Der Holzmarkt*, 1916, No. 124) the freshly-sawn timber is heated in a closed vessel and subjected to the action of a steady current of vapour from an organic liquid, preferably a good solvent for resins and fats. This causes the sap to exude from the

wood, and while part falls as liquid to the bottom of the vessel, the remainder passes with the vaporised solvent to a condenser, where the aqueous portion separates and is drawn off. The condensed solvent, charged with rosin, turpentine, fat, etc., is conducted to an evaporator, whence the vapours are returned to the seasoning vessel. The drying process is continued until the water only separates in drops, and it is essential that the solvent should not be allowed to condense within the pores of the wood, since this affects its firmness. So long as moisture is present in the wood the temperature in the vessel keeps below the boiling point of the lower boiling constituent, e.g., at 75° C. when the mixture consists of water and trichlorethylene (b.pt. 88 to 90° C.). After removing the last traces of solvent, and cooling, the wood, which is quite free from cracks, is completely seasoned and sterile, and ready for immediate use for polishing, etc. The process entirely prevents the blue discoloration which is responsible for a considerable loss of timber in the ordinary seasoning process. The extract from the wood varies with the origin, species, and age of the tree. On the average fir yields about 1% of rosin, oil, etc. The thinner the planks of wood the greater the proportion of rosin obtained and *vice versa*. The value of this extract is estimated at not less than M. 1.40 per kilo. (about 7½d. per lb.) Taking it as only M. 1 per kilo. (about 5½d. per lb.), the average annual yield of resinous extract from German-grown wood would be worth M. 124,620,000 (about £6,000,000), while the imported wood would give an extract worth M. 46,225,700 (about £2,250,000). About half of the extract would consist of rosin and turpentine, and the remainder (120,200 metric tons) of fat, mainly compounds of oleic acid. This quantity of fat would be nearly a fourth of that contained in the oil-fruits imported into Germany. Sawdust, waste wood, etc., extracted by this process must be treated as soon as possible, since the solubility of the rosin rapidly decreases on oxidation. The extracted sawdust is particularly suitable for packing purposes and may be used as a filling material for fodder. The extracted material is suitable for making paper pulp, and may also be advantageously used for dry distillation, and has the advantage of yielding a strong pyrolygneous acid. It should also be sufficiently pure for nitration.—C. A. M.

Varnish analysis and varnish control. II. Viscosity of varnishes. M. Y. Seaton, E. J. Probeck, and G. B. Sawyer. J. Ind. Eng. Chem., 1917, 9, 35—40.

For the routine examination of varnishes the use of the Doolittle viscometer is recommended, the results being expressed in "degrees of retardation" in the rotation of a standard cylinder immersed in the varnish at 40° C. In the case of varnishes viscous at that temperature, smaller cylinders of ½ to 1 in. are substituted for the standard 1½ in. cylinder, the results being brought to the standard viscosities by reference to curves showing the relationship between the different cylinders. The two types of solution (true and colloidal) which appear to be present in all varnishes differ materially in their viscosity characteristics. The colloids also show pronounced differences, the "suspensoids" having a viscosity but little higher than that of the dispersion agent, whereas the "emulsoids" may show a very high viscosity. The changes which occur in the viscosity of varnishes during ageing or on the addition of certain solvents can usually be traced to changes in the character of the colloids present. The colloidal material in varnishes is generally present in the emulsoid form and hence shows great variations in viscosity when the concentra-

tion of the varnish is increased, or when the degree of dispersion of the colloid is changed. In the case of varnishes of the true solution type, *e.g.*, those containing much soluble gum and but little polymerised oil, the curves showing the changes in viscosity with the temperature from 20° to 60° C. were very similar in form and quite distinct from the viscosity-temperature curves of varnishes of the colloidal type, which were practically straight lines. Hence by plotting the results obtained at different temperatures it is often possible to obtain information as to the nature of the varnish. As a rule the viscosity of emulsoids rises on decreasing the degree of dispersion, and *vice versa*. Hence on adding a suitable solvent, such as rosin acids or acid linseed oil, to a varnish containing an emulsoid, such as polymerised wood oil, the viscosity should be lowered, and in practice this is found to be the case. In like manner, the addition of an active thinner to a colloidal varnish will change the viscosity temperature graph from a straight line to a curve. The changes which are caused by the degree of dispersion of the colloidal material in varnish are seen in the case of a black baking Japan varnish, which, when incorrectly boiled, increased in viscosity from 83 to 110 in a month. The viscosity was reduced by the addition of rosin oil, which was a solvent for the asphalt, the gradual change in the degree of dispersion of which had caused the increase in the viscosity. By altering the method of manufacture a product was obtained, the viscosity of which fell from 91 to 74 in a month, and then remained constant, showing little change even when additional solvent was introduced. The method is also applicable to the investigation of lithographic linseed oils. One sample, for example, with an original viscosity of 81, gave a reading of 69 after a month, whereas a different type of oil increased in viscosity from 68 to 80 in the same time. The second oil was considered less valuable as a medium for paints. In general it has been found that with stable varnishes the viscosity becomes approximately constant after a month. If the viscosity continues to rise materially after that time it will usually be found that the increase will continue for a long time, until, finally, the varnish becomes unsuitable for general use.—C. A. M.

Linoleum: Manufacture of — and its valuation.
A. de Waele. J. Ind. Eng. Chem., 1917, 9, 6—18.

APART from the tests used by the German Government (this J., 1900, 255), and certain tests devised by Ingle (this J., 1904, 1197), there have been few chemical tests applied to linoleum. With regard to the determination of the "acetone extract" and "unsaponifiable matter insoluble in acetone," which appear in specifications for goods to be supplied to the English Government, it is pointed out that acetone, like ether, will extract an indefinite amount of soluble matter, and that the amount of "unsaponifiable matter" will vary with the conditions of saponification. For example, cork when saponified with alcoholic potash in an open basin yielded 33 to 36% unsaponifiable matter, whereas under a reflux condenser it yielded 72%. It is possible, however, to obtain constant results by saponification with 0.25% aqueous sodium hydroxide solution under a reflux condenser, and the amount of unsaponifiable matter multiplied by 1.13 approximates closely to the amount of cork. *Manufacture of linoleum*:—Taylor-Parnacott or Corticene floor coverings differ from true linoleum in the fact that the oil is prepared by a polymerisation as distinct from an oxidation process. "Taylor cloth" or "cork carpet," is hung for several weeks in a steam-heated room at 120° to 160° F. (49°—71° C.), to convert the coating from the "green"

condition into a leathery product. In the Walton processes for linoleum (see Reid, this J., 1896, 75) the linseed oil is oxidised by boiling with suitable driers and pouring in thin successive layers over cotton fabrics or "serims," or the raw oil is mixed cold with a small amount of insoluble drier and made to fall from a "shower bath" in a continual rain on to the bottom of an inclosed vessel heated by means of steam pipes, the thickened oil being afterwards mixed with 5% of whitening and "smacked" in horizontal steam-jacketed drums containing a horizontal shaft with radial arms. In the Wood-Bedford process the whole of the oxidation is effected in the "smacker" within 48 hours at temperatures up to 110° F. (60° C.), but owing to the speed of the reaction the product is greatly inferior to those obtained by the Walton processes. The oxidised oil, by whichever process obtained, is agitated in a steam-heated pan, while first an eighth of its quantity of melted rosin and then the same amount of gum kauri is run in, and the agitation is continued until the mixture thickens to the required degree, when the hot "cement" is poured on to revolving water-cooled rolls or other cooling device, and, after cooling, is allowed to "hang" or mature for a week or two. *Reactions*:—In the equations suggested by Ingle (this J., 1913, 610) for the change produced in linolein, the position given to the double bonds is not in accordance with the commonly accepted structure for that compound, but there is evidence, in the evolution of volatile substances with aldehydic groupings, for the view that the reaction is one of rupture in the chain in the middle of a peroxide group. In the author's opinion the change is not one of polymerisation, but either a molecular rearrangement of complex groupings or a condensation or both. *Action of solvents on oxidised oils* (see this J., 1892, 550):—On extracting with ether a sample of the dried skin obtained by the scrim process, 67.50% was extracted in 24 hours, but the extraction was not complete after 4½ months, when the extract was 85.32%. Similar results were obtained with alcohol, benzene, chloroform, and acetone, but petroleum spirit of b.pt. 35° to 50° C., although also showing no definite end-point in the extraction, yielded extracts which differed in physical and chemical properties from the extracts obtained with other solvents. For the practical examination of these products two extractions give useful results:—(1) Extraction for 24 hours with petroleum spirit, and (2) extraction of the residue with ether. The petroleum spirit extract is a pale greenish-yellow, fairly mobile oil, which thickens but does not form a skin on exposure, whilst the subsequent ethereal extract is a viscous sticky yellowish-brown oil which dries on exposure, forming a fairly hard elastic skin. Taking "linoxyn" to represent the final insoluble residue, the variations in the distribution of the fractions in the "skins" obtained by the "scrim process" were as follows:—

	1	2	3	4	5	6	7
Linoxyn %	49.57	47.08	43.62	48.41	40.22	57.09	42.46
Ether extract %	31.16	26.79	27.93	29.38	25.45	25.16	32.91
Petroleum spirit extract %	19.27	26.13	26.45	22.21	25.33	17.75	24.63

It was proved that the physical properties of the "skins" were better in proportion to the amount of ether extract, and inversely so to the amount of petroleum spirit extract, whilst the residual linoxyn affected the "body" or solidity of the mass. On this basis No. 6 would be classed a

poor sample, whilst No. 7, in which the linseed oil is oxidised with a special drier, would be considered an excellent one, as in practice proved to be the case. In similar tests with oxidised oils prepared by the Walton "shower-bath" process, the following results were obtained:—

		1	2	3	4	5	6
Linoxyn	%	40.2	32.4	50.0	42.2	37.4	37.7
Ether extract	%	35.0	38.1	30.3	31.2	29.6	34.9
Petroleum spirit extract	%	21.7	27.7	18.3	26.3	33.0	26.4

The higher ether extracts of these products compared with those made by the "serim" process account for their superior tenacity and binding power, and explain why they alone are suitable for the manufacture of "Walton Inlaid." The following results obtained with Taylor-Parnacott or Corticine oil show why it is impossible to use that product for making inlaid linoleum and also explain its low covering power:—Linoxyn, 60.4; ether extract, 9.6; and petroleum spirit extract, 30.0%. *Linoxyn and "cyclofin"*:—The substance insoluble in ether which is obtained by polymerising linseed oil by heat has been provisionally termed "cyclofin." It differs in a pronounced way from the linoxyn produced in the oxidation of linseed oil. Thus its saponification value does not exceed that of the raw oil, it is difficult to saponify, and is very stable, whilst it contains no oxidised acid. Again, linoxyn is completely soluble in amyl alcohol at 120° C. (6 to 8 hours), whereas cyclofin swells up but only dissolves to the extent of about 20% in that solvent. Similar experiments with other oxidised oils and with polymerised wood oil showed that as a general rule oxidised oils are completely soluble, whilst polymerised (solid) oils contain an insoluble portion. In every case in which unchanged polymerised wood oil was used in linoleum cement it could be recognised by this method. *Resins and Chinese wood oil in cements*:—From experiments on these lines the following conclusions were drawn:—(1) At least 20% of resins must be present to obtain the maximum conversion of the oily matter into a substance with high binding capacity. (2) If resin is the only resin present, the "body" (as measured by the linoxyn) is liable to fall below the practicable limit. (3) The presence of gum kauri is essential for the reduction of greasiness (petroleum spirit extract). (4) Chinese wood oil (the use of which has been patented as a substitute for kauri gum) has no chemical influence on the transformation, but is disadvantageous as it reduces the amount of oxidised oil in the mixture. (5) The best proportions for the three ingredients are about 80% of oil, 10% of kauri gum, and 10% of resin. —C. A. M.

PATENTS.

Drying rooms especially intended for baking enamel on to metallic surfaces. A. E. White, London. From Reliance Drying Room Co., Chicago, U.S.A. Eng. Pat. 102,539, Feb. 9, 1916. (Appl. No. 1929 of 1916.)

The drying chamber is provided with a turn table floor, part of which (substantially a half) projects outside. This floor is divided into, preferably equal, sections by a vertical partition, which moves with the floor and in one position engages with the walls to close the chamber. The heating compartment surrounding the inner walls of the chamber is preferably made to conform sub-

stantially to the shape of the inner portion of the turntable, whilst a fan or blower may be provided at the top to deliver downward currents of hot air into the drying chamber. Whilst the charge of material on the portion of the floor within the chamber is being dried, a fresh charge is being arranged on the portion of the floor outside the chamber. —C. A. M.

Enamel on metallic surfaces; Air-circulating systems for drying rooms for baking—A. E. White, London. From Reliance Drying Room Co., Chicago, U.S.A. Eng. Pat. 102,685, Feb. 9, 1916. (Appl. No. 7046 of 1916.)

The drying room comprises a drying and heating chamber in communication with each other at the top and bottom of a vertical partition separating them. A pipe system communicating with the chambers at the bottom leads upward therefrom to a fan or blower which discharges air downwards into the drying chamber; ventilating pipes leading from this chamber are provided for removal of foul or saturated air; these converge together into a single flue to a suitable point of discharge. The system is preferably used in conjunction with a drying room provided with a turntable floor (see preceding abstract). —T. H. B.

Phenols, formaldehyde, and salts of sulpho-acids; Process for obtaining solid products of condensation from—K. Tarassoff, Moscow, and P. Shestakoff, Petrograd. Eng. Pat. 102,635, Jan. 20, 1916. (Appl. No. 956 of 1916.)

SOLID, infusible, and insoluble products are obtained by condensing phenols with formaldehyde in presence of ammonium, alkali, or alkaline-earth salts of sulpho-acids (preferably naphtha sulpho-acids or sulpho-aromatic fatty acids), and of an acid which does not decompose such salts. For example, 300 parts by weight of "commercial carbolic acid 99–100% cresols," is gradually mixed with 135 parts of a 40% solution of sodium salts of naphtha sulpho-acids, 9 parts of hydrochloric acid (sp.gr. 1.14), and 150 parts of 40% aqueous formaldehyde, and heated to 65°–70° C. A resinous liquid mass separates with a watery layer on top; the latter is removed and the resinous mass heated until there is a loss of 70–75 parts by weight of the total materials used. After cooling to 35–45° C., 120 parts by weight of aqueous 40% formaldehyde is added and the whole mixed to a homogeneous mobile liquid, which is poured into moulds, left to rest some hours, then gradually heated for one hour to 45° C., then, at intervals, by 10°–15° at a time, to 100° C. —T. H. B.

Hard compositions; Production of—from formaldehyde and phenols with carbohydrates, albuminous materials, and tannins. K. Tarassoff, Moscow, Russia. Eng. Pat. 102,751, Jan. 19, 1916. (Appl. No. 892 of 1916.)

THE process described in Eng. Pat. 7560 of 1914 (see also Eng. Pat. 528, and 6716 of 1914; this J., 1914, 557; 1915, 187, 1201), according to which organic bodies containing no aldehyde, phenol, or sulpho-groups, or substances in which these groups are not essential constituents, may be caused to take part in the reactions between phenols and formaldehyde, in the presence of one or more organic sulpho-acids, is now modified by the inclusion of carbohydrates, albuminous materials, and tannins amongst these "fillers." For example (1) carbolic acid, 100; a 37% solution of naphtha sulpho-acids, 50; egg albumin, 20; and water 50 grms. are heated at 75°–80° C.

until the added water is evaporated. The mass is cooled and formaldehyde (40%), 40 grms., is added. When the reaction, which takes place at 60°–80° C. moderates, a further 50 grms. of water is driven off by heating, the mass cooled to 25°–30° C., and formaldehyde (40%), 50 grms., added. The viscous liquid is poured into moulds and left for 10–12 hrs., and the hardening process is then completed by heating up to 75° C. for half-an-hour, up to 85°–90° C. for 1–2 hours, and at 100° C. for an equal length of time; 205 grms. of a very hard, elastic, non-fusible, non-transparent, bluish-yellow solid is obtained. The egg albumin may be replaced by blood albumin, gelatin, casein, glue, etc. (2) Carbohydric acid, 100; formaldehyde (40%), 50; sulpho-acid solution, 50; and wheat starch, 30 grms. are heated together to 40–45° C.; heat is evolved and a jelly is formed which thins on boiling, the starch being deposited. The mixture is rendered homogeneous by stirring, and 55–60 grms. of water is then evaporated by heating. The mass is cooled to 20–25° C., formaldehyde (40%), 40 grms., is added, and the viscous tarry mass is then poured into moulds and heat-treated as in example (1); 200–215 grms. of hard, rose-coloured, infusible, elastic material is obtained. (3) With carbohydric acid, 100; sulpho-acid solution (40%), 50; crystalline tannin solution (50%), 60; and formaldehyde (40%), 40 grms., heated to 60–80° C., and then until 70–75 grms. of water has been driven off, subsequently cooled, mixed with formaldehyde (40%) 50 grms., and hardened off in moulds as before, a hard, infusible, "chestnut-yellow" mass is obtained.—E. W. L.

Vulcanised oils: Preparation of solutions of —, obtained by the action of sulphur chloride, in amyl acetate. M. Poto. Fr. Pat. 480,939, Feb. 12, 1916.

The oil, e.g., castor oil, 1 kilo., is intimately mixed with amyl acetate, 2 litres, and sulphur chloride, 250 grms., is then stirred in. A stiff, almost colourless jelly is formed, which gives off large quantities of hydrogen chloride, resulting from the decomposition of some acetyl chloride produced during the reaction. When left in a hermetically closed vessel for several days, this product completely liquefies, the vulcanised oil passing into solution. Sodium or barium or other carbonate, or sodium thiosulphate—but preferably barium carbonate—is added to neutralise the free acid present, and the solution is then decanted and filtered. This solution may be used for impregnating fabrics and other materials, or it may be mixed with other solvents, and nitrocellulose, as well as with soluble colours and pigments, and used for varnishing black and coloured leathers and for a variety of other purposes.—E. W. L.

White pigment of the lithopone type: Inalterable —. R. B. Llopert. Fr. Pats. 180,846 and 180,847, Feb. 2, 1916. Under Int. Conv., Feb. 19 and Mar. 16, 1915.

SEE U.S. Pats. 1,139,427 and 1,110,351 of 1915; this J., 1915, 670, 715.

[Resinous] condensation products: Process for the manufacture of insoluble —. F. Pollak, Berlin. U.S. Pat. 1,211,227, Jan. 2, 1917. Date of appl., Aug. 15, 1912.

SEE Fr. Pat. 147,909 of 1912; this J., 1913, 436.

Process of manufacturing bronze powder. Fr. Pat. 480,504. See X.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

PATENTS.

Vulcanisation; Circulation and exhausting apparatus for —. A. E. Alexander, London. From Goodyear's Metallic Rubber Shoe Co., Naugatuck, Conn., U.S.A. Eng. Pat. 102,802, Aug. 29, 1916. (Appl. No. 12,204 of 1916.)

IN apparatus for vulcanising rubber boots and similar articles, in which a difference of pressure is maintained between the inside of the perforated forms on which the articles are mounted and the heated fluid (gaseous) medium surrounding the articles, a certain leakage of the medium (e.g., carbon dioxide) into the interior of the forms occurs. Loss of heat units and of heating medium is minimised, according to the invention, by inserting an exhaust pump in series with the low pressure and the high pressure sides and thus returning the gaseous leakage quickly through a preheater, to the high pressure atmosphere of the vulcaniser. Good circulation is ensured by running a branch pipe from within the vulcaniser, opposite the gas inlet, to the suction end of the pump. The interior of the forms communicates with the hollow frame of the trolley which carries them, and this in turn is connected with the external suction pipe of the pump.—E. W. L.

Vulcanisable composition: Process of manufacture of a —. J. S. Campbell. Fr. Pat. 479,960, Oct. 8, 1915.

FINELY divided leather is heated with oil or fat, and whilst continuing the heating, caustic soda or potash (sufficient to saponify the oil), vegetable fibrous material, magnesia, filling material, such as steatite or chalk, and a binding material such as gum or caoutchouc are successively added at intervals, and the whole thoroughly mixed. The mass is then dried and worked up by passing between cylinders, during which operation sulphur or some other vulcanising agent is added. The material may then be made into sheets, etc., and vulcanised.—F. C. T.

XV.—LEATHER; BONE; HORN; GLUE.

PATENTS.

Skins: Deliming and bating of —. J. Meister. Fr. Pat. 480,196, Nov. 10, 1915.

SKINS are submitted to the action of pepsin or other suitable enzymes in very dilute hydrochloric acid, the temperature being maintained at 40° C. Other acids (boric, lactic) and also salts (ammonium chloride) are added to keep up the hydriion concentration. The process is much more rapid and reliable than the usual one.—F. C. T.

Tanning extracts: Manufacture of —. Soc. Anon. des Matières Tannantes et Colorantes. Fr. Pat. 480,300, Nov. 23, 1915.

AN extract suitable for tanning is prepared from the pods of *Acacia arabica* and *Acacia Senegal* or of other similar trees.—F. C. T.

Tanning. Gunn Tragasol Supply Co., Ltd. Fr. Pat. 480,456, Dec. 16, 1915.

SEE Eng. Pat. 7635 of 1915; this J., 1916, 748.

Process for utilising osier-bark. Fr. Pat. 480,637. See V.

Manufacture of a vulcanisable composition. Fr. Pat. 479,960. See XIV.

XVI.—SOILS; FERTILISERS.

Phosphoric acid: Valuation of water-soluble as compared with citrate-soluble—E. J. Franke. J. Ind. Eng. Chem., 1917, 9, 51—55.

IN the reports of some of the American experimental stations the "valuations" or "trade-values" for water-soluble phosphoric acid have been put at higher figures than those for citrate-soluble phosphoric acid, although these "values" are not intended to show the agricultural value of the products. Moreover they are not justified by the selling prices. Thus the cost of the available (water-soluble plus citrate-soluble) phosphoric acid in acid phosphate (superphosphate) decreases with the rise in the proportion of water-soluble to citrate-soluble phosphoric acid, whilst citrate-soluble acid in organic phosphates costs more per unit than does the available acid in superphosphate.—C. A. M.

Third report on the improvement of indigo in Bihar. Howard. See IV.

Relationship existing between oxydase activity of plant juices and their hydrogenion concentration, with a note on the cause of oxydase activity in plant tissue. Bunzell. See XVIII.

PATENTS.

Manures; Manufacture of compound—C. Desguide. Fr. Pat. 480,569, Dec. 30, 1915.

INSOLUBLE phosphates are transformed into soluble products by the action of sodium bisulphate, dissolved in water or in liquids containing fertilising elements in solution or suspension.—B. N.

Manure; Soluble phosphatic—and process of manufacture. E. Stoppani and V. Volpato. Fr. Pat. 480,697, Jan. 17, 1916. Under Int. Conv., Jan. 26, 1915.

A SOLUBLE phosphatic manure is formed by mixing natural phosphates with about 6% of carbonates, oxides, or salts of alkali or alkaline-earth metals, and then heating to about 600 °C., afterwards hydrating, preferably whilst hot, by the addition of water.—B. N.

Calcium cyanamide; Apparatus for the treatment [granulation] of—G. W. Sinclair. Odda, Norway. U.S. Pat. 1,211,252, Jan. 2, 1917. Date of appl. July 7, 1914.

SEE Eng. Pat. 9821 of 1914; this J., 1915, 916.

Peat [as fertiliser]; Utilisation of—Wetearbonizing, Ltd. Fr. Pat. 480,979, Oct. 26, 1915.

SEE Eng. Pat. 18,838 of 1914; this J., 1916, 133.

Phosphates; Manufacture of citrate-soluble—S. B. Newberry. Fr. Pat. 480,355, Nov. 30, 1915.

SEE U.S. Pats. 1,162,802 and 1,162,911 of 1915; this J., 1916, 133.

Manufacture of cellulose, and utilisation of the waste lyes. Fr. Pat. 177,895. See V.

XVII.—SUGARS; STARCHES; GUMS.

Invertase; Presence of—in cane sugars from Demerara and St. Domingo. H. Pellet. Bull. Assoc. Chim. Sucr., 1916, 33, 263—266.

MAQUENNE has detected the presence of invertase in raw cane sugars from Demerara and St.

Domingo, particularly the former. It originates, doubtless, from micro-organisms, probably bacteria of the type described by Lewton-Brain and Deere (this J., 1909, 845), which develop in the finished sugar under suitable conditions of humidity and temperature. The presence of invertase explains why in order to avoid rapid decomposition of sucrose, liquors should be submitted as soon as possible to a temperature of 90—100 °C., and also why the presence of certain antiseptics is not efficacious in preventing alteration of the syrups and other products. It suggests that to obviate decomposition of solutions of cane sugar products, it is desirable to destroy the enzyme by heating to a moderate temperature in presence of an alkali, and also to operate with highly concentrated solutions.—J. P. O.

Clarification [of sugar cane juices]; Processes for the— with direct filtration through presses. C. Fribourg. Bull. Assoc. Chim. Sucr., 1916, 33, 227—255.

THE author has shown previously that after treatment with kieselguhr and dicalcium phosphate, it is possible to filter defecated cane juice in its entirety through filter-presses and obtain a clear liquor and good cake, instead of following the present more lengthy system of decantation and after-treatment of the "bottoms" and scums. Further details are now given, and it is pointed out that the total filtration of juice in this way is impossible when soluble phosphates alone (that is, phosphoric acid and monocalcium phosphate from concentrated superphosphate and acid phosphate) are added to the juice already sulphited and lined as usual, the effect being to produce a gelatinous precipitate which prevents filtration in presses. On the other hand, kieselguhr alone at the rate of 2.5 kilos. per 1000 litres of juice produces the desired effect, although no appreciable increase of purity results. Soluble phosphates in conjunction with kieselguhr cause an increase of purity, while allowing of direct filtration, but a relatively large amount of kieselguhr is required. Economical and generally satisfactory results with an appreciable increase of purity are stated to be obtained by the use of a mixture of kieselguhr and dicalcium phosphate (insoluble) in the proportion of 2 : 1, and employing 3—4 kilos. (or 4—5 kilos. with low purities) per 1000 litres of the juice after it has been submitted to sulphiting and liming as usual. Under these conditions the filtering surface required will be 50 sqm. per 100 tons of cane worked, the process is rapid and simple, and there is a marked saving in labour and steam. The amount of press-cake (dry state) obtained per 1000 litres of juice, with ordinary sulphitation and defecation, is 6—8 kilos., while with the further addition of both kieselguhr and dicalcium phosphate it is 11—12.5 kilos., and all or almost all the phosphoric acid added can be recovered with that normally present in the juice, giving a cake containing 5 to 14% of phosphoric acid, 7 to 8% of nitrogen, and 10 to 20% of lime, which forms a useful fertiliser in the cane field.—J. P. O.

Sugar; Quantitative determination of minute amounts of— by α -naphthol and the estimation of entrainment losses [in sugar factories]. A. F. Blake. Int. Sugar J., 1917, 19, 26—28.

TRACES of sucrose in water, up to 100 parts per million, can be estimated, with a possible error of 20% for pure solutions, by the following method. Ten c.c. of concentrated sulphuric acid is added carefully to 5 c.c. of the liquid under test containing 5 drops of a 20% solution of α -naphthol in pure alcohol; the mixture is stirred vigorously and after 2 mins. the purple colour

produced when sugar is present is compared with a series of standards. The standards for concentrations of sugar up to 20 parts per million are made by mixing solutions of cobalt nitrate and copper sulphate; those for larger amounts are made from red and blue organic dyestuffs and require to be renewed about once a month. Vessels of uniform size should be employed and should not be wiped with a cloth before use. The presence of iron in the liquid interferes somewhat with the test, and products from the destructive distillation of low-grade materials vitiate it entirely. With the salt water from condensers the test has given perfect satisfaction. The author applies it to the examination of condensed water from evaporation, employing a device (illustrated in the original paper) for taking periodic samples from the condenser fall pipe; by this means the losses from evaporator entrainment are determined regularly.—J. H. L.

Sucrose; Simplified inversion process for the determination of—by double polarisation. H. S. Walker. Hawaiian Chem. Assoc., Oct. 12, 1916. Int. Sugar J., 1917, 19, 31—35.

THE following method of inversion, applied to the determination of sucrose in pure sugar and in waste molasses, gave percentage values rarely differing by more than 0.1 from those obtained by Herzfeld's method. Seventy-five c.c. of the solution to be inverted (normal strength for sugars and half-normal for molasses), in a 100 c.c. flask, is heated in a water bath to 65° C., then withdrawn from the bath, treated with 10 c.c. of a mixture of equal volumes of hydrochloric acid (sp. gr. 1.188) and water, and allowed to cool spontaneously in the air for 15 mins. or as much longer as may be convenient. After being cooled to the ordinary temperature the liquid is made up to 100 c.c. and polarised as usual. In the case of products which have been clarified with a large excess of basic lead acetate, the excess alkalinity is neutralised before heating, e.g., by addition of 1 or if necessary 2 c.c. of the dilute acid. A considerable latitude appears to be permissible as regards the temperature of the sugar solutions when the acid is added (63°—70° C.), and the rate of cooling as influenced by the temperature of the laboratory (in the author's experiments this seems to have been in the neighbourhood of 26° C.) and the thickness of the glass flasks.—J. H. L.

Sugar; Report on—. [Modification of the Clerget process of double polarisation. Use of invertase as hydrolyst in the double polarisation method.] C. A. Browne. J. Assoc. Off. Agric. Chem., 1916, 2, 131—143.

IN the original Clerget process, in which 50 c.c. of the normal or half-normal sugar weight solution is made up to 55 c.c. with hydrochloric acid and inverted, there is a diminution in volume due to the following three causes: (1) the contraction following on inversion; (2) the increase of temperature produced by the addition of the hydrochloric acid; and (3) the evaporation of water from the neck of the flask during heating, the combined influence of these causing the diminution of the volume of the 55 c.c. by 0.33 c.c. for the half-normal weight of 13 grms. In order to eliminate all three sources of error, it is proposed to make up the volume of the solution after and not before inversion, the process being thus made more exact than any modification involving dilution to 100 c.c., in which any error is multiplied by 2. It is further recommended that inversion be made at the ordinary temperature over-night. The sucrose is calculated by the following formula allowing for differences in specific rota-

tion caused by varying concentration when less than the normal weight of 26 grms. is taken; A is the direct polarisation and B the invert polarisation corrected for increase of volume, and t is the temperature at which the invert solution is read:—

$$100(A-B) \\ 144.9 - \frac{t}{2} - 0.01 \left[141.9 - \frac{t}{2} - (A-B) \right]$$

Hudson's method of double polarisation using invertase as hydrolyst (this J., 1910, 143), in which the lead used for the clarification of the product is eliminated by sodium carbonate or potassium oxalate, is shown to give far more accurate results than the method of acid inversion in the analysis of complex mixtures containing sucrose and levulose. For purposes of commercial analysis, however, it cannot at present displace acid inversion, the preparation of the invertase solution being troublesome, and the whole process requiring much care and watchfulness, but it is invaluable as a control upon other methods.

—J. P. O.

Decolorising carbons; Action of different—on pure and impure sugar solutions, and their influence in the analysis of sugar factory products. H. Pellet. Bull. Assoc. Chim. Sucri., 1916, 33, 220—227.

DECOLORISING carbons of different origin vary considerably in their properties. Thus, "Eponit" (this J., 1911, 146, 1177) has a density of 250 grms. per litre, carbon from the shells of cherry-stones one of 573, while ordinary unwashed animal charcoal has one of 895. Similarly, their decolorising power and ash content show wide differences, the latter varying from 1.5% (cherry-stone carbon) to 81.8 (animal charcoal) per 100 of dry substance. When used as clarifying agents in the double polarisation method of determining sucrose, all adsorb a greater or less quantity of sugar, and with 100 c.c. of a pure solution of sucrose, originally polarising 26.85°, the reading after the addition of 2 grms. of the different grades was as follows: "Eponit," 25.80°, animal charcoal, washed successively with hydrochloric acid and water, and dried, 26.20°, ordinary unwashed animal charcoal, 26.20°, and cherry-stone carbon, 26.80°. In the case of solutions of sugar factory products defecated with basic or normal lead acetate, the adsorption is less, while in that of liquids first treated with basic lead acetate and afterwards with excess of sulphurous acid, that is under the conditions of the sulphurous acid direct polarisation method, practically no diminution could be observed. On the contrary, a slight increase, averaging 0.15° with a polarisation of about 28.0°, was noticed, this being apparently due to the adsorption of lead salt, the effect of which on the optically-active amino-acid derivatives causing a levorotation was thus modified. An adsorption of optically-active substances in unfermented cane vinasse by decolorising carbons was also demonstrated, but cupric reducing substances contained in both beet and cane molasses do not appear to be affected.—J. P. O.

Raffinose; Determination of—in presence of sucrose by double inversion using top and bottom fermentation yeasts. H. Pellet. Bull. Assoc. Chim. Sucri., 1916, 33, 255—262.

OWING to the presence in beet sugar factory products of optically-active amino-acids and their derivatives, the rotation of which depends upon the reaction of the solution, whether alkaline or acid, the ordinary method of determining raffinose by acid inversion is subject to an appreciable error. On examining the method of double fermentation by top and bottom yeasts suggested by Bau, and elaborated by Hudson and Harding (this J., 1915,

1905), the author obtained good results, both in pure solutions as well as in the presence of dextrose, levulose, lactose, maltose, and other carbohydrates. In the case, however, of very impure liquids, as molasses, though equally reliable results are obtainable, fermentation is very slow, particularly with the bottom fermentation yeast, and demands about 7 hours, sometimes much longer. It is important that both the fermented liquids should be examined at the same temperature, and in order to avoid any error from adopting corrections, it is advisable to read throughout at 20° C. With a product obtained by the desaccharification of molasses by the strontia process, it was observed that the difference between the ordinary and the acid direct polarisations was very slight, this being due to the fact that the optically-active substances capable of causing differences are almost entirely removed with the mother-liquors, after their decomposition.—J. P. O.

Carbohydrates; Methods for the estimation of mixtures of four or more — involving oxidation with bromine. E. G. Wilson and W. R. G. Atkins. *Biochem. J.* 1916, **10**, 501–521. *Analyst*, 1917, **42**, 19–20.

DEXTROSE and maltose are quantitatively oxidised by bromine at the ordinary temperature when their solutions are saturated with bromine and allowed to stand: the liquid, however, still retains a small amount of its original cupric-reducing power. Levulose is not oxidised at all, or only to a very small extent, under these conditions, whilst in presence of *N*/10 sulphuric acid there is a slight loss of levulose in 68 hours at the ordinary temperature. A mixture of sucrose, maltose, dextrose, and levulose may be analysed as follows:—The sucrose is determined by polarisation and reduction before and after treatment with invertase. The resulting mixture of reducing sugars is treated with bromine under standard conditions of acidity and temperature for a given time (see following abstract), whereby dextrose and maltose are oxidised, whilst levulose remains unaffected: the reducing power of the solution may be taken as due to levulose only, the result being corrected for the portion derived from the sucrose. By subtracting the rotation due to sucrose and levulose from the initial rotation, the rotation due to dextrose and maltose is obtained, and in like manner by subtracting the reduction due to levulose from the initial reduction, the reduction due to dextrose and maltose is obtained. The amounts of dextrose and maltose can then be calculated.

It was observed that addition of dilute alkali (*N*/2 or 2*N* sodium hydroxide) to a solution of dextrose, levulose, or maltose, produces a large temporary increase in the reducing power of the solution.

Honey and other substances containing levulose; Analysis of —. W. R. G. Atkins. *Analyst*, 1917, **42**, 12–13.

THE method of Wilson and Atkins (see preceding abstract) of oxidising sugars other than levulose by means of bromine is rapid, and although less accurate than the fermentation method of Davis and Daish (this *J.*, 1913, 1025), gives fairly good results in the analysis of mixtures of dextrose, levulose, and maltose. An excess of bromine is added to the solution, which should contain sufficient sulphuric acid to make the strength decinormal, and the flask is kept in constant agitation for 12 hours at the ordinary temperature. After the oxidation the maltose retains only a trace of its cupric-reducing power and the dextrose, about 1% thereof, whilst the levulose shows a reduction of approximately 1 to 2% in reducing power

owing to its decomposition by the *N*/10 sulphuric acid and the hydrobromic acid produced during the oxidation of the other sugars. This loss in the quantity of levulose is approximately balanced by the residual reducing power from the other sugars. After removal of the excess of bromine by means of gaseous sulphur dioxide and finally by titration with a solution of sulphurous acid, the solution is rendered only slightly acid or neutral (but not alkaline) by the addition of potassium carbonate, and the reducing power of an aliquot portion is determined. For this purpose Kendall's solution (this *J.*, 1912, 351) is suitable as it does not dissolve the cupric oxide, and the amount of levulose may then be found by reference to the author's table (*Biochem. J.*, 1916, **10**, 137). In the case of honey or other mixtures containing only dextrose and levulose, sufficiently accurate results are obtained by determining the reducing power before and after the oxidation. For the determination of sucrose in honey the reducing power is determined before and after inversion, and the inverted solution afterwards oxidised with bromine, due allowance being made for the dextrose and levulose produced by the inversion. The method of oxidation with bromine affords an easy means of detecting abnormal quantities of dextrose in honey, jams, etc.—C. A. M.

Fructose [levulose]; Evidence indicating the existence of a new variety of —. A reactive form of methylfructoside. J. C. Irvine and G. Robertson. *Chem. Soc. Trans.*, 1916, **109**, 1305–1314.

IN a previous paper (this *J.*, 1915, 627) some derivatives of a new highly reactive form of glucose (dextrose), γ -glucose, differing from the well-known α - and β -modifications presumably in the position of the oxide link, were described. It would now appear that this γ -type is represented also in the case of the other monohexoses, galactose and fructose. One of the characters of this series is the ready formation and equally ready hydrolysis of the methylglucosides and fructosides, which are hydrolysed, like sucrose, on warming with highly dilute acids. There is a strong presumption in favour of the view that the fructose component of sucrose belongs to the new γ -type, whereas the glucose component is of the ordinary type. The evidence on which the view of the existence of " γ -fructose" is based is largely contained in work by Purdie and Paul (*Chem. Soc. Trans.*, 1907, **91**, 289) on the formation of tetramethylfructose from the crude methylfructoside obtained, according to Fischer, by the condensation of fructose with methyl alcohol containing 0.5% of hydrogen chloride. This reaction proceeds readily at 35° C. and in this respect shows a marked difference from the mode of preparation of alkylglucosides where prolonged heating at 100° C. is generally required. The product is obviously a mixture and its resolution is complicated by the fact, now first ascertained, that the portion of the methylfructoside corresponding with the new γ -modification of the sugar combines readily with whatever traces of acetone may be present in the methyl alcohol employed, yielding methylfructoside-monoacetone, which can only be isolated by fractional distillation under the highest vacua afforded by the Gaede pump. Two distinct tetramethylfructoses, a crystalline and a liquid modification, are formed from the mixture, which must contain at least four isomeric methylfructosides: two of the latter correspond to the ordinary form of fructose (α and β) and two to the new γ -form which also is capable of existing in α and β modifications. The specific rotation of these new modifications of fructose when in equilibrium is low and is probably dextro in sign; the melting points of the sugars would be lower than those of the ordinary

form: they may be syrups. Taking the analogy of γ -glucose, it is assumed that γ -fructose contains the ethylene oxide ring, while the ordinary fructose contains the butylene oxide linkage.—J. P. B.

Galactose: Determination of free and combined —.

A. W. van der Haar. Chem. Weekblad. 1916. 13, 1204—1213.

THE galactose is oxidised by means of nitric acid and the resulting mucic acid is weighed, as first suggested by Creydt (*Dissert.*, Erlangen, 1888). From 0.25 to 1 gm. is mixed with 60 c.c. of nitric acid (sp.gr. 1.15 at 15° C.) in a beaker 12 cm. high by 60 mm. in diameter, which is immersed in a boiling water bath. The contents are stirred at intervals and the heating continued until the liquid is reduced to less than 20 grms., when the mixture is cooled and made up to 20 grms. with water. After the addition of 0.5 gm. of dry mucic acid which has been purified by recrystallisation from alcohol, the liquid is left for 18 hours at 15° C., and the deposit of mucic acid is then collected on an asbestos filter in a Gooch crucible, washed with 5 c.c. of water, and dried at 100° C. until constant in weight, the weight of mucic acid added to promote the crystallisation being afterwards deducted. For the determination of galactose in glucosides or polysaccharides, from 0.25 to 1 gm. of the anhydrous substance is hydrolysed with 25 c.c. of 2 to 5% sulphuric acid, and the liquid filtered, after 24 hours, from any insoluble products. The filtrate and washings are concentrated, rendered slightly alkaline with sodium hydroxide solution, made up to 30 c.c., and treated with 30 c.c. of 50% nitric acid, and as much sucrose as corresponds to the non-sugar part of the glucoside (e.g., sapogenins). The oxidation is then effected as described above. From the weights of mucic acid obtained the corresponding quantities of galactose may be found by reference to the following tables (intermediate figures may be obtained by interpolation):—

I. *Galactose alone.*

Mucic acid.	Galactose.	Mucic acid.	Galactose.
mgms.	mgms.	mgms.	mgms.
— 4	0	366	500
+ 0.8	10	455	600
20	50	525	700
55	100	615	800
100	150	679	880
142	200	688	890
180	250	695	900
215	300	780	1000
296	400		

II. *Galactose made up to 1 gm. with sucrose.*

Mucic acid.	Galactose.	Mucic acid.	Galactose.
mgms.	mgms.	mgms.	mgms.
— 4	0	205	300
+ 2.4	10	284	400
28	50	325	450
62.5	100	360	500
100	150	440	600
133	200	475	650
140	250	555	750
165	250	780	1000

—C. A. M.

Gum-yielding plants of Brazil. H. Montandon. Chacanas e Quintaes, 1916. 13, 417—421. Bull. Agr. Intell., 1916, 7, 1295—1296.

SUBSTITUTES for gum arabic are obtained from the following Brazilian plants:—(1) Different species of "angico," *Enterolobium ellipticum* (*Pithecolob-*

ium gummiferum); (2) "Arvore da gomma" or "gomma lagrima" (*Vochisia gummifera*), which is common in the province of Rio de Janeiro; and (3) "Vinheiro do Campo" or "Arvore do vinho" (*Vochisia thyrsoidea*), which is common in the State of Minas Geraes. The best quality or "gomma lagrima" is free from impurities and is perfectly colourless and transparent. It is completely soluble in 11 parts of cold water, yielding a colourless, transparent mucilage. A sample with sp.gr. 1.601 at 26° C. had the following composition:—Water, 11.79; arabin, 87.67; yellow bitter substance, 0.03; resinous substance 0.01; insoluble matter, 0.012; and ash, 0.41%. Experiments made by Pizarro showed that the gum of *Vochisia thyrsoidea* has 10 times the adhesive power of gum arabic, and is quite equal to it in medicinal properties. Consignments of Brazil gum have been exported to Liverpool and to Germany from 1900 onwards.—C. A. M.

Utilisation of diseased potatoes as fodder and industrial raw material. Wehmer. See XIXA.

PATENTS.

Fondant [sugar cream]; Manufacture of —.

P. H. Schluter, Chicago, Ill. U.S. Pat. 1,201,357, Oct. 17, 1916. Date of appl. Mar. 8, 1916.

FOR making fondant or sugar-cream for filling sweetmeats, a suitable charge of sugar, e.g., 25 lb. of pure cane sugar and 5 lb. of glucose, is mixed with only sufficient water to effect complete solution on boiling, and the solution is boiled in the open air until it attains a temperature corresponding to 228° F. (109° C.) at sea level. The charge is then subjected to a vacuum as complete as possible (28—28.5 ins.) and as soon as vigorous ebullition has set in, the application of heat is discontinued and evaporation allowed to proceed under vacuum until the syrup reaches a density corresponding to a boiling point of 238° F. (114.5° C.) in the open air. During the evaporation of the syrup without the application of heat, the temperature will have become so reduced that the operation of heating to cream may proceed immediately. The apparatus may consist of a pan and gas-heated furnace mounted on lifting gear beneath a hood connected with a vacuum pump, so that boiling in the open or *in vacuo* may be carried out by lowering or raising the pan.

—J. F. B.

Sugar; Process for the manufacture of —. O.

Carr, Asheville, N.C. U.S. Pat. 1,201,936. Oct. 17, 1916. Date of appl. Sept. 9, 1914.

SUGAR juice, either raw or treated with precipitating agents, is atomised into an air-chamber in which the moisture of the juice is absorbed by the air at a moderate temperature and the solids are rapidly deposited as a dry powder. The non-sugar impurities of the juice in the dried state are soluble with difficulty in cold water and especially after treatment of the original juice with lime, aluminium hydroxide, or metallic salt precipitating agents. The sugar solids are dissolved by lixiviation preferably in the cold; suitable substances may be added to the lixiviating water to prevent solution of impurities, e.g., lime, alcohol, etc. The solution may be clarified by carbonation or decolorising agents, and evaporated either by atomising or boiling to "grain" in the usual manner.—J. F. B.

Sugar beets; Process of treating —, and the product derived therefrom. G. H. Benjamin, New York.

U.S. Pat. 1,207,810, Dec. 12, 1916. Date of appl. Dec. 17, 1911.

BET slices are dried, e.g., by air at about 170° F.

(77° C.) until about 90% of their moisture has been removed, in such a way as to coagulate the coagulable matters without destroying the enzymes, rupturing the cell walls, or rendering them incapable of permitting osmosis when the dried product is subsequently treated by the diffusion process. The dried product may be treated with a material which will prevent fermentation or mouldiness.—J. H. L.

Bleaching liquids [sugar juices]: Apparatus for —, L. J. Foret, Lockport, La., U.S. Pat. 1,208,531, Dec. 12, 1916. Date of appl. Jan. 22, 1916.

The apparatus comprises a vertical cylinder provided with a series of annular ribs fixed to the interior wall, a series of annular shelves loosely mounted on the ribs, each formed of two semi-circular segments, a vertical rotary spindle projecting downwards through the centre of the casing and provided with a series of circular discs overlapping the inner edges of the annular shelves, and means for introducing liquid into the upper part and gas into the lower part of the casing and for discharging waste gas from the upper part and the treated liquid from the lower part.—J. H. L.

Starch: Process for making soluble —, J. Kantorowicz, Breslau, Germany, U.S. Pat. 1,207,177, Dec. 5, 1916. Date of appl. Oct. 19, 1914.

SOLUBLE starch, solutions of which do not solidify or gelatinise at ordinary temperatures, is made by acting on starch with organic acids together with substances which convert starch into soluble starch, e.g., persalts, with or without mineral acids.—J. H. L.

XVIII.—FERMENTATION INDUSTRIES.

Malts: Comparative studies of floor-, drum-, and box —, L. Adler, Z. ges. Brauw., 1916, 39, 201–201, 217–221, 225–226.

THREE malts were prepared from the same barley by germinating (1) on floors, (2) in a Galland malting drum, and (3) by the Kropff system (this J., 1912, 39). All the malts were kilned under similar conditions. In germinating by the Kropff system, the barley, after four days on the malting floors, was transferred to a box in which it formed a layer 3 feet deep on a perforated floor, and in which it was aerated for about an hour after successive resting periods of 6, 6, 10, 10, 21, and 21 hours. The three malts were subjected to a very thorough investigation. In almost all respects the characters of the floor malt were intermediate between those of the other two. The Kropff malt, owing to restricted respiration during the later stages of germination, showed a smaller malting loss than the others, but it was darker in colour. It was further distinguished by the activity of its diastatic, proteolytic, and acid-forming enzymes and its phosphatases, and by rapid saccharification and high yield of extract. The wort from it filtered rapidly and well, possessed a high acidity as determined by titration, and exhibited a coarsely flocculent "break." The drum-malt, on the other hand, was characterised by high malting loss, defective modification, and weak enzymic activity. It saccharified less rapidly than the others and gave a lower yield of extract. The wort from it possessed a lower acidity as determined by titration, but a higher concentration of hydrogen ions, than either of the others; this is attributed to its relative poverty in respect of proteolytic

products, which exert a "buffer" action towards acids. The quality of the drum-malt could probably have been improved by rotating the drum less frequently and reducing the aeration during the germinating process.—J. H. L.

Fermentation: Loss [of sugar] in alcoholic —, L. Lindet, Comptes rend., 1917, 164, 58–61.

THE author designates as "fermentation loss" the proportion of sugar decomposed which cannot be accounted for, in accordance with Gay Lussac's equation, by the quantity of alcohol produced. This loss is due to the formation of various by-products accompanying yeast growth, and its magnitude in relation to the amount of yeast produced varies according to the nature of the nutritive substances present. In fermentation experiments with pure sucrose solutions containing only salts, including ammonium sulphate as source of nitrogen, the fermentation loss was on the average about 17 times as great as the weight of the yeast crop (dry substance) which itself amounted to only about 0.85% of the weight of sugar decomposed, and the loss consisted to the extent of $\frac{2}{3}$ of carbon dioxide. The loss was practically the same when ammonium tartrate, lactate, or acetate was used instead of sulphate, and it was not much less when urea or asparagine was employed. In similar solutions, however, containing also 2% of substances such as gum arabic, tannin, or peat humus, fermentation was much more rapid, the yeast crop was approximately trebled, and the fermentation loss, relatively to the yeast crop, was reduced to one-third of its former value. These results were not very different from those obtained in media, such as beer wort, containing ready-formed proteins. The author concludes that of all the carbohydrates studied, except arabinose and xylose, sucrose is the least readily assimilated by yeast, the latter having great difficulty in synthesising proteins from sucrose and ammoniacal or amide nitrogen. On the other hand, in presence of gum arabic, tannin, etc., and ammoniacal or amide nitrogen, yeast develops almost as readily as in media containing proteins.—J. H. L.

Beer: Pre-mashing and protein-haze. Concentration of hydrogen ions in — and in the course of its manufacture, F. Emslander, Woch. Brau., 1916, 33, 169–171.

THE author's experience with pre-mashing confirms the statement of Windisch (this J., 1916, 1170) that this practice increases the yield of extract from malt, but using a hard brewing water he found that pre-mashing tended to render the beer more difficult to clarify. This difficulty was in large measure overcome by boiling the water before use. An explanation of the influence of pre-mashing on clarification is suggested. In an electric field the constituents of beer which are liable to separate on chilling, migrate towards the anode and are therefore alkaline in character. The author suggests that they consist of compounds of lime or magnesia with proteolytic products which, owing to the severance of peptide linkages and consequent liberation of acid groups, have acquired the power of combining with bases. Since pre-mashing assists proteolysis it is therefore likely to accentuate the formation of protein-haze in beers made from waters rich in lime and magnesia.—J. H. L.

Beer: Sterilisation of — by filtration, E. Zahm, Brewers' J., 1917, 53, 37–40.

THE sterilisation of beer by pasteurisation injuriously affects the flavour and character; it also arrests or

destroys the action of the enzymes, so that much of the value of the beer as a foodstuff is lost. The ordinary pulp beer filters do not sterilise effectively not because the pulp fibres are incapable of holding back micro-organisms, but because of the mobility of the material under fluctuations of pressure: rigid filtering beds are absolutely necessary. These are constructed of kieselguhr compressed in a moist condition into blocks 12 ins. long and 3 ins. square, which are then fired in a kiln like porcelain. The blocks are turned to cylinders of 2 ins. diam., bored, and fitted with a head-piece screwed and cemented into the bore and provided with a tubular neck. These filter cylinders are tested for efficiency by immersing them in water and subjecting them to a gas pressure of 6 lb. per sq. in., it having been determined that resistance to this pressure of gas in water corresponds with an effective resistance to the passage of micro-organisms. The filters comprise a pair of units each containing 55 filter cylinders, the beer is pumped through a pressure-governor into the inlet chambers of the units and passes through the filter cylinders into the outlet chambers and thence to the bottling machine. The governor varies the pressure in the inlet chamber as the demand for beer at the bottling machine increases or decreases the difference in pressure required to force the beer through the filters. The necks of the filter cylinders pass through orifices in two partitions forming an open chamber, so that in the event of any leakage in the fittings, the escaping beer falls into this chamber and not into the discharge chamber. The whole apparatus is sterilised with hot water at 180° F. (82° C.) before use and then tested collectively by displacing the water in the inlet chamber with carbon dioxide under a pressure of 6 lb.; if there is a defective tube bubbles of gas will be seen rising through the water and the cover must be removed and the tube plugged. A filter with 110 cylinders has a capacity of 50 pint bottles per hour. Sterilisation by filtration involves effective sterilisation of the bottles. This is done with hot alkaline solution and water in an automatic machine fitted with brushes. The bottles are cooled gradually with water sprays and pass, without handling, to the beer bottling machine.—J. F. B.

Ammonia [from nitrogen in brewing materials: Determination of—by the boric acid method. L. Adler. Z. ges. Brauw., 1916, 39, 161–161, 169–172. (See Winkler, this J., 1913, 185; 1915, 79.)

In applying Winkler's method to the determination of nitrogen in brewing materials, the author obtained accurate results by using a water-cooled condenser dipping (for the first 15 mins. of distillation) into 50 c.c. of a 1% solution of crystallised boric acid, this quantity of acid sufficing for the quantitative absorption of amounts of ammonia up to 70 mgrms. and possibly beyond. The distillate after addition of a few drops of a 0.05% solution of methyl orange was titrated with standard sulphuric acid with the help of a colour standard prepared by treating 250 c.c. of distilled water with a few drops of methyl orange and 0.15 c.c. of N/10 sulphuric acid.—J. H. L.

Rum distillery: Scientific control of a —. F. L. Seard. Int. Sugar J., 1916, 18, 198–502.

For the complete control of a rum distillery, the data required are as follows: (1) the amount of "sweets" (as dextrose) entering into the process; (2) the degree of attenuation, from which the amount of alcohol formed by fermentation is calculated and compared with the theoretical quantity to be expected from the "sweets" used to set up the wash; (3) the amount of spirit

actually distilled, and the relation between it and the theoretical amount; (4) the examination of the spent wash for alcohol as a check upon the operation of the still; and (5) the amount of esters in the spirit. In addition the observation must be determined, *i.e.*, the error in the determination of the alcohol concentration by the hydrometer due to the colouring matter added to the rum. "Faults" are indicated by diluting the rum with twice or its own volume of water and allowing it to stand in a cylinder for 24 hours, any cloudiness formed being due to: (A) resinous matter from the wood of the cask; (B) the use of a too highly burnt colouring; or (C) the presence of substances of the fusel oil class, which during distillation should have been retained in the low wines.—J. P. O.

Oxydase activity of plant juices and their hydrogen ion concentrations: Relationship existing between—, with a note on the cause of oxydase activity in plant tissue. H. H. Bunzell. J. Biol. Chem., 1916, 28, 315–333.

WHILE the results of the experiments recorded do not establish clearly the quantitative relationship existing between the extent of the oxydase activity of a plant material and the hydrogen ion concentration existing in the medium, it appears that this relationship consists of two factors—one the direct destructive effect of the acidity on the active matter, the other the retardation of the rate of oxidation by the hydrogen ions. The hydrogen ion concentrations corresponding with complete inhibition cover a rather narrow range for each type of plant material (for potato, 3.55 to 3.70; for tulip tree material, 2.30 to 2.80), and it would seem that this acid sensitiveness is nearly constant for different genera of the same family. It would appear that the oxydase activity of plants is controlled by some constituent which is easily destroyed by acids, by heat, or by alcohol, and which changes gradually to an inactive form on standing in aqueous solution, but will keep practically indefinitely when dry. Proteins would fulfil these requirements; like all colloids, the proteins in tissues may exist in a greater or less degree of dispersion and have a more or less active surface accordingly. Condensation of oxygen on the surface of the colloid particles may explain the oxydase activity either by means of the greatly increased rate of reaction due to increased oxygen concentration, or by an increased oxidation potential of the oxygen when in such condition.

—W. P. S.

PATENTS.

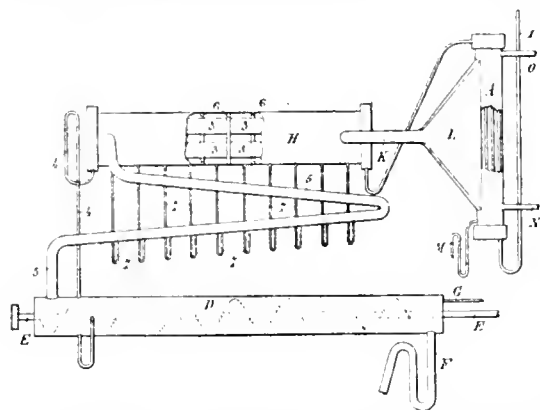
Grape juice and process of preparing the same. A. Fonzo, Chicago, Ill. U.S. Pat. 1,207,011. Dec. 5, 1916. Date of appl., Mar. 25, 1916.

THE acid-content of grape juice is increased by a proportion of a palatable acid, *e.g.*, 0.1–1.0% of lactic acid, which may be produced by lactic fermentation.—J. H. L.

Distillation: Apparatus for continuous —. E. A. Chenard. Fr. Pat. 180,558, Dec. 24, 1915.

THE liquid to be distilled, *e.g.*, alcohol, passes by the pipe, 1, to the tubular heater, A, where it is raised to a temperature below 75° C., and thence through the tubes, 3, and pipe, 1, to the cylinder, D. A rotating shaft, E, carries a helical conveyor which transports the liquid to the outlet, F. Steam entering by the pipe, G, takes up vapour from the heated liquid and carries it through the pipe, 5, to the cylinder, H, provided with baffles, 6. Progressive condensation occurs by contact with the

tubes, 3, containing cooler liquid, and the condensed liquid passes by pipes, 7, to the vapour pipe, 5, so that the vapour becomes richer in alcohol as it passes to the outlet, K. An enlarged



mouthpiece, L, admits the vapour to the preliminary heater, A, and the mixture is fractionated by withdrawing separate portions from the pipes, O, N, and condensed liquid from the pipe, M.

—W. F. F.

Alcohol of high strength and strong aroma: Process of manufacturing — particularly colonial rums. P. M. H. Hervé, Fr. Pat. 480,601, Dec. 10, 1915.

THE wash is distilled through any ordinary distillation column so as to produce a distillate containing about 25% of alcohol; the distillate is then re-distilled through a rectifying column to obtain a spirit containing 77% of alcohol.

—W. P. S.

Industrial preparation of mixed cream of tartar [potassium and sodium bitartrates], and soda cream of tartar [sodium bitartrate]. Fr. Pat. 480,620. See VII.

XIXA.—FOODS.

Phosphatides in milk; Distribution of —. T. B. Osborne and A. J. Wakeman, J. Biol. Chem., 1916, 28, 1—9.

ALCOHOL removes from milk casein, which has been precipitated by dilute hydrochloric acid, about the same quantity of phosphatides as was obtained previously from the lactalbumin separated by heating the filtrate from the casein (this J., 1915, 883); since the amount of casein is more than six times that of the lactalbumin, the proportion of phosphatides in the casein is correspondingly less. When skimmed milk, freed from casein and heat-coagulable proteins, is neutralised with sodium hydroxide, the precipitate formed contains a very small amount of the same phosphatides and fatty substances that can be obtained from the alcohol washings of the lactalbumin; the non-protein fractions of fat-free milk contain only minute traces of phosphatides. The total quantity of phosphatides present in 1 litre of whole milk is about 27 mgms. Phosphatides are intimately associated with the protein constituents of milk and are possibly combined with them as "lecithalbumins."—W. P. S.

Casein; Influence of carbohydrates on the accuracy of the Van Slyke method in the hydrolysis of —. E. B. Hart and B. Sure, J. Biol. Chem., 1916, 28, 211—219.

THE presence of carbohydrates during the hydrolysis

of casein by the Van Slyke method brings about a total redistribution of the amino-acids and this varies with the nature of the carbohydrate. The redistribution is particularly marked in the hexone bases and a decided loss of amino-nitrogen also takes place when the protein is hydrolysed in the presence of xylan. The method of direct hydrolysis is, therefore, unreliable when applied to the determination of amino-acids in feeding stuffs; owing to the variation in the nature and quantity of the carbohydrates in feeding stuffs, it is impossible to establish factors of correction for the results. (See also Gortner, this J., 1916, 1030; Roxas, *ibid.*, 1916, 1174.)—W. P. S.

Kafirin, an alcohol-soluble protein from kafir (Andropogon sorghum). C. O. Johns and J. F. Brewster, J. Biol. Chem., 1916, 28, 59—65.

A NEW alcohol-soluble protein was separated from kafir seeds; it constitutes more than one-half of the protein in the seed, and has been named *kafirin*. It resembles zein in its composition, but differs from the latter in that it coagulates readily. Kafirin contains tryptophane and lysine, both of which are lacking in zein, and, when examined by the Van Slyke method, differences are found in the distribution of nitrogen in the two substances. Kafir is now an important cereal crop in the United States. In 1910, three million acres was under cultivation and the value of the crop was \$30,000,000.—W. P. S.

Proteins from the Jack bean (Canavalia ensiformis). D. B. Jones and C. O. Johns, J. Biol. Chem., 1916, 28, 67—75.

Two globulins, canavalin and concanavalin, and an albumin of the legumelin type were isolated from the jack bean. The distribution of nitrogen in canavalin and the albumin was:—

	Canavalin	Albumin
	g.	%
Human nitrogen	0.28	0.23
Amide nitrogen	1.41	1.16
Basic nitrogen	8.17	3.73
Non-basic nitrogen	11.55	11.18
Total nitrogen	16.41	16.30

—W. P. S.

Proteins of the peanut, Arachis hypogaea. The globulins arachin and conarachin. C. O. Johns and D. B. Jones, J. Biol. Chem., 1916, 28, 77—87.

TWO globulins, arachin and conarachin, separated from peanut (earthnut) meal, contained 0.4 and 1.09% of sulphur, respectively. Arachin contained 4.96%, and conarachin 6.55% of basic nitrogen, the latter being the highest percentage of basic nitrogen recorded for any seed protein. Peanut cake will probably prove highly effective in supplementing food products made from cereals and other seeds the proteins of which are deficient in basic amino-acids.—W. P. S.

Protein-copper compounds. T. B. Osborne and C. S. Leavenworth, J. Biol. Chem., 1916, 28, 109—123.

WHEN copper sulphate solution was added to a slightly alkaline edestin solution, the whole of the protein was precipitated when the mixture became neutral; further addition of copper sulphate resulted in the formation of a basic salt; by adding sodium hydroxide solution to a mixture of edestin and copper sulphate solution, edestin free from

copper was at first precipitated, whilst with further addition of alkali the basic copper salt was precipitated. It was possible to obtain an edestin-copper compound containing 35% of copper, but this compound was unstable. A compound which gave the biured coloration in alkaline solution contained 12.7% of copper. Similar results were obtained in the case of gliadin. The precipitates did not represent definite copper compounds of the proteins, the amount of copper hydroxide available for combination being determined by the quantity of sodium hydroxide present in the protein solution.—W. P. S.

Rices of Bihar and Orissa, J. N. Sen, Arg. Research Inst., Pusa, Bull. No. 62, 1916, pp. 1-20.

EIGHTEEN samples of rice grown on Government farms in Bihar and Orissa, India, were examined; the average results obtained were as follows:—

	Husked rice.	Polished rice.
Moisture.....	11.95	10.80
Ether-extract	2.36	0.88
Proteins	7.48	7.25
Soluble carbohydrates ..	75.86	79.99
Woody fibre	0.76	0.20
Ash	1.59	0.79
Phosphoric acid	0.70	0.36
Potash	9.36	0.22

"Husked" rice indicates rice which was simply husked, i.e., rice "in the bran," whilst "polished" rice had had much of the "skin" and germ removed by the polishing operation. The composition of the rices is similar to that of other rices, especially of Burma rice.—W. P. S.

Potatoes: Utilisation of diseased — as fodder and industrial raw material, C. Wehmer, Jahresversamml. Ver. angew. Botanik, Frankfurt, Sept., 1916. Chem.-Zeit., 1916, 40, 1073.

THE normal annual production of potatoes in Germany is estimated at about 50 million metric tons. Assuming the loss through disease, freezing, etc., to be only 0.25%, it would be equivalent to at least 100,000 metric cwt. of starch. Experiments on a large scale have proved the practicability of utilising decomposed potatoes to obtain a sound, tasteless product, containing about 50% of starch and 6% of nitrogen, which has given good results in feeding experiments. The tubers may be treated either by a wet process (separation of starch by disintegration in water) or preferably by a dry process. With slight modification of the process it is also possible to separate the starch in the usual way, but for the preparation of pastes, dextrin, alcohol, etc., this is unnecessary, since the diseased potatoes may be directly hydrolysed with acid.—C. A. M.

Fruits and vegetables: Conversion of — into dried products, V. Valvassori, Atti. R. Acad. Econ.-agr., Florence, 1916, 13, 56-61. Bull. Agr. Intell., 1916, 7, 1353-1355.

In the case of pears and apples, the best results were obtained by subjecting the peeled and halved fruits to the action of sulphur dioxide for 10-15 mins., followed by treatment with steam for 5-10 mins., and then drying them at 80-90° C. for 8 hours. Stoned peaches and apricots were sulphured for 15 mins. and then dried at 80-90° C. for 8 hours. Plums were steamed for 90 secs., or immersed in boiling 5% potassium carbonate solution and then rinsed in cold water; they were dried first at 50° C., then at 70° C., and

finally at 90° C. Good results were obtained by either treatment. Cherries were steamed for 5 mins. and then dried at 85° C. for 12 hours, whilst figs were peeled, cut in halves, then treated with sulphur dioxide for 30 mins. and dried at 50° C. for 2 or 3 days. Vegetables, including potatoes, carrots, cabbage, cauliflower, spinach, celery, peas, beans, onions, leeks, turnips, and turnip tops were scalded or steamed and then dried at 10° to 60° C.—W. P. S.

Cherry by-products: Utilisation of —, F. Rabak, U.S. Dept. Agric., Bull. No. 350, 1916. Bull. Agr. Intell., 1916, 7, 1355-1357.

ABOUT 1400 tons of cherry-stones and 112,000 galls. of juice are obtained as by-products in the cherry-preserving industry of the United States; these products are wasted at present but it would be quite possible to turn them into valuable commercial products. By treating the crushed stones with a solvent 8.3% of a fatty oil (pit oil) can be obtained, or, if the kernels alone are taken, and submitted to pressure, about 30% of fatty oil is obtained; the resulting cake, when steeped in water and steam-distilled, yields about 1% of a volatile oil. The oils have the following characters:—*Stone oil*, Sp. gr. at 25° C., 0.9137; n_D^{25} = 1.4611; solidifying pt., 12° C.; saponif. value, 179.7; iodine value, 93.7; Reichert-Meissl value, 3.7; insoluble fatty acids, 92.5%; acetyl value, 3.45; unsaponifiable matter, 1.12%. *Kernel oil*, Sp. gr. at 25° C., 0.9092; n_D^{25} = 1.4635; solidif. pt., 13° C.; saponif. value, 180.8; iodine value, 92.8; Reichert-Meissl value, 4.7; insoluble fatty acids, 92.8%; acetyl value, 12.67; unsaponifiable matter, 0.44%. *Volatile oil*, Sp. gr. at 4° C., 1.012; hydrocyanic acid, 7.91%; benzoic acid, 67.95%. The fatty oil does not differ essentially from sweet almond oil, whilst the volatile oil is, for all practical purposes, similar to that of bitter almonds. The pressed cake, after removal of the oils, is useful as a cattle food. It contains: Moisture, 1.05; proteins, 30.87; ash, 3.94; cellulose, 8.90; ether extract, 13.10%. The juice from the stones is a bright red liquid; it may be concentrated, after neutralisation with lime and filtration, to a syrup, or fermented to produce alcohol. With the addition of pectin and sugar, the concentrated juice forms an excellent jelly.—W. P. S.

[*Japanese*] seaweeds, Miyama. See VII.

Analysis of honey and other substances containing larvulose, Atkins. See XVII.

Relationship existing between oxydase activity of plant juices and their hydrogen ion concentration, with a note on the cause of oxydase activity in plant tissue, Bunzell. See XVIII.

PATENTS.

Food products: Process of making [fatty] —, T. B. Walker, Austin, Tex. U.S. Pat. 1,206,951, Dec. 5, 1916. Date of appl. Dec. 16, 1914.

A PRODUCT containing about 22% of stearin is made from an edible fatty material by hydrogenation, and then incorporated with a different edible fatty material to impart a flavour and consistency resembling those of a natural edible fat. A product resembling lard may thus be prepared from hydrogenated cottonseed oil and oily lard.—J. H. L.

Alimentary pastes and other products: Drying chamber for —, G. Falchi, Fr. Pat. 480,975, Feb. 15, 1916.

The paste, e.g., macaroni, etc., is placed on trays

or hung on supports arranged on a wheeled carriage and the latter is run into a closed chamber; air is pumped into the chamber and the current is distributed by fans; adjustable ventilators are provided for the escape of the air so that the rate of drying may be regulated.—W. P. S.

Casein; Process for treating —, A. Bartels, Harburg, Germany. U.S. Pat. 1,209,539, Dec. 19, 1916. Date of appl. Dec. 28, 1915. Renewed Aug. 16, 1916.

SEE Eng. Pat. 13,203 of 1915; this J., 1916, 1125.

Artificial milk; Process for the manufacture of —, and treatment of its residues, W. J. Melluish, Upper Parkstone. U.S. Pat. 1,210,667, Jan. 2, 1917. Date of appl. Oct. 22, 1915.

SEE Eng. Pat. 13,903 of 1915; this J., 1916, 1031.

Separation of casein and albumin from creamery sewage. Eng. Pat. 18,023. See XIXB.

XIXB.—WATER PURIFICATION ; SANITATION.

Oxygen (in water); Determination of — by Winkler's method, G. Bruhns, Chem.-Zeit., 1916, 40, 985—987, 1011—1013. (See this J., 1916, 138.)

DETAILS of further small improvements in Winkler's process for the determination of dissolved oxygen are given. *N* 100 Thiosulphate was found to be very satisfactory for titration and to keep well, particularly if made slightly alkaline to phenolphthalein. In the process, after precipitation has been effected, if the liquid completely clarifies upon standing, the greater part may be siphoned off and only the residue treated with potassium iodide and acid; the result is slightly more accurate owing to the small volume of liquid titrated. Long standing, however, is not desirable as the result may be affected by impurities in the water. When potassium bicarbonate is used, some gas bubbles are observed in the liquid after the crystals have dissolved; these bubbles are due to contraction of the liquid and are without influence on the result. The blue colour which reappears a short time after titration is due to delayed decomposition of the iodine-potassium iodide complex; the error thus caused does not, however, amount to more than 0.006—0.008 "per 1000 normal" (*loc. cit.*). A little additional blue colour may be produced subsequently owing to the catalytic action of manganese salts, the action of light, and the presence of nitrites.—J. H. J.

Boiler-feed water; Determination of sodium and calcium bicarbonates in —, M. Monkaupf, Chem.-Zeit., 1916, 40, 1011—1013.

THE case of a boiler water is considered which contains only bicarbonate alkalinity and is therefore neutral to phenolphthalein. The determination consists of two titrations with *N* 10 acid in presence of methyl orange, firstly directly on the water, secondly after addition of *N* 10 caustic soda equal to the acid used and removal of the precipitate by filtration. The acid used in the first titration is subtracted from that used in the second, and the result multiplied by 8.1, gives the amount of sodium bicarbonate in mgrms. per 100 c.c., if 100 c.c. of the water was taken. The acid used in the second titration is subtracted from twice that used in the first, and the result multiplied by 2.8 gives the amount of lime in the form of bicar-

bonate. Should there be a trace of phenolphthalein alkalinity in the water, this is titrated with the acid, and twice the result is subtracted from the second titration before calculating the sodium bicarbonate content. Calcium sulphate can only be present in the absence of sodium bicarbonate, and in this case twice the phenolphthalein alkalinity must be subtracted from the first titration before calculating the lime content. Salts of magnesium cause no irregularities in the method.—J. H. J.

Tobacco smoke; Removal of nicotine from —, J. Tóth and K. Dangehrer, Chem.-Zeit., 1916, 40, 1013.

IT was found that many tobaccos yield a smoke containing large quantities of free nicotine, which can be extracted by passing the smoke through a cotton-wool plug treated with tannin. In some cases as much as 12.3% of the total nicotine can be recovered in this way. It is suggested that the use of such plugs by smokers would be of advantage from a health point of view.—J. H. J.

Flavine and Brilliant Green; new and powerful antiseptics, Browning and others. See XX.

Use of diphenylamine and diphenylbenzidine for colorimetric determinations, Smith. See XXIII.

PATENTS.

Sewage; Method of and apparatus for the treatment and purification of —, E. B. Martin, Eccles, Lancs. Eng. Pat. 17,163, Dec. 14, 1915.

THE apparatus consists of a cylindrical tank, divided into segments, each segment forming a treatment unit. The apparatus may be worked on the continuous flow or on the quiescent system, or on a combination of both. The sewage enters any one segment where it meets with activated sludge, and the mixture is agitated by air blown in from the bottom and evenly distributed by baffle-plates. The treated sewage overflows into a radial trough in which any sludge settles out and is run back into the segment, while the liquid flows over a weir and is led into the next segment for further treatment. One or more of the last segments is used as a settling tank before the completely purified liquid is discharged. One segment is always being emptied and cleaned in the cycle of working. The activated sludge is run out from each segment into a central well. The volume of air supplied to any segment can be varied at will by adjustable valves.—J. H. J.

Creamery sewage; Separation of casein and albumin from —, G. Ebrill and T. Kiersey, Dublin. Eng. Pat. 18,023, Dec. 21, 1915.

CREAMERY sewage, *i.e.*, any waste water containing milk or milk constituents, is treated with sulphuric acid (about 1.5 lb. of acid per 1000 lb. of skimmed milk contained in the sewage) and then led into a tank where it is aerated. The precipitated casein floats on the surface of the liquid and is discharged over the side of the tank into a collecting channel, an inclined baffle-plate being provided to guide the frothy precipitate over the side of the tank. The acidified liquid may be passed through a series of such aerating tanks. To remove albumin, the liquid, from which the casein has been separated, is treated with lime and conducted through a second similar series of aerating tanks. The aerating means are situated at the bottom of the tanks and consist of porous carbon tubes through which the air is forced so that it issues in a finely divided state.—W. P. S.

Sewage: Process of disposing of — A. Potter, New York. U.S. Pat. 1,207,621, Dec. 5, 1916. Date of appl., Oct. 18, 1913.

THE sewage flows at a very slow rate through a tank of such shape as to facilitate the deposition of the sludge, which is allowed to digest, and is then raised, a part allowed to flow away with the liquid from the tank, and a part allowed to return to the sludge space.—J. H. J.

Water-softener: Process for producing a — G. H. Widner, Assignor to Des Moines Refining Co., Des Moines, Iowa. U.S. Pat. 1,207,826, Dec. 12, 1916. Date of appl., Aug. 10, 1916.

A MINERAL containing hydrated aluminium silicate is dried to remove free moisture, ground to a suitable size, mixed with salt, and baked without fusing until hard enough to withstand the powdering action of water. It is then stored in water.—J. H. J.

Water: Process and apparatus for softening — L. Linden. Fr. Pat. 480,108, Dec. 13, 1915.

THE water is conducted into the upper part of a vertical cylinder containing perforated baffle-plates, certain of which are of copper and are connected with a source of electric current; carbon dioxide is also admitted to this part of the apparatus. The water then passes through filters (perforated metal plates supporting a layer of fabric and a layer of coke) placed across the cylinder, and is next distributed over the surface of horizontal plates in the lower half of the cylinder supporting layers of spongy aluminium. Some of these plates are connected with a source of electric current, and if necessary, carbon dioxide may be introduced. The water finally passes through a spongy iron filter and is collected at the bottom of the cylinder.—W. P. S.

Disinfectant, antiseptic, deodorant, and detergent materials. C. Billing, New York. Eng. Pat. 16,410, Nov. 20, 1915.

THE material consists essentially of a mixture of 2 parts of an alkali monoborate with 1 part of an alkali diborate, with or without sodium chloride. A fluid form is prepared by dissolving 136.24 parts by weight of caustic potash (90%) and 115.8 parts of boric acid in 150 parts of water, and when the solution is cold, adding water until the specific gravity is 1.42 at 60° F. (15.5° C.). Chlorides or hypochlorites may be added. A solid form is prepared by dissolving 89 parts by weight of caustic soda (70%) in 90 parts of water, adding 138 parts of borax, and heating with stirring until fluid; then allowing to cool, and continuing the stirring, until granular. About 116 parts of sodium chloride is then added, so that the product shall contain 10% of anhydrous borate.—J. H. J.

Tins: Treatment of waste — in a dust-destroyer. E. J. Lovegrove, London. Eng. Pat. 102,693, June 15, 1916. (Appl. No. 8119 of 1916.)

A CHAMBER for the treatment of the tins is placed beside a dust-destroyer, so that the whole or a portion of the flue gases can be passed through it. The chamber consists of a furnace with hopper at top, an entrance for flue gases below the hopper, and an exit at the bottom of the chamber. On each side wall below the grate, two plates are fixed, sloping towards a trough in the centre. The tins are fed into the chamber through the hopper, which is then closed, and the dampers controlling the gas pipes are opened to allow the flue gas to pass down through the mass of tins, between the sloping plates below the grate, and out. Dirt attached

to the tins is burned off, the solder is melted, drops on to the sloping plates, and runs into the trough. When the solder is all collected, the inlet pipes for the gases are closed, the trough of solder withdrawn, and the tins removed through a side door.—J. H. J.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Flavine and Brilliant Green: new and powerful antiseptics. C. H. Browning, R. Gulbransen, E. L. Kenaway, and L. H. D. Thornton. Report to the Medical Research Committee. British Medical J., Jan. 20, 1917. Pharm. J., 1917, 98, 73—74.

IN the case of all antiseptics in common use, a concentration which is sufficient to cause death of the organisms is also detrimental to phagocytosis. Thus, phenol kills organisms and inhibits phagocytosis at a concentration of 1:250 to 1:500, and mercury perchloride exerts both effects at 1:7,000 to 1:10,000. On the other hand, Brilliant Green kills cocci at 1:30,000 and only inhibits phagocytosis at 1:2,000, whilst Flavine kills both cocci and *B. coli* at a concentration of 1:100,000, whereas to affect phagocytosis a concentration greater than 1:500 is required. Of all the compounds examined, Flavine stands out as possessing the highest sum of desirable properties for therapeutic purposes, and tested clinically, the results as regards both Flavine and Brilliant Green have been eminently satisfactory, and the indications are that they will largely supersede the toxic antiseptics at present employed. Flavine (diamino-methyl-acridinium-chloride), which is likely to be the more generally useful of the two, was originally prepared by Benda (see this J., 1912, 678), and was found to have a very marked effect on trypanosome infections. Attention was first drawn by Browning and Gilmore to the powerful action of this substance on bacteria. On account of its trypanocidal action the compound was called Trypoflavine, but as its range of use promises to be much wider it is more convenient to denote it simply as Flavine. It is a fairly stable substance, and solutions may be boiled or heated up to 120° C. in the autoclave. Hitherto the preparation of Flavine has been worked out by Drs. Barger and Ewins in the chemical laboratory of the department of biochemistry and pharmacology of the Medical Research Committee, but arrangements have now been made for the commercial production of the compound on a larger scale. The products will be tested biologically at the Bland-Sutton Institute of the Middlesex Hospital, and will be available for trial on application to Dr. Browning on behalf of the Medical Research Committee.

Alloxan: Preparation of — H. Biltz and M. Heyn. Annalen, 1916, 413, 69—67.

WHILE chlorine has no action on uric acid suspended in boiling acetic acid, oxidation to alloxan occurs in the presence of three or more mols. of water, and by leading a rapid stream of chlorine through a mixture of 300 c.c. of glacial acetic acid and 50 c.c. of water in which 100 grms. of finely divided uric acid was suspended, a yield of 60—65 grms. of alloxan monohydrate was obtained after about 15 mins. chlorination, the completion of the reaction being indicated by the passing into solution of the uric acid and the deposition of coarse heavy crystals of the alloxan monohydrate. By recrystallisation from water, and if crude uric acid has been employed, decolorisation with

animal charcoal, colourless crystals of alloxan tetrahydrate are obtainable. The preparation of alloxan by this method is sufficiently rapid to be adapted to a lecture experiment.

As an addendum to the paper the microscopic identification of the methylated uric acids by the crystal form obtained by precipitation from solution in concentrated sulphuric acid by dilution with water is recommended.—G. F. M.

Urethane: Influence of acid radicles containing different alkyl groups on the narcotic action of —, J. Odaira, Mem. Coll. Sci., Kyoto Imp. Univ., 1916, 1, 319–340.

NUMEROUS acyl derivatives of urethane were synthesised by the action of the corresponding acid chlorides on this substance, and their physiological action was compared by experiments on rabbits and frogs. The narcotic action of urethane was strengthened by the acylation of the amino-group, and more particularly so when the acid residue contained a secondary alkyl group. Thus diethylacetylurethane, or detonal, and ethyl-propylacetylurethane, or epronal, are both more effective than the parent substance, and epronal is almost equal to veronal (diethylbarbituric acid) and hedonal (methylpropylcarbinol) urethane in the duration of narcotic action, and in addition much more rapid in action. It seems probable that a further increase in the number of carbon atoms up to propylbutyl- or dibutyl-acetylurethane still further increases the strength of the narcotic action. The minimum effective dose of epronal, which was studied more closely than the other substances, was 0.3–0.5 gm. per kilo. of body weight for a rabbit, whilst 2.5–3.0 grms. caused death in 20–50 hours. In doses of 1.5 grms. per kilo. the blood pressure remained normal, and the vagus and respiratory centres were not affected, but the action on the heart becomes more and more effective with the higher homologues as the narcotic action increases. N-Iso-amylurethane, which differs from detonal only by the absence of the carbonyl group, although a somewhat stronger narcotic, is far more poisonous than detonal.—G. F. M.

Cyanamide from calcium cyanamide: Preparation of —, E. A. Werner, Chem. Soc. Trans., 1916, 109, 1325–1327.

THE stability of cyanamide in the presence of acetic acid has been utilised to prepare it from calcium cyanamide, 100 grms. of the latter being added, in portions of 15 grms. each, to 125 grms. of pure acetic acid and 120 grms. of water in a cooled mortar with constant stirring. The pasty mass is well kneaded, and dried in the air for 24 hours. The easily-powdered solid is then extracted six or seven times with ether in a Soxhlet, the extract concentrated by distillation at a gentle heat, and finally evaporated to dryness in a desiccator over sodium hydroxide. The yield varied from 91 to 96% of the theoretical value. It is of great importance that the mass, before extraction with ether, be faintly acid throughout.—B. N.

Saurool, a substitute for ichthyol. L. Méran, Vet. Rec., 1916, 287. Pharm. J., 1917, 98, 43.

SAUROOL is an oil obtained by distilling a bituminous shale found in a mine not far from Lake Lugano, Switzerland. The purified oil contains 6–7% of sulphur in organic combination and closely resembles ichthyol in its therapeutic properties.

Sodium citrate: Action of — and its decomposition in the body. W. Salant and L. E. Wise, J. Biol. Chem., 1916, 28, 27–58.

SODIUM citrate is rapidly oxidised and eliminated

when injected intravenously into cats and dogs; large doses when given by the mouth render the urine alkaline, but the urine contains only traces of the citrate. The fatal dose of sodium citrate, when injected intravenously, varies from 0.4 to 1.6 gm. per kilo. of animal, and 70 mgrms. may produce slight symptoms. Only large amounts (more than 3 grms. per kilo.) are toxic when ingested. The toxicity of sodium citrate depends on the rate of its oxidation in the body; it is more toxic for animals in which larger quantities are eliminated unchanged; the rate of oxidation is greater in rabbits than in cats. The presence of 1% of sodium citrate inhibits the coagulation of blood for 4 days at 10°C. The acute effect of sodium tartrate is less than that of sodium citrate.—W. P. S.

Utilisation of cherry hy-products. Rabak. See XIXa.

Estimation of arsenic in organic compounds. Ewins. See XXIII.

PATENTS.

Acetic anhydride: Manufacture of —, H. Dreyfus, Basle, Switzerland. Eng. Pat. 17,920, Dec. 22, 1915. Under Int. Conv., Dec. 23, 1914.

ACETIC anhydride is manufactured by acting on an acetate with sulphuric anhydride (which may or may not be mixed with chlorosulphonic acid), or with a compound of sulphuric anhydride and an inorganic salt, e.g., sodium chloride or sulphate. A diluent such as acetic anhydride is used, and the reaction mixture must be cooled initially to 0–5°C. if sulphuric anhydride is employed directly, or to atmospheric temperature by water-cooling if a compound of sulphuric anhydride is employed. *Example.* 800 kilos. of sulphuric anhydride is added fairly quickly, with constant stirring, to 1600 kilos. of powdered anhydrous sodium sulphate, and when combination is complete the mass is cooled and added to a mixture of 1640 kilos. of powdered anhydrous sodium acetate and 1600 kilos. of acetic anhydride, the mixture being stirred and water-cooled. The temperature may afterwards be allowed to rise to 60°–70°C. to complete the reaction, and the acetic anhydride is distilled off *in vacuo*. The product is of a high degree of purity, and free from chlorine.—F. Sp.

Liniment. C. A. and G. Cofman-Nicoresti, London. Eng. Pat. 18,060, Dec. 28, 1915.

SOLID preparations of volatile oils such as amber oil, eucalyptus oil, camphor oil, terebene, etc., containing from 80% to 95% of the oil, are obtained by incorporating with the oil a salt of one of the higher fatty acids, such as stearic and palmitic acids. The salt as such may be emulsified with the oil, or separate portions of the oil may be mixed with the acid and base respectively and then mixed together. The addition of about 1 part in 500 of paraffin wax assists the solidification.

—B. V. S.

Pharmaceutical products containing arsenic, and process of making same. J. Calsen, Elberfeld, and W. Grütten, Volhwinkel, Germany. Assignors to Synthetic Patents Co., Inc., New York. U.S. Pat. 1,201,692, Oct. 17, 1916. Date of appl., July 29, 1916.

COMPOUNDS containing the following atomic groups are claimed:— $\text{RC}^{\text{R}}\text{As}$, $\text{RCX}^{\text{R}}\text{As}$, $\text{RCX}^{\text{R}}\text{AsO}$, $\text{RCX}^{\text{R}}\text{AsO}(\text{OH})_2$, $\text{RUCl}^{\text{R}}\text{AsO}(\text{OH})_2$ (in which R, R' is hydrogen or a hydrocarbon

radical, and X is a halogen), and in particular the chloroarsinic acids produced by causing arsenic trichloride to combine with acetylene hydrocarbons, treating the product with water to form the arsenoxide, and oxidising the latter. *Example:* 240 parts of heptene (*n*-pentylacetylene) and 900 parts of arsenic trichloride are heated together for 16 hours under a reflux condenser. The excess of arsenic trichloride is removed by distillation *in vacuo*, and the oily residue is dissolved in 3000 parts of wet ether. Aniline is added as long as a precipitate forms, and the aniline hydrochloride is filtered off. The filtrate is washed with dilute hydrochloric acid, then with water until neutral to Congo red, dried over sodium sulphate and freed from ether *in vacuo*. Heptenechloroarsenoxide remains as a thick dark liquid, 44 parts of heptenechloroarsenoxide is dissolved in 400 parts of acetone and treated with 3% hydrogen peroxide until oxidation is complete. The solution is shaken with 500 parts of ether, and the ethereal layer washed with dilute caustic soda and water. The alkaline wash water is acidulated with hydrochloric acid, and evaporated *in vacuo* at 60–70° C. until the heptenechloroarsinic acid crystallises. It is separated, washed with a little ether, heated with animal charcoal in 50 parts of water, and recrystallised. It forms white shining leaflets, easily soluble in water to a neutral solution. It is valuable in the treatment of anæmia, chlorosis, leucæmia, chorea, and skin diseases.—F. Sp.

Auro-mercaptobenzenes, and process of making same. A. Feldt, Frankfurt, and P. Fritzsche, Assignors to Farb. vorm. Meister, Lucius, and Brüning, Höchst, Germany. U.S. Pat. 1,207,284, Dec. 5, 1916. Date of appl. Oct. 17, 1916.

AURO-MERCAPTOBENZENES, of the general formula, X.S.Au , where X is any benzene nucleus, are obtained by the action of double gold chlorides on mercaptobenzenes. They are yellowish solids. The sodium salt of 4-amino-2-auromercaptobenzene-1-carboxylic acid is a yellowish powder, readily soluble in water, insoluble in organic solvents.—B. V. S.

Halogenation of hydrocarbons and other processes of chlorination, and reactions between gases or vapours in general. B. S. Lacy, Fr. Pat. 480,064, Oct. 22, 1915.

SEE Eng. Pat. 14,709 of 1913; this J., 1916, 653. The method is applied to other processes of halogenation and to reactions between gases or vapours in general.

Tobacco-plants: Process for treating the green juice of— T. Oelenheinz, Karlsruhe, Germany. U.S. Pat. 1,209,327, Dec. 19, 1916. Date of appl. July 24, 1912.

SEE Eng. Pat. 17,037 of 1912; this J., 1913, 882.

Olefinic terpene derivatives: Hydrogenising— C. Paal, Leipzig, Germany. U.S. Pat. 1,210,681, Jan. 2, 1917. Date of appl., July 18, 1914.

SEE Eng. Pat. 16,180 of 1914; this J., 1915, 982.

Alcohols: Manufacture of [aliphatic]— C. Bill, Fr. Pat. 177,812, Oct. 6, 1914. Under Int. Conv., Oct. 4, 1913.

SEE Eng. Pat. 20,550 of 1914; this J., 1915, 575.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

Colour sensitising of photographic plates: Preparation of dyes for— W. Harrison and S. E. Bottomley. Preliminary Report of the Investigation carried out at the University of Leeds and the City of Leeds Technical School (Printing Crafts Department). Nov. 1916.

METHODS are given for the preparation of ethyl iodide, quinaldine (Doebner and Miller, Ber., 1883, 16, 2465), toluquinoline (Skraup, Monastsh. Chem., 1881, 2, 158), and toluquinoline, and from these of Formocyanine (Pinaeyanol) (Ger. Pat. 172,118; see Eng. Pat. 16,227 of 1905, this J., 1906, 368), and Tolucyanine (Orthochrome T) (Ger. Pat. 167,159; see Eng. Pat. 9598 of 1903; this J., 1904, 381). Small quantities of the dyes in an impure condition have been prepared; spectra of plates prepared with Formocyanine prepared as described, and with Pinaeyanol of German origin are given for comparison.—B. V. S.

Colour sensitising: Production of dyes for— W. J. Pope. Brit. J. Phot., Jan. 12, 1917.

IMPROVED methods have been devised at the University Chemical Laboratory, Cambridge, for preparing the intermediate products and all the sensitisers in ordinary use, including Pinaverdol, Pinaeyanol, and Orthochrome, and several plate-makers have been supplied with these dyes for some months. Details of the methods in use are not given.—B. V. S.

PATENTS.

X-Ray photography. T. T. Baker, South Croydon. Eng. Pat. 17092, Dec. 1, 1915.

THE time of exposure in taking X-ray photographs is reduced by the use of two intensifying screens, on either side of the sensitive plate or film, the one nearer the X-ray tube being of crystalline calcium tungstate, more transparent to X-rays, and the other one being of the semi-crystalline salt, much less transparent to X-rays.—B. V. S.

Developing and fixing photographic exposures: Composition of matter for— F. W. Hochstetter, Assignor to H. P. Patents and Processes Co., Inc., New York. U.S. Pat. 1,207,042, Dec. 5, 1916. Date of appl. Oct. 7, 1913.

A COMBINED developing and fixing solution contains a reducer, sodium sulphite and thiosulphate, an alkali carbonate, glycerin, and citric acid.—B. V. S.

Photographic process. [Colour photography.] W. E. Fox, Assignor to Kinemacolor Co. of America, New York. U.S. Pat. 1,207,527, Dec. 5, 1916. Date of appl., June 23, 1914. (See also Eng. Pats. 552 and 8728 of 1914; this J., 1914, 1227.)

TWO negatives are taken through screens of complementary colours (*e.g.*, red and green). A print is made through one of the negatives and toned to a colour complementary to that of the taking screen. A second print, through the other negative, is then superposed in register on the first print and stained by mordanting and dyeing to the colour complementary to its taking screen.—B. V. S.

Photographs and photogreasures: Process for producing—J. H. Christensen. Fr. Pat. 184,119, Mar. 10, 1916. Under Int. Conv., Mar. 10, 1915.

AFTER development plates are treated with a fixing solution which acts on the unreduced silver salt to form a compound which fills up the pores of the film. The most suitable substances to use are alkali polysulphides and thiostannates, Schlippe's salt, and similar compounds which easily deposit sulphur in the fixing process, but similar effects can be obtained with iodides, thio-cyanates, and some other substances. The best effect is obtained by a mixture of a sulphur compound and a solvent of silver halides such as thio-cyanate. Collodio-bromide films to be treated in this way are preferably previously made very porous by the addition of a substance such as glycerin, benzoic acid, etc., which washes out during development, while gelatin films should be previously hardened with chrome alum, alum, or formaldehyde. The varying porosity of the films on plates so prepared may be utilised in several printing processes. For example, colour printing plates for a three-colour process may be prepared by printing through the colour negatives on to a composite plate consisting of a lower dyed collodion film on a suitable base and an upper collodio-bromide film. After development and fixation according to this process, the transfer of dye from the lower film to a printing paper varies with the porosity of the upper film, and a coloured print is obtained. —B. V. S.

Colour photography. P. D. Brewster, East Orange, N.J. U.S. Pat. 1,208,739, Dec. 19, 1916. Date of appl. Jan. 29, 1911. Renewed May 11, 1916.

SEE Eng. Pat. 1073 of 1915; this J., 1916, 329.

XXII.—EXPLOSIVES; MATCHES.

Trinitrotoluol: U.S. Navy Department Specifications for—

THE following U.S. Navy Department Specifications for trinitrotoluol (5TT2) have been issued:—
Grade A—Refined. Trinitrotoluol must be a high-grade material, made from a suitable quality of raw materials. It must be thoroughly purified by recrystallisation from an approved solvent, so that the finished product shall have the following characteristics:—The material must be in the form of a slightly yellow, fine, and uniform crystalline powder. At least 99% must pass through a sieve 12 mesh per linear inch. No odour of any by-product or crystallising agent may be present. It shall have a melting point of at least 79° C. It shall be free from acidity and shall not show more than traces of metallic salts or residual solvents. Average moisture of a lot shall not be greater than 0.1%. Average ash of a lot shall not be greater than 0.1%. It shall not contain more than 0.15% of material insoluble in alcohol. It shall contain no free toluol or products giving a nitric-acid reaction with a sulphuric acid solution of diphenylamine. It shall contain not less than 18.20% nitrogen as determined by the Dumas combustion method. It shall give a heat test of at least thirty minutes at 65.5° C. with potassium iodide-starch paper.

Grade B—Crude. Trinitrotoluol must be a high grade material, made from a suitable quality of raw materials. It shall be thoroughly stabilised, and washed free from stabilising materials and by-products of stabilising process, and thoroughly dried. It shall be a yellowish, uniform crystalline powder of such fineness that at least 90% will pass

a sieve 40 meshes per linear inch. It shall have a melting point of at least 75.5° C. It shall be free from acidity. It shall show not more than traces of metallic salts. Conditions as to ash, moisture, percentage soluble in alcohol, and content of free toluol or products giving a reaction with diphenylamine are the same as for the refined product. It shall contain not less than 18% nitrogen as determined by the Dumas combustion method.

The manufacture of the material shall be open to inspection in all its details by the officers and employees of the Bureau of Ordnance assigned to duty for that purpose, and must be satisfactory at all its stages to the inspector at the works or to such one of his assistants as may be designated.

For purposes of inspection 4000 lb. of trinitrotoluol will constitute a "lot," and from each lot the inspector will select a sample of one pound and ship it at the expense of the Government to the Naval Proving Ground, Indian Head, Md., for chemical test.

Additive compounds of trinitrobenzene. Sudborough. See 111.

Additive compounds of s-trinitrobenzene with amino-derivatives of hydrocarbons. Cadre and Sudborough. See 111.

PATENTS.

P perchlorate explosives. Stockholms Superfosfat Fabriks Aktiebolag, Stockholm. Eng. Pat. 17,584, Dec. 16, 1915. Under Int. Conv., Dec. 23, 1914.

EXPLOSIVES containing perchlorates are subjected to a pressure of not less than 300 kilos. per sq. cm., which diminishes their sensitiveness to shock and increases their specific gravity, thereby making them suitable for charging shells. —F. Sp.

Nitrocellulose: Process of producing—A. C. Vournasos, Athens. Eng. Pat. 9547 of 1915; date of appl. July 22, 1914.

NITROCELLULOSE is produced from cellulose derived from *Hibiscus cannabinus* (see previous abstract) by immersing 30 parts by weight of the fibres in a mixture of 250 parts of nitric acid (sp.gr. 1.381) and 500 parts of sulphuric acid (sp.gr. 1.82) for 24 hours at 15° C. Either the crude or the bleached fibres may be used, the latter yielding a product stated to be superior in stability to the nitrocellulose from pure cotton.—F. Sp.

Matches: Damp-proof—J. W. Mills, Birmingham, and W. Morgan, Bristol. Eng. Pat. 18,028, Dec. 28, 1915.

MATCHES tipped with brimstone or other inflammable material are rendered damp-proof by coating them with a solution of celluloid or nitrated cellulose. In addition to this treatment, the solution may also be applied to the wood prior to the application of the brimstone, etc. —C. A. M.

Match-ignition material. Process of drying the composition heads of matches. W. A. Fairburn, Short Hills, N.J., Assignor to The Diamond Match Co., Chicago, Ill. U.S. Pats. (A) 1,206,827 and (B) 1,206,828, Dec. 5, 1916. Dates of appl. Apr. 6, and July 28, 1915.

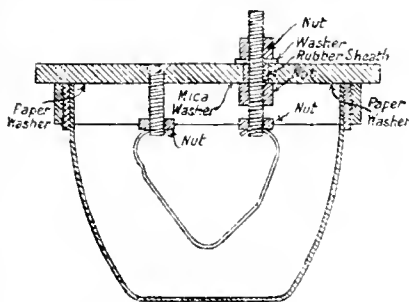
(A) Rosin, dextrin, plaster of Paris, antimony sulphide, and amorphous phosphorus are incorporated to form a match-ignition material. (B) An oxidising composition is applied to the match splints, which are then passed through a series of drying zones, where they meet rapid currents of fairly dry air, first at temperatures

increasing successively to about 120° F. (49° C.) and then decreasing successively to about 80° F. (27° C.), after which the heads are coated with the sensitive ignition composition.—C. A. M.

XXIII.—ANALYSIS.

Combustion methods for use in the laboratory. [Determination of sulphur.] J. Hewett. London and Southern Distr. Ind. Gas Assoc., Jan. 5, 1917. Gas J., 1917, 137, 72–73.

SULPHUR may be estimated in volatile liquids, e.g., crude benzols, by drawing air through the liquid and after further diluting the air-vapour



mixture, passing it through a silica tube heated to redness, when complete combustion occurs. The gases then pass through two wash-bottles containing sodium hydroxide. After oxidation of the product with bromine or hydrogen peroxide, sulphur is estimated as sulphate in the usual way. The author indicates the wide applicability of the estimation of sulphur by combustion with sodium peroxide. It is carried out in a nickel crucible (see fig.) fitted with a screwed top and electrical ignition device. A ring of filter paper makes a tight joint. The crucible may be immersed in water when the charge is fired. The substance under test must be thoroughly incorporated with the sodium peroxide in suitable proportions. The reaction should be complete in a few seconds. The contents of the crucible when cold, are extracted with distilled water and after acidification and filtration, sulphur is estimated as sulphate in the usual way. This method may be used for any substance which can be brought to react vigorously with sodium peroxide either alone or with the addition of sulphur-free combustible matter, e.g., wood dust or alcohol. It has been used with tar and tar products, oils, fats, greases, coal, coke, new and spent oxide of iron. With spent oxides, the reaction product is suitable for the estimation of iron and alumina as well as sulphur. The analysis of spent oxide in this way can be conducted much more speedily and conveniently than by the usual methods. The reaction is extremely violent. Not more than 1 gm. of combustible substance should be taken and then 20 grms. of sodium peroxide usually gives a suitable melt. The substance should be approximately free from moisture, as water may cause dangerous premature ignitions.—H. J. H.

Colorimetry by combustions with sodium peroxide. W. G. Mixer. Amer. J. Sci., 1917, 43, 27–31.

A DETAILED account of the construction of a silver bomb-colorimeter (and of the necessary appurtenances) employed by the author in a

series of thermochemical researches. Full directions are given for its use in the determination of the heat of oxidation of elements which do not burn in oxygen and which form oxides insoluble in acids. The method of fusion with sodium peroxide is also adapted to the determination of the heat of combination of certain oxides with sodium oxide. Experimental figures for determination of the heats of formation of Fe_2O_3 and of pyrites are appended. Results obtained by this method are compared with those yielded by other modes of procedure. Some substances when burnt with Na_2O_2 do not evolve sufficient heat to fuse the mixture and some readily combustible body such as sulphur or carbon must be added.—F. C.

Phosphoric acid in qualitative analysis: Removal of —. L. Gattermann and H. Schindhelm. Ber., 1916, 49, 2416–2422.

WORKING with 1 gm. of material, the filtrate from the hydrogen sulphide group is boiled until free from hydrogen sulphide, concentrated to 100 c.c., filtered if necessary, and treated with 5 c.c. of 6% ammonium phosphate solution. It is then nearly neutralised with dilute ammonia (until only faintly acid to litmus), 3 c.c. of dilute hydrochloric acid (7–8%) is added, and the briskly boiling solution is treated with 3 c.c. of a freshly prepared solution containing 3 grms. of crystallised stannic chloride, dissolved in the cold. Stannic phosphate is thus precipitated, and if necessary more of the stannic chloride solution is added, in portions of 0.5–1 c.c., to the boiling solution until no further precipitate is obtained on testing a little of the filtered liquid with ammonium molybdate. The boiling solution is then filtered, using a Büchner funnel and double filter, the precipitate washed with boiling water, the warm filtrate, which should be quite clear, is treated with dilute hydrochloric acid and hydrogen sulphide, to remove excess of tin, and the metals present are detected in the usual way. When the phosphate precipitate has a greenish colour, it is tested with caustic soda and hydrogen peroxide for chromium which, like ferric (but not ferrous) iron, is liable to be carried down with the precipitate. If too little phosphoric acid be present, the mixture containing the stannic phosphate precipitate is difficult to filter, but satisfactory conditions are ensured by adding ammonium phosphate as directed.—F. SODN.

Diphenylamine and diphenylbenzidine: Use of — for colorimetric determinations. L. Smith. Z. anal. Chem., 1917, 56, 28–42.

THE intensity of the colour obtained with diphenylamine in the colorimetric estimation of nitric acid (compare Tillmanns, this J., 1911, 44, 918), is largely influenced by shaking the tube, excessive shaking causing a diminution. To obtain reliable results, therefore, shaking should be avoided, the necessary mixing being done by moving a suitable stirrer a few times up and down in the tube, and then allowing the liquid to remain at rest for the prescribed period of one hour. It is suggested that the observed phenomenon is due to the formation of a volatile substance during the oxidation of diphenylamine, the presence of hydrogen chloride being also a determining factor. The stability of the colour is at a maximum at ordinary temperatures. The sensitiveness of the reagent depends largely on its composition, and for the determination of the following amounts of nitric anhydride per litre the annexed formulae are recommended:—0.1–3.0 mgrms.: 0.04 gm. diphenylamine, 39 c.c. water, concentrated sulphuric acid to 100 c.c.; 0.5–10.0 mgrms.: 0.01 gm. diphenylamine, 26 c.c. water, and sul-

phuric acid to 100 c.c.; 1.0–2.5 mgrms.; 0.08 gm. diphenylamine, 20.5 c.c. water, and sulphuric acid to 100 c.c. Diphenylbenzidine behaves analogously to diphenylamine as a reagent for nitric acid; its sensitiveness is somewhat greater. — G. F. M.

Arsenic in organic compounds: Estimation of —. A. J. Ewins. Chem. Soc. Trans., 1916. 109. 1355–1358.

THE methods, previously described for the estimation of arsenic in organic compounds, are either very laborious and involve complicated processes, or are only applicable to certain compounds, such as salvarsan or neosalvarsan. The Norton-Koch method (this J., 1905, 1129), the principle of which is the same as the Kjeldahl method of estimating nitrogen, has been successfully applied by the author to the estimation of arsenic in arsanic, acetylarsanic, and diethylbenzarsinic acids, salvarsan, and a number of other organic substances. 0.1–0.2 gm. of the substance is heated with 10 grms. of potassium sulphate, 0.2–0.3 gm. of starch, and 20 c.c. of concentrated sulphuric acid in a Kjeldahl flask of about 300 c.c. capacity for about 4 hours, until the liquid becomes colourless or pale yellow. The contents are cooled, made just alkaline with 10–12N caustic soda, cooled to 30–40° C., and the liquid made just acid with sulphuric acid. A saturated solution of sodium bicarbonate is added until an excess of 5–10 c.c. of this reagent is present, then 2 c.c. of a 1% solution of starch, and the arsenious acid is titrated with N/20 iodine, until a permanent deep blue colour is obtained. — B. N.

Determination of naphthalene [in coal gas] by picric acid. Knudlauch. See HA.

Assaying gold in copper matte. Clase. See X.

Analysis of antimonial lead. McCabe. See X.

Copying ink pencils and the examination of their pigments in writing. Mitchell. See XIII.

Varnish analysis and varnish control. II. Viscosity of varnishes. Seaton and others. See XIII.

Manufacture of linoleum and its valuation. De Waele. See XIII.

Evaluation of water-soluble as compared with citrate-soluble phosphoric acid. Pranke. See XVI.

Determination of minute amounts of sugar by α -naphthol and estimation of entrainment losses. Blake. See XVII.

Simplified inversion process for determination of sucrose by double polarisation. Walker. See XVII.

Action of different decolorising carbons on pure and impure sugar solutions, and their influence in the analysis of sugar factory products. Pellet. See XVII.

Report on sugar. [Modification of the Clerget process of double polarisation. Use of invertase as hydrolyst in the double polarisation method.] Browne. See XVII.

Determination of raffinose in presence of sucrose by double inversion, using top and bottom fermentation yeasts. Pellet. See XVII.

Methods for the estimation of mixtures of four or more carbohydrates, involving acidification with bromine. Wilson and Atkins. See XVII.

Analysis of honey and other substances containing levulose. Atkins. See XVII.

Determination of free and combined galactose. Van der Haar. See XVII.

Determination of ammonia [from nitrogen in brewing materials] by the boric acid method. Adler. See XVIII.

Scientific control of a rum distillery. Seard. See XVIII.

Influence of carbohydrates on the accuracy of the Van Slyke method in the hydrolysis of casein. Hart and Sure. See XIX.

Protein-copper compounds. Osborne and Leavenworth. See XIX.

Determination of oxygen [in water] by Winklers' method. Bruhns. See XIX.

Determination of sodium and calcium bicarbonates in boiler-feed water. Monhaupt. See XIX.

PATENT.

Gas; Apparatus for the analysis of —. Aktiebolaget Ingeniörsfirma F. Egnell. Fr. Pat. 480,661. Jan. 12, 1916. Under Int. Conv. Feb. 6, 1915.

IN apparatus for determining the proportions of carbon dioxide and monoxide, oxygen, and hydrocarbons in a gaseous mixture, the gas passes in series through a measuring vessel, an absorbing solution, and finally either in series or parallel through a retort containing electrically heated finely divided metal or oxide which reduces or oxidises the gas, and a measuring vessel for the residue of gas. In a modification, additional absorption apparatus may be inserted before and/or after the retort. In another modification, the retort may be placed before the first measuring vessel and another absorption apparatus after that vessel. The residue of gas may be cooled and humidified. — W. F. F.

Books Received.

YEAR-BOOK OF PHARMACY AND TRANSACTIONS OF THE BRITISH PHARMACEUTICAL CONFERENCE. JULY 12, 1916. J. and A. Churchill. 7, Great Marlborough Street, London. 510 pages, large 8vo. Price 10s.

THE first section of this useful year-book, covering 432 pages, contains abstracts of the various papers on chemistry, pharmacy, and materia medica, edited by J. O. Brailwaite, together with chapters on new remedies, by T. Stephenson. The remainder of the book, edited by R. R. Bennett, is occupied by the Transactions of the British Pharmaceutical Conference at the 53rd Annual Meeting, held in London on July 12th, 1916. Only one paper is reproduced, namely, that on "Some medicinal plants of Australia," by S. Plowman.

PROHIBITIONS OF EXPORT IN FORCE IN BRITISH INDIA, THE SELF-GOVERNING DOMINIONS, EGYPT, AND CERTAIN OTHER BRITISH POSSESSIONS. Supplements to "The Board of Trade Journal," Part I., Jan. 18, and Part II., Jan. 25, 1917. Price 3d. each.

TRADING WITH THE ENEMY. Consolidating statutory list of persons and firms in countries other than enemy countries, with whom persons and firms in the United Kingdom are prohibited from trading. Complete to Dec. 22, 1916. No. 15A. H.M. Stationery Office, Imperial House, Kingsway, London, W.C. Price 3d.

Journal of the Society of Chemical Industry.

No. 4, Vol. XXXVI.

FEBRUARY 28, 1917.

No. 4, Vol. XXXVI.

Official Notices.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY.

Owing to unforeseen delays in the receipt of the manuscript of certain sections of these Reports, it is regretted that the publication of the first volume is unavoidably postponed until March.

CROSS AND BEVAN ESSAY PRIZE OF £20 AND LATHAM RESEARCH GRANT OF £300.

The Council have pleasure in announcing that a gift of £20 has been made by Messrs. Cross and Bevan as a prize for an essay on "The Interconnection of Economic Botany and Chemical Industry."

A further sum of £300 has also been presented by their friend, Mr. T. P. Latham, of Weybridge, to be paid in three annual instalments to such one of the competing essayists as may be judged to be of conspicuous ability, as a grant towards his expenses, on the condition that he apply himself, during three years, to research of approved character on a subject cognate with that discussed in his essay.

The immediate object of the donors is to promote the study of economic botany with special reference to its bearing on chemical industry, giving the widest possible interpretation of the relationship.

They desire, under the auspices of the Society, to assist in forming public opinion in this direction and to discover and further the career of a student of promise who may wish to devote himself to work in such a field.

The Essay Prize will be open to all members of the Society who are British subjects. The Research Grant will be limited to competitors under 25 years of age at the time of sending in the essay.

Essays are to be submitted to the Council of the Society not later than the close of the year 1917. The awards will be made promptly. Neither the prize nor the first grant will be given unless the essayist or essayists shall be deemed to have real merit. The Latham Research Student will be required to submit a report at the close of each year, to satisfy the Council that he has made and is likely to make proper use of the grant.

Edinburgh Section.

Meeting held at Edinburgh, on Tuesday, January 16th, 1917.

PROF. JAMES WALKER IN THE CHAIR.

THE BROWN COAL DISTILLATION INDUSTRY OF GERMANY.

BY D. R. STEUART, F.L.C., F.R.S.E.

Brown coal is a substance intermediate in its nature between peat and ordinary coal. Formed in comparatively recent geological times, Tertiary or Cretaceous, it has not yet developed into a true coal. Peat contains 80 or 90% of water from which it parts with great reluctance; it cannot be separated by pressure. Brown coal or lignite has 20% to 60% of moisture, common coal 2% or 3%.

There is little brown coal in Britain. At Bovey Tracey in Devonshire it has been worked for 200

years but is of only local importance. There are vast fields of it in the United States of America; great fields of unknown extent in Alberta, Saskatchewan, and Manitoba, Canada; and some 1700 square miles of it in Victoria, Australia. Brown coal generally has no great covering on it, lies in beds of great thickness, and can often be worked opencast. The amount of water in it is a great drawback, and also its want of coherence when air-dried. In Manitoba, Saskatchewan, and Alberta it cannot be used for locomotive fuel on the railways on account of the dangerous sparks it throws out.

Brown coal is widely distributed through middle and north Germany and in Austria. Near Cologne it is 260 to 400 feet thick. Improved methods of mining and of preparing the products have given great importance to the industry in Germany and these methods are worthy of consideration in other parts of the world.

In the German Empire in 1905 the total coal output was 121 million tons and 30% of that was brown coal. The total output of coal in 1910 was 222 million tons. The coal production in the British Empire in 1910 was 312 million tons.

In Germany for the last half century brown coal has been subjected to low temperature distillation, and it may be of interest to give some description of the process for comparison with our Scottish shale oil industry. The products of the distillation are somewhat similar: permanent gas, spirit, lamp oil, gas oil, lubricating oil, and solid paraffin, but in Germany the oils require more chemicals in the refining, and after all the result is not so good. Dr. Scheithauer, Dr. Graefe, and others have described the German methods very fully.

This industry requires a very special brown coal and it is found only in two localities, namely, in the region of Halle on the Saale in Saxon Thuringia, and at Messel near Darmstadt. The material is quite different in the two localities, and the retorting different. The principal centre is at Halle, and works are situated between the towns of Weissenfels and Zeitz, and of Aschersleben and Eisleben. The ordinary brown coals of Germany do not contain sufficient bitumen to make retorting profitable. At first it was thought that any brown coal would do, and starting works on this supposition and without proper scientific expert advice, many ended in ruin. So a distinction arises at once between retort-coal and fuel-coal, but it often requires an expert, or chemical examination, to tell the one from the other.

The Saxon Industry.

The retort coal is found in layers situated among the fuel coal, as shown in the accompanying section of the strata in one locality (Fig. 1). There is twice as much fuel coal as retort coal.

Freshly mined retort coal forms a plastic and sometimes greasy mass, of a brownish black colour; when dry it is yellow to light brown. The fuel coal becomes black or light brown when dried. Retort coal melts on ignition and burns with a smoky flame; fuel coal does not melt. Retort coal has sp. gr. 0.9 to 1.1; fuel coal 1.2 to 1.4. The value for retorting depends on the proportion of bitumen present. The coal is of Tertiary age, Lower Oligocene, and contains 50% to 60% of water. In the Tertiary period the brown coal districts were occupied by extensive bogs with a luxuriant sub-tropical flora. Submerged in swamps the plants and trees were converted into peat as in our own peat-bogs. Sometimes large areas

were exposed to atmospheric influences for a time by droughts or alteration of water level, so that

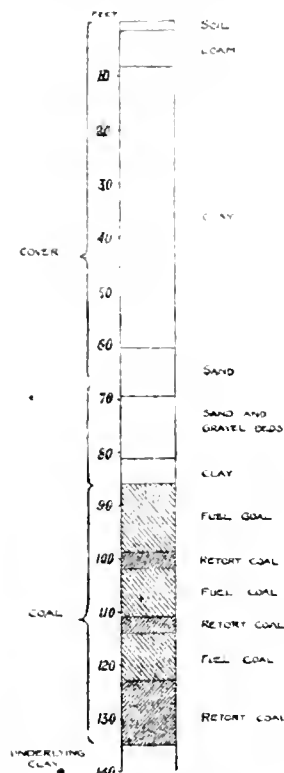


FIG. 1.

the cellulose became partly or completely decomposed and only waxy, fatty, or resinous materials remained, and these covered up later by peat and sediments became through time the retort coal. Botanists state that the plants of that period supplied such wax or resin. The purest bitumen, called pyropissite, was at one time found throughout the coal then used, but seems to be now exhausted. It was yellow in colour or in the purest form white. The bulk of the bitumen in the coal is soluble in benzene, toluene, ether, acetone, alcohols, carbon disulphide, and carbon tetrachloride; but the amount and character of the material got in this way depends on the solvent used.

Bitumen is extracted by a solvent, or by distillation with superheated steam under vacuum, and from it montan wax is manufactured. It is a pure white or yellowish wax with a very high melting point, the crude wax having m.pt. 80° or 90° C., refined 70° C. It is manufactured by six companies with a combined output of 400 to 500 tons per annum. The coal is generally dried and then extracted with benzol. There is a wet extraction process in which alcohol and benzine are used at once on the fresh coal, the alcohol removing the water and the benzine dissolving the wax and the solution separating into two layers.

The following analyses by E. Erdmann are given by Scheithauer:—

	C.	H.	O(N) by dif.	S. Volatile.	Ash.
Pyropissite	73.12	11.63	9.43	0.10	7.72
Retort coal	64.84	7.02	13.18	0.48	7.89
Fuel coal, Waldau	62.15	6.12	22.11	0.16	8.86
Fuel coal, Greppin	58.36	4.88	23.95	1.41	11.40

The three first subjected to distillation in the natural moist state in the laboratory gave the following yields:—

	Pyropissite.	Retort-coal.	Fuel-coal.
Crude oil	32.61	18.75	8.88
Coke	10.33	20.83	28.88
Gas	7.96	10.12	12.24

The water in the materials as they came from the pit was about 50%. The sulphur is seldom above 1%. The basic substances of the ash are oxide of iron, alumina, and lime, with smaller quantities of magnesia, potash, soda, and sometimes manganese and traces of strontia. These are combined with silica, sulphuric acid, sulphurous acid, hydrogen sulphide, carbon dioxide, traces of hydrochloric acid and occasionally phosphoric acid. The ash is practically of no use as a fertiliser, but it improves the physical state of the soil.

Mining.—The coal is first proved by boring. If the cover is not thicker than the coal it is worked opencast. If, however, the coal is thick, sometimes even up to 2 of cover to 1 of coal is worked opencast, and then the cover is removed by steam navvy. With small cover it may be removed by hand. Opencast workings have haulage inclines operated by chain or rope. Most of the retort coal is worked by shafts. The depth is seldom more than 33 fathoms, although a few shafts are over 10 fathoms.

From the bottom of the shaft a double line of rails goes across the field and single lines go at right angles out to the boundary. These are for the little wagons called hutchies in Scotland. For short distances they are pushed by hand, for longer distances by endless chain or wire rope. When the thickness of the coal is great the upper part is taken out first, a layer of over 2 fathoms being removed. Spaces of 18 to 24 square yards are taken out, the timbers removed, and the cover allowed to subside. Adjoining spaces are thus worked out until the whole layer is removed. The roof is allowed time to consolidate and then another layer is removed. Sometimes 3 or 4 layers are taken out before the bottom of the coal is reached. The total bed is sometimes 40 fathoms thick, worked opencast.

Retorting in Saxony.—At first, as in this country, the retorts used were of the old iron gas-retort type. Various forms were tried. At the last they were made of oval section, 8 to 10 feet long, about 30

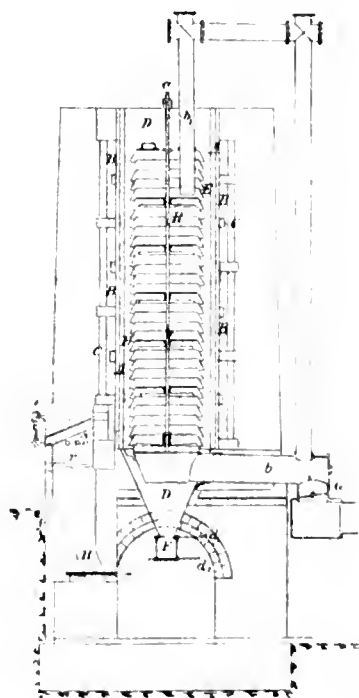


FIG. 2.

inches wide, and $11\frac{1}{2}$ inches deep. Thickness of metal 1 to $1\frac{1}{2}$ inches. A layer of coal 1 inch thick was shovelled in. There were 10 or 12 retorts in a bench, and they were heated by fuel coal of equal volume to the retorted coal. Distillation was completed in 8 hours and the coke raked out. Riebeck, the James Young of Saxony, started building works at Webau in 1858, and built several others afterwards. In 1858 Rolfe constructed a vertical retort, and its use became general, and with some minor improvements, is now the only type of retort used in Saxony. It gives a higher yield and a better quality of crude oil, works continuously and with less labour, and puts through five times as much per unit.

The retort is circular, of firebrick, and heated by firebrick flues around the outside (see Fig. 2). Inside the retort a hollow cylinder is made of a series of flat iron rings. The rings are bevelled and arranged above each other louvre fashion, and the coal passes down the narrow space 3 to 4 inches wide between the rings and the brick wall. The products of distillation pass through the louvres into the hollow centre of the retort and are carried off to the condensers by a pipe from near the top and another from near the bottom. The top pipe may either pass down outside the bench to join the pipe coming from the bottom, or it may pass downwards inside the retort to join the bottom pipe. A Koerting injector sucks the vapours from the retort through these pipes and passes them on to the condensers (Figs. 3 and 4).

In Scotland large amounts of steam are introduced into the shale retorts. No steam is introduced into the Saxon retorts. The raw coal

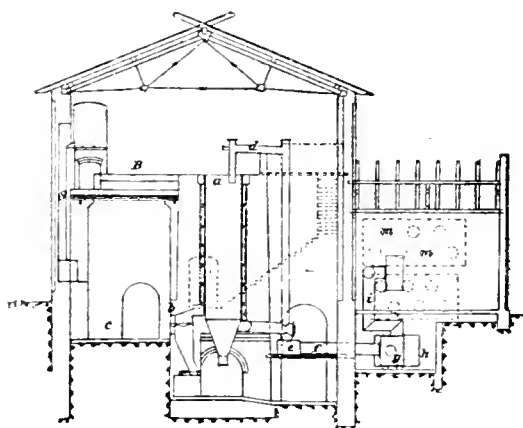


FIG. 1.

has over 50% of moisture and this supplies the steam. The coal must be crushed, or broken by hand, and lumps must not be larger than $1\frac{1}{2}$ to $2\frac{1}{2}$ inches in diameter. If too damp it is partially dried on the charging platforms of the retorts.

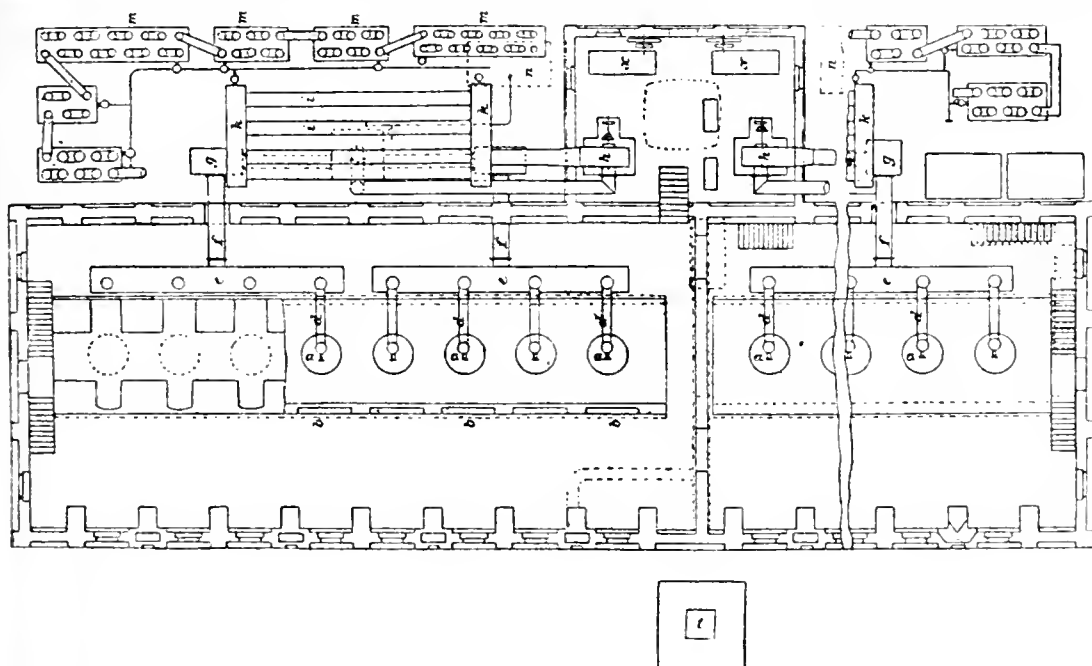


FIG. 3.

At first all the firing was done by coal. Sometimes gas firing is now used alone, but generally it is assisted by a fuel coal furnace at the side. Gas-firing, besides being a great economy, has given 20 to 30% increase of distillate. The temperature in the heating flues around the retorts increases from the top downwards from about 400° C. (752° F.) to 600° C. (1112° F.). The retort was at first 3 feet in diameter and 12 feet high, but is now 5 or 6 feet in diameter and 20 to 25 feet high.

The vapours issuing from the retort should have a temperature of 120° to 150° C. (250° to 300° F.).

The moisture content must not be more than 60%, otherwise the coal tends to stick in the retort; nor less than 30%, for then the oil vapours are decomposed by the heat, steam being necessary to protect them from decomposition. The top of the retort is closed by a heap of the coal ready to be passed down.

The residue of the distillation is a coke of some value for fuel purposes. It falls into a box below, which is shut off from the retort while the box is being emptied. This box is emptied 30 or 40 times in 24 hours. Automatic arrangements prevent the box being opened before it is shut off

from the retort. The coke is dropped into hutches and drenched with water to quench it; or immersed in and hauled through pools of water, as used to be the practice in Scotland.

The retort rings and walls get encrusted in time; after cooling down the retort, the rings are lifted by a tackle and cleaned, and the retort walls are also cleaned. This requires to be done at intervals of 5 to 12 months according to circumstances. The coal ash is basic and the firebricks used must be basic also. If acid bricks are used the ash gets encrusted as a double silicate on the brick, and when cleaning this off, part of the brick breaks off also. The bricks are segments of a circle, keyed into one another, and when building they are ground into each other for tightness. To stand the heat the bricks are best made of pure aluminium silicate. There are various recipes for mortar, of clay, finely ground sand, kaolin, and ground firebrick, mixed with molasses.

The coke after quenching contains moisture 20%, ash 15 to 25%, and the remainder is carbon. It is sold in this state. Its calorific value is 6000 to 7000 calories. Up till the middle of the "seventies" the coke was tipped on spoil heaps. Now it is burned in special but very simple stoves for cooking, for heating workshops, in metallurgy as a reducing agent for zinc, and for other purposes.

The retorts are grouped in benches of 10 to 12 in a single row, with a safety wall dividing the benches. The tops are protected by walls with felt roofing. Retorts are estimated to last a dozen years. The through-put of retort coal seems to be about 3 tons per retort per 24 hours, and less than this if the coal is rich.

The condensing is all done by air-cooling. The vapours are passed through thin-walled malleable iron pipes beginning 36 inches diameter and decreasing further on to 31, 28, 20, 16, and 12 inches, finally finishing up in 1 inch pipes. They are all horizontal until near the end when they are vertical. For a retort 5 or 6 feet in diameter a condensing surface of 960 to over 1000 square feet is allowed. Slow cooling is held to be necessary. Water cooling has been tried and rejected, although lately tried again. The suction from retort to condensers used to be by Koerting steam injectors; but now fans are much more in favour. There is no oil-scrubbing of the gas for spirit in Saxony, as there is at Messel and in Scotland.

In Saxony the water condensed along with the crude oil amounts to 40 to 50% of the retort coal, and more if Koerting injectors are used for propelling the vapours. The amount of ammonia in the water is only 0.03 to 0.07%, and it does not pay to recover it, although efforts have been made to do so. The liquor is supplied to neighbouring farmers gratis; it does not pay to convey to any distance. The great bulk of it has to be sent into the streams after some purification by aeration and filtration, or by filtering through spoil heaps. It contains besides ammonia, aldehydes, ketones, methyl alcohol, and acetonitrile, with acetic, propionic, butyric, and valeric acids, and catechol, and is faintly alkaline in reaction.

The crude oil contains hydrocarbons of various aliphatic series, and also acid and basic substances, with some aromatic compounds. The cellulose, humic acids, and bitumens of the coal produce their own products of decomposition. There is about 0.3% of nitrogen in the coal, and in the crude oil there is $\frac{1}{4}$ to $\frac{1}{2}$ % of nitrogenous bodies; 10% of the nitrogen of the coal is found in the crude oil, 12% in the condensed water, 66% in the coke, and 12% in the gas. These vary with the kind of coal and the method of distillation. The Rolle type of retort is adhered to on account of the good coke it produces.

In the Saxon field there are 12 works putting through together about one million tons of brown coal per annum, producing 60,000 tons of crude

oil and yielding over 7000 tons of solid paraffin. The crude oil yield now is about 18 gallons to the ton of coal. (Scottish production of crude oil is 273,500 tons per annum.)

The Messel industry.

Retorting methods.—The industry began in 1885. The retort coal is quite different from that of Saxony, and is distilled differently. It seems unique in its nature, being a mixture of bituminous clay and coal, and having the organic matter in combination with the mineral matter. The bitumen cannot be extracted by solvents. It has a high percentage of moisture, like brown coal, and a high percentage of ash, like shale. It is more lumpy than the Saxon brown coal, which allows steam to pass through it in the retort. It lies under not more than 13 feet of cover, and is about 480 feet thick. It fills an ancient hemispherical depression, and is in layers like an onion. There are 240 acres of surface. It is worked down 80 feet or so and will last a long time. The fossils indicate a joint animal and vegetable origin. It has the consistency and cut of Dutch cheese, is blackish green in colour, with conchoidal fracture when dry. Alternate frost and thaw make it separate into thin sheets like paper. The moisture is 45%, the ash 30%. The calorific value is low and would not pay cost of carriage for heating purposes. Dry distillation in the laboratory yields water 11%, crude oil 7.8%, coke-residue 35%, gas 6.2%. The condensed water contains volatile and fixed ammonium salts together with catechol and its homologues. The ammonia is recovered. In the fixed ammonium salts are quite a series of homologous fatty acids. The ash is rich in iron oxide.

The coal is won by opencast working and the hutches are brought to the surface by chain and let down by gravitation. The power is from small gas engines direct, or from one large gas engine in a central power-house with electromotors where required.

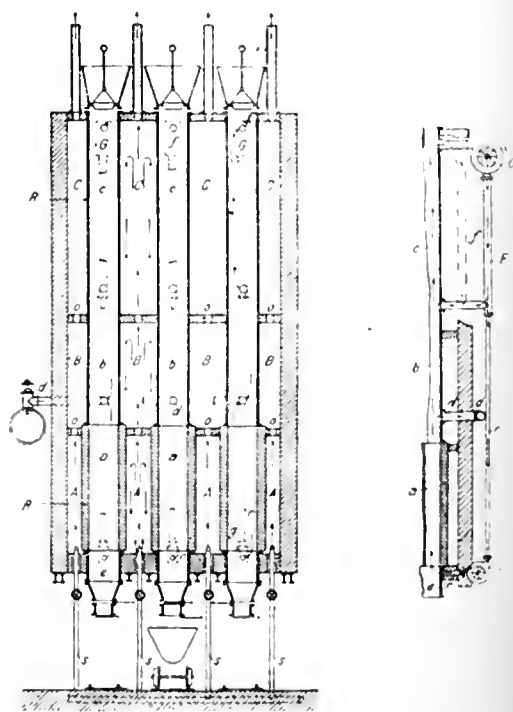


FIG. 5.

The crude oil is distilled from the coal in the presence of steam, and the coke is dropped into a gas-producer below and the gas used to heat the retorts. There is no marketable coke. At one time a special stove was used to reduce the moisture from 44% to 6%, the dried material was distilled in the presence of steam, and the coke dropped into the gas-producer. Thus coal was consumed in drying the retort coal, and also in raising steam from water for the coal distillation. Now the moisture of the coal is used as a steam for the retort. Vertical retorts are used of a type somewhat similar to that used in Scotland (see Ger. Pat. 200,602, May 23, 1906). The working is continuous (Fig. 5). There is a hopper on top from which the coal is let into the retort by a valve as required. More than two-thirds of the retort is of iron; the lower part is of firebrick, and this is the gas-producer, and from it the coal ash is dropped into a hutch below. In the top part of the retort the coal is dried and the steam resulting is drawn from the top by an electrically driven fan; a part is returned into the retort further down, and part caught by another fan is passed into the bottom of the gas-producer where superheated steam acts on the carbon and nitrogen to produce water-gas and ammonia. The oil is distilled at the middle of the retort and the products of distillation led off from here to the condensers. The flues around the retorts are much more spacious than the flues of the Scotch retorts. The flues are divided by partitions into three compartments, and from one compartment to the one above there is communication by a comparatively small passage. The result is that there is a surging circulation of the products of combustion in each compartment, keeping each at the required temperature, and only a quantity passes off towards the chimney in proportion to the suction. The utilisation of heat is good. The products of combustion pass to the chimney at 200 C. The vapours passing from the retort get partially cooled which causes the separation of ammoniacal liquor containing fixed ammonium salts, and some soluble organic compounds. The still hot vapours are passed on up a kind of Glover tower where all the ammonia is absorbed by dilute sulphuric acid. The ammonium sulphate solution so obtained is concentrated by the heat of the vapours, and after being centrifuged and dried the product is

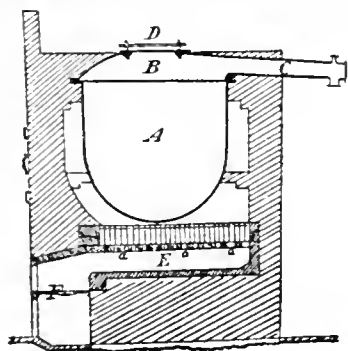


Fig. 6.

ready for the market. The oil vapours pass from the Glover tower and are cooled by water condensers. The water now condensed along with the oil is free from ammonia, and to reduce the quantity of effluent it is used in tubular condensers and towers and so is much evaporated. The gas is finally led up heavy-oil towers to catch the light spirit still left in it. From 70 to 80% of the permanent gas (some 10,000 cubic feet per ton) is used for heating the retorts; the rest goes to the power station. It may be used to raise steam,

or after purification from hydrogen sulphide with iron oxide, it may go to gas engines. There is above 20% of carbon dioxide in the gas, and when this is absorbed the gas is well adapted for incandescence lighting. The ammoniacal liquor is passed down a tower-still with alkali, and the ammonia absorbed in sulphuric acid. From the spent water catechol and its homologues are recovered, and also fatty acids. The Germans extract every practicable substance from their by-products.

At one time the retort coal at Messel was graded, and yielded 1 to 14% of crude oil; now all goes together and averages about 7½% (= 19 gallons per ton).

Would a retort of this type not be suitable for distilling a rich peat? Air-dried peat might serve quite well if moist peat is too wet. Peats no doubt vary in the proportion of bitumen they

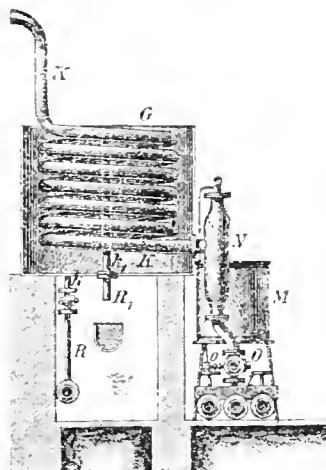


Fig. 7.

contain and they ought to be examined from this point of view. The brown coals of our Colonies should also be investigated.

Refining in Saxony. Distillation.—The crude oil is of a yellow-brown or dark brown colour, sp.gr. 0.850–0.890, usually determined at 11 C. When richer coal was obtainable the sp.gr. was sometimes as low as 0.820 to 0.850 and seldom above 0.880. The present-day crude oil is generally 0.880 to 0.900. Its sets between 20 and 30 C. The constituents boil at 80–400 C., the greatest volume between 250 and 350 C.

The refining of the crude oil is in outline the same as in Scotland. The operations consist of several distillations with fractionation, treatments with sulphuric acid and with caustic soda between the distillations, and separation of the solid paraffin from the heavier oils by cooling and pressing. The first distillation is always partly a destructive distillation, and gives a deposit of carbon and production of permanent gas.

The distillations in Scotland are done at atmospheric pressure, and in the presence of steam more or less superheated. In Saxony they are carried on sometimes at ordinary pressure, sometimes under extra pressure, sometimes under partial vacuum; sometimes with steam, often without; but under pressure it is not for "cracking." The stills are vertical cylinders with hemispherical bottoms for a charge of 140 to 550 gallons, not more; this is only one-fourth of the size of the smallest of our Scotch stills (Fig. 6). The height of the still is 5 feet and the width at top 5½ feet; the cover is domed and is made in one piece with an exit-pipe about 20 inches long. There is a

manhole in the centre of the top, 20 in. 24 in. The stills are bricked in in various ways so as to protect them from direct impact of the flame and send the products of combustion around the flues. The material is cast-iron, rarely wrought iron. Cast steel has been tried and rejected. Till comparatively recent years it was the invariable custom to work each still independently. The condensers (Figs. 7 and 8) are circular coils of piping in a vertical cylindrical water-tank. The coil is about 27 yards long, made of lead or iron, that is of gas-piping, or of cast iron semi-circular segments with flanges. The cooling surface per still is 85 to 95 sq. ft. Between the condenser and receiver there is a "U" bend and from between the condensers and this there rises a pipe to lead the permanent gas upwards

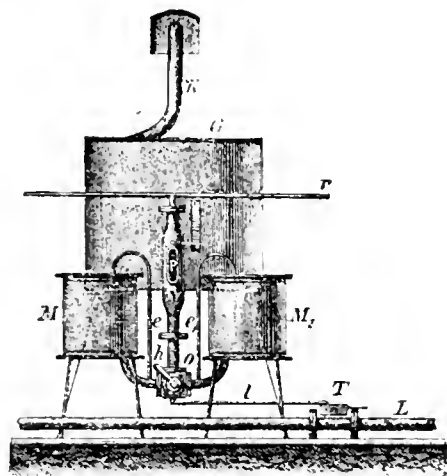


FIG. 8.

into the atmosphere or onward to a gas-holder. There are two receivers, one at each side, each of 33 gallons capacity. When partial vacuum is used it is produced by Koerting steam injector or a vacuum pump.

The crude oil is sometimes treated chemically before distillation, and, if so, slaked lime or caustic soda (1 to 1%) is added to the charge. Manganese oxide and bleaching powder have been tried to lessen the creosote and remove the sulphur; but although the creosote is reduced and the smell is improved the sulphur is left as before. A 2 or 2½ ton charge is distilled in 19 hours; the coke is removed by broad iron spades and shovels through the manhole, and the still is re-charged every 24 hours. One stoker serves 8 to 10 stills, and a stillman attends to 11 to 16 stills. The stills are generally coked, but sometimes the distillation is stopped and the residue run off to coking stills; this adds to the life of the stills. With vacuum distillation the suction is gradually increased from a slight vacuum at the beginning to 16–20 inches of mercury when the heavy oil and paraffin come over. Three-fourths of the charge is distilled off in 6 or 7 hours, the residue is cooled for 1½ hours and then run off to the coking still. The principal still gets 15 to 16 charges per week. Vacuum distillation saves fuel and has many advantages. The plant is kept fully occupied. Ten stills are charged at once in 10 minutes, hastened by the suction of the vacuum plant. The receivers are sometimes of cement, but now generally of iron.

Continuous distillation has only lately come into use. Wernecke in 1907 introduced a new type of continuous still (Fig. 9). It is of circular cross-

section, conical, broad at the top, narrow below. There is a series of flat rings fixed to the side of the still at such an angle as to form a series of gutters or channels. The oil introduced at *a* flows from channel to channel down the stairs, distilling all the time. The figure shows the heating and setting. The residue runs off by *d*. The vapour exit, *B*, at top carries off the light vapours to a condenser, while the pipe, *C*, rising from the centre of the bottom carries off the heavy vapours to another condenser. The pipe, *e*, carries a coil of plaited wire gauze with a shield, *D*, on the top. The oil vapours never touch the heated walls of the still and so do not crack, and the oil surface is twice that of the heating surface. The still only requires cleaning once in 6 or 8 weeks, and then the rings are easily lifted; there is little coking. A vacuum of at least 720 mm. is used (28 inches). The vacuum reduced the fuel consumption by 25%. There is a preliminary feed heater with a furnace for itself; and the temperature is shown by two thermometers, and ranges from 100°–210° C. There are three thermometers in the still. Towards the top the temperature is 230°–240° C., and towards the bottom 260°–280° C. The still produces an oil of high viscosity. The greater the vacuum, however, the less crystalline is the paraffin. The charge of oil is 600 kilos. (150 gallons), and 1,500,750 kilos. (380,000 gallons) is distilled in 826 hours.

The still benches are in all cases protected by walls, and roofed over with corrugated iron or felt. The stillman's platform has a fireproof partition protecting it from the fireman's platform.

The crude oil stills if distilled to dryness at ordinary pressure last 6 or 8 months; vacuum stills 6 to 8 years.

The ordinary specific gravity of Saxon crude oil is 0.870–0.880. By the first distillation it is fractionated into: 33% light oil, sp.gr. about 0.870, boiling range 100°–350° C.; 60% paraffin mass; 2% red grease, used for grease-making; 1% red product, returned to the crude oil; 2% coke; 2% permanent gas.

The light oil chemically treated and distilled produces a light oil and an intermediate oil containing soft paraffin. This light oil treated and distilled produces the marketable products benzine and solar oil. The benzine has sp.gr. 0.790 to 0.810 and flash point 25°–35° C. It has a taintly yellow colour with blue fluorescence and is used mostly for refining the paraffin. The bulk of it boils below 200° C. The solar oil, sp.gr. 0.825 to 0.835, has a light brown colour; flash point 45°–50° C. It boils below 270° C. Formerly used solely for lamps, it is now used for oil-engines.

If the crude oil has not been treated with

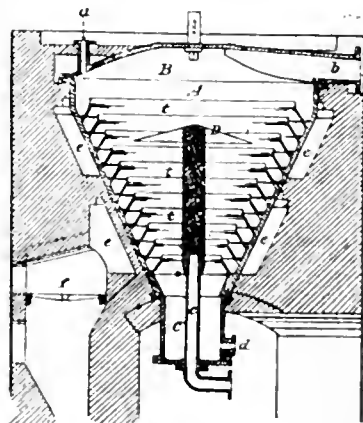
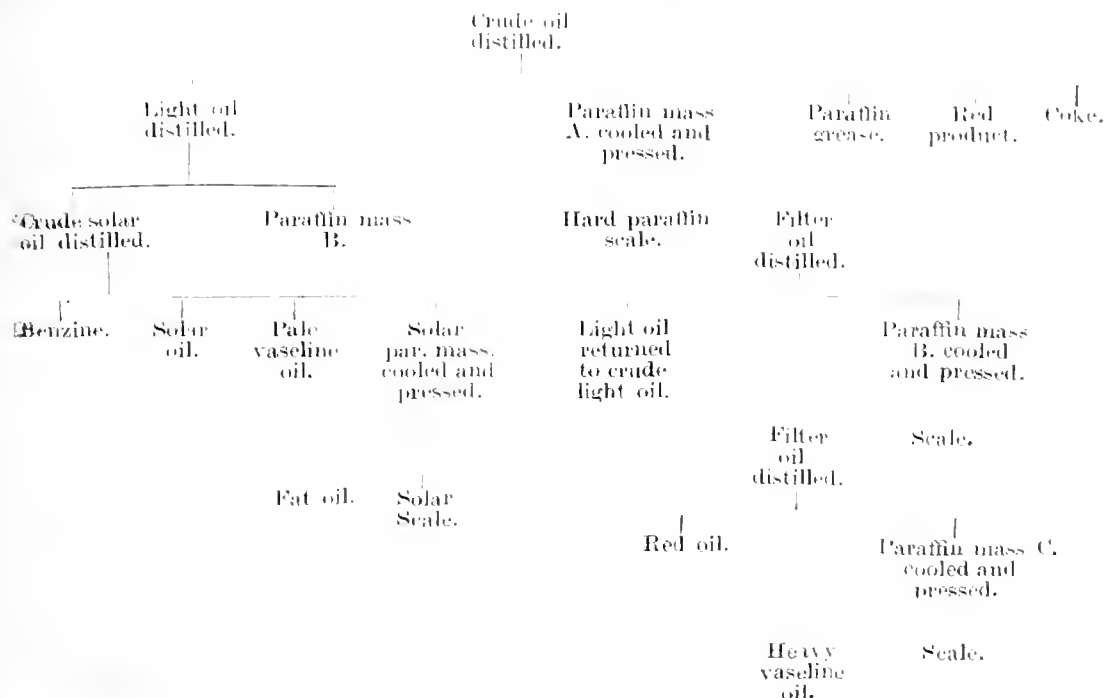


FIG. 9.

chemicals before distillation, the paraffin mass (the heavy oil containing paraffin) is now treated before cooling and pressing. The expressed oil is sometimes treated before distilling again, sometimes not. In distillation the oil is not coked, but 5% of the residue is run off without distillation, and sold as gondron. In the after distillations there are great variations in the different works and in the same works at different times, depending on the requirements of the market.

The following is a simplified diagram of one scheme of working:



The heavier oil products are:

Pale vaseline oil, a general name for cleaning oil, 0.848–0.850, having a pale yellow colour; yellow oil, 0.860–0.870, which is straw yellow; and red oil, 0.870–0.880. The yellow and red oils are mostly used for gas-making.

Dark vaseline oil, or **gas oil**, 0.880–0.890. Red-brown, used mostly for lighting railway carriages with incandescence burners; also for carburetting water-gas. It is extensively used for Diesel motors.

Heavy vaseline oil, 0.905–0.920. Dark brown, used for same purposes as dark vaseline oil, also as liquid fuel for the Navy; for the last-named purpose it is atomised by steam jet.

Fat oil, also 0.905–0.920. Red or brown. Sold unwashed; or refined for lubricating oil mixtures, when it is yellow.

Chemical treatments.—When the crude oil is treated before distillation the sulphuric acid used is of sp.gr. 1.53 or 106 Tw. In the other treatments the acid is sp.gr. 1.84 or 168° Tw. Fuming acid has been tried but does not give satisfactory results.

The caustic soda solution is made by dissolving drum soda in water, and is used of sp.gr. 1.36 to 1.38, or 73° to 76° Tw.

Some impurities in the oil are separated as tar with either sulphuric acid or caustic soda, whichever is used first, and sulphuric acid being the cheaper is in general applied first, unless there is a demand for creosote, when the soda is used first. To use the soda first has this advantage that the products of the soda reaction are more easily

washed out than the products of the acid reaction, so that secondary reactions are more easily avoided in subsequent distillations.

After the sulphuric acid treatments, settling and running off the tars, the oil is washed with water once or twice, then with recovered or weak caustic soda, and finally with strong caustic soda solution. The acid and soda washings are done in the same vessel, except for the finishing treatment. Creosote left in the oil causes the retention of solid paraffin.

The washers have capacities of 1100 to 1400

gallons. (In Scotland 30,000 to 40,000 gallons is washed at once.) Formerly the washers were of wood, now all are of lead-lined iron, the lead being 1.5 inch thick or so. The washers are always housed with sometimes a pipe to carry off the sulphur dioxide and other gases into the open air. The agitation long ago was effected by wooden paddles worked by hand; afterwards mechanical stirrers were used; in recent years it is by air-stirring. The washers are vortical cylinders with conical bottom, and the air is led down to the centre of the bottom by a lead pipe (Fig. 10). (In Scotland it is the custom to use malleable iron washers without lead lining, the strong sulphuric acid scarcely acting on the iron.) Oil containing paraffin is kept liquid for treatment by steam coil or steam jacket.

Whether the crude oil should be treated before distillation or not is a matter on which authorities differ. Treating first has certain advantages. There is less noxious gas on distillation, the coke is 50% less, and there is less permanent gas. Less heat is needed on the stills, and the stills last longer. With certain crude oils the yield of paraffin is increased by the preliminary treatment; with others it is decreased. It may be that when bitumen is present as such in the crude oil it comes down with the vitriol tar, and bitumen is capable of producing solid paraffin by destructive distillation, and is thus lost. Certain authorities hold that the retorting can be manipulated so that all the bitumen is decomposed and that if this is managed the preliminary acid treatment

does only good. (In Scotland it is found that destructive distillation of the crude oil is best; if acid is given first the total loss on refining is increased. The still-coke is valuable, and it is washed free from chemicals.)

When the paraffin mass has to be treated before cooling and pressing, it has to be very thoroughly washed with water after the soda treatment.

In treating the crude oil, to free it from water, $\frac{1}{4}\%$ of 106 Tw. acid is stirred in, or 1 to 2% of recovered acid. After this has settled and the tar run off, 3 or 4% of 168 Tw. acid is stirred in for $\frac{1}{4}$ hour. After settling for 3 or 4 hours and running off the tar, hot water is sprayed over the surface and milk of lime stirred in for $\frac{1}{4}$ hour. After settling and running off the tar the oil is ready for distillation. At this stage there is a great tendency for the oil to emulsify, and to prevent it skill and care are required.

In the subsequent treatments the lightest oils get 1–2% of acid, the heavier ones 2 to 4%, the hard paraffin mass 3 to 6%.

For the finishing treatments the acid and soda have separate washers. Only the paper oils get a finishing treatment at all, and this only in a few works. If found necessary to give a finishing treatment to the heavier oils, 1 to 3% of sulphuric acid is used, then weak caustic soda, sodium

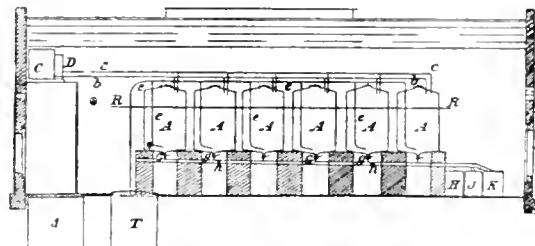


Fig. 10.

carbonate, or sodium silicate. Sodium silicate is very useful for pale heavy oils. In refining, a total of 6 to 7% of sulphuric acid is used and 0.8 to 1.3% of caustic soda, calculated on the crude oil.

The refined oils are settled in iron tanks, holding 10 to 30 tons, until the water settles out and the oil becomes bright. For heavy oils a close steam coil is fixed at the bottom of the tank. Storage tanks, generally cylindrical, used to consist of pits of concrete or brick faced with cement; now they are generally of iron, embedded in a bricked pit, or on sand with a layer of asphalt. There is great variation in size, the largest being 770,000 gallons. Some are constructed as shown in Fig. 11, supported on a circular wall of brickwork. It has a central shaft fitted with a ladder, and having a glass window above the top of it.

All the oils used to be sent to market in barrels, and in very early times in glass carboys. Now 75%, or so is delivered by railway tank wagons.

Solid paraffin separation and refining.—Exhaustive attempts have been made on a works scale to extract the solid paraffin direct from the crude oil without distillation. The scale turned out dark and difficult to refine, and the method was abandoned. Paraffin is insoluble in alcohol, while the oil, resin, and creosote are soluble; but no practical man thinks of trying this on a works scale, although the method has been patented.

The distilled paraffin mass has been experimented on, to try to separate the paraffin by other means than cooling and crystallising, but as yet without success. Certain gases have been tried. Krey proved that the separation could not be carried out by dialysis. Centrifuging has not yet been successful.

In Saxony the paraffin mass is cooled in vessels, holding 6 to 12 gallons, with sides either vertical or tapered towards the bottom. They are exposed in cellars, first to air-cooling, then to water that has been used and is somewhat warm, then to cold water from spring or mine, so that by gradual cooling good crystals should form and grow. The cooling takes 1 to 6 days. Occasionally larger vessels of 22 gallons are used, and cooled only by air in airy apartments. This takes 10 to 15 days. The hard paraffin mass is cooled to 15° to 18° C. by natural cold in this way, and no refrigeration is used.

The soft paraffin masses are in some works crystallised in tanks of 500 to 1100 gallons capacity by the natural cold of winter, and the product is stored until winter comes and is then worked up. This requires a storage of about 1.3 the annual crude oil through-put. The cooling tanks are housed in buildings of light construction, and with walls that can be manipulated like venetian blinds, so as to let in the cold or keep out the heat as required.

In other works refrigerating machinery is used for the soft paraffin mass, which is put into small vessels, and cooled first with water, and then with cold brine. Ammonia solution machines were first adopted and the cold carried to the oil by a brine; but compression ammonia machines are now preferred as more efficient. The mass is cooled to -10° C. Refrigerating is much more efficient than natural cooling, and is carried on all the year round with many advantages. Wernecké uses cooling cells in a brine tank, and when the mass is firm it is ejected by pneumatic pressure into a conveyor to take it to the filter-presses. It is considered that for smaller works up to 5000 to 6000 tons a year natural cooling is most suitable; but for larger works refrigerating machines are certainly better. When natural cold is used and the paraffin crystallised, the oil can be drawn away from the paraffin without the use of filter-presses. Otherwise filter-presses are used first and hydraulic plate-pressing after. Plate-pressing without the filter-pressing was tried but would not do.

The chilled paraffin masses are pulped in a mechanical crusher (see Fig. 12), pumped from the receptacle below, and delivered to the filter-presses. The paraffin is scraped from the cloth of the filter-press with wooden spades. One filling of the filter-press yields about $1\frac{1}{2}$ cwt. of scale, containing still

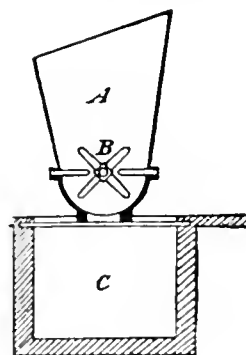


Fig. 11.

some 26 to 30% of oil, and this is taken out with vertical plate-presses as in Scotland. The pressure is 100–150 atmos. The plate-press cloths are 32 to 38 inches square and the best are of wool on the inner side and linen outside, folded to a square of 15 to 22 inches; they are superposed in the press and covered with plates of sheet iron slightly warmed. $1\frac{1}{2}$ cwt. of scale from a filter-press yields

120 lb. of pressed scale. Referring to the diagram of operations given above:—

- "A" mass yields 15–20% of paraffin, m.pt. 50–55° C.
 "B" mass yields 10–15% of paraffin, m.pt. 40–45° C.
 "C" mass yields 10–15% of paraffin, m.pt. 38–42° C.
 Solar mass yields 15–26% of paraffin, m.pt. 35–40° C.

Attempts have been made to refine paraffin with sulphuric acid, as in ozokerite refining, also with chlorine, sodium sulphide, etc.; but all methods have given way to washing with brown coal light oil, called benzine, although it is too heavy and of too high a flash point to be included among the "spirits." Brown coal scale is always dark in colour. The sweating process used in Scotland and elsewhere does not serve the purpose; the amount of impurity is too great and the colour too persistent. Plate-pressed scale still retains 10–15% of oil. The paraffin is melted, mixed with benzine, and run off on to the surface of water. It solidifies into a homogeneous mass. The cake, 1 inch thick, is cut into squares and pressed in a horizontal hydraulic press. The presses hold 30–60 cloths, and a pressure of 200–250 atmos. is used. Two pressings are given, sometimes three, using lighter benzine each time. The presses are seldom heated with steam-pipes. The smell of benzine is removed by currents of steam passed through the melted wax, sometimes in stills, sometimes in open vessels; and if a still is used vacuum may be caused by a Koerting injector on the

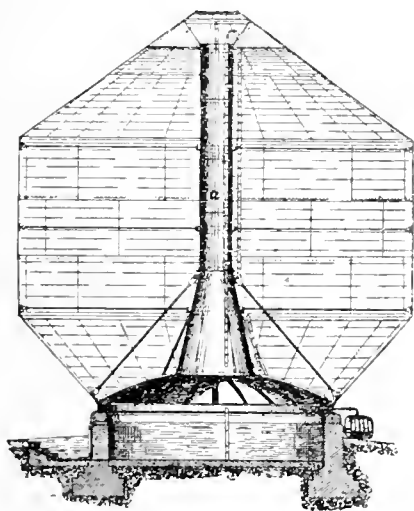


FIG. 12.

condenser. The steaming is continued for 30 to 48 hours. The temperature of the steam is kept at 130° to 140° C. and must not be over 140° C. The steam must therefore not be highly superheated or at more than 4 atmos. pressure. This treatment makes hard paraffin odourless, but soft paraffin retains some smell. The colour of the wax is a faint greenish yellow. Boneblack was formerly used for a finishing treatment; latterly, char from ferrocyanide making has been employed. Clay, fullers' earth, and vegetable charcoal have also been tried. Before use the powder is dried at 100°–110° C. in ovens of various kinds derived from other industries. From 1 to 2% of char is used. No advantage is found from using more than this quantity, but it is sometimes given in two quantities. It is found inadvisable to use air in stirring. The product is thoroughly mixed for $\frac{1}{2}$ hour by mechanical or hand-operated stirrers, at a temperature of 70°–80° C. The mixture is allowed to settle and the wax filtered through paper in filter-presses. The paraffin is extracted

from the used char by benzine in apparatus that differs in every work. The char cannot be regenerated by calcination. Each works tests for itself the decolorising powder most suitable in its own case. A mixture of pure carbon and silicates is good.

Other liquids have been tried in place of benzine. Oleine, amyl alcohol, and other alcohols have been tried but found impracticable and expensive. Amyl alcohol has a strong smell and produces headache. The use of carbon disulphide involves high fire risk. Pyridine bases produce a fine white wax which is rendered inodorous by sulphuric acid of 1.26 sp.gr. (52° Tw.); this reagent is cheap enough but its penetrating disagreeable odour renders it inapplicable.

The paraffin wax varies in m.pt. from 35° to 62° C. When it melts below 50° C. it is called soft wax, above this it is called hard wax. It flashes at 160–165° C. The sp.gr. of paraffin of m.pt. 20° C. is 0.883; m.pt. 15° C., 0.908; m.pt. 58° C., 0.915. The hard wax is used principally for candles. There are five paraffin candle works in Saxony turning out 8000 tons of paraffin and composite candles per annum. The m.pt. of the candles is 125–130° F. (50–55° C.).

Soft wax, m.pt. 35–40° C., is largely used for dipping the sticks of matches; 1000 tons per annum is used for that purpose.

Messel refining. At Messel the sp.gr. of the crude oil is 0.855 to 0.860. On distillation it yields: Spirit, 1.00%; gas oil, 33.00%; and crude paraffin, 7.50%; while gas, coke, and loss in refining amount to 25.50%.

The crude oil is settled and without chemical treatment is pumped into high-level charging tanks from which the oil is run to the stills as required. The stills are much larger than in Saxony, and hold 16.00 to 1700 gallons. Partial vacuum is applied, and there are stirrers in the stills, which are worked continuously. The heavy residue is run off and coked in separate stills. There are mercury gauges to show the vacuum. The fuels used are the tars extracted from the vitriol and soda tars. The crude oil distillate is 16% light oil and 76% of a heavy fraction. The light oil is treated with 2% sulphuric acid and 3% caustic soda solution, and on distillation yields spirit, lamp oil, and gas oil. The heavy fraction receives a similar treatment and on distillation yields some light oil and the bulk as paraffin mass. The mass is air- and water-cooled to 15° C. and pressed, giving a hard paraffin. The oil filtrate is cooled down to –2° C. by cold brine from a freezing machine and pressed again, giving a soft paraffin. The oil is used for gas oil. The lamp oil is treated and has a good colour and smell, sp.gr. 0.800; but for burning in lamps it cannot compete with petroleum. The plant for cooling the paraffin occupies only one-tenth the space of a Saxon cooling plant. The vessels for the first cooling are vertical cylinders with scrapers which disturb the mass little but let new oil forward to the cold wall, and send the solid towards the centre. The oil is much more viscous than in Saxony. The second cooling of the oil filtered from the hard scale is carried out in large jacketed cooling tanks, with horizontal scrapers working at a slow speed. When chilled sufficiently the mass is pumped to the filter-presses without requiring further breaking up. The scale from the filter-presses is plate-pressed in vertical hydraulic presses. The Messel paraffin can be sweated to quality equal to American semi-refined for the market; or it may be further refined with benzine. For double refining it is first treated with small quantities of acid and soda, distilled in vacuum, and then refined as usual. The products are: spirit, sp.gr. 0.800, used extensively for petroleum engines; cleaning oil, 0.825 to 0.835; fat oil, 0.860; and lubricating oil, 0.890–0.892, used for

ght machinery. There are small quantities of other products.

Full details of Messel working are not given.

In Scotland the sulphuric acid is used twice over the refinery, first for the finishing treatment of the oils and then for the first treatment. The acid is separated from the vitriol tar with hot water, saturated with ammonia, evaporated in vacuum apparatus, and the sulphate of ammonia centrifuged. In Saxony they do not recover the ammonia, they wash out the acid as we do, but a proper use of it is still sought. Some of it is used for setting the cressote from the soda tar, and some goes to the mature manufacturers. It cannot readily be purified or concentrated.

The recovery of purified nitrogenous bases has been successfully carried out in several works. The pyridine bases were used for purification of anthracene, and for denaturing spirit to suit the German law of 1887. Now, however, the denaturing law is more stringent and this use has been given up. There is little pyridine present, the series beginning in quantity with the picolines. Lutidines are present, but bases of higher boiling point present in larger quantities have not even been isolated.

The vitriol tar neutralised with soda tar is dissolved and the residue is a glossy black solid, sold as asphalt. The gondron, the residue of the heavy oil not coked, is black and has the consistency of dough.

In the brown coal oil factories the chemists analyse the coal and select the material suitable for retorting, and see that it is properly distilled. They test the intermediate and finished products. They analyse and advise on the chemicals to be sought. The problem is always before them of improving the marketable products and at the same time cheapening the refining.

In regard to the coal testing, after careful sampling, which is always the most important part of an analysis, the moisture and ash are determined, the result of dry distillation noted, and the calorific value and percentage of bitumen determined. In determining the moisture it must be remembered that the coal readily absorbs oxygen and gives off carbon dioxide; so it is carried out in a current of inert gas or *in vacuo*. The laboratory distillation is carried out in a glass retort, fixed to a glass receiver by a cork which has also a tube to carry off the gas evolved: 20 to 30 grms. of the retort coal in its natural moist state is used. The heat is applied gradually, kept an hour at full heat, and the temperature then gradually lowered. It takes from 4 to 6 hours. The retort is weighed empty, charged, and after the distillation; and the receiver before and after use. The receiver is heated to cause a thorough separation of the oil from the water, then chilled with cold water or ice, and the cake of solid crude oil taken out, dried with filter paper, and weighed. The oil yield in the works is only 60% of the laboratory yield.

The bitumen is determined in dried coal with benzene in a Soxhlet apparatus. The bitumen extracted is a brittle solid melting at 80–85°C., and is extensively used for phonograph cylinders and stove polishes.

Crude oil contains 10 to 15% of solid paraffin, and the products of distillation the paraffin series is present from C_1 to C_{22} , or more, also olefines, acetylenes, and other hydrocarbons. In the crude oil the following substances are present according to Erdmann as quoted by Scheithauer: Paraffin series: Heptane, normal nonane, normal decane, undecane, heptadecane, octadecane, nonadecane, eicosane, heneicosane, docosane, triosane. Ethylenes: Decylene. Aromatic hydrocarbons: Benzene, toluene, *m*-xylene, mesitylene, naphthalene, chrysene, picene, and a hydrocarbon, $C_{11}H_{18}$, m.pt. 117°C., b.pt. 300–302°C. Naph-

thenes, in small quantity. Bases: Pyridine, α -picoline, β -picoline, γ -picoline, 2,6-dimethylpyridine (lutidine), 3,4-dimethylpyridine, 2,4-dimethylpyridine, 2,5-dimethylpyridine, 2,1,7-trimethylpyridine (collidine), quinoline, aniline, and a nitrile. Oxygen compounds: Homologues of acetone, phenol, *o*-cresol, *m*-cresol, *p*-cresol, guaiacol, creosol. Sulphur compounds: Carbon disulphide, thiophene.

My principal authorities for the foregoing notes are:—*Die Braunkohlenteer-Industrie*, by Dr. Ed. Graefe, 1906. *Die Braunkohlenteerprodukte und das Oelgas*, by Dr. W. Scheithauer, 1907. *Die Schmelzeere, ihre Gewinnung und Verarbeitung*, by Dr. W. Scheithauer, 1911. Of this last book there is a translation into English by Charles Sulter, "Shale Oil and Tars" (Scott, Greenwood & Son). Eleven of the illustrations in this paper are taken from the last-mentioned work, and are reproduced here by the kind permission of the publishers.

Newcastle Section.

Meeting held at Bolbee Hall, on Wednesday, February 14th, 1917.

Mrs. HENRY PELLE IN THE CHAIR.

THE CONSTITUTION OF COAL.

The members of the Section discussed the papers by Drs. Wheeler and Stopes on this subject (see this Journal, Jan. 31, 1917, Supplement pages 1 and 5).

Dr. P. PHILLIPS BEDSON said that there were so many different aspects of the chemistry of coal that it was no simple matter to determine in what way best to attack the problem of the nature of the substances which went to form the complex material. He was decidedly inclined to think that the best method of attack would be found to be based upon a systematic separation by the aid of solvents and such an examination of the several solutes as would afford more information as to their nature than could be obtained by the study of the products of their more or less destructive distillation. In the report of the Committee of the British Association, Section B, published in 1896 at the Liverpool Meeting, would be found a reference to the resinous bodies obtained from coal by the action of solvents which Muck, in his "Steinkohlenchemie," grouped as accessory constituents. Many of these resinous bodies would appear from the descriptions given by their discoverers to be mixtures. In looking through papers dealing with the subject, he (Dr. Bedson) had found one by Dr. Smythe, which was printed privately and published in 1897. That paper contained a valuable contribution to the chemistry of brown coal and illustrated a method of attacking the problem and, seeing that, of late, an interest in the chemical constitution of coal had revived, he thought it was desirable that it should be republished. The coal had been submitted to a systematic treatment with solvents and from the solutions some well-characterised substances had been obtained. The residual coal, *i.e.*, the portion not attacked by the solvents, had then been oxidised by a mixture of hydrochloric acid and potassium chlorate, yielding chlorinated products similar to those which Cross and Bevan had obtained some years previously by the action of chlorine on Wigan coal and which they recognised as similar to the chlorinated products obtained from lignified fibres. The oxidation products were very complex and their separation and isolation were

difficult. Amongst these products there would appear to be trichloroacetic acid and solids from which, by treatment with solvents such as ether, a complex $C_{22}H_{11}Cl_3O_{10}$ was isolated. As would be seen by reference to the 1896 report, similar complex products were obtained by treatment of bituminous coals. The difficulty met with in attempts to elucidate the constitution of these chlorinated products had led to the abandonment of that line of investigation. In the course of the examination of the action of solvents on coal about 1899, he had found pyridine a more satisfactory solvent than phenol or aniline, and, in his paper read before that Section in 1908, he detailed some of the results. These were avowedly incomplete but he was not without hope that, with a continuance of that method of working and with newer solvents, some further insight into the constitution of coal would be attained.

Dr. J. A. SMYTHE said that what little work he had done on the subject had convinced him of the enormous complexity of the problem. He had treated coal with various solvents and extracted some rather interesting substances, which seemed to be allied to those extracted within the last few years by Pictet, who had extracted coal on a very large scale with benzene and isolated some hydrocarbons. One of these was a C_{12} substance and Pictet had showed that that hydrocarbon absorbed oxygen from the air and became oxidised. As mentioned by Dr. Bedson, chlorination had led to the formation of very complex compounds indeed, one of the formula Dr. Bedson had quoted. In a series of the products that he had analysed, the hydrogen decreased quite regularly with the increase in chlorine. The large percentage of oxygen present was very interesting. He thought Dr. Wheeler somewhat ill-advised to introduce the term "cellulosic." It was an ugly word and implied a knowledge they did not yet possess. He regarded Dr. Stopes as more honest in the way that she made her classification as a result of an *a priori* deduction, more as a result of argument than founded upon a scientific study of the subject. He considered that these authors were attacking the subject in the right way by microscopic examination and chemical study. He had tried in the past to make transparent sections of coal and knew the extreme difficulty of getting them.

Dr. J. T. DUNN said that the amount of absolute knowledge of the constitution of coal which had yet been obtained was almost negligible. It was certainly no greater than it was in 1908 after Dr. Bedson published the results of his experiments on the exhaustion of coal by pyridine. The only new step seemed to be Dr. Wheeler's extraction of the pyridine extract by chloroform in which he seemed to have shown that that pyridine extract was composed of two separate parts. He thought the relation of the portion insoluble in pyridine to the portion soluble in pyridine but not in chloroform was a question that very much required examination. Parr and Hadley, of the University of Illinois, had done some interesting work, which seemed to have been very elaborate and careful. They had examined a great many of their local coals with the aid of phenol but, generally, the results of their phenol extractions corresponded with the results Dr. Bedson had obtained with pyridine. There was very little difference in the ultimate analyses. There were certain differences in the behaviour of the two when subjected to destructive distillation but no definite information was got and the American experimenters very wisely refrained from drawing any deductions as to the nature of the compounds from which that part of the coal was derived. The speaker thought that Dr. Wheeler had stated something to the effect that none of the hydrocarbons obtained by distillation from coal existed in the coal itself.

That was quite contrary to the result of the work of Pictet to which Dr. Smythe had referred. Pictet had distilled coal at as low a temperature as possible and had obtained some tar from which he had isolated a number of hydrocarbons running between C_8 and C_{12} . When he extracted a raw coal with benzene, he obtained from the raw coal hydrocarbons which were identical with those he had obtained from the tar, and, therefore, he assumed that they had simply distilled in his low temperature vacuum distillation. He thought that Dr. Stopes was going on the right lines in proposing to investigate microscopically not only the coal but the products of coal obtained by solution in pyridine and other solvents.

Mr. S. H. COLLINS asked as to the distribution of the nitrogen in coal.

Dr. DUNN said that Parr and Hadley had found it both in the portion soluble in phenol and in the insoluble portion.

Mr. COLLINS said that pyridine struck him as being a double-barrelled sort of extractor, in that it would extract resins as well as anything that was likely to be acidic in nature. The authorities all seemed to have the idea that humic bodies were present and anything of an alkaloid character would tend to extract these. The resin substances would affect the photographic plate and the humic substances would not. The results shown on the screen supported that idea. It would be interesting to know if these could be examined any further. Coal was a very curious substance because there were some instances in which coal made quite a good soil and other cases where it certainly made an extraordinarily bad one, and he did not quite know what it was that made the difference. The best soils produced from coal were generally from the type of coal one would not want to burn—i.e., coals with a very high percentage of ash.

Dr. BEDSON added that he did not altogether appreciate the idea that the way to get information about the nature of the various solids was to submit them to destructive or partially destructive distillation. He should rather like to see attempts which would lead to the discovery of individual substances amongst those bodies extracted by the different solvents from coal. Mr. Collins was perfectly right in his view of pyridine. He (Dr. Bedson) was very much entranced with pyridine, in the first instance, because it did so much, but it did rather too much for the purpose, and he thought the proper method of applying it would be to use as many solvents for resin as one could employ—and there were some coming on the market now with which he was making some experiments and, perhaps, at some future date in the next decade, he might be able to say something about the results. He had gone certainly on the idea that he should not apply pyridine directly to the raw coal but should treat the coal with pyridine after he had extracted as much as possible by other solvents which appeared to attack the resinic constituents. He did not know that Dr. Wheeler was altogether justified in distinguishing between resinic and cellulosic constituents. Besides the vegetable origin of coal, they had to consider the animal remains present from which, he dared say, some of the nitrogen came, and it was rather lumping things together to divide them into resinic and cellulosic constituents. That was a subject that had interested him for many years now. Whilst 20 years ago, chemists had been rather inclined to regard coal much as the ordinary consumer regarded it and, beyond that, to take very little interest in it except to use it for distillation purposes, he was glad to see that, in this country and in France and, no doubt, in Germany, in the last 20 years, a very considerable interest had developed in the nature of the compounds that went to form coal. The

outcome of that work must be very advantageous to science and lead to a considerable extension of our scientific knowledge. The subject was a vast one, but if the work were carried on systematically and the results properly collated, he felt that conclusions would be reached which would advance our knowledge of the nature of coal.

Replying to the Hon. Secretary (Mr. E. F. Hooper), Dr. BEDSON stated that, in using the pyridine, they had usually rectified it and used it with a fairly constant boiling point.

Mr. HOOPER remarked that Dr. Wheeler might obtain interesting results if he undertook the extraction of coal under reduced pressure by pyridine, so as to get the very lowest possible temperatures. He might very well extract bodies of a different character with pyridine at a low boiling point than he would under ordinary conditions.

Dr. DENN said that Parr and Hadley, dealing with phenol, had used it both in the cold and at the temperature of boiling toluene, and they had found no essential difference in the products, but they did find that the hot solvents extracted 1 or 2% more than the cold solvents.

Dr. BEDSON said that when quinoline was used, different results were obtained. They had carried out some coal extractions with pyridine at the ordinary temperature on a very considerable scale, filtering the pyridine through layers of coal two to three feet deep, and also there were some experiments with pyridine at boiling point. At the ordinary temperature, there was a difference in the nature of the products obtained.

The CHAIRMAN asked whether the resinic matter extracted by pyridine was the matter that bound the coal together when it coked.

Dr. BEDSON replied that what struck him at the very outset was that the pyridine extract of a coking coal coked readily but the residue had lost its coking powers. The pyridine extract would fill up an ordinary platinum crucible with the intumescent matter which was formed and the residue would give a sandy coke. One of the things that had always puzzled him was that cannel coals, for instance, the shales, yielded comparatively little to pyridine. He assented to the Chairman's suggestion that the resinic matter had something to do with the coking of coal. His impression was that less was extracted from a non-coking coal.

The CHAIRMAN said that he had been doing some work to see whether it was possible to ascertain whether certain pitches had greater binding powers than others.

Mr. HOOPER said that his experience in briquetting fine coal was that he could make as good a fuel briquette out of a coke-oven pitch as out of a coal-tar pitch, irrespective of the greater amount of soluble or volatile matter in the coal-tar pitch.

The CHAIRMAN said that a coke-oven pitch which had been made at a very much higher temperature had not the same binding power as a pitch that had been distilled direct, so far as electrode carbon manufacture was concerned.

Mr. HOOPER said that in fuel briquetting they had found it possible to use nearly 1% less of the by-product tar pitch than of coal-tar pitch and make as sound a block. That was admittedly against their previous ideas. Despite the fact that there was more soluble and volatile matter in gasworks pitch, the by-product pitch served as well.

Dr. BEDSON said that when he had first mentioned the matter of the action of pyridine on coals and the different behaviour of the solute and the residue from the coking point of view, Dr. Henry Louis had suggested that it might be possible to use the extract from the coking coal to make a non-coking coal into a coking coal.

New York Section.

Meeting held at Rumford Hall on Friday, January 19th, 1917.

MR. JEROME ALEXANDER IN THE CHAIR.

PRESENTATION OF THE PERKIN MEDAL TO DR. ERNST TWITCHELL.

The CHAIRMAN, in the course of his introductory remarks, gave a brief outline of the history of the Perkin Medal, and mentioned the names of previous recipients. He also called attention to some of the more important inventions made by Americans during the past fifty years.

He then called upon Professor Chandler to make the presentation of the Medal.

Prof. C. F. CHANDLER spoke as follows:—It is my privilege and very pleasant duty to present to Ernst Twitchell the eleventh impression of the Perkin medal. Dr. Twitchell was born in Cincinnati, on February 26th 1863. He graduated in 1886 from the University of Cincinnati and was then appointed chemist to the Emery Candle Co., of Cincinnati, with which firm he has been connected ever since.

Dr. Twitchell has devoted the past thirty years chiefly to the chemistry of fats. In 1891 he published his method for the determination of rosin in fatty acids of soap. The method is based on the fact, observed by him, that the fatty acids when dissolved in absolute alcohol, are readily and completely converted into ethyl esters by the action of dry hydrogen chloride. On the other hand, the rosin acids under the same treatment remain unchanged, and may be determined volumetrically with standard soda solution, or gravimetrically. Lowkowitz, in his comprehensive work on "Oils, Fats, and Waxes," remarks, "Of all the methods for determining rosin acids in the presence of fatty acids, the Twitchell method gives the best results."

Dr. Twitchell's most important contributions to industrial chemistry involve methods for the hydrolysis of oils and fats for the production of the free fatty acids and glycerin. These methods have very largely superseded the old methods such as that of Chevreul and Gay Lussac (in 1825), who saponified in open kettles with alkali. This process was improved by Milly in 1831, who substituted milk of lime for alkali, and later by conducting the saponification in closed vessels, under pressure, reduced the amount of lime required from fourteen per cent. of the fat to as low as two per cent. Then came the process of Dubrunfant, first applied practically in 1842 by Jones and Wilson, in which the fat was saponified by sulphuric acid, and the fatty acids subjected to distillation.

Wilson and Gwynne later applied the discoveries of Berthollet and Nelsens in a process in which the fat was decomposed by superheated steam and subsequent distillation, which was practised at the works of Price's Candle Co., Battersea. Finally in 1854, Tilghmann introduced his process in which the fat, emulsified in water, was forced through a coil at a temperature of 320° C. Marix found that by adding a little calcium or magnesium carbonate to the water, the temperature and pressure could be very materially reduced to as low even as 3 to 5 atmospheres.

The art of saponifying the fats had reached this stage of development when Dr. Twitchell made an entirely new departure by the application of new reagents, which by acting as catalysts, even when used in such small proportions as one to two per cent., are able completely to saponify the fats. The operation may be conducted by simply boiling the

fat with water and the proper quantity of the "saponifier." The agents first employed by Dr. Twitchell were the sulphonic acids of the fatty acids, such as sulpho-stearic acid, sulpho-oleic acid, etc. Later Dr. Twitchell found that by introducing an aromatic radical into the sulpho-acid, a much more satisfactory catalyst was obtained—a sulpho-fatty-aromatic acid. Such aromatic radicals as are furnished by benzene, phenol, and naphthalene are employed, naphthalene stearo-sulphonic acid being a favourite catalyst. These acids when converted into salts of such metals as barium, calcium, magnesium, aluminium, etc., can be produced as stable dry powders, to be used with a suitable proportion of sulphuric acid or hydrochloric acid to make them active.

The Twitchell process has made possible the large scale saponification of fats for the production of crude glycerin free from salt and of fatty acids for direct combination with soda to make soap instead of using the more expensive caustic lye on the neutral fat.

Low-grade fats, such as garbage grease, cottonseed oil foots, etc., were formerly with difficulty used in the soap or candle industry. Such material can now be readily worked up by the Twitchell process, the fatty acids being distilled to remove their colour before use. This releases a large quantity of the higher grade fats for use as food products.

The bulk of the soap used in Belgium, Holland, Germany, and Scandinavia is said to be prepared from fatty acids direct, and 75% of these acids is made by the Twitchell method. Millions of pounds of fat are saponified yearly in the United States by this process; and practically all of the larger soap factories have Twitchell plants.

All of the recent books in German and English on the soap and fat industries discuss the Twitchell process in full.

After giving a list of Dr. Twitchell's publications and patents, Prof. Chandler presented the Medal.

Dr. TWITCHELL, in acknowledging the presentation, said: The first suggestion which led to my discovery of a special catalyst for hydrolysing fats came to me in studying the so-called acidification process. This was one of the oldest methods used in candle factories for separating glycerol from fatty acids. It consisted in treating the fat at a fairly high temperature, over 100° C., with a small amount of concentrated sulphuric acid—4% or considerably less could be used; the product was then boiled with an excess of water. The result is a layer of fatty acids floating on the acid water containing the glycerol.

This reaction could not be explained by the assumption that there is a combination of sulphuric acid with the fat or fatty acid and glycerol, which decomposes during the subsequent operation of boiling with water, because there was not enough sulphuric acid to combine with all of the fat. I have seen various theories given to explain the acidification process, some quite absurd. For instance, in one text book it is stated that fats consist of minute globules surrounded by membranes and that the function of the sulphuric acid is simply to char and destroy these membranes, leaving the fat in a condition to be hydrolysed by water at 100°. Another theory I have frequently seen even in recent articles, is that compounds are formed which cause the fat to emulsify with water, and the idea evidently is that if a good enough emulsion is obtained, hydrolysis will take place even at 100°. I have seen this theory given to account for the action of my hydrolysing reagent. As a matter of fact, fats do not hydrolyse at 100°, practically speaking, with water alone, even though they may be perfectly emulsified. At higher temperatures than 100°, and under pressure, hydrolysis takes place as is illustrated in the autoclave process of separating glycerol.

In the course of practical experiments with the acidification process I found that I could reduce the amount of sulphuric acid used very considerably and yet obtain complete decomposition; but often the boiling with water had to be decidedly prolonged. It seemed clear that there was some catalytic agent which caused the reaction between the fat and the water in this process of boiling, and it would naturally occur to any one that this catalyst was probably some sulphur compound produced by the action of sulphuric acid on fat. I found that compounds of this nature could be roughly separated from the fat which contained them by treating with petroleum ether, in which they were insoluble. They could be further purified by solution in ether and extraction with water and were easily identified as sulphonic acids by their acidity, the formation of potassium sulphate on fusion with caustic potash, and other characteristics.

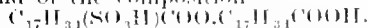
It occurred to me to prepare this catalyst outside the body of fat, thus avoiding the action of the sulphuric acid in forming with the fat undesirable compounds, in charring, discolouring, and partially destroying it.

As these sulphonic acids were probably produced by the action of the sulphuric acid on the oleic acid constituent of the fat, I first studied the results of the action of sulphuric acid on pure oleic acid under various conditions of temperature, quantity, etc.

The action of sulphuric acid on oleic acid at low temperatures, as was known, produces a compound of sulphuric acid, stearo-sulphuric acid, an acid sulphuric ester. This was not the catalyst that I was seeking. It very probably has all the properties of a catalyst for the hydrolysis of fats except one: it is decomposed on boiling with water, and as the hydrolysis of a fat hardly takes place at all under any circumstances at a lower temperature than 100°, it is plain that this compound would not serve my purpose.

The compounds obtained on treating oleic acid with sulphuric acid at a temperature of 100° or over are not sulphuric acid compounds but are true sulphonic acids. The principal one seemed to be derived from two molecules of oleic acid and contained one sulphonic acid group and one carboxyl group.

I have never seen this sulphonic acid described, but I believe that I had in my hands a fairly pure compound of the composition—



This was my first hydrolysing reagent or "saponifier." But as it was difficult to prepare commercially in fair yield and of any degree of purity, I dropped further investigation along this line on the accidental discovery of the fatty-aromatic sulphonic acids, described in the Journal of the American Chemical Society of January, 1900.

In this research the most important question was: What properties must a substance have to act as a catalyst to accelerate the hydrolysis of fats? My views on this subject I have partially expressed in my paper "A reagent in the chemistry of fats," published in the Journal of the American Chemical Society of February, 1906, where I say that it must be a strong acid, one dissociated strongly in water giving a considerable concentration of hydrogen ions; and then it must be soluble in both fat and water and cause the one to dissolve in the other.

The only bodies that I can at present conceive to have the desired properties are sulphonic acids containing higher fatty radicals. They have the physical character of fats or oils, yet are soluble in water forming soapy solutions, and are strong acids.

As I have said, the discovery of the fatty-aromatic sulphonic acids was made by accident. On treating a mixture of oleic acid and benzene with

an excess of sulphuric acid and pouring the mass into water, I found an oily layer floating on the acid water, which was soluble in pure water; that did not surprise me, as I supposed I had simply stearo-sulphuric acid; but when I found that after boiling for half an hour with water it still remained soluble, I concluded that I had a sulphonic acid, and the analysis of the product confirmed my conclusion. This is the compound which has been put to practical use in the separation of glycerol and fatty acids. Instead of benzene, naphthalene is used with oleic acid in the manufacture of the commercial article. This "saponifier" when added in the proportion of 0.5% or less to fat boiling with water in an open tank, will cause the separation of the glycerol.

Besides the compounds containing two stearic radicals and a sulphonic group, the first which I found to have the catalytic property, and the fatty-aromatic sulphonic acids, I have also prepared hydrolysing reagents by treating oleic acid at 200–220° C. with sulphur, or in the cold with sulphur chloride (S_2Cl_2), and then oxidising with nitric acid, potassium permanganate, bromine, or other oxidising agent. The resulting compound contained one sulphonic and one carboxyl group and its molecular weight and other properties showed it to be a sulphonic acid of the stearic radical.

Belonging to this class of substances is a compound, cetyl-sulphonic acid, described by A. Reyher two or three years ago. When I saw this description I was sure that it was also a catalyst of the same type as my reagent, although Reyher does not mention this as one of its properties. As this is a typical compound, it may be interesting to describe how it was prepared, partly following directions given in Reyher's paper. Cetyl alcohol, prepared by saponifying spermaceti with caustic potash and extracting the soap with petroleum ether, was converted into the iodide by dropping iodine into a heated mixture of the alcohol and red phosphorus. This iodide, after purification, was converted into the sulphhydrate by treating with alcoholic potassium hydrogen sulphide and the cetyl sulphhydrate converted into cetyl-sulphonic acid by oxidising with potassium permanganate, the excess of which was reduced with sodium sulphite. The cetyl sulphonates could be freed from most of the foreign matter by taking up with hot water, from which sodium cetyl sulphonate crystallised on cooling. This was dried, extracted with petroleum ether, then dissolved in water and treated with hydrochloric acid. The salted out cetyl-sulphonic acid was dissolved in ether and remained in a nearly pure state as a residue on evaporating the ether. It can be further purified by crystallising its sodium salt from dilute alcohol and there can be no doubt as to its composition. It is a simple sulphonic acid of a hydrocarbon of the paraffin series.

Reyher explains some peculiar properties of this compound in this way: the sulphonic radical tends to make it very soluble in water, while the long hydrocarbon chain has just the reverse effect. The result is that it forms colloidal solutions. Fabron, in reviewing Reyher's article, calls the cetyl-sulphonic acid, "Reyher's hydrogen soap," and that term hydrogen soap is as good a definition as I can think of to cover the whole group of compounds which catalytically induce hydrolysis of fats on the principle of my discovery. An alkaline soap plus hydrogen ions would no doubt have the same effect if it were possible to have such a combination.

Besides its use in hydrolysing fats, my catalytic agent has been applied to other less important ones. A catalytic agent which would accelerate the hydrolysis of an ester in the presence of an excess of water, would also accelerate the esterifi-

cation of a fatty acid and an alcohol on the removal of the water formed. Fatty acids can be made to combine with glycerol and other alcohols of high boiling point by simply treating a mixture of the two with a small quantity of the reagent and evaporating the water formed at 100° C.

The solubility of sulpho-fatty acids in both fat and water leads to a method of separating solid and liquid fatty acids of which I have made some application. If a small quantity of the sulphonic reagent is dissolved in melted mixed fatty acids and the mixture allowed to cool, the solid acids will crystallise out pure and the liquid acids will contain the sulpho-fatty acids, being thus rendered slightly soluble in water, and on treating with water, can be washed out from the mixture, partly in solution but mainly as an emulsion.

Patents have recently been obtained by Grigori Petroff of Russia for a reagent obtained as a by-product in refining petroleum with fuming sulphuric acid. This is a sulphonic acid of hydrocarbon radicals, probably not of the paraffin series. It is a very efficient catalyst in the hydrolysis of fats, for which purpose it is now largely used.

THE TWITCHELL PROCESS AND THE GLYCERIN TRADE.

BY A. C. LANGMUIR.

The Twitchell catalytic process (U.S. Patent 601,603, July 17, 1897) was invented at a time when catalysis was not the universal subject of attention it is to-day.

Twitchell's work has been characterised by a sound appreciation of the work of physical and organic chemists and his analytical and technical methods have been worked out, not empirically, but from theoretical premises. Thus the Twitchell method for the determination of rosin in mixtures with fatty acids, as in soap analysis, rests upon the principle of the esterification of the fatty acids when treated with dry hydrogen chloride in presence of absolute alcohol and his discovery that resin acids when so treated refused to combine with alcohol and could subsequently be separated as pure rosin. Although published in 1891 this method stands to-day as the most accurate process for the determination of rosin in presence of fatty acids.

Again in 1897 we find him bringing out a method for the separation of saturated and unsaturated fatty acids based upon the solubility of fatty acids with double bonds, such as oleic acid, in concentrated sulphuric acid at ordinary temperatures, with the formation of sulpho-fatty acids soluble in water. The saturated fatty acids such as stearic acid are unacted on. In 1914 Twitchell made use of the principle of the equal depression of the freezing point for equal molecular proportions and determined the composition of mixtures of fatty acids by the observation of the freezing point in the Beckmann apparatus. To test whether a given sample of fatty acids is identical with a fatty acid of known character he adopted the novel plan of adding a portion of the known acid and noting whether there is any change in the melting point of the mixture.

Possibly his investigation of the action of concentrated sulphuric acid on fatty acids led to his discovery of the catalytic action of these sulpho-fatty acids in bringing about the decomposition of fats by water, as little as 0.5% splitting up the fats almost completely on digestion with water.

The prevailing method for the manufacture of soap consists in the saponification of the fat by boiling with caustic soda lye. The fatty acids combine with soda as soap, which is separated by the addition of salt and comes to the surface in the molten condition. The glycerin is set free and remains dissolved in the spent lye. It is contami-

nated by the presence of the salt used to render the soap insoluble. During the concentration of the spent lye for the recovery of the glycerin a large quantity of salt is thrown out, making the evaporation somewhat difficult, although this difficulty has been largely eliminated of late years by the use of properly designed evaporators working *in vacuo*. The final crude glycerin is a saturated solution of sodium chloride and some sulphate together with sodium salts of the lower fatty acids, in glycerin and water. The glycerin averages about 80% and contains about 10% mineral salts.

The glycerin refiner distils this crude soap-lye glycerin with superheated steam *in vacuo* for the production of dynamite glycerin and chemically pure glycerol. The presence of so much salt raises the boiling point of the glycerin and reduces its vapour tension so that the output is reduced. Furthermore, the salt accumulates in the still producing finally a semi-solid mass of salt and glycerin together with tarry matter which constitutes the "foots" of the glycerin trade. It is a difficult matter to extract all the glycerin from this residue without undue loss. The treatment of the "foots" is one of the problems of the glycerin trade.

The glycerin distiller therefore prefers a crude glycerin which is free from this large admixture of salt. Up to the early nineties all the crude glycerin refined consisted of what is termed saponification or candle crude. It was the by-product of the candle factory and was produced by the breaking up of fat in autoclaves by heating under pressures of 200 lb. and more with water and a little lime. The fat was split into fatty acids and glycerin directly and the latter was a product of considerable purity, containing about 88% glycerin and less than 1.0% of mineral matter. With the greatly increased demand for glycerin for explosives, the soap makers, who formerly discarded their spent lyes, found it profitable to work them up; to-day scarcely a soap plant can be found that does not recover its glycerin as a by-product. This change in the business compelled refiners to develop methods for distilling soap lye crude glycerin and eventually the larger refiners were working mainly on soap lye rather than candle crude, although there were still a number of glycerin refiners who worked exclusively on candle crudes. Saponification crudes free from salt have always been in greater demand and have commanded a higher price per unit of glycerin. For several years before the advent of the Twitchell process it looked as if saponification glycerins would practically disappear as a raw material in glycerin refining, but with the success of this process the Twitchell saponification crudes made their appearance and are now a factor of very considerable importance.

The ideal of the glycerin refiner has thus been the production of a saponification rather than a soap lye crude by the soap manufacturer. It has also been the hope of the soap trade to obtain directly by the deglycerinising of the fat a relatively pure glycerin as a by-product and free fatty acids which could be combined with the cheap alkali, sodium carbonate, to make soap instead of the relatively expensive caustic soda. To meet this need have been developed the Twitchell process, the Krelitz lime saponification method, and the Comstein process.

The Twitchell process is characterised by its simplicity, and the low cost of the plant. Prior to Twitchell's discovery free fatty acids could only be obtained by the autoclave process, involving a heavy capital outlay for copper apparatus, which could only be used in small units and at a high temperature and pressure, making the operation expensive and somewhat dangerous. The autoclave saponification was used only in the preparation of fatty acids for candle manufacture, as the

process was too costly to be used in the production of fatty acids to be used in soap. The Twitchell process is effected in loosely closed wooden tanks by digestion with water and as little as 0.5% of the reagent and at a temperature not exceeding that of exhaust steam. The reaction may be carried out on a scale limited only by the size of the tank. The Twitchell process has made possible the saponification of fats on a huge scale for the direct production of free fatty acids and saponification glycerin. When combined with the distillation of the fatty acids for the improvement of their purity and colour, it has opened up for the soap trade the use of low grade fats such as garbage grease and cotton seed oil foots, the distilled fatty acids being combined directly with carbonate of soda to produce light coloured soaps, and the glycerin being made available for the manufacture of dynamite glycerin. In this way the Twitchell process has benefited the glycerin trade in these days of glycerin scarcity by opening up new sources of supply, which were previously unavailable.

The crude glycerin prepared by the Twitchell process comes to us from all parts of the world in normal times. There is no evidence that it is any less pure than the saponification glycerin prepared by other processes provided the fat used as a raw material is reasonably pure. Of course a crude glycerin manufactured from a low grade fat will fall behind a crude made from good yellow, but this is the fault of the fat and not of the Twitchell process.

THE TWITCHELL PROCESS IN THE SOAP AND CANDLE INDUSTRY.

BY MARTIN H. ITNER.

It is essential in the candle industry to have a satisfactory method for separating the fatty acids, as such, from fats and oils. In the soap industry such a method, although it may be considered highly desirable, is not absolutely essential, since very satisfactory methods of direct saponification by alkali with the formation of soaps have long been utilised.

In recent years there has been an ever-increasing demand for fats and oils and for glycerin, resulting in greatly increased market prices for these articles. The market for soap and candle materials is directly related to the market for fats and oils for edible purposes, and an increased demand from either source usually results in higher prices for all fatty materials. High costs of fatty materials have made the practice of economy in the soap business essential. This economy may manifest itself in several ways. We will assume at the outset that the soap manufacturer wishes to maintain the quality of his products and therefore does not wish to make any sacrifice in this direction. His economy must therefore direct itself in one of the following directions. He must be able to utilise the fats and oils which give the greatest soap-making value at the lowest cost per unit, whether these materials are of the better or of the poorer grades, and he must so utilise his raw material that his final product will be of the same high quality no matter which grade is used. This means that he must have a method for getting good results out of poor material when poor material gives him the greatest value. It is also essential that he have some method whereby he may realise the maximum yield of glycerin at a low expense for recovery. This will readily be understood when I explain that at present market prices for fats and glycerin, which are both abnormally high, the value of the glycerin which can be obtained from one pound of neutral fat is about one third of the cost of the fat. Another possible way of economising is by quicker and easier methods of manufacture.

All of these advantages have been realised in some degree by the advent of the Twitchell process. This process has given a rapid and easy method of obtaining fatty acids and glycerin from the better grades of fats so that the fatty acids are at once ready for making into better grades of soap, and the glycerin is in a condition suitable for easy refining. With care of operation the yield of glycerin may be made to approximate closely to that theoretically obtainable. When one operates on fats of poorer quality, and this may include black greases, the Twitchell process furnishes a most satisfactory method for saponifying. It renders the glycerin available even from such material and gives acids in good condition for refining by means of distillation. Such acids when carefully distilled yield a product of light colour suitable for making good soaps of light colour.

The use of fatty acids as such, has made it practicable to use soda ash very largely in the place of caustic soda. The former will combine direct with fatty acids making soap from which the glycerin has already been recovered, whereas caustic soda is necessary for the direct saponification of fats into soap, and tedious methods must be used for recovering the glycerin, and, except with the greatest care, the yields will be poor. It will thus be seen that in the use of fatty acids a saving may be effected even in the alkali employed, as soda ash is considerably cheaper than caustic soda per unit of alkali.

Fatty acids suitable for making into soaps are also suitable for making into candle material. Partial solidification on cooling will, with the aid of pressing, separate the solid from the liquid acids. The former yields commercial stearic acid, so extensively used in candle manufacture, and the liquid portion yields the oleic acid, or red oil of commerce. Red oil is used for many purposes, one of the most important being the manufacture of soaps for washing wool. The manufacture of stearic acid and red oil did not originate with the Twitchell process, but the advent of the Twitchell process gave a new and satisfactory method for the saponification of fatty materials at atmospheric pressure, with advantages over methods formerly used. Saponifications by means of the Twitchell process may be carried out on a larger scale, with less danger and with greater ease than is obtainable by other methods of acid saponification.

Twitchell's first process in which he recommended the use of sulpho-oleic acid was soon very much improved by the use of naphthalene along with the oleic acid during sulphonation. Whatever the chemical action in the formation of this reagent, it is my observation based on many experiments that satisfactory saponification will result from saponifiers made as Twitchell recommends, whereas poor results only are obtainable when separate sulphonation and subsequent mixing are tried. I may say that I was among the first to have an opportunity to become acquainted with the process, and that this acquaintance has become closer with added years. This process has been put to extensive use not only in America but also in European countries.

Twitchell later devoted himself to a method of manufacturing his reagent which would enable him to produce it in a more concentrated form. He accomplished this by methods of washing, extraction, precipitating as an insoluble salt readily convertible into an active reagent, and drying.

Twitchell and others allied with him have been busy in trying still further to perfect the process of atmospheric saponification of fats into fatty acids and glycerin, with the result that a new sulphonated reagent with increased efficiency has lately been put upon the market.

The Twitchell process has been so simple in use

that one is almost inclined to look upon it as nothing out of the ordinary. On careful thought one is forced to conclude that it is this simplicity, which has become almost commonplace, that commends it most to the many who have become familiar with it in operation.

Mr. HERMAN B. SCHMIDT followed with an appreciation of the work of Dr. Twitchell, in which he recalled the primitive conditions under which chemical work was carried out in the early days of Dr. Twitchell's career.

Nottingham Section.

Meeting held at University College, on Monday, December 11th, 1916.

DR. R. M. CAVEN IN THE CHAIR.

OUR NEED OF A NATIONAL FUEL AND POWER POLICY.

BY HENRY E. ARMSTRONG.

At a time when action and action taken without avoidable loss of time alone can save us, I am loth to come before you merely as a talker—being sick of talk, of my own feeble efforts especially: indeed, my talking on so outworn a theme will only be justified if I am successful in securing your promise of action, of action that will serve to promote reforms long overdue, the need of which is the consequence of that mental slothfulness by which we have so unfortunately been afflicted. As a nation, we are on our trial in every direction. Within the next few years, we have to show that our past lack of receptivity is not innate, but the outcome of a false and narrow system of education, lacking all the elements of true culture; without fail, we must raise up a new generation, one that is alive to its opportunities and responsibilities, fully prepared while meeting the latter to take advantage of the former. We must abandon mere book learning, deskery in schools, and take to doing things and thinking the while; there must be far less so-called teaching and some real learning: effective training must be substituted for parrot knowledge. As the Australian Prime Minister forewarns us, in his eloquent brief introduction to one of the most significant of recent books, Dr. E. J. Dillon's "Ourselves and Germany":—"We must awaken or be awakened ere it be too late. Germany," he says, "is living in the present and the future. It is a present of determined effort, of unlimited sacrifice, of colossal hope. The future for which she strives and suffers is a future incompatible with those ideals which our race cherishes and reveres. Either our philosophy, our religion and code prevail, or they fade into decay and Germany's aims remain. The choice is definite."

If Mr. Hughes be right, it is to be feared that, pending the inevitable but probably far distant struggle between East and West, we are cruelly destined to be in constant antagonism with our Teutonic neighbours. The skin-deep veneer of civilisation having been stripped from them, we are made aware that their instincts, at bottom, are more primitive than ours; being receptive, systematic, and almost superintelligent, this makes them all the more dangerous as a people—because,

in many ways they are ruthless where we are apt to be considerate. The streak of altruism which runs through our composition will be a distinct hindrance to us in the struggle of the future—inevitable because competition is the essence of progress—so that if we are to counteract its adverse influence, we must sharpen our intelligence to the utmost.

When the present conflict on the field of battle is at an end, we shall be called upon to face a more enduring and difficult struggle in the fields of industry and commerce. The race will be neither to the swift nor to the strong so much as it will be to the intelligent and the persevering.

Fuel, as the source of mechanic power, if not the chief, will obviously be one great factor in the struggle. We have long been told that our fuel supplies will suffice us for but few centuries. Should supplies be still available in Central Europe when ours are exhausted, our position must be a sorry one. If, therefore, we can look forward and desire to retard our downfall, we must seek to conserve our supplies of fuel to the utmost farthing of value. Meanwhile, it would seem that we have it in our power at least to halve our present coal bill by improving the methods of using fuel.

But little argument should be necessary to recommend so self-evident a proposition as that I have posed in my title—if it be not already accepted as proved, no further argument that might be advanced will make it acceptable.

Our policy hitherto has been one of drift—of wait and see, a self-condemnatory phrase, because those who wait to see, never having seen, never will see. The question is—are we ever to be too late in dealing with Fuel and Power Problems? If we never acquire and display the gift of insight, if we do not now realise that we must organise all our forces in dealing with such problems and subject them to comprehensive treatment, the solution cannot be otherwise than partial and unsatisfactory. "The Times," only a few days ago, printed an account of a speech by a Bavarian Prince, and in doing so provided it with the proud heading, "We are prepared for everything." Can we say that we are prepared for anything? I fear not.

The question is: Can we overcome our innate deficiencies and be practical—in other words, apply theory to its utmost limits and be seized by and act in accordance with the spirit of our times, the spirit of progress. To use eloquent words put into the mouth of Cromwell by Lowell, it is clear, that—

"New times demand new measures and new men;
The world advances and in time outgrows
The laws that in our fathers' days were best;
And doubtless after us some purer scheme
Will be shaped out by wiser men than we.
Made wiser by the steady growth of truth.

Our time is one that calls for earnest deeds.

When, several months ago, I undertook to introduce the present discussion here, I was not aware that this is the most sinful town of consequence in the kingdom—the most sinful in its Fuel and Power policy or rather in its lack of a policy worth calling one. I say this having learnt recently that several important firms in the town are spending large sums on the installation of electric power plant—because the Corporation, which has the monopoly, declines to supply electric current on terms other than those it wrings from the ordinary small user who consumes only the equivalent of a few candles a day—3½d per unit for light and 1½d. per unit for power.

What is of more consequence, you have the distinction, I believe, of being the worst served city in the kingdom. This is clearly brought out

in Table I., in which figures are given for all the towns where ten million units or more are generated per annum.

TABLE I.

Town.	Costs.	Selling price.	Total units in millions.
Aberdeen	0.58	1.28	10.46
Belfast	0.68	1.16	19.03
Birmingham	0.56	1.13	73.76
Bolton	0.64	1.11	28.74
Bristol	0.67	1.44	13.5
Coventry	0.33	0.89	20.25
Dundee	0.61	1.04	14.95
Edinburgh	0.91	1.75	17.87
Glasgow	0.56	1.07	88.83
Greenock	0.51	1.03	14.20
Halifax	0.65	1.28	11.07
Huddersfield	0.79	1.31	10.5
Hull	0.78	1.44	12.9
Leeds	0.40	1.00	44.79
Liverpool	0.59	1.5	53.07
Manchester	0.56	1.02	117.92
Nottingham	1.04	1.78	12.86
Salford	0.79	1.29	19.65
Sheffield	0.42	0.97	44.87
Stalybridge	0.29	0.66	23.6
Sunderland	0.60	1.08	15.05
West Ham	0.61	0.88	35.64
Wolverhampton	0.55	1.00	13.12

Although close to a colliery, your coal costs are higher than those of other towns in the district of far smaller output, no better nor worse situated than you are (Table II.).

TABLE II.

Town.	Coal costs.	Oil, etc.	Total costs.	Units generated.
Loughborough ..	0.28	0.03	0.78	1,300,000
Derby	0.31	0.02	0.72	8,000,000
Long Eaton	0.56	0.02	1.05	1,100,000
Burton	0.23	nil	0.65	3,500,000
Chesterfield	0.33	0.03	1.06	1,750,000
Kettering	0.34	0.04	0.87	1,890,000
Lincoln	0.26	0.02	0.75	2,300,000
Mansfield	0.28	0.07	0.81	1,600,000
Nottingham	0.59	0.06	1.04	12,860,000

You also compare most unfavourably with other towns in electrical costs and the number of units sold per head of the population (Table III.).

TABLE III.
Electrical Costs.

Town.	Works costs.	Units generated.	Average price.	Units sold per head.	Financial results.
Stalybridge	0.29	18	0.63	178	+ £4,171
Coventry	0.33	20	0.89	161	+ 22,455
Leeds	0.36	43	0.91	62	+ 12,171
Bury	0.38	10	0.69	154	+ 2,038
Sheffield	0.42	44	0.97	70	+ 25,800
Keighley	0.49	5	0.86	102	+ 1,025
Luton	0.54	8	0.91	146	+ 4,430
West Ham	0.61	35	0.86	99	— 8,552
Average	0.427	23	0.84	121.5	
Nottingham	1.04	13	1.78	27	+ £13,400
% Difference	144		110	450	

I am told that the heat lost in waste steam at the generating station would keep the town warm.

But I have no desire to pillory your town. It is entirely an accident that I happened to light on you as a crying example of the need of reform and

especially of a national policy to influence the public treatment of grave problems such as those before us.

* * * * *

Action must be taken if we are to move forward as a nation. Some few of us must apply the spur so sharply that it be felt and responded to.

The spur I wish to apply is that of a Central Fuel and Power Board. The first duty of such a board would be to take stock of our national requirements and resources and to excooperate a policy of meeting the former while utilising the latter in the most scientific and economical manner possible.

Without such a Central Board and a National Policy, it will be impossible to overcome the vested interests by which the path of progress is now blocked; also to avoid the colossal waste of money and the still worse delays that will be entailed if ignorance and the lawyers are allowed to intervene at every step. If we are to save ourselves, short and summary methods must be used, our national position being at stake.

You have coal at your doors but you make no proper use of it; you do not for one moment appreciate its value—what is in it, what can be made of it. Why is it not used scientifically or economically; do your schools allow your children ever to learn anything of consequence about it—if they did, would not housemaids and others know how to light fires; why is no organised connexion established between commerce, coal gas and electricity in your district; why are you not provided with smokeless fuel; why are you wasting so many good things which might be won from the coal you burn if it were used rationally? These are questions which the public should ask at elections—questions which they should insist on having answered by deeds not words. If a town or two took such a line of action, our country might be saved.

* * * * *

If an example be once set, it will spread like wildfire among the ignorant, particularly if the order be given to do likewise: we are learning every day that we can be obedient and do things easily when forced by circumstances.

There are two main directions in which we must move—the one being that of economy and conservation of our resources, the other that of public health and comfort; the two are coincident, in many ways.

It is well known that our methods of getting coal are in many respects inefficient. Prof. Lewis dealt with this question, as an expert, at the recent annual meeting of our Society.

But our ways of using coal are far more defective than our ways of getting it. The discussion carried on in the Press of late with regard to dye-stuffs has made the public aware of the special value of some of the products from coal but owing to the rapid improvement and wide application of the internal combustion engine and the present shortage of liquid fuel, we have been suddenly led also to appreciate the need we are in of developing our home supplies as fully as possible; large quantities of liquid fuel may be obtained especially by coking coal at relatively low temperatures and we cannot well escape the moral obligation we are under to develop this source of supply to the utmost.

It appears to be desirable, from every point of view, to submit coal to a preliminary carbonisation, as not only the liquid products are of value but the gas which is given off coincidentally is of special value and the residual coke has qualities which eventually must make it a more popular fuel than any other at our disposal.

It is unnecessary to speak at length of the value of gas as a fuel—it is daily becoming more popular with the public and is also being more and more brought into use in manufacturing operations, on account not only of the ease and certainty with which temperatures can be regulated but because of its cleanliness and the saving of labour its use entails. Those who are unacquainted with what can be done by gas should visit Wolverhampton and some of the other towns in the South Staffordshire district supplied by the Mond Gas Co. Over 160 firms are now supplied by this company and are using gas with complete success in a great variety of operations. We need only to develop the firing of boilers by gas, so that it may rank in efficiency and simplicity with coal firing, under the best conditions, to make this form of firing universally preferred—the saving of coal-transport costs and of handling ashes would be very considerable and would go far to meet the cost of producing and piping the gas; the greater ease with which variations in the load factor can be met when gas is used is also a matter of no slight importance.

There has been a continuous tendency hitherto to lower rather than to raise the quality of gas. It will be necessary to reconsider this policy, in view of the fact that the cost both to producer and consumer and also the dimensions of the necessary mains vary inversely rather than directly with the quality. The following figures given by Young in 1900 may be quoted by way of illustration.

Description of gas.	At point of Production.			At point of Distribution.		
	Calorific power B.Th.U. per 1,000 cu. ft.	Cost to produce 1,000 cu. ft.	Cost of 100,000 B.Th.U. in pence.	On-cost charges per 1,000 cu. ft.	Total cost at point of distribution.	Cost price to Consumer of 100,000 B.Th.U.
Water gas ..	300,000	d. 4	1-33	20	24	8-00
Coal gas ..	600,000	12	2-00	20	32	5-33
Cannel gas ..	900,000	24	2-66	20	44	4-88

It would obviously pay to deliver benzene vapour alone, if this were practicable. I have always myself advocated the supply of a rich rather than of a poor gas. The point is of importance, because in coking coal at a relatively low temperature, the gas produced—say from 5000 to 6000 cubic feet per ton—is of high calorific power.

Until gas heating appliances are more developed and the whole subject has been placed upon a proper scientific basis, it will be premature to come to any final conclusion with regard to the quality of supply that is most desirable; probably it will be found to vary as the possibilities in different districts and the requirements vary.

The problem which most nearly concerns the general public, at the moment, is that of coking coal so as to produce a satisfactory smokeless fuel—such a fuel cannot be much longer withheld. The gas engineer has been the main cause of delay and his primary fault is that he has almost advisedly neglected the chemical side of the industry. Being, as a rule, brought up in the works and saturated with the prejudices of past generations, he has had but one object in view—the production of the maximum volume of gas per ton of coal carbonised: the coke produced under such conditions is necessarily a hard one which burns with difficulty; unfortunately the technical journals have systematically written down all attempts to produce a soft coke suitable for general con-

sumption. All the coking plants in operation in the country have been designed either by Belgians or Germans and not a few are of foreign construction. There is no reason why we should not do such work entirely ourselves but the problems will not be solved until chemist and engineer are brought into fruitful conjunction.

In the past, attempts to produce a satisfactory smokeless fuel have been made with unfortunate results but I am satisfied that the ultimate verdict will be that the public owe much to those who have been pioneers in the cause. The late Mr. Thomas Parker, a well-known electrical engineer, one of the first in the field in that industry, was a man of ideas and ideals. He conceived the idea of producing an easily combustible smokeless fuel by carbonising coal at a low temperature and was the first who set to work to solve the problem—his labours, so far as they went, were successful but he made the mistake of operating in small iron retorts, on an impossible scale, so that the money spent in his trials was practically wasted, except as a contribution to the fund of knowledge required in such an industry. Carried forward by his enthusiasm, a number of men supported him who were quite unacquainted with the subject and naturally such men made mistakes. But gradually, taught by that great but oftentimes expensive master experience, they mended their ways and by systematic trial, under competent supervision, have gradually evolved a satisfactory process.

A plant will be in operation, if not before the year closes, at the very beginning of next. I know its details and have no doubt as to the ultimate success of the enterprise. The ovens carry a ton of coal apiece and the charge is to be drawn and renewed every eight hours, so that in a battery of 18 ovens fully 50 tons will be coked daily.

My own strong feeling is that we have to blame our senseless empirical methods—our general neglect of science and scorn of theory—rather than the extravagance of those who are held to have wasted large sums of money: in time we shall come to recognise the sacrifice that has been made and be grateful that there are some enthusiasts and idealists among us; in the absence of science, without their aid, we should have been nowhere. It will be felt to be to our national disgrace that we did not far sooner set ourselves the task of solving the problem by systematic means, at national cost.

The process of low temperature carbonisation is in no sense on its trial—only its minuter details are in course of evolution. It is useless to say that we cannot warrant the success of the system—we can. Gas making, for town use, has long been an established success, although its by-products have always been treated as of secondary importance. Many high temperature plants, in which coke is produced as primary product for use in metallurgical operations, are now established and beehive ovens are rapidly being supplanted by these everywhere. In such plants, the by-products are systematically recovered but by no means to the extent that is desirable—and yet they afford large profits. The low temperature differs from the high temperature process mainly in affording a fuel which is suitable for general domestic use—one that is required everywhere and that is bound to meet with universal favour when put upon the market in a suitable form and supplied regularly. I go so far as to assert, therefore, that within a few years the use of such fuel will be made compulsory, if only because it will be possible to abolish the smoke nuisance by using it in place of coal.

The gas given off at low temperatures, though less in volume, is of far greater calorific power than that given off in producing blast furnace coke but the richness more than compensates for the lack of volume: it will bear dilution with

2.5 volumes of producer-gas before it is reduced to a value of 300 British thermal units. It is not proposed to use any of the gas in carbonizing but to fire the ovens with producer-gas made from the small proportion of coke breeze obtained in the process and from cheap slack and washery refuse. I should say that only washed coal will be carbonized, in order to produce a smokeless fuel of standard calorific value and low average ash content.

A 200-ton coking plant such as I have in view is expected to produce daily, for outside use, 5,600,000 cubic feet of gas (300 B.Th.U. calorific value) and 124 tons of a smokeless easily-combustible coke. The amount of sulphate of ammonia obtainable will be from 20—25 lbs. per ton of coal carbonized; taking into account that made from the producer gas, the daily output of sulphate should be nearly four tons.

The gas will be scrubbed to remove benzene and similar hydrocarbons.

The one uncertain asset of the industry will be the condensable liquid products, as the use of some of these has yet to be developed; but this asset is an adjustable one, as their character may be more or less changed by secondary treatment, if not directly, by varying the conditions in the upper part of the ovens.

I am of opinion, however, taking into account the great and increasing value of liquid fuels, that the liquid products will be equal if not superior in value to those produced either in gas-making or high temperature coking plants.

The problems of coal are not to be regarded only from an economic aspect, all important though this be; moral, hygienic and political considerations must also be taken into account in determining our future policy and action.

Recent Government action in South Wales has at least called attention to the political issues and may well have advanced the discussion of the question of ultimate ownership. The question of export must also be most carefully considered—instead of glorying in the amount sent away, we must be misers to the last degree and seek to make far better use of the coal ourselves, if possible, not sell our British birthright without thought of consequence.

Some form of public control must be instituted to compel efficiency. There can be no question that our present wasteful methods of getting coal must be drastically overhauled and all waste prevented. We are clearly under an absolute moral obligation to exercise the most rigid care and economy in order that our fuel supplies may be conserved as long as possible. On this account, the utilisation of everything in or producible from coal should be a first moral charge upon our nation: it must be ordered, at no distant date, that no raw bituminous coal shall be used and that all such coal shall be first carbonised in order to abstract the volatile matters. As much of the residual coke as possible must be gasified, so as to utilise the nitrogen and recover it as ammonia. From the last point of view, coal which is not carbonized for by-products should be regarded as coke and gasified, if a remunerative amount of ammonia can be obtained from it.

Gaseous fuel is clearly foreshadowed on many grounds as the fuel of the future for industrial purposes.

Obviously, to develop a satisfactory programme, it will be necessary to consider where and for what purposes power will chiefly be required—to what extent it will be advisable to establish power producing centres at the mines, to what extent relatively coal and coke shall be the solid fuels distributed throughout the country.

The pit mouth in future should be something more than a coal dump—indeed we may confidently look forward to this often being made an

operative industrial centre of the first magnitude.

We have to foresee the electrification of some of our railways and the provision of electric power for canal use—a step of some urgency in view of the importance of cheap carriage.

Certain coals should be set aside for definite purposes—for example, Durham coal perhaps for the production of metallurgical coke. The best coking coals might well be reserved for the production of smokeless fuel and gas. Each large town might well coke as much coal as would be needed to produce the coke required locally by domestic consumers—coke being the more bulky article, the carriage of coal will probably be more economical than that of coke.

On hygienic grounds, the use of smokeless fuel is to be regarded as of primary importance and great weight must be given to this consideration in dealing with coking processes. So much has been said on smoke abatement—so little done to effect improvement—that I will not weary you by discussing it but merely say that we have but to make up our minds to take the problem in hand; we know that it can be solved if we wish to solve it.

Other points might be raised but I have said more than enough, I trust, to justify my thesis that the establishment of a National Central Fuel and Power Board, with full authority, at the earliest possible date, is a matter of Imperial consequence and must be advocated in every possible way. The first duty of the Board would be to develop and establish a national programme, while carrying forward with despatch all necessary experiments which would conduce to the rapid introduction of an improved practice.

Finally, let me repeat the proposition that coal should be made to pay for inquiries relating to coal—in other words, I would urge that all costs be met by a direct tax upon coal as it is raised from the pit.

DISCUSSION.

Mr. ROLLASON said that the theory put forward that all coals should either be gasified or carbonised with recovery of their by-products was based on imperfect knowledge of the varying physical and other properties possessed by the different seams of coal which determined their condition for gasification or carbonisation purposes. During the development of our great national industries the engineers responsible had been able to select the grade and quality of coal best suited to their requirements. The larger grades and best qualities being most in demand, commanded higher prices than the lower grades. It had been found that these lower grades could be economically used for power production in boiler furnaces, and as long as there was an ample supply prices of such fuels would remain low. By this method all coals raised were used and there was no loss of fuel which had been raised to the surface. It was by the use of such low-grade coals that large power-supply companies had been enabled to supply cheap power. To carry out the proposals made by Professor Armstrong the demand would immediately overtake the supply; consequently cheap power, on which our industries depend, would disappear. The proposals did not aim at the reduction of the cost of power, but at the conservation of coal and the prevention of smoke. Owing to the losses in the producer plant and retort when gas or coke was used for firing of boiler furnaces, there could not be any reduction in the tonnage of coal used. On the question of smoke the largest percentage arose from boiler furnaces which could be easily overcome by secondary means. The necessity for changing our methods for the generation of power in order to prevent smoke therefore ceased to exist. He

had found that by the addition of a small percentage of finely-ground amorphous sodium carbonate to all boiler slacks, the hygroscopic water (contained in the coal) was separated from the carbon, and if the air necessary for its combustion were present and the draught regulated, the whole of the carbon content of the fuel was consumed, which resulted in an economy of fuel and an absence of smoke. For gasification purposes on the lines proposed, coals low in hydrogen with a high nitrogen content were required. For carbonisation purposes, in order to produce a smokeless fuel with a low ash content, the best quality of coking coals, high in volatile matter with a low oxygen content and low in ash, was necessary. As these classes of coals were already scarce and dear, and every known seam of such coals was being worked at the present time, there would not be sufficient available to carry out the proposals of Professor Armstrong, if such were adopted.

Professor KIPPING said that even an ordinary householder could not fail to be struck with the enormous waste of fuel which went on in houses, and which had gone on since coal was burnt.

Councillor ATKEY said that he believed that some very strong and urgent measures were necessary in order to wake up the people of this country to the importance of the subject. The point of view from which he regarded it was one as affecting the latest form of motor traction in this country. To-day it was realised that even from the point of view of defence a supply of motor fuel was one of the absolute needs of warfare. Naturally the point of view from which he regarded it was one as affecting the latest form of motor traction in this country. To-day we realised that even from the point of view of defence a supply of motor fuel was one of the absolute needs of warfare. We did not regard war as the principal thing to live for, but it was evident, he thought, to most people to-day that a supply of liquid motor fuel was absolutely essential for our progress in times of peace. And that was the problem which really faced us and which gave Professor Armstrong's lecture such outstanding importance. The position at the present time, from the national point of view, was that we had to depend upon ships to bring to this country practically every gallon of liquid motor fuel that was necessary for transport purposes in this country; and when one realised, and saw, the enormous use that motor traction was to our every-day life; when one saw how it had come to be the means by which our very bread was brought to our doors, both literally and figuratively, then he thought they were bound to realise that the problem of motor traction was probably as great a one as we had to face.

He entirely agreed with the sentiments which had crept into the lecturer's paper where he had said that if we were to survive and justify our position among the nations of the world we must combine in future the theorist and the scientist with the commercial or business man who would translate his theories into practical use and benefit.

He did not venture to hope for very much from any Government, but certainly the one that had now been formed started a new era inasmuch as it had moulded into itself men who were not politicians but were business people. That certainly gave them reason to hope, and he ventured to think that lectures of this character, if properly taken to heart, and realised, would provide those business men with the necessary force that should translate the commonsense that they had heard that night into the practical policies of to-morrow.

He hoped that before they left that night it might be possible to take some definite line whereby all they had heard might be brought to

practical effect. He spoke particularly in regard to what he ventured to say was the most important industry in this country to-day, and which in time to come would be the greatest and of the utmost service to mankind. That industry required fuel that was now being wasted in the atmosphere—that was being absolutely thrown away in reckless fashion.

Mr. ULLETT said that there was no doubt that a combination of gas and electrical and coal combustion would have to be found. If the author's proposal was feasible, why should not a gas department be put down to produce coke which could be burnt in the electric light station and at the same time also produce chemicals? Was it commercially possible to put down a plant consuming something like, say, 5000 tons of coal per annum where there was a demand for steam for generating power, gas for furnaces, benzol, and a certain amount of coke? As an electrical engineer, he agreed that the electrical power station was absolutely out of date, inefficient, and costly. The power station of Nottingham was placed in the wrong position of the town, almost at the highest part of the town. Then, again, the plant was run very largely non-condensing, and consequently one-third of the steam was blowing away up the chimney to waste. The generators and engines were excellent in their way, no doubt, but absolutely out of date at the present time as far as steam consumption was concerned. The water was being bought from the water department, he supposed at the recognised rate. Could it be wondered that the cost was so much higher than in other towns; that the coal consumption was 50% more than it ought to be, and the total cost 60% more? Then, again, the plant had a capacity of 12,000 kilowatts, and was producing about half the output that other large towns were getting for the same size plant, and the electricity was sold at a far higher rate.

Mrs. ATKEY suggested that some pressure might be brought to bear upon builders to stop the installation of the present expensive and frightfully wasteful domestic kitchen stoves. When she went to the house she now lived in three years ago the kitchen stove that was then installed—her cook had told her—took three buckets of coal to get it to a proper heat. The one she had now was an American stove, which took less than half a bucket of coal; it did not need frequently replenishing, and there was very little smoke. And what would appeal to those who had to pay the bill, the cost of the installation of the stove, which was the heaviest expense, had been paid in one year by what the stove had saved in fuel, leaving the benefit of the economy for years to come.

Mr. CARR said that unless they, as citizens, used every means in their power to get action taken, the old state of *laissez faire* would be certain to continue. England was bleeding away its power by wasting fuel which would help, if conserved, to continue the supremacy of this country for centuries longer than it could continue unless they took to heart such teaching as Professor Armstrong's. Therefore he hoped that they would bring this subject before the Town Council and insist upon having the matter threshed out; insist, too, upon having the fuel which was utilised for the township, as well as that which was used in private consumption, dealt with economically and profitably.

Mr. EDGCOMBE asked whether this matter had been considered altogether from the financial standpoint? He was connected with a railway company where a lot of coal was used for stationary boilers especially and for electrical generation, and they found it always paid to get coal of the lowest grades, wasting the by-products, to get the steam rather than coke at three or four times the price. In regard to the question of the

carbonisation of fuel, the way in which Professor Armstrong might help them would be in the direction of some method of grading coals. They had tried many grades of coal and found nothing but trouble with most of them—difficulties in the producers themselves. The quality caused various troubles. The difficulty with coke was that the fire became very hard and not broken up and in that way they got high temperatures and the formation of a tremendous lot of slag. They had found in many cases a great improvement by mixing coals. Smudge coal simply slagged up the whole stoker, but by a judicious mixing of low-grade fuels they got satisfactory results in their furnaces. At one time they used to have a lot of steam coming away from steam hammers and machines of that sort, but now they had put in a pipe to convey all this to an exhaust steam turbine. They would like to know how it was possible to get hold of a proper or simple set of rules as to the best way of dealing with these fuels. At the present time he was trying to recover sulphate of ammonia, but could not get more than 35 lb. per ton. He thought it was a question of the temperature at which they gasified the coal.

Mr. PULSFORD reminded the meeting that there was already in existence—and had been in existence for many years—a Royal Commission to deal with this matter. There was also now in existence the British Association Fuel Committee for dealing particularly with this matter. He hoped that the resolution which was to be proposed would result in the inauguration of some association which would deal very vigorously with the matter. Professor J. S. S. Brame, lecturing at the Royal Naval College on December 1st, said that in 1913, when there were many labour troubles in the coal areas of the United Kingdom, of the 287,430,473 tons of coal raised the amount that was retained for home consumption was 187,000,000 tons, leaving 98,430,473 tons of coal which were exported from this country. That was more than 33½% of coal exported and upwards of 60% only consumed at home. He further stated that within the next 50 years or 100 years the situation in the collieries of this country would be such that coal would be immeasurably dearer than it was to-day. Now that brought very vividly forward a question that was really of national interest. Manufacturers could not possibly produce unless they had cheap fuel. Our industries would, undoubtedly, much more quickly than many appreciated, be very seriously handicapped. There were three great coal-producing countries—the United States of America, Germany, and our own. The United States retained for home consumption 90% of the coal got; Germany retained 75%, and the United Kingdom 67%. The reserve in the United Kingdom in relation to the coal areas is 0.14%, in Germany 0.01%, and the United States 0.13%. He urgently suggested that a tax for research should be placed upon the coal exported from this country.

Mr. WILKIE said that a magnificent piece of industrial research had been carried out in Germany with a view commercially to combining hydrogen and nitrogen for the production of ammonia. In the normal course of events, had the European war not taken place, shortly afterwards, this country would be faced with competition in natural sulphate of ammonia and its synthetic product. The research was of fundamental importance and enormous difficulties had to be overcome, but even then the combination must be carried out under such stringent conditions that it was by no means an easy operation. But in this country nature had given us the raw material—crude coal—which effected this combination for us, anyhow by heat, it gave us sulphate of ammonia. By manufacturing gas this was

saved, and coincidentally the pollution of our town atmosphere and at the same time harmful effects upon the people were prevented. England had been the greatest, or at least one of the greatest, producers of phenol, and we produced the substance and foolishly, he thought, gave all this valuable material to the Germans who were able absolutely to rule the markets of the world. Consequently they had not only bought the crude material and controlled the phenol market and the benzol market, but they could force down the price, and in other ways make the benzol market impracticable, allowing us in this country very little benzol indeed. It was incumbent upon every one to make up his mind that this chemical deficiency of ours must be remedied in the future, and he hoped engineers, colliery owners, and colliery managers would view the idea of this treatment of fuel with the greatest sympathy. No doubt these changes would cost even producers and large consumers of coal temporary inconvenience, and it would be wonderful if any legislative action which disturbed the established procedure of years did not dislocate arrangements which had accompanied previous usage, but he put forward a strong plea for everybody to help forward this work as much as they could.

Professor ARMSTRONG, replying, said that Mr. Atkey had drawn attention to the fundamental issue which was before us. It was a moral issue really—the utilisation of our coal fuel so as to get not merely heat from it directly but also the liquid materials which nowadays were really of more importance to us even than solid fuel. Liquid fuels, used in internal combustion engines, were having a great effect on the war—on under-water war and to a considerable extent also on above-land war. We *must* have such fuel and the way to get it was to take it away from coal. Mr. Bollason had left that point out of account altogether, he thought. Many things had to be found out but what he wanted to insist upon was that we had passed the experimental stage so far as the production of coke was concerned, *i.e.*, smokeless fuel. We had only got to settle details. The principle was settled. He thought it would be shown within the next few months—the next year probably—that the matter was practically settled. It was not a subject for small-scale investigation. Research in the ordinary laboratory sense was quite a secondary matter. It was large-scale practical work that was required and that was being started in Yorkshire; it would be started also directly that it had been declared a success in other districts and then there would be co-operation between the coal pit, the coking plant, the gas fire, the production of electricity and the production of various by-products—all these various industries would be brought into association as far as possible on the very best lines. He could not imagine that in the near future there would be many cases of individual use of any considerable quantity of fuel. A larger amount of work would be done by electric current, a larger amount of gas would be supplied; it would not be desirable to have relatively small-scale plants at work, which, of course, were necessarily more or less inefficient. In regard to the domestic difficulty, there was no doubt that the builder was one of the chief sinners. We had need of experimental work from that point of view also; there ought to be special regulations. The borough surveyor was not unfertile in suggestions for putting down drains and for building walls of a certain thickness; there was no reason why we should not have proper kitcheners installed in a house and important economies effected in the consumption of fuel. There were very many such problems which touched the public at every point, in which there were a large number of conflicting interests. At the present time it was essential

to develop a practical policy; therefore we should have some body of men called together, a small executive, who would bring the various opinions in this country to bear on the problems and work them out in their various details. Naturally this will be a slow process but it should bring about a practical result and a totally different condition of things from the one existing at the present moment. From that point of view, if possible, we should carry the matter forward and get the Government to make it a public question without delay; take it up as a matter of public necessity and arrange that it should be threshed out as thoroughly as possible.

Mr. RALPH BATES, President of the Nottingham Society of Engineers, spoke as representing the iron and steel industries, which were undoubtedly amongst the greatest sinners as regards the wastage of fuel. They consumed it in large quantities in blast furnaces and steel furnaces and steam boilers counted by the score. Remedies had been mentioned, and difficulties also had been dealt with by Professor Armstrong. The difficulties were largely these. First, there was the waste that was taking place in those works which had been established for anything from 50 to 100 years—plants that had been built up out of very spare capital and hardly wrought together. It was all very well for scientists to say: "You must sweep these away; you must adopt economical methods." But from the practical point of view it was a very difficult question to grapple with. But Professor Armstrong had dealt with it from the other side—it must be dealt with in large units. The manufacturer could not put in costly plant for the economy of fuel, but to deal with it from a large centre was the only solution that was practicable for the future, and undoubtedly it would be done.

THE RESOLUTION.

He then moved the following resolution:—

"That it is imperative, without delay, by public effort and legislative action, to promote the development of a comprehensive national policy to govern the use of our fuel supplies, as the sole sources of heat and power, so that they may be used with greatest effect, with utmost economy, and without creating nuisance, for the general good of the country."

Mr. PENTECOST, in seconding the resolution, said that, as a manufacturer, along with many others, he had suffered from the reluctance of the City Corporation to connect up electric power to his works. On four occasions, at any rate, he had approached the City Corporation to get the power connected up, but there had been so many conditions and difficulties and excessive financial responsibilities put before him that he had had to give up the idea. But when they got power and heat in the way Professor Armstrong had suggested, it would remove a good deal of the anxieties and troubles of ordinary manufacturers and make manufactures much cleaner and easier.

The CHAIRMAN put the resolution to the meeting and it was carried unanimously.

Sydney Section.

Meeting held at Sydney on Wednesday, 15th November, 1916.

MR. H. G. SMITH IN THE CHAIR.

COMPARATIVE TESTS WITH MANGROVE AND WATTLE BARKS.

BY F. A. COOMBS, F. ALCOCK, AND A. STELLING.

The mangrove barks are now being used in large quantities by tanners who are producing sole-

leather. These barks have a very high tannin value and very large supplies are available for the production of leather.

In a previous paper* we gave the tannin values of some Australian mangrove barks. After examining the mangrove trees in Cairns and Cooktown districts, North Queensland, we found that *Rhizophora mucronata* represents fully 75% of the trees suitable for stripping, the remainder consisting largely of *Bruguiera gymnorhiza* and *Ceriops condolleana*. For commercial reasons strippers are not likely to take the bark from the different species and keep each one in a special grade. The above three species† grow in a very mixed state and buyers can assume that bark from these districts consists of an excess of *R. mucronata* and small varying proportions *B. gymnorhiza* and *C. condolleana*. The majority of the mangrove bark from German East Africa‡ is also taken from the above three species.

We have used the commercial mangrove bark for our tanning experiments, and *B. gymnorhiza*, *R. mucronata*, and *C. condolleana* were examined by the aid of the usual qualitative tests.

The colour and precipitation tests gave results which did not differ from those described by other workers for mangrove bark. The solubility tests for mangrove tannins have not received a great deal of attention from leather chemists, and the results given for these tannins may have been obtained from one or a mixture of the genera which are described as mangroves.

The following values have been given§ for mangrove:—Ethyl acetate figure, 0 to 5; alcohol figure, 0 to 5, and gallic acid value 0.68.

These differ to a certain extent when compared with our results shown below.

	<i>C. condolleana</i> .	<i>R. mucronata</i> .	<i>B. gymnorhiza</i> .
Ethyl acetate figure	20 to 25	7	4
Alcohol figure	0	0	11, 12, 24
Gallic acid value	0.785, 0.738, 0.692, 0.657	0.600, 0.595, 0.501, 0.479	0.450, 0.385, 0.381, 0.359

Procter and his students have carried out a considerable amount of work in connection with the oxidation of tannins with permanganate and the results obtained are useful as qualitative tests for the recognition of various tannins. He gives the gallic acid value of one gm. of chestnut tannin as varying between 0.56 and 0.66 and of valonia tannin as varying between 0.55 and 0.63.

These variations are common to mangrove and apparently no constant figure can be given which represents the gallic acid value of these tannins. The gallic acid value of mangrove tannins apparently reaches the maximum with *C. condolleana* and the minimum with *B. gymnorhiza*. Procter states that the phlobaphenes or reds are probably anhydrides of their respective tannic acids, and it is a well-known fact that the catechol tannins change on exposure to heat or light from a medium to a dark red colour. This change brings about a more complicated and larger molecular aggregate; and as this aggregate increases, its solubility in water decreases, until it finally reaches the state known as insoluble reds or phlobaphenes. The tannins in wattle and mangrove barks appear to exist as variable molecular aggregates ranging from the parent body, or unit molecule, to the insoluble red; and it is probable that the oxidation values would differ for the unit molecule and the difficultly soluble reds. The tannin from *B. gymnorhiza* has a low oxidation figure and probably a high mole-

cular aggregate. Mallet bark tannins also have a low oxidation value (gallic acid value, 0.288) and the rate of penetration is slow.

Recently Bennett (this J., 1914, 1182) suggested certain changes in the I.A.L.T.C. official method for estimating tannins. He believes that the present method returns a high percentage of non-tans, and we are confronted with the problem that certain substances exist which are tannins or non-tannins according to the ratio, within certain limits, between hide-powder and tannin.

The non-tannins have a low oxidation figure and it would probably throw some light on the subject if oxidation figures were obtained for tannins and non-tannins from one sample of bark using both the official and Bennett's revised methods for estimating the tannin. Such results would show if the substances under dispute were akin to tannin or non-tannin, and we might get a better view of the value of the gallic acid figure.

The leather-forming properties of mangrove barks were tested by an experimental process described in *Collegium*.*

Two duplicate tests were carried out for comparative purposes, and wattle bark was used for the standard tannage. The mangrove bark has already been described and the wattle bark was the same as the tannins used under the name of Adelaide bark (*Acacia pycnantha*).

The hide is cut into sections of equal area and numbered as shown in the diagram. The sections are approximately 1 ft. 9 in. square and they are soaked, lined, and tanned in upright vats measuring 2 ft. × 2 ft. × 4 in. Two sections are suspended in each vat and about 32 litres of liquor is required to cover them.

The sections 1 and 5, 2 and 6, 3 and 7, and 4

and 8 are approximately constant in area, thickness (substance) from grain to flesh, and in general structure.

The first two sections, Nos. 1 and 5, are both soaked, lined, and delined in the same vat at the same time; therefore temperature, time, and constituents of all liquors are constant for these two pieces until they reach the tan liquors. Then they are separated and No. 1 goes into wattle-bark liquors and No. 5 into mangrove liquors. Under skilled control these two sections are approximately constant until they reach the tan liquors, and then if any variation occurs, it will be due to a difference either in the process of tanning or in the tanning materials. In this experimental work the tanning process has been kept approximately constant for both duplicate tests, so that if the hide sections be constant the variations can be traced to difference in the tan liquors (acidity, non-tans, etc.), or in the structure of the tannin molecule. What has been said of No. 1 and 5 applies also to the groups Nos. 2 and 6, 3 and 7, and 4 and 8, but it is hardly necessary to point out to practical men that No. 1 will differ from all others with the single exception of No. 5 section, and likewise No. 4 will differ from all except No. 8 section.

Sections 1 and 5, and 2 and 6 were used for the first test and the other two pairs were used for the second. For both, the soaking occupied two days with two changes of water; lining seven days in one fresh lime liquor; wash pits (after dehairing, etc.) two days, with two changes of water;

* Australian Mangrove Barks. Leather World.

† Specimens identified by Dr. J. Shirley, Brisbane.

‡ See Paessler, *Collegium*, 1912; this J., 1912, 446.

§ Leather Chemists Book, Leeds University.

and deliming, one hour in lactic acid solution (2 grms. per litre).

The tanning process was continued at a constant tannin strength for both tests.

Acidity of the mangrove liquors for both tests is higher than the wattle liquors, and one might therefore expect the mangrove leather to fix more tannin. However, we are now carrying out comparative tests for the value of acid in tan liquors and hope to discuss this point at a future date. The variable ratio between tannin and specific gravity is fully demonstrated in both tannages. The wattle tannins penetrated the hide quicker than the mangrove tannins.

The figures for the tanning process show a small irregularity due to the process of extracting the tannin from the bark. We were extracting tannin from the bark at irregular intervals and some liquors had a short time for exposure to fermentation. The amount of difficultly soluble tannins was low for these tan liquors, and these conditions might adversely affect the percentage of combined tannins.

First test.

SECTIONS 2 AND 5. Mangrove bark liquors.				SECTIONS 1 AND 6. Wattle bark liquors.	
Days.	Tannin.	Barko- meter.	Lime water.	Barko- meter.	Lime water.
	grms. per litre.		c.c.		c.c.
2	16.64	8.2°	2.6	7.7°	1.8
4	24.96	12.3°	3.9	11.6°	2.7
6	35.56	18.0°	4.7	17.0°	4.4
8	47.6	24.3°	9.4	24.1°	5.9
10	67.0	32.6°	11.3	32.7°	8.0
20	90.53	47.3°	8.7	45.4°	8.4
29	111.8	62.0°	15.0	62.2°	8.0

Second test.

SECTIONS 4 AND 7. Mangrove bark liquors.				SECTIONS 3 AND 8. Wattle bark liquors.	
Days.	Tannin.	Barko- meter.	Lime water.	Barko- meter.	Lime water.
	grms. per litre.		c.c.		c.c.
2	17.86	8.7°	3.8	9.3°	2.8
5	26.8	13.3°	5.6	13.9°	4.2
6	39.86	18.7°	8.2	17.6°	5.3
8	47.31	23.0°	9.0	22.4°	5.4
10	63.63	31.3°	11.2	32.8°	5.8
19	88.75	41.8°	12.8	44.8°	7.8
28	117.06	60.0°	15.3	62.1°	9.6

The following are results obtained by weighing each section after it was taken out of the various tan liquors. The pelt weight is taken at 100 and the percentage increase is added to that figure. It will be noted that the increase is higher with the mangrove tannage, but the increase for both tannages is lower than the amount representing combined tannins, and therefore we can assume that as the hide takes up tannin water is expelled.

Weight gained during tanning process.

Sections. Tannage.	1. W.	5. M.	6. W.	2. M.	3. W.	7. M.	8. W.	4. M.
Pelt weight	100	100	100	100	100	100	100	100
1st Liquor	104.6	101.9	102	102.4	103.4	105.1	104.5	102.8
2nd "	105.5	105.0	105.3	105.4	106.4	108.4	109.2	108.9
3rd "	107.6	106.5	107.6	106.4	109.1	111.3	112.1	112.2
4th "	110.4	109.2	110.5	108.1	110.7	113.3	113.1	114.1
5th "	111.4	111.0	111.3	111.0	112.8	116.7	115.2	116.9
6th "	112.5	113.0	111.7	112.4	113.1	117.2	116.3	117.5
7th "	113.2	114.1	112.3	114.4	113.7	117.7	117.2	118.2
Wash-pit	—	—	—	—	108.4	109.8	108.3	109.9

Sections 1, 2, 5, and 6 were taken from the tan liquors and suspended in water for two hours, drained overnight, scoured on the grain, oiled, and then finished as sole-leather. Sections 3, 4, 7, and 8 were washed in water and allowed to dry.

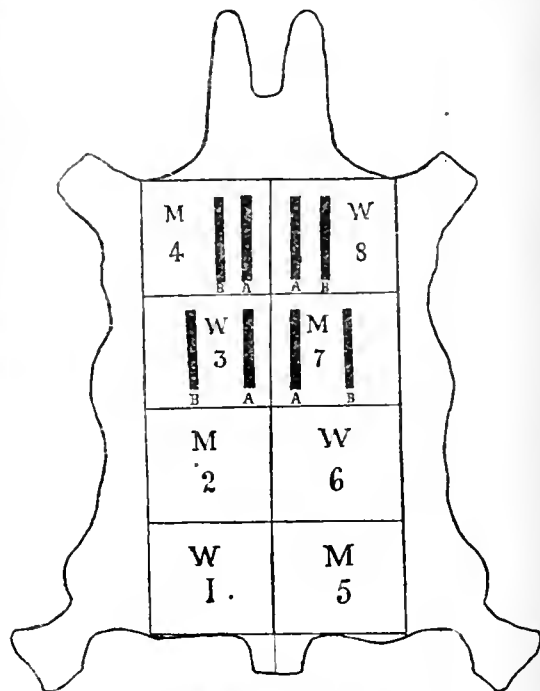


Diagram of Ox-Hide.

These sections did not receive any oil. The dry rolled sections were what tanners call "firm" but not hard. The mangrove leather was a bright clean red colour. The dry unrolled mangrove-tanned sections were not inclined to a brittle grain, so that scouring is not a necessary factor in the finishing process.

The analytical results are worked out on a leather free from fat. The sum of water, total solubles, combined tannin, and hide-substance is 100%. The non-tannins are very low, suggesting that the total solubles include free tannin which was originally combined tannin. Total solubles were extracted from the leather shavings at a temperature of 45° C. The time for extraction was three hours. Previous experiments with pine and wattle barks show that the degree of tannage is low for these mangrove and wattle tests. This difference is partially explained by the fact that we used a thicker hide for this experiment. Another matter would be the age of the leather. For the pine bark experiment the leather was not analysed until ten months after it was removed from the tan liquors, but for this experiment the same work was all completed within one

month. It has been proved* that the catechol tannins, both free and combined, are gradually changing in the air-dried leather. Probably this change adversely affects the solubility of these substances and the natural result would be a lower figure for total solubles. When leather is placed in water at 45° C. it apparently releases a certain amount of combined tannin, so that, omitting bloom and reids, a final and approximately constant figure might be obtained for mangrove tannins. We carried out a second extraction for Sections 4 and 8, and the usual standard process was repeated daily for four days. The results obtained brought the degree of fannage down to 32·7 for mangrove and 31·8 for wattle; after several days the mangrove (in water 18° C.) was still giving up a little colouring matter, and it seems probable that under these conditions we could have reached 30 as a final figure for both tannages.

The stability of the combination of hide-substance and tannin, as shown by the degree of fannage, varies to a considerable extent according to the process of extraction, etc. We took four pieces out of each section, when sampling for analysis, and the samples from the two sections in each group were in the same water bath during the process of extraction; so that the results show differences between the two sections of any one group under approximately constant conditions. We have to compare results from leather shavings with results from leather ground in a mill,† and if higher total solubles were obtained from the latter then it would appear as if these tannins produce a very unstable leather. However, we recognise that we must carry out more experiments in connection with this problem of extraction.

From a commercial standpoint the leather weight returns calculated on the pelt and green-salted weights are all in favour of mangrove.

Sections.	3.	7.	8.	4.
	Wattle.	Mangrove.	Wattle.	Mangrove.
Air-dried leather	19·0	19·7	18·5	18·9
1 Minute	51·1	54·9	49·0	47·2
1 " "	63·7	56·4	64·9	62·4
1 " "	74·3	65·3	77·9	73·3
1 " "	83·7	72·6	89·9	83·1
1 " "	90·0	79·6	97·9	90·8
1 " "	94·0	83·3	103·9	97·8
1 " "	96·3	86·6	110·0	101·1
5 " "	97·1	88·7	114·7	105·1
20 " "	98·9	91·0	120·7	108·7
13 Hours	103·1	94·1	129·1	113·9
32 " "	108·6	99·2	137·7	120·7

If t_1 is the percentage of water absorbed by a leather containing a small amount of water-solubles, t_2 that absorbed by a leather with a large amount of solubles, and t_3 that absorbed by a rolled leather with a large amount of total solubles, then

$$t_1 = \frac{w}{r} 100, \quad t_2 = \frac{w-x}{r+y} 100, \quad t_3 = \frac{w-(x+m)}{r+y} 100$$

where w = weight of water absorbed

r = weight of leather,

x = water displaced by the extra amount of solubles,

y = weight of the extra amount of solubles,

m = the decrease in the volume of air spaces after the leather has been rolled.

Another factor would be an increased amount of insoluble matter such as combined tannin, bloom, and adulterants. Let t_4 be the percentage of water absorbed by a leather with a large amount of solubles and an excess of insoluble matter, then

$$t_4 = \frac{w-(x+b)}{r+y+u} 100$$

1ST TEST.

2ND TEST.

Section numbers	1.	5.	6.	2.	3.	7.	8.	4.
Tannage	W.	M.	W.	M.	W.	M.	W.	M.
Water	14·00	14·00	14·00	14·00	14·00	14·00	14·00	14·00
Total solubles	20·05	17·31	20·00	19·52	16·54	15·91	18·6	20·31
Non-tans	3·11	2·55	3·24	2·85	1·93	1·36	2·26	1·89
Tannin	16·94	14·76	16·76	16·67	14·61	14·55	16·34	18·42
Hide-substance	43·84	39·92	42·59	39·09	45·40	38·89	44·71	40·33
Combined tannin	22·11	28·77	23·41	27·39	24·06	31·20	22·69	25·36
Degree of tannage	50·43	72·07	54·97	70·07	53·00	80·23	50·75	62·88
Pelt weight × 100	116·9	119·9	126·1	122·6	118·7	126·0	129·9	126·8
Green weight								
Leather weight × 100	76·35	85·56	80·87	85·45	68·8	80·19	63·84	70·25
Green weight								
Leather weight × 100	65·31	71·35	64·15	69·73	57·91	63·60	49·12	55·29
Pelt weight								
Hide-substance in pelt	28·63	28·48	27·32	27·25	26·29	24·73	21·97	22·33
Fats	1·35	1·31	1·09	1·53	0·40	0·31	0·58	0·47
Ash	0·30	0·33	0·35	0·40	0·29	0·22	0·23	0·20

The water-absorption test was carried out by placing the unrolled sections in water for various periods as shown below. The leather weight, calculated free from water, is taken at 100, and the water absorbed is shown as a percentage on that figure. In both cases the mangrove absorbed less water than the wattle leather. The sum of the fixed tannin and total solubles is greater with the former than with the latter, and therefore there is less room for water in the mangrove leather, providing other conditions are equal for both leathers.

* Report of the Committee of the Soc. of Arts on Leather for Bookbinding; this J., 1901, 819; 1902, 128.

† Leather Industries Laboratory Book.

where

l = water displaced by excess of insoluble matter,
 u = weight of the excess of insoluble matter.

Leather, like wood, contracts or swells according to the moisture content, and this varies with the different tannages. The rate at which water penetrates the leather is related to the solubility of the substances deposited on the leather fibres. Leather adulterated with an easily soluble substance, like glucose, offers very little resistance to water penetration.

The tensile strength tests were carried out by Mr. H. T. Swain at the Mechanical Engineering Laboratory of the Sydney Technical College. Two pieces were cut from each section as shown on the

diagram. Mangrove 4A and wattle 8A are placed together for comparative purposes, as they differ only in the barks used for the tanning process. The other groups are shown below, the results being all in favour of the wattle tannage.

The moisture in the leathers is slightly higher with the wattle, and it is not possible to get the four sections with constant percentage of water when they are exposed to changeable climatic conditions. However, the difference is below

Balderston* has described a machine for testing the wear-resistance of sole-leather, and his results show that the loss by friction is at the minimum with a straight chrome and the maximum with a hemlock tannage. Now this is just the position one would expect them to occupy in a series of tests for tensile strength. Hard leather offers a low resistance to friction, the tensile strength is not high, but the water resistance is generally good.

Tensile strength test.

		1ST TEST.		2ND TEST.		3RD TEST.		4TH TEST.	
Tannage		Wattle.	Mangrove.	Wattle.	Mangrove.	Wattle.	Mangrove.	Wattle.	Mangrove.
Number		3A.	7A.	3B.	7B.	8A.	4A.	8B.	4B.
Original dimensions	Moisture	13.79	12.82	13.79	12.82	13.2	12.6	13.2	12.6
	Breadth	1.5	1.51	1.5	1.51	1.51	1.49	1.53	1.51
	Thickness	0.25	0.239	0.25	0.210	0.229	0.239	0.255	0.239
	Area	0.375	0.368	0.375	0.363	0.346	0.345	0.390	0.360
Stress in pounds	Total	960	750	1200	920	800	650	810	740
	Per square inch ..	2560	2038	3200	2531	2312	1884	2077	2055
	Total elongation, %	35.6	31.9	33.4	33.4	47.2	38.9	55.6	40.25
	Time	12 min.	10 min.	—	11 min.	15 min.	10 min.	16 min.	13 min.

1%, and this amount will probably be reduced in future experiments.

The leather received no special treatment for this work, and was absolutely free from oil, fat, etc., other than the natural fats in the original hide. The pieces tested were not cut out of the best part of the hide and therefore the results obtained have no value outside of this experiment.

Analyses show that these leathers differ after they are tanned, and therefore the results obtained may be influenced by this. The tensile strength of each section is at the maximum in the raw hide, where the physical condition is all that could be desired. A fibrous structure would be at its maximum tensile strength under conditions which allowed the weight to be evenly distributed between all the fibres. The other extreme would be under conditions where the whole of the weight was on a few fibres which break, and then the weight is thrown on another small portion which breaks also, and the result must be a low value for that particular test. It would not be possible to place all the weight on a few fibres until they break, if one were testing a strip of raw hide, where the elastic properties and the general structure are so finely balanced that a strain on any group of fibres causes them to stretch, and then the weight is partially taken up by other fibres, and in this way it is distributed over the whole number before any single fibre breaks. When the raw-hide or pelt is placed in tannin solutions, the physical condition is changed. It loses to a certain extent its elastic properties. The semi-liquid intercellular substances combine with tannin to form a non-elastic solid. The fibres contract and under certain conditions they may reach a brittle state.

Procter states that the tensile strength decreases with increased amounts of fixed tannin, and the same could be said of those water-solubles which dry like tannin extracts to a hard brittle state. However, the variations in fixed tannin, etc., and their influence on these results is a problem which will require special research. If all other conditions were equal we would still expect a difference in tensile strength because the various tannins could combine with the hides in equal proportions by weight, and yet the resulting leathers would differ in their physical properties. The leather with the higher tensile strength will probably offer the greater resistance to friction.

We do not claim to be working the best processes for preparing the pelt or tanning the leather, but we feel certain that this "One hide experimental process" is capable of giving results which should enable tanners to prove the value of a great number of factors such as various tanning materials, laying away in bark, acidity of liquors, strong liquors, time for tanning, etc.

DISCUSSION.

The CHAIRMAN asked what species of mangrove had been used in the experiments.

MR. A. H. DETTMANN said that leather tanned with mangrove answered well for the soles of boots, as it took up less water, and so resisted damp better than when tanned with wattle. The dark colour given by mangrove was commonly supposed to be caused by "loading," and there was a prejudice against colour.

MR. A. E. STEPHEN asked if there was any difference in the tensile strength of tanned and green hide.

MR. R. W. CHALLINOR drew attention to the great variation in total solubles from the proportion in the original liquor. He asked what had been done in testing the tensile strength after soaking at 45° C.

MR. COOMBS, in reply, said that *Rhizophora* predominated in the Queensland mangroves, but it was impracticable to keep the different kinds separate, and their experiments were made with the ordinary commercial mixed bark. The sections had been taken from the hide, and the tests made in such a way, alternately, to guard against any possible variation in the right and left halves of the hide, though he did not think there was any difference. Tensile strength was at its maximum when the hide was newly off the animal, but the hide must be tanned so as to preserve it from decay, even at the cost of loss of strength. He had made no experiments on soaking at 45° C.

CHEMICAL EXAMINATION OF THE OIL FROM THE AUSTRALIAN DUGONG.

BY R. W. CHALLINOR, F.I.C., AND A. R. PENFOLD.

The dugongs or sea cows are herbivorous mammals found inhabiting the shallow bays and

* J. Amer. Leather Chem. Assoc., 1916, 11, 429. See this J., 1916, 935.

creeks of the Red Sea, East Coast of Africa, Ceylon, Islands of the Bay of Bengal, Indo-Malayan Archipelago, and, in more or less abundance, the Queensland Coast of Australia from Moreton Bay on the South throughout the Great Barrier Reef to Torres Strait on the North, being more numerous in the waters of Wide, Hervey's, and Rodd's Bays than they are farther south, and although they are not usually observed further south than Moreton Bay, instances are on record of them having been seen off the Tweed and Richmond Rivers. The finding of bones of the dugong in the excavation of Shea's Creek, which runs into Botany Bay, by Etheridge, David, and Grimshaw (Journ. Roy. Soc. N.S.W., XXX., 158) indicates that the animals may have inhabited Australian waters much further south than they do at present.

The dugongs are usually described as ungainly creatures with small brains and very limited intelligence, hence are too easily captured or destroyed, and in consequence are now somewhat thinned in numbers.

Estimates of the length of the dugongs vary considerably, ranging from 6 to 16 ft., and even 20 ft. in exceptional cases; but the average for the Australian dugong appears to be from 8 to 10 ft.; the weight is 4—6 cwt. for ordinary specimens, and from 10 to 12 cwt. for larger animals. The average yield of oil appears to approximate to about 1 gallon per hundredweight of body-weight of dugong.

The dugongs belong to the natural order SIRENIA, genus *Halicore*, to which also belong the *Manatees*, which in some respects resemble the dugongs but do not inhabit the same waters.

The dugong fishery is carried on in Queensland at Moreton, Wide, and Hervey bays, but not very extensively, and principally for the oil, which is obtained from the blubber situated beneath the hide of the animals, and also from the tail. Other parts are also utilised to some extent. The hides are cured, the tusks sold, and the bones, which are of a fine and hard grain, and in sp. gr. and appearance approach nearly to the nature of ivory, are also utilised in various ways. The flesh is considered a relishing article of diet; roasted it has the flavour of pork and when cured the flavour of bacon, and has been exported from Queensland as dugongs bacon (R. L. Simmonds, Annual Food Products, p. 130).

The demand for the oil is somewhat limited, and according to a communication received from the Brisbane Government statistician, only 400 gallons was placed locally three years ago. It was supplied to the chemical firms in a crude state, and by them refined and placed upon the market as a medicinal product. Suppliers of oil at Traviston, Queensland, estimate the annual collection of oil at present at about 600 gallons. The price of the oil as quoted by two of the principal Sydney drug houses is 28s. and 22s. 6d. per gallon respectively.

The particular sample of oil which is the subject of this investigation was obtained directly from the fishery at Traviston, Hervey's Bay, Queensland, from one animal measuring 8 feet in length and 6 feet in girth, which gave 3 gallons of oil. The oil is obtained from the blubber by allowing it to melt in the sun's rays, and we understand that this is the usual practice at this place. It is of a pale straw tint, clear and limpid, and almost odourless, without pronounced taste and quite as palatable as olive oil. On standing, a copious white crystalline deposit separates out which at winter temperatures renders the oil of a thick creamy consistency. It was found that the solid redissolves completely at a temperature of 36° C., and remains in solution for some hours even when the temperature falls below 20° C. The white crystalline deposit, examined microscopically,

consists of innumerable wheat-sheaf-like bundles of needle crystals, somewhat like beef stearin when crystallised from ether.

The principal use to which dugong oil has been put appears to be as a medicinal oil. Dr. Hobbs, Health Officer of Moreton Bay, Queensland, about 10 years ago strongly advocated the use of this oil for wasting diseases and lung troubles, and claimed that it was not only equal to cod liver oil for this purpose but that it differed from the latter in being sweet and palatable and free from the nauseousness of cod liver oil.

In the Queensland annexe of the International Exhibition, 1872, at a dinner given by the Agent-General for Queensland, dugong oil successfully took the place of butter and lard in the menu for the preparation of the pastry and biscuits (Pharm. Journ., III., 3).

In Squire's Companion to the B.P., 1916 Ed., p. 563, it is stated, with reference to this oil as a substitute for cod liver oil, that "although recommended at one time as not being disagreeable in taste it does not now possess this character." This may apply to a sophisticated sample, but the characters of our sample do not confirm this statement.

In the experimental part of this work it is shown that two constituents which contribute to strong odour and taste in fish and marine animal oils are present only in almost negligible quantities in dugong oil, *e.g.*, the acidity, calculated as oleic acid, is only 0.15% whilst the insoluble polybromides amount only to 0.77% on the mixed fatty acids, or 0.69% on the oil.

The melting point determination of the latter shows that it is at least an octobromide and possibly a small amount of clupanodonic acid is present, although this is not suggested by the odour or taste of the oil, and moreover from a consideration of the iodine value of the liquid acids in conjunction with the amount of highly unsaturated acid indicated by the percentage of polybromide obtained, there is probably an acid present which is more unsaturated than clupanodonic acid. According to J. W. Riedel (J. Chem. Soc., 1914, 106, I., 1123) clupanodonic acid has a fishy smell and acquires after a time the odour of cod liver oil. It is a characteristic of all fish-liver and blubber oils and is the constituent by means of which these oils are at present recognised.

The complete absence of fishy odour and taste from the oil of the dugongs is undoubtedly due to the vegetable food partaken of by these marine animals, as they feed entirely upon the zostera-like marine grass "*Posidonia Australis*" and other sea weeds.

The colour reaction worked out by Tortelli and Jaffe (Annali Chim. Appl., 1914, 2, 80; see this J., 1914, 1061), which they claim is given by the oils and fats of marine animals, and by no others, when applied to dugong oil gives a negative result.

Very little chemical work appears to have been done upon dugong oil, and in those instances where constants have been determined, as far as can be ascertained, no mention is made of the source from which the sample was obtained. The examination was carried out in each of the two instances, mentioned by Lewkowitsch (Vol. 2, p. 466), apparently with the object of detecting adulteration of cod-liver oil.

The constants published by E. W. Mann (Chem. and Drug., 1903, 63, 939) and J. F. Liverseege (Analyst, 1901, 211) are included in the tabulated results of our own examination of the oil (Table I.) and it will be noticed that we differ a little as to specific gravity, free acid, and unsaponifiable matter.

Experimental. The oil was submitted to examination by the standard methods and gave the results indicated in the subjoined table. The

unsaponifiable matter was determined by the modified method of Allen and Thomson (Lewkowitsch, 5th Ed., 1, 458).

perature of the ether used to dissolve the lead salts of the liquid acids. The yields of the acids, after deducting 0.6% unsaponifiable matter (prob-

Sp.gr. 15.5° C.	Refractive index.	Optical rotation (2 dm. tube).	Iodine value, %	Acid value, mgrms. KOH.	Free acid as oleic acid %	Saponification value, mgrms. KOH.	Unsaponifi- able matter, %	Observers.
0.9161	1.4628 at 30° C.	- 0.21°	61.26 (Hanus)	0.31	0.15	209.3	0.61	Challinor and Penfold.
0.9203	60.3° at 25° C. (butyro-refract.)	—	66.6	4.7	2.39	197.5	3.74	Mann.
below 0.920	— n. 1.4661	-0.1°	—	5	2.5	—	0.9	Liversidge.

The slight lavo-rotation of the oil suggests that the unsaponifiable matter is probably cholesterol, more especially as cholesterol if present would find its way into the liquid acids by the usual methods of separation and render them optically active also, which is in accordance with our observations.

The presence or absence of cholesterol will be confirmed in a second communication.

The mixed fatty acids. The mixed fatty acids were separated from the oil by the usual method (Lewkowitsch, Vol. I, 110), care being taken to wash the fatty acids entirely free from mineral acid with subsequent drying by means of absorbent

ably cholesterol) from the liquid portion, together with their iodine values, are given as under:—

	Percentage found.	Iodine value.
Liquid acids	65	94.45
Solid acids	25	4.72

For the further examination of these acids, 40 grams of the mixed fatty acids were separated by the lead salt-ether method of Tortelli and Ruggeri (L'Orosi, 1900, 23, 109; see this J., 1900, 1013), the results being shown in the following table:—

TABLE II.
Solid and liquid acids.

Acids.	Refractive index.	Optical rotation (2 dm. tube).	Sp.gr.	Melting point.	Iodine value, %	Neutralisation number. (mgrms. KOH)	Mean molecular weight.
Solid	1.4390 at 60° C.	—	0.8911 60°/60° C. 0.8811 60°/15° C. 0.8867 40°/40° C.	51° C.	4.63	207.49	269.89
Liquid ..	1.4567 at 30° C.	-0°18 at 23° C.	0.8999 15°/15° C.	—	92.58	202.37	276.7

paper. On examination by the standard methods they gave the following results:—

Refractive index at 40° C.	1.4499
Specific gravity 40°/15° C.	0.8811
40°/40° C.	0.8867
Melting point	35°—36° C.
Solidifying point	33° C.
Iodine value	66.19
Neutralisation value	180.4
Mean molecular weight	310.43
Ether-insoluble polybromide	0.77%

The ether-insoluble polybromide was prepared by dissolving the mixed fatty acids in dry ether to a 10% solution, running in dry bromine drop by drop from a finely drawn-out pipette, and allowing to stand for several hours. After filtering on a tared filter-paper, the polybromide was washed well with cold ether, dried at 98°—100° C., and weighed. We have tried various modifications of the procedure as regards temperature of bromination from -10° C. to 0° C., and also the time of standing from 3 to 24 hours, but these variations had no effect on the percentage of insoluble bromide obtained (see Lewkowitsch, Vol. I, 5th Ed., 573; Eilmer and Muggenthaler's experiments dealing with the hexabromides from vegetable oils). The bromide obtained is a white powder which precipitates in a flocculent form, and turns slightly grey on drying at 100° C. On heating it darkened a little at 200° C., and decomposed at about 220° C., which indicates that it is the octobromide of elupanonic acid or the bromide of a more unsaturated acid.

Separation of solid and liquid acids. The process used was the modified Gussow-Varrentrapp method (Lewkowitsch, I., 515—7), particular attention being given to the volume and tem-

According to Lewkowitsch, oleic acid has refractive index, 1.4585 at 30° C.; sp.gr. 0.898 (15°) iodine value, 90.07, theory 92.3 for chemically pure sample; neutralisation number, 198.9, and mean mol. wt., 282.

A determination of ether-insoluble bromide from the liquid acid gave a yield of 0.97%.

The constants found for the liquid acids indicate that oleic acid is the principal constituent, together with a small amount of a highly unsaturated acid; further particulars of this will be included in a second communication on the chemistry of dugong oil, which will also deal with the soluble, insoluble, and volatile acids, and other points of interest which have arisen during this investigation.

In conclusion we wish to express our appreciation of the care taken by Messrs. Corser and Co. of Maryborough, Queensland, in securing us the fresh and authentic sample of dugong oil and for information respecting the industry at Hervey's Bay. Our thanks are also due to Messrs. Baker and Smith of the Technological Museum, Sydney, for the use of their refractometer, and free access to the library.

This investigation was carried out in the Organic Chemical Laboratory of the Sydney Technical College.

DISCUSSION.

Mr. A. A. RAMSAY asked what time had been used in the determination of the iodine value? This was usually 3 hours, but sometimes 6.

Mr. B. J. SMART asked if the fine crystalline substance obtained on cooling had been isolated, purified, and examined, and whether any examination had been made of the mixed acids?

Dr. R. K. MURPHY inquired if the low figures obtained for acidity were in any way connected with the age of the samples and whether the acidity increased with age?

Mr. N. C. NASH pointed out that the acidity of fats might be considerably modified by the method of preparation. Fats melted in the sun, which he understood was the practice in extracting the dugong oil in Queensland, gave low acid values, while those melted in a digester under pressure gave high values.

Mr. CHALLINOR, in reply, said that in determining the iodine values the time was 2 hours in all cases. The crystalline substance obtained on cooling had not yet been fully examined, but was now being investigated, as well as the mixed acids. The acidity found was the lowest that had been reported, and in their experience it did not increase at all with age.

Mr. PENFOLD added that they had made altogether 10 or 12 determinations of acidity, and were sure of the accuracy of their results. With reference to a suggestion about hydrogenation, there were plenty of other suitable materials available that could be operated on more cheaply.

Communication.

DETECTION OF HYDROCYANIC ACID.

BY DR. GEORGE W. ANDERSON.

(Paper read before a meeting of the Science Circle, Ruhlleben, on Jan. 5th, 1916.)

Free hydrocyanic acid or its alkali compounds, even when present in very small quantity, can be detected by the smell of bitter almonds. The acid is liberated at ordinary temperatures by weak acids, such as carbonic acid, hydrogen sulphide, tartaric acid, etc., and this property is utilised to separate it from mixtures. The usual procedure is to pass a stream of carbon dioxide through the solution heated to 50°–60° C.,¹ collecting the hydrocyanic acid either in water or in alkali hydroxide solution. By this method only poisonous simple and double cyanides, *e.g.*, AgCN or AgCN, KCN, are decomposed, complex compounds such as ferrocyanides and thiocyanates being unchanged under these conditions.²

In the series of experiments described below, which were carried out to ascertain the sensitiveness of the various methods for the detection of hydrocyanic acid, solutions of potassium cyanide (of 98.5% purity) were prepared ranging in strength from 0.00001% to 0.1%, *i.e.*, containing 0.00000393 to 0.0393 grm. CN in 100 c.c. For each test 10 c.c. of solution was employed, and all the reagents were examined and found to be pure.

Detection of hydrocyanic acid as silver cyanide. A precipitate of silver cyanide is formed when silver nitrate solution is added to a solution of hydrocyanic acid or an alkali cyanide in presence of nitric acid. This precipitate is easily soluble in excess of potassium cyanide or in ammonia. In a series of tests of this reaction made with cyanide solutions of different strengths, it was found that in a 0.01% solution (0.00039 grm. CN per 10 c.c.) a precipitate is formed, but with more dilute solutions only an opalescence is produced. The limit of sensitiveness is reached in a 0.0001% solution, in which case the opalescence can only be detected against a black background and in a column 12 cm. in height.

A. Link and R. Möckel³ recommend that the solution to be tested should be supersaturated with ammonia before the addition of silver nitrate and nitric acid. The author tested this modifica-

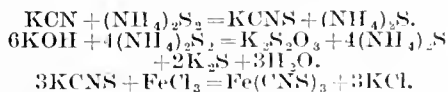
tion but obtained no better results. In fact the addition of 2 c.c. of 10% ammonia solution and a corresponding quantity of 20% nitric acid greatly reduced the sensitiveness of the reaction, owing to the solubility of silver cyanide in solutions of ammonium salts. Excess of acid must also be avoided, but excess of silver nitrate is necessary if the maximum sensitiveness of the reaction is desired.

Detection as Prussian blue. The Prussian blue reaction is very widely used for the detection of hydrocyanic acid. According to Almen⁴, two drops of a ferrous-ferrie salt solution and two drops of dilute caustic soda solution are added to 2 c.c. of the solution to be tested; after five minutes the solution is acidified with hydrochloric acid, when a blue precipitate or coloration will appear if hydrocyanic acid is present. Excess of alkali and of acid must be avoided. Some difference of opinion exists as to the advisability of boiling the solution. Link and Möckel⁵ recommend boiling, especially in the case of weak solutions, whereas Almen⁶ regards it as unnecessary. The present author has found that boiling is advantageous in that it accelerates the reaction.

This reaction was examined for sensitiveness, and it was found to fail when less than 0.000039 grm. CN was present in 10 c.c., *i.e.*, at concentrations lower than 0.001%. At this latter concentration the coloration appeared only after half to one hour.

The comparatively low sensitiveness of this reaction suggested the possibility that the conversion of cyanide to ferrocyanide was incomplete, and this was confirmed by a test with pure ferrocyanide, which it was possible to detect at dilutions corresponding to 0.000024 grm. CN.

Detection as thiocyanate. This method for the detection of hydrocyanic acid, originally proposed by Liebig, is both sensitive and reliable; it consists in converting the hydrocyanic acid into thiocyanate and applying the ferric chloride test to the latter. Link and Möckel (*loc. cit.*) describe the test as follows: To the aqueous solution of hydrocyanic acid or alkali cyanide sufficient yellow ammonium sulphide is added to impart a yellow tint. After adding a few drops of dilute caustic soda solution, the mixture is evaporated to dryness on the water bath and the residue dissolved in water with the addition of a little dilute hydrochloric acid. Addition of a few drops of ferric chloride solution produces a red coloration, which, in the case of very dilute solutions, may not appear for some time. The addition of hydrochloric acid is necessary to destroy thiosulphate which is produced during the process. The following reactions are involved:—

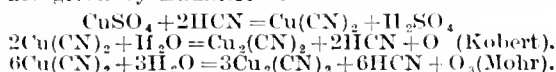


In a series of tests carried out according to the above directions it was found that when 0.00039 grm. CN (0.01%) or more is present in 10 c.c., a deep red colour appeared which became lighter with increasing dilution, finally showing a faint orange tint. The limit of sensitiveness is reached with a 0.0001% solution (0.0000039 grm. CN per 10 c.c.). The reaction may be conveniently carried out in a white porcelain basin.

Detection by means of picric acid. On adding to a solution of hydrocyanic acid or an alkali cyanide a cold saturated solution of picric acid together with a little caustic potash, a deep red coloration is produced, owing to the formation of potassium isopurpurate.⁷ According to Dragen-dorf⁸ the solution should be kept at 50–60° C., but the reaction also takes place at ordinary temperatures, though a half to one hour may be required before it is complete. A series of tests of

this reaction showed the sensitiveness to be limited, and moreover the same coloration may be produced by impurities in the acid and alkali or by reducing substances, *e.g.*, sugar, sulphur dioxide, etc.⁹ With a 0.1% solution of cyanide (0.0039 grm. CN in 10 c.c.) an orange colour developed after half an hour, and after twelve hours a brown-red; with a 0.01% solution an orange red colour appeared after six hours at ordinary temperature. A 0.001% solution failed to give the reaction at the ordinary temperature, but a colour developed on heating. This method, therefore, cannot be recommended.

Detection by means of guaiacol. This test, known as the Schönbein-Pagenstecher reaction, is the most sensitive for the detection of hydrocyanic acid, and is carried out, according to Link and Möckel (*loc. cit.*), as follows:—Filter paper is saturated with a 4% alcoholic solution of guaiacum resin and dried. Immediately before the test the paper is moistened with a $\frac{1}{2}$ % solution of copper sulphate. When the paper is suspended over strong hydrocyanic acid solutions it immediately becomes sky-blue. More dilute solutions are applied to the test paper, or the reagents may be used in solution. The coloration is not caused by the hydrocyanic acid itself, but is due to the oxidation of the resin by oxygen or ozone developed by the conversion of cupric cyanide into cuprous cyanide. The following equations are given by Baumann¹⁰:—



Tests as described above were carried out with test paper to a dilution of 0.0001%, but for greater dilutions the reagents were applied in solution. W. Maisel¹¹ suggests the addition of a little caustic potash to the solution to be tested, the whole being then concentrated on a water-bath. The concentrated solution is acidified with tartaric acid and the solutions of resin and copper sulphate are added. By means of this modification, as little as 0.00000039 grm. CN in 10 c.c. (0.00001% KCN) can be detected, according to the present author's tests. A 0.1% solution of potassium cyanide gave the reaction with the test paper immediately and a 0.01% solution in a few minutes. Solutions as dilute as 0.0001% gave a pale blue coloration in ten minutes, or in twenty seconds in presence of acid.

H. Kunz-Krause¹² recommends the use of an alcoholic solution of guaiacolic acid instead of the crude resin, together with a 0.1% copper sulphate solution. This modification does not appear to increase the sensitiveness of the reaction, but the coloration appears more rapidly and is a purer blue, and hence is to be recommended.

It should be borne in mind that this reaction is easily disturbed by the presence of alien substances, *e.g.*, ammonia or cigar smoke. The colour produced by cigar smoke is identical with that given by hydrocyanic acid, but ammonia produces a greenish-blue coloration.

A summary of the results obtained above is given in the subjoined table of limits of sensitiveness of the various tests:—

Test used.	Strength of KCN solution.	Amount of CN. grm. per 10 c.c.	Sensitiveness of reaction calculated as KCN.	
			According to test.	According to literature.
Silver cyanide	0.0001%	0.0000039	1 : 245,000	1 : 250,000*
	0.001%	0.000039	1 : 24,500	1 : 50,000*
Prussian blue	Ferrocyanide,			
	0.0006%	0.000021	1 : 39,000	—
Thiocyanate	0.0001%	0.0000039	1 : 245,000	1 : 4,000,000*
Picric acid	0.01%	0.00039	1 : 2450	1 : 2000†
Guaiacol	0.00001%	0.00000039	1 : 2,450,000	1 : 3,000,000*

*Link and Möckel. *Z. anal. Chem.*, 1878, 17, 455.

†Reichardt. *Chem.-Zeit.*, 1901, 25, 537.

Although the Schönbein-Pagenstecher method is the most sensitive, it can only be used as a preliminary test in conjunction with use of the other reactions, *e.g.*, the Prussian blue or silver cyanide tests, of which the latter is often preferred in forensic chemistry. This test, however, generally requires a double distillation of the original solution to be tested in order to obtain a distillate free from chlorine. The Prussian blue test will suffice for ordinary purposes, whilst the thiocyanate reaction may be useful in special cases. The picric acid reaction cannot be recommended, as already stated.

¹Jacquemin. *Ann. Chim. et Phys.*, 4, 135. *Z. anal. Chem.*, 1875, 13, 231; 1897, 36, 40.

²G. Baumann, *Lehrbuch der gerichtl. Chem.*, Vol. I., 259, 262, 264.

³*Z. anal. Chem.*, 1878, 17, 456.

⁴*Z. anal. Chem.*, 1872, 11, 361.

⁵*loc. cit.* ⁶*loc. cit.*

⁷E. Böcker, *Ber.*, 37, 4390.

⁸*Z. anal. Chem.*, 1872, 11, 361.

⁹C. Reichardt, *Chem.-Zeit.*, 1901, 25, 537.

¹⁰Baumann, *Lehrbuch gerichtl. Chem.*, 1., 252.

¹¹Forschungsber. über Lebensmittel usw., 2, 399.

¹²J. Gasbeleucht., 1901, 726.

Industrial Notes.

SULPHURIC ACID MANUFACTURE BY THE CHAMBER PROCESS.

An interesting method of controlling the working of sulphuric acid chamber plant has been patented by A. M. Fairlie; brief abstracts of the claims have already been published (U.S. Pats. 1,205,723 and 1,205,724; this J., 1917, 82, 83), and a full description of the process was given by the inventor in a paper read before the Georgia Section of the American Chemical Society, and reproduced in the Jan. 27th issue of the Chemical Trade Journal.

The text of the paper is as follows:—

It is well known that the largest single item of expense in operating a sulphuric-acid chamber plant is nitrate of soda. Efforts to improve the economical operation of such a plant are naturally directed, therefore, towards the conservation, or the recovery, of the valuable nitrogen compounds. The most important of the inventions designed to effect a saving in the consumption of nitrate of soda was of course the Gay-Lussac tower. Since the use of that tower for the recovery of the oxides of nitrogen escaping from the last chamber has become universal, wherever the chamber process is in operation, many devices have been introduced to improve the efficiency of the tower. These include various styles of packing material, various ways of distributing the acid fed on the top, the use of water instead of steam in the chambers, the introduction of towers fed with cold acid between the chambers to effect greater cooling of the chamber gases, and so forth.

Even with the best of these improvements installed, the efficiency of the Gay-Lussac tower will depend largely upon the way the process is

handled—upon the proper regulation of the streams of acid in the towers, and of the steam or water in the chambers; upon the efficient cooling of the acid on the Gay-Lussac, upon the avoidance of interruptions due to break-downs; and, above all, upon the careful introduction of just that amount of nitre required for the oxidation of the sulphur dioxide admitted to the chambers per unit of time.

Let us assume that the plant has been designed and constructed intelligently—that proper materials of construction have been used; that spare pumping appliances have been provided to permit the uninterrupted flow of the streams of acid over the towers under any possible conditions; that by-pass flues or spare fans have been installed, to insure the continuous and uniform flow of gas, even in case of breakdown; that the plant, in short, has been built under the direction of a competent sulphuric-acid engineer, experienced in operation as well as in construction—let us assume further that the plant is manned by a competent crew of workmen, able to operate the appliances without interruption, and turn our attention to the regulation of the nitre in the system.

The well-known, time-tried methods of regulating the quantity of nitre introduced, or, let us say, of controlling the process are: (1) by observing, the differences between chamber temperatures at different parts of the system, learning by experience what differences yield the best recoveries in the Gay-Lussac tower, and endeavouring thereafter to maintain such desirable temperature-differences constant. (2) By observing the colour of the gases in the chambers or connecting pipes by means of windows or "sights." (3) By a combination of both of the above methods.

These methods may be satisfactory in the main, as long as the gas entering the Glover tower contains a substantially uniform percentage of sulphur dioxide, but it is questionable if, even under the best of conditions as regards uniformity of grade of burner gas, these methods are adequate to yield the most economical results. To control by these methods is to control by symptoms, whereas the rational method of control is by analysis of the gases. Certainly when the grade of burner or furnace gas is irregular, as in the case of plants manufacturing acid as a by-product of zinc or copper-smelting operations, the time-tried methods of control should be replaced by the analytical method. The temperature-difference method fails, when operating on a fluctuating burner gas, because the indications of the temperature-differences are misleading. The same change in the temperature-difference may be due to one of several causes, and as the temperature-difference does not indicate in case of trouble to which cause the trouble is due the wrong remedy may be applied. The colour method alone is altogether inadequate as a guide for controlling the chamber process. In the first place, the sight glasses are usually placed at the back end of the chamber system, whereby information about the colour of the chamber gases is obtained too late to prevent the damage which has been done; and besides, even if the sight glasses are in the front chamber, the colour there is so obscured by the white mists that few persons possess the ability to detect the differences in shade, by day and by night, which would indicate whether or not the gas mixture contained the correct amount of nitrogen oxides.

The Fairlie method of controlling the chamber process is the only analytical method known to the industry. It has been in continuous daily use at the plant of the Tennessee Copper Company, where it was invented, for the past six years, and has proved its value every day that it has been in use. It consists in determining the percentage of sulphur dioxide in the chamber gases at some point near the front end of the chamber system,

and in comparing such percentage with the percentage of sulphur dioxide in the burner gas, before admixture with nitre fumes. The comparison shows, after experience, that a certain ratio between the two sulphur dioxide percentages must be maintained in order to secure the best results in the Gay-Lussac tower. What this desirable ratio is must be determined for every possible grade of burner gas. Once determined, the desirable ratios are set down in tabular form on a card, which is framed and fastened in a convenient place for reference by the chamber operator. This operator keeps his analytical apparatus in good order at all times, and by taking frequent gas tests of the burner gas and of the front chamber gas, accurate indications as to the condition of the gas mixture, and as to the speed of oxidation of sulphur dioxide, are obtained, and obtained in time to apply the proper remedy in case anything is about to go wrong. An increase in the sulphur dioxide ratio above what is desirable indicates the need of more nitre; whereas a decrease below the desirable ratio indicates that the quantity of nitre must be reduced.

The analytical method adopted for determining the sulphur dioxide percentage in the gases is the Reich method—in its original form for the burner gas, but modified by the addition of solution of acetate of soda and acetic acid to the absorption bottle, for the chamber gas. The original unmodified Reich method is impossible for the chamber gas, because the presence of nitrogen oxides causes the starch-iodide blue colour to recur, and vitiates the results. The Reich method, as modified, will give results on chamber gas agreeing within 0.01%, and this is sufficiently accurate for the most careful control of the process. The method of testing the gases can easily be learned by a workman of usual intelligence, so that the expense of employing a chemist for the analysis of the gases is avoided.

It may be remarked in this connection that by means of the modified Reich method, as applied to chamber gases, important information may be obtained regarding the percentage of sulphur dioxide desirable in the gases entering the Gay-Lussac. Some of our old acid makers and, indeed, some of our old acid engineers, grown grey in the sulphuric acid industry, scoff at the idea of any sulphur dioxide being desirable in the Gay-Lussac tower gases. This is because the older men are not familiar with any rapid method for determining accurately the percentage of sulphur dioxide in gas mixtures containing nitrogen oxides. And because the methods of analysis which they used failed to indicate the presence of sulphur dioxide at the Gay-Lussac tower, they have formed the conclusion that none is ever present, under normal conditions. The facts, however, are these:—The nitrogen oxides are recovered most completely in the Gay-Lussac tower when the proportion of nitric oxide (NO) and nitrogen peroxide (NO₂) in the gases entering that tower are such that the combination gives nitrogen trioxide (N₂O₃) with no excess of either of the constituent gases. The presence of a small quantity of sulphur dioxide is needed in the gas mixture entering the Gay-Lussac to keep a sufficient amount of the nitrogen gases reduced to the nitric oxide form. If the quantity of sulphur dioxide present be deficient, or if there be none at all, an excess of nitrogen peroxide will be present, above what is needed to combine with nitric oxide to form nitrogen trioxide, and this excess, being only slightly soluble in the cold 60° acid with which the tower is fed, will be lost, as indicated by the red fumes escaping into the air through the exit stacks. On the other hand, if too much sulphur dioxide be present in the gas mixture entering the Gay-Lussac, an excess of nitric oxide, above the quantity needed to combine with the nitrogen peroxide to form the trioxide, will be present.

As nitric oxide likewise is only slightly soluble in cold sulphuric acid of 60° strength, this excess will be largely lost, as before, although, because the nitric oxide is a colourless gas, the loss will not be so readily detected by observation of the colour of the gases escaping from the top of the tower, as in the case of the red gas, nitrogen peroxide. For this reason it is of especial importance to have some other means of knowing when there is an excess of nitric oxide present in the gases entering the Gay-Lussac. By means of the modified Reich test it has been demonstrated that the right proportions of nitric oxide and nitrogen peroxide will be present when the percentage of sulphur dioxide entering the Gay-Lussac is between 0.07 and 0.10%, in cold weather, or between 0.09 and 0.12% in moderate or warm weather. Under moderate weather conditions any deviation in the percentage of sulphur dioxide above the high limit of 0.12% indicates an excess of nitric oxide, and any deviation below the low limit of 0.09% indicates an excess of nitrogen peroxide, so that careless handling of the process at the front end of the system will be plainly indicated by testing the gas at the entrance to the Gay-Lussac tower.

The analytical method of controlling the chamber process ought to eradicate that old advice to the chamber operator: "In case of trouble, first increase your nitre at the pots, then find out what is wrong." This advice, advocated by two such authorities as Lange and Falding, is, on the face of it, absurd. How foolish to add more nitre in case of trouble, when the thing that is wrong may be already too much nitre. The rational thing to do in case of trouble is to proceed by the indications of the analytical method. First find out what is wrong by analysis of the gases (thirty seconds of time is all that is needed), then either increase or reduce the quantity of nitre, according to indications.

The analytical method of controlling the chamber system is particularly valuable in starting up a set of chambers after a shut-down, or in starting up a new plant for the first time. It has been the experience of most chamber-plant owners that in starting up a plant a period of experimentation must elapse, varying from two weeks for an old plant to several months for a new one before the chambers settle down to regular work. The reason for this is that nobody knows, in starting up a plant, what is wrong, because the time-tried methods are useless while the process is upset. The analytical method of control, on the other hand, indicates precisely what is wrong, and indicates to what extent it is wrong, thus permitting the proper remedy to be applied, in the correct proportions. By means of the analytical method of control the immense plant of the Tennessee Copper Company has been repeatedly put into regular working condition, after a shut-down, within thirty-six hours. The new 400-ton plant of this company, started for the first time last July, and using the analytical method of control from the start, was in regular working condition forty-eight hours after the gas was first admitted to the Glover tower.

ECONOMY OF FOOD WHICH MIGHT BE EFFECTED BY THE PROHIBITION OF BREWING.

REPORT OF COMMITTEE OF THE ROYAL SOCIETY.

At the request of the President of the Board of Trade, a Committee was appointed by the Royal Society to consider the question of the food supply of the United Kingdom. One section of the report

of this Committee deals with the economy in food materials which would be rendered possible if brewing were prohibited. In 1916-17, under the "Output of Beer (Restriction) Act of 1916," a maximum of 26,000,000 barrels per annum of original gravity 1055° was allowed to be brewed. (It may be noted here that by an order of the Food Controller, the output for 1917-18 has been further reduced to 18,200,000 barrels.) The figures for consumption of brewing materials in 1916-17 were not available, but taking an average of the years 1911 to 1914, and assuming the same proportions of materials to have been used, it is calculated that the 26,000,000 barrels would require 38,200,000 bushels of malt, 59,000 bushels of malted corn, 1,090,000 cwt. of rice, grits, etc., and 2,320,000 cwt. of sugar. From these figures it is estimated that the materials contained 13,500 metric tons of nitrogen and 3,935,000,000,000 calories, whilst the products obtained are computed to have contained 12,590 tons of nitrogen and 3,267,000,000,000 calories, a loss of 6.7 and 17.0% respectively. About half the nitrogen loss is accounted for in the precipitate produced on boiling the wort and filtered off with the spent hops, and part of the loss in heat value occurs by oxidation during malting and fermentation.

It is recognised that it is not possible to utilise as human food the whole of the materials used in brewing. The sugar could be utilised, but barley would not be likely to yield more than 60% of its weight of flour, the remainder being only of indirect value as food for pigs. Direct experiment has convinced the Committee that wheat flour containing 15% of barley flour will yield a palatable loaf. It would also be possible to utilise the grits as human food. On this basis, allowing for the conversion of barley offals into pig flesh, it is estimated that the amount of human food obtainable from the whole of the brewing materials used in 1916-17 would contain 9250 metric tons of nitrogen and 2,822,000,000,000 calories, i.e., 68.5 and 71.7% respectively of the amounts in the original materials.

Dealing with the extent to which the nutritive value of the various brewery products can be realised, it is stated that brewers' grains, malt culms, and dried yeast cannot be used directly as human food, but they give their best return when converted into milk, in which case it is estimated, that 2 lb. of mixed brewers' by-products will yield 1.07 lb. of milk.

In view of the difficulty of assessing the value to the human body of the nitrogen and calories in beer, the yield of human food has been estimated, (A) allowing full calorific value for the alcohol and taking the beer at full protein value for the nitrogen; and (B) allowing no calories for alcohol and 50% of the value for protein. These calculations work out as follows:—

	(a)		(b)	
	Protein, metric tons	Million Calories.	Protein, metric tons	Million Calories.
Beer.....	17,900	2,200,000	8950	990,000
Culms, grains, and yeast	5,970	107,000	3070	107,000
Total	22,970	2,307,000	14,020	1,097,000
Percentage of original materials available	27%	59%	16.6%	27.9%

As it is certain that alcohol has some food value, the energy yield to the body lies between these two extremes. It is concluded that the loss of energy in the brewing process lies between 41% and 72%, and that the loss of protein is at least 73% (com-

pared with 29% and 32%, respectively, estimated when the materials are used as or converted into human food).

It is pointed out that if the production of beer is prohibited, the quantities of human food specified above will only be realised if the materials are used as stated, *i.e.*, barley for flour, etc. If their destination is not controlled the greater part would probably be used as food for live stock, in which case the maximum protein and calorie yields would be 17% and 15% respectively.

REGISTRATION OF BUSINESS NAMES.

A very large number of firms and persons carrying on business in the United Kingdom will be affected by the Registration of Business Names Act, 1916, which is now in force. For many years there has been a strong feeling amongst Chambers of Commerce and others that some legislation should be brought into effect which would make public the actual names of the partners of firms and businesses having designations which give no hint as to their identity; this feeling was accentuated on the outbreak of the present war, when accurate knowledge as to enemy firms was desired, and the result was the introduction of the Registration of Firms Bill, in 1911. After much amendment this Bill gave place to the present Act, which received the Royal assent on December 22nd, 1916.

The Act provides that "every firm having a place of business in the United Kingdom and carrying on business under a business name which does not consist of the true surnames of all partners who are individuals and the corporate names of all partners who are corporations without any addition other than the true Christian names of individual partners or initials of such Christian names," must register before March 22nd at offices to be set up in London, Edinburgh, or Dublin. The same applies to every individual trading under a name other than his own, and also to an individual who has changed his name or a firm of which a member has changed his name. It is not, however, necessary to register where the addition to a name merely indicates that the business is carried on in succession to a former owner, or where two or more partners have the same surname and have added to it the letter *s*, or again where the business is carried on by a trustee in bankruptcy or by a receiver or manager appointed by any court. Again, Section 2 of the Act provides that where a firm, individual, or corporation having a place of business in the United Kingdom carries on the business wholly or mainly as nominee or trustee of or for another person, or other persons, or another corporation, or acts as general agent for any foreign firm, the first-mentioned firm, individual, or corporation must be registered. The registration, which must

be made on prescribed forms, obtainable at Post Offices, and bearing a 5s. stamp, must disclose the business name, the general nature and principal place of business, the full name or names of individuals or partners, former names, nationality (and nationality of origin, if different), usual residence, and other business occupations, if any. Where a business is carried out under two or more business names, each of those business names must be stated. When any change is made in any of the particulars registered, particulars as to the nature and date of the change must be furnished.

It is further provided that where a business is carried on under a name containing the word "British" or other word which, in the opinion of the registrar, indicates that the business is under British ownership and control, and the registrar is satisfied that this is misleading, he shall refuse to register the name or shall remove the name from the register; the decision of the registrar may be appealed against to the Board of Trade, whose decision will be final.

The Act contains another important provision regarding the publication of true names, which is to the effect that, after March 22nd, every individual or firm required to be registered must mention on all catalogues, trade circulars, show-cards, and business letters, the present Christian name or names (or initials) and the present surnames, any former Christian names and surnames, the nationality if not British, and nationality of origin, of each individual or partner. The London Office of the Registrar of Business Names for England and Wales is at 39, Russell Square, London, W.C.

It should be noted that Limited Companies or Corporations do not come within the scope of this Act, excepting where they are acting as "nominee or trustee" or as "general agent" as set forth in Section 2 (see above). The following are cases in which registration will be necessary:—Henry Lewis, carrying on business as H. Lewis and Co., or as P. Lewis, or as H. Smart; H. Lewis and R. Carter, trading as Lewis, Carter and Co., or as Lewis, Smart and Co., or as The United British Chemical Works; H. Lewis (formerly Levi), carrying on business as H. Lewis; a firm in which Lewis (formerly Levi) is a partner must also register. Another case is where Lewis carries on the business of Lewis and Carter; here he must either register, or trade as Lewis or as Lewis, late Lewis and Carter. Again, if Henry and John Carter are partners, they may style themselves Carter and Carter, or Carters, but not Carter and Son or Carter Brothers without becoming liable to registration.

These few examples, and the brief description given above, will serve to show the far-reaching effects of this urgently-needed legislative measure, which should prove of great value as a safeguard to the commercial interests of this country in the industrial struggle which will follow immediately on the cessation of hostilities.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.

United States.—1s. each to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—Patent number, date, name of patentee, and title of invention.

French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56 Rue Feron 8, Paris (36.) Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris

I.—GENERAL; PLANT; MACHINERY.

Gases; Absorption of.—W. Hempel. *Z. angew. Chem.*, 1917, 30, 6—11.

The general practice of gas washing is surveyed and particulars are given of the treatment of the flue gases from a Hoffmann brick kiln, which had

a marked destructive action on vegetation. This has been traced to the presence of silicon fluoride in these gases, which contain 0.6 grm. fluorine per cubic metre. The clay used in this works contains 0.16% fluorine. Compared with hydrochloric acid and sulphur oxides, silicon fluoride is difficult to remove from the gases, probably

because of the slowness of the reaction:— $3\text{SiF}_4 + 11\text{H}_2\text{O} + 21\text{H}_2\text{SiF}_6 + \text{Si}(\text{OH})_4$ which precedes absorption. Satisfactory results were obtained by leading the flue gases from the kiln through a cast iron pipe, 24 m. long and 50 cm. in diameter. The temperature fell from 180° to 130°—110° C. thereby, and was further reduced to 30°—40° C. in passing through a fan of special construction containing a water spray. The fan, the axis of which is of cast iron and the blades and casing wood, drove the gases under a pressure of 25 mm. water through a stoneware pipe into a so-called "filter channel." This consisted of a trench dug in the ground, 80 cm. deep and 265 metres long. It was covered in with wooden grids carrying in layers, first coarse stones, then small stones, and on top sand or earth. The flue gases had to traverse this porous filter mass before escaping into the outer air, and in so doing all acid gases and also soot were retained. The removal of the soot from the "filter channel" has to be done only once a year. Dilution of the flue gases from the kiln with air by means of numerous holes in the upper part of a chimney stack was found to be partially effective, but influenced by the direction of the wind. As a new filling material for gas washing apparatus, an artificial pumice stone is suggested (see this J., 1916, 632), which is acid-resistant. Common bottle glass is powdered and mixed with 1% of carbon. The mixture is fused, when a considerable development of gas occurs, so that the melt solidifies on pouring to a bulky, cellular product which floats on water. The filling materials in common use are all much heavier and require correspondingly greater mechanical strength in the construction of the containing apparatus. By using the material described, it is suggested that glass might be employed in the construction of gas-washing plant on the large scale.—H. J. H.

Waste heat for steam generating purposes: Utilisation of —. A. D. Pratt. *Met. and Chem. Eng.*, 1916, 15, 696—708; 1917, 16, 27—31.

The development and use of the modern waste heat boiler is considered in connection with open-hearth steel furnaces, cement kilns, furnaces for smelting and refining copper, beehive coke-ovens, and furnaces for heating and miscellaneous uses. Numerous constructional and other details are given, with data relating to various installations. In modern waste heat practice which has been developed mainly in connection with the utilisation of low-temperature gases from regenerative furnaces, an induced draught is used to produce the gas velocity necessary for a satisfactory rate of heat transfer; in certain classes of work such draught has the additional advantage of improving the operation of the primary furnace. In most cases the saving effected by the use of waste heat boilers lies mainly in the value of the power produced by the steam generated. At the present time such boilers are most largely employed with open-hearth steel furnaces, and, in this connection, have been the means of reducing the net cost of producing steel by 20–25c. (10d.—1s. 0½d.) per ton.—W. E. F. P.

Colloidal graphite in oil. Holde. See VII.

PATENTS.

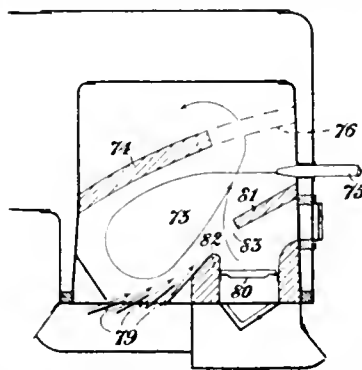
Furnaces: Apparatus for feeding pulverulent fuel to —. J. E. Muhlfield, Scarsdale, and A. Z. Caracristi, Bronxville, N.Y., U.S.A. Eng. Pat. 13,007, Sept. 13, 1915.

Is apparatus for feeding pulverulent fuel such as coal, coke, lignite, or peat to furnaces for domestic, industrial, metallurgical, or transport use, the fuel is fed by a screw conveyor of increasing pitch toward the delivery end, on to radial or

helical blades carried by the conveyor shaft, and thence into the air blast nozzle. Other forms of apparatus are also described. (1) The air blast nozzle may surround the conveyor tube and may itself be surrounded by a return screw conveyor extending further forward into the mixing nozzle. Any excess of fuel is thus conveyed back and returned to the rear end of the forward conveyor. (2) The air blast is supplied from an annular surrounding chamber through jet holes in the wall of the return conveyor in advance of the forward end of the forward conveyor. (3) The air blast is so delivered as to fill only the lower half of the mixing nozzle, and the fuel is delivered on to the top of the air stream; a return conveyor is arranged below the mixing nozzle. (4) The fuel is supplied by measuring drums to the mixing chamber. (5) The fuel is fed downward from the supply hopper by vertical screw conveyors in separate tubes which extend into a diverging mixing chamber through which air is blown; the tubes are progressively shorter as the mixing chamber diverges.—W. E. F.

Furnaces fed with pulverulent fuel. K. H. W. von Porat, Stockholm, and Metala Verkstads Nya Aktiebolag, Metala Verkstad, Sweden. Eng. Pat. 103,097, Nov. 18, 1915. (Appl. No. 15,150 of 1916.)

PULVERULENT fuel is injected by the pipe, 75, into the mixing chamber, 73, where it is deflected, as shown, by the plates, 74, 82, and 81. Air for combustion is drawn in through the louvres, 79,



so as to mix with the fuel jet, which is ignited by a fire on the grate, 80, through the restricted opening, 83. The combustion gases pass to the boiler tubes through openings on each side of the central member, 76. In a modification the pipe, 75, extends through the space below the grate, 80, into the bottom of the mixing chamber where it diverges correspondingly with the walls of the chamber. In another modification the pipe, 75, projects the fuel jet first downward along the plate, 81, and then upward along the plate, 74. A single damper-controlled air opening is provided at the turning point of the fuel jet. (See also Eng. Pat. 16,298 of 1915; this J., 1916, 1251.)—W. E. F.

Furnaces: Gas-fired crucible —. R. Halkett, Glasgow. Eng. Pat. 103,232, Apr. 20, 1916. (Appl. No. 5781 of 1916.)

A GAS-FIRED crucible furnace is provided with a permanent brickwork lining, in which the gas and air supply pipe to the burners is embedded to pre-heat the fuel. The pipe is provided with outside connections to the removable burners. The crucible is supported on a block of graphite resting on a refractory lining carried by a removable base-plate, and an inclined outlet is provided for running off material in case of breakage of the

crucible. The brickwork is lined internally with a refractory composition consisting of fireclay or ball clay, 75%, alumina, 5%, sawdust, 5%, sodium silicate, 5%, and water, 10%.—W. F. F.

Furnace. A. W. Moyer. New York. U.S. Pat. 1,209,321, Dec. 19, 1916. Date of appl. Sept. 25, 1915.

A FURNACE is divided by a perforated horizontal arch, into an upper combustion and a lower heating chamber. The upper chamber is supplied with liquid or gaseous fuel under pressure and the products of combustion pass down through the perforated arch into the heating chamber below. The side walls of the lower chamber have ports for the discharge of the waste gas, but no other openings, so that they present a large surface to store up and radiate heat.—W. H. C.

Furnace-hearths: Mounting —. F. Wedge. Ardmore, Pa. U.S. Pat. 1,209,914, Dec. 26, 1916. Date of appl. Apr. 13, 1915.

AN annular furnace comprises an inner rotating cylindrical wall built up of blocks supporting annular outwardly projecting hearths, and an outer fixed concentric wall with inwardly projecting hearths alternating with the revolving hearths. The revolving hearths pass through the supporting wall and have an inner portion bearing against the inner face of the wall. The outer hearths rest on fulcrum blocks in the inner face of the supporting wall and are provided with retaining blocks above them, within the wall at a greater radius from the centre.—W. F. F.

Nitric acid vacuum pumps: Means for packing the pistons of —. S. Dreyfus, Denton. Eng. Pat. 102,527, Jan. 26, 1916. (Appl. No. 1216 of 1916.)

THE packing consists of an annulus, *a*, of vulcanised rubber, channel-shaped in cross-section, and bevelled on the exterior, which is placed between the bevelled sides of a recess formed by the two halves, *b*¹, *b*², of the piston. This recess is provided with an inflatable rubber tube, *c*, which, on being filled with air or other fluid, keeps the packing in close contact with the cylinder. The rubber is practically acid-proof.—E. H. T.

Gases: Apparatus for purifying, cooling, and mixing —. H. E. Theisen, Munich, Germany. Eng. Pat. 103,133, Jan. 6, 1916. (Appl. No. 225 of 1916.)

AN apparatus of the type described in Eng. Pat. 22,433 of 1910 (this J. 1911, 1045), in which concentric rings of beaters revolve in opposite directions, the beaters are formed like turbine blades so that the fluid is transferred from one set to the next with the maximum change of direction and the minimum of shock, and consequently with the minimum loss of energy.—W. F. F.

Gases or superheated steam: Automatic regulation of the temperature of —. P. A. W. Parkyn, London. Eng. Pat. 103,196, Feb. 16, 1916. (Appl. No. 2316 of 1916.)

A CLOSED tube containing mercury or other liquid

projects into the main through which superheated steam is passed. An inner tube opening at the bottom into the mercury is provided with a piston or float, so that a change of volume of the liquid due to a change of temperature in the main moves the piston. The piston is connected by levers to a stop valve which controls the admission of saturated steam to the main until the temperature is brought back to a predetermined value.

—W. F. F.

Slimes: Method of and apparatus for treating —.

D. Cole, Tucson, Ariz. U.S. Pats. (A) 1,205,326 and (B) 1,205,327, Nov. 21, 1916. Dates of appl. (A) Apr. 12, 1913. (B) Mar. 21, 1915.

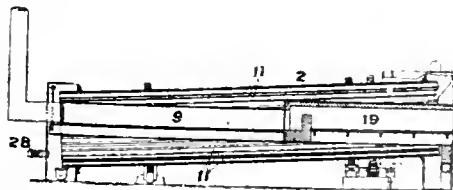
(A) For the separation of crystalloids from slimes which tend to become flocculent, the slime mixture is diluted sufficiently to allow the crystalloid particles to settle, and passed in a slow stream through a shallow trough in which the crystalloid particles settle out before the slimy matter has time to deposit. (B) The apparatus consists of a shallow tank, allowing of a transverse flow of liquid. Slime is introduced at one side of the tank in an extended shallow stream, and several adjacent endless conveyor belts, running on pulleys, travel horizontally on the bottom of the tank, transversely to the direction of flow, the return run of the belts passing outside the tank. Adjacent belts can be made to travel at different speeds and in opposite directions, to prevent the formation of disturbing currents. A pair of superposed tanks may also be used, the belts dipping into one tank in one direction, and into the other in the reverse direction.—W. R. S.

Elutriation: Process of fractional — of simple or mixed substances. W. Aegher, Berlin. Ger. Pat. 291,908, Nov. 13, 1913.

THE substances are subjected to a mechanical elutriation process in an aqueous solution of an organic non-electrolyte which depresses the surface tension. The following substances, both colloidal and non-colloidal, exert a marked deflocculating action—egg albumin, peptone, gelatin, tragacanth, agar, rubber, glue, saponin, cyclamine, amygdaline, amyl alcohol. In general the action increases with molecular weight. The process can be applied to ochre, chalk, barytes, *blanc fixe*, lithopone, white lead, talc, graphite, clay, kaolin, and metallic powders and oxides such as are used for catalytic processes.—H. J. H.

Revivifying char: Apparatus for —. R. S. Kent, Brooklyn, N.Y. U.S. Pat. 1,207,178, Dec. 5, 1916. Date of appl. June 25, 1913.

CHAR is passed through an inclined rotary conveying drum, 2, in which is fitted a stationary furnace, 19, entirely within the drum. Heating



gases pass from the furnace through the conduit, 9, out of contact with the char, which is raised and showered within the drum by the ribs, 11. A gaseous medium may be admitted to the interior of the drum through the pipe, 28, to alter the carbon content of the char.—J. E. C.

Aerating apparatus. C. H. Nordfl, Milwaukee, Wis. U.S. Pat. 1,208,821, Dec. 19, 1916. Date of appl. Mar. 23, 1916.

A FALSE bottom, formed of slabs of wood cut

across the grain, is fitted in a tank, leaving an air chamber below. The liquid is placed in the tank above the false bottom and air is forced into the lower space and passes up through the "fibrous passages" in the wooden slabs into the liquid above.—W. H. C.

Heat of chemical action: Method and apparatus for conserving — C. S. Bradley, New York, U.S. Pat. 1,209,258, Dec. 19, 1916. Date of appl., Feb. 26, 1915.

REVERSIBLE chemical reactions which are endothermic in one direction and exothermic in the opposite direction, are conducted in a closed system so that the heat evolved in the exothermic part of the reaction is conserved and retained in the system.—W. H. C.

Retort. J. F. Wells, Seattle, Wash. U.S. Pat. 1,209,365, Dec. 19, 1916. Date of appl. May 21, 1915.

THE joint between the door and door casing of the retort is made tight by suitable elastic packing material, which will give way when exposed to excessive pressure.—W. H. C.

Radiant heat; Apparatus for utilising. C. I. Gessell, Buenos Aires, Argentine, U.S. Pat. 1,209,956, Dec. 26, 1916. Date of appl., Aug. 9, 1916.

A PORTION of the surface layer of a large expanse of water exposed to the sun's heat is isolated by a floating partition wall, which also carries suitable means for covering the surface of the isolated portion of water and preventing loss of heat. The warm surface water is conducted through a vaporising apparatus and its heat is used to vaporise a liquid. The vapour is condensed by, and gives up heat to, the cooler water from below, flowing upwards to replace the warm water.—W. H. C.

Drying and cooling substances: Apparatus for — G. H. Hess, La Grange Park, Ill. U.S. Pat. 1,210,166, Dec. 26, 1916. Date of appl., Mar. 20, 1915.

THE material to be dried is fed continuously into a vertical rack provided with inclined plates to support the material. The inner edges of the plates do not extend quite to the median line of the rack, and the distance between the inner edges of adjacent plates decreases gradually from the bottom to the top of the rack. The material is withdrawn from the rack at a controlled rate while air is passed through it.—W. F. F.

Drying room and apparatus. O. Lilly, Memphis, Tenn. U.S. Pat. 1,211,325, Jan. 2, 1917. Date of appl., May 15, 1916.

A DRYING room is provided with a perforated horizontal partition below the ceiling, and another above the floor. The drying medium is admitted above the upper partition, passes downwards over independently controlled heating pipes as it enters the drying chamber, and is finally exhausted from the space below the lower partition.—W. F. F.

Dryer; Cylindrical — with concentric inner cylinder. W. Freytag, Dortmund, Ger. Pat. 295,016, July 30, 1915.

THE material to be dried passes with a current of air first along the inner cylinder and then back along the outer annular space, through which the hot gases from a heating furnace travel. A baffle at the end of the inner cylinder prevents the entry of heating gases which travel with the material in the outer space.—H. J. H.

Solution-specific-gravity-regulating apparatus. L. Logan, Syracuse, N.Y. U.S. Pat. 1,210,180, Dec. 26, 1916. Date of appl., July 12, 1916.

THE supply of the materials which, when mixed, form the desired solution, is controlled by electrical means actuated by floats supported by a balance beam. One float is supported in a solution having the desired sp. gr. and the other in a vessel through which the other solution or a portion of it flows. Both vessels are maintained at the same temperature, and any variation in the sp. gr. of the solution causes a rise or fall of the float, and the resulting movement of the beam actuates the electrical controlling device.—W. H. C.

Catalysers: Method of making — M. Reynolds, St. Elmo, Tenn. U.S. Pat. 1,210,367, Dec. 26, 1916. Date of appl., Feb. 18, 1916.

UNREDUCED catalytic material is exposed to the action of a reducing gas, including carbon monoxide, which is non-explosive in the presence of oxygen.—W. H. C.

Decanting apparatus. J. H. Alpenfels, Denver, Colo. U.S. Pat. 1,210,392, Jan. 2, 1917. Date of appl., Feb. 5, 1916.

THE apparatus comprises a series of settling vats each provided at the bottom with an outlet for the settled solids and at the top with several outlets for the liquid, connected with a gutter formed in the upper edge of the wall of the vat. Filter screens are placed over the liquid outlets to prevent any solid matter entering the gutter.—W. H. C.

Liquids: Separating the component parts of — E. J. Sheehan, Assignor to W. S. McCay, Pasadena, Cal. U.S. Pat. 1,211,361, Jan. 2, 1917. Date of appl., Feb. 8, 1915.

LIQUIDS extracted from vegetable, animal, or mineral matter are cooled and agitated until one of the constituents solidifies. The liquid is sterilised by contact with ozone, and the solid and liquid parts separated.—W. F. F.

Boiler compound. V. J. Melsted, Winnipeg, Canada. U.S. Pat. 1,210,965, Jan. 2, 1917. Date of appl., Dec. 10, 1913.

A MIXTURE of comminuted metallic mercury, and a "separating substance," liquid at ordinary temperatures, such as petroleum.—W. F. F.

Vacuum mixing machine for substances sensitive to pressure and friction. A. Wilhelm, Benthien, Ger. Pat. 294,776, Feb. 28, 1915.

THE mixer consists of a circular covered pan, jacketed to permit of temperature regulation. Mixing is effected by an agitator which hangs from a bearing in the lid of the apparatus where a gas-tight joint is made by the use of a mercury seal. The amount of clearance between the agitator arms and the sides of the pan can be carefully regulated, thus avoiding any contact.—H. J. H.

Separation of adsorbed, colloidal, soluble, or finely divided substances from substances carrying them. Elektro-Osmose A.-G. (Graf Schwerin Ges.), Berlin. Ger. Pat. 295,043, Jan. 26, 1915. Addition to Ger. Pat. 265,628 (see Eng. Pats. 14,369 and 24,666 of 1912; this J., 1913, 241, 432).

THE passage of feebly migrating substances through the diaphragm is facilitated by stirring. The deposition on the diaphragm of layers which impede the migration is thereby hindered, and the substance can come into the sphere of action.—H. J. H.

Colloidal solutions; Production of stable—
Aktiebolaget Kolloid i Likvidation, Stockholm.
Ger. Pat. 295,161, Mar. 31, 1914. Under Int.
Conv., Dec. 18, 1913.

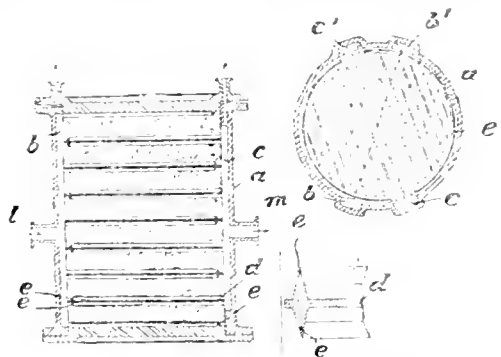
THE substance taken—*e.g.*, wool fat, resin, castor oil, or phosphorus—is exposed to the action of a liquid, in which it is normally insoluble, at a suitably chosen high temperature and corresponding pressure, for a sufficient time, and then rapidly cooled under normal pressure. This gives a colloidal solution stable at ordinary temperatures. A protective electrolyte may be added to produce smaller particles and accordingly greater permanence of the colloidal solution.—H. J. H.

Filtrating apparatus. C. and J. Garnatz, Berlin.
Ger. Pat. 295,221, Mar. 28, 1915.

THE lower part of the filter is a shallow inverted cone offering a large filtering surface, the upper part being dome-shaped with a wide neck. The liquid to be filtered is in an inverted bottle, the neck of which is placed in the neck of the filter; the level of the liquid in the filter is thus kept constant until the bottle is empty.—B. V. S.

Liquid filter with grids and filtering medium arranged in a closed chamber. A. Lippert, Berlin-Pankow.
Ger. Pat. 295,215, Feb. 22, 1916.

A CYLINDRICAL chamber, *a*, which can be closed at both ends, has two or more longitudinal grooves, *b*, *b'*, *c*, *c'*, from end to end, one side connecting with the inlet tube, *l*, and the other with the outlet tube, *m*. Circular filter grids, *d*, separated by



the filtering medium, are arranged in the chamber. They have flanged edges, *e*, with gaps corresponding with one set of grooves in the wall of the chamber; the gaps are so arranged with respect to the grooves that the grids communicate alternately with the inlet and the outlet grooves. Pressure can be applied so as to pack the filtering medium tight enough to prevent leakage.—B. V. S.

Roasting and like furnaces; Automatic charging devices for—A. Mond, London. From Metallbank and Metallurgische Ges., Frankfurt, Germany. Eng. Pat. 100,259, Jan. 18, 1916. (Appl. No. 788 of 1916.)

Centrifugal machines and methods. L. P. Sharples, West Chester, Pa., U.S.A. Eng. Pat. 100,342, Jan. 18, 1916. Under Int. Conv., Apr. 27, 1915. (Appl. No. 819 of 1916.)

SEE U.S. Pat. 1,207,230 of 1916; this J., 1917, 123.

Powder and other hygroscopic substances; Method and apparatus for protecting from moisture. Scovill Manufacturing Co., and R. S. Sperry, New Haven, Conn., U.S.A. Eng. Pat. 101,961, May 20, 1916. Under Int. Conv., Oct. 23, 1915. (Appl. No. 7231 of 1916.)

SEE U.S. Pat. 1,178,187 of 1916; this J., 1916, 623.

Furnaces. R. Niedergesaeess, Seattle, Wash., U.S.A. Eng. Pat. 103,228, Apr. 17, 1916. (Appl. No. 5602 of 1916.)

SEE U.S. Pat. 1,185,526 of 1916; this J., 1916, 729.

Filtrating apparatus. K. Kiefer, Cincinnati, Ohio, U.S. Pat. 1,211,917, Jan. 9, 1917. Date of appl., Apr. 8, 1913.

SEE Eng. Pat. 14,136 of 1913; this J., 1911, 632.

Means for the gradation of coal and other materials. Eng. Pat. 103,230. See II.A.

Apparatus for heating or melting and delivering resin or other material. Eng. Pat. 102,835. See XIII.

II.A.—FUEL; GAS; MINERAL OILS AND WAXES.

Board of Fuel Research; Appointment of

A BOARD of Fuel Research has been appointed by the Committee of the Privy Council for Scientific and Industrial Research, on the recommendation of their Advisory Council. Sir George Beilby, F.R.S., has consented to act as Director of the new organisation, and he will be assisted by the Hon. Sir Charles Parsons, K.C.B., F.R.S., Mr. Richard Threlfall, F.R.S., and Sir Richard Rednayne, K.C.B., Chief Inspector of Mines, as Members of the Board. It will be the work of the Board to investigate the nature, preparation, and utilisation of fuel of all kinds, both in the laboratory and where necessary on an industrial scale. Sir George Beilby, with the assistance of his Board, will be responsible for drawing up schemes of research into these problems, and when the schemes have been approved by the Advisory Council and the Committee of the Privy Council, authority will be given him to carry them into effect. By arrangement with the Governors of the Imperial College of Science and Technology, the Lord President has retained Professor W. A. Bone, F.R.S., as Consultant to the Board of Fuel Research under the Department of Scientific and Industrial Research.

Brown coal deposits in Victoria. Board of Trade J., Feb. 15, 1917.

THE existence of brown coal at Morwell, Victoria, is well-known, but it appears that until quite recently no coal has been produced in the locality for nearly twenty years. Previously, various attempts had been made to develop the field on a commercial basis, but for various reasons, success was not achieved. The need of additional sources of fuel supply has once more directed attention to the Morwell deposits. There are several outcrops in the locality, but that which is now being prepared for coal-winning is the Great Morwell seam, which outcrops in a gully at the foot of thickly-timbered hills. All the coal that has been won so far has been from an open cutting; at the present stage of development a mine does not exist, though one may be opened up later on. The State Mines Department has made preparations for exhaustive preliminary tests, in which it is hoped to show that crushed brown coal is suitable for boilers and furnaces of the open-hearth type for steel-making. Gas-making tests which have been made are stated to be encouraging. The coal has also been used for briquettes, and it is reported that in this form it can compete with black coal for steam raising.

Oil shales: The Norfolk — W. Forbes-Leslie. J. Inst. Petrol. Tech., 1916, 3, 3—35.

A RECORD of research on the Norfolk portion of the Kimmeridge outcrop. Geographical, geological, and historical details are given concerning the English shale fields. The physical characteristics of the upper and lower layers of the Norfolk shales are described in detail. In the latter the presence of resinous substances can be detected by the microscope. When crushed to 30-mesh size the sp.gr. of the Norfolk shale is 1.55. When shaken with ether the shale yields 1% of oil; carbon bisulphide extracts only 0.25%. The oil also exudes when the shale is wetted. In three specimens the volatile organic matter varied from 31.7 to 35.1, the ash from 39.8 to 46.8, and the moisture from 4 to 10%. The inorganic matter has also been determined in both the original and the spent shale. The sulphur content varies from 4.3 to 7.8%, and much of this remains in the spent shale. The yellowish-black mobile oil has sp.gr. 0.942 to 0.960. The yield is 10 gallons to the ton, together with 66 lb. of ammonium sulphate and 25,000 cubic feet of dry gas. The oil yields a considerable quantity of motor spirit, 3 to 4% of phenols, and a similar amount of benzene and toluene. A large proportion of the oil distills from the shale below 300° C. Laboratory experiments show that the sulphur in the oil can be reduced to below 3%, while it seems that some oils containing as much as 4% of sulphur can be used in internal combustion engines. Calculations based on the extent and thickness of the Dorset and Norfolk shale beds indicate very considerable additions to the oil resources of the United Kingdom.—F. C.

Petroleum and asphalt: Nature and origin of — C. Richardson. Met. and Chem. Eng., 1917, 16, 25—27. (See also this J., 1916, 244.)

THE compositions of gases from the Trinidad asphalt deposit and oil wells in the vicinity are compared with those of natural gases from various American States, and it is pointed out that in the California gases associated with highly asphaltic oils, the methane and ethane are nearly as variable as in the Trinidad gases, and that both series are characterised by a high percentage of carbon dioxide. The latter constituent is not found in gases associated with purely paraffin oils, and it is suggested that carbon dioxide may be a determining factor in the production of asphaltic hydrocarbons by contact action between the gases and the oil "sands." In cases where natural gas occurs unassociated with petroleum, it must be assumed that the gas does not remain long enough in contact with the "sands," or that the contact surfaces are unsuitable in character or extent, for condensation to be effected.—W. E. F. P.

Hydrocarbons: Pyrogenesis of — E. Lomax, A. E. Dunstan, and F. B. Thole. J. Inst. Petrol. Tech., 1916, 3, 36—120.

THE first thirty-five pages of this paper contain perhaps the most complete summary yet published of the work which has been done on the subject. Over 150 references and a chronological list of patents are appended. The processes of Hall, Rittman, Lucas, Burton, and Redwood and Dewar receive special notice. In the second part the effects of varying the temperature and pressure during cracking experiments are considered from the standpoint of thermochemistry and Le Chatelier's rule. In the majority of commercial processes the tendency is for the formation (at about 500° C.) of a mixture of paraffins and olefines, while at about 700° C. aromatic compounds are produced. The general effect of excessively high pressures is to bring about reactions at low temperatures, which otherwise

would require more drastic heating. The influence of catalysts is fully dealt with, as is also the effect of various anhydrous metallic halides. It seems probable that the particular material to be cracked has little influence on the nature of the final products. Cracked oils always contain paraffins, cycloparaffins, olefines, diolefines, and aromatic hydrocarbons, while in the gas produced hydrogen, gaseous paraffins, olefines, and diolefines, together with small amounts of the vapours of volatile liquid products occur. Erythrene appears to be almost always formed. A paraffin hydrocarbon yields on cracking an olefine and a lower paraffin. The olefine may then be similarly degraded to lower olefines and finally to ethylene. It also may isomerise, forming a cycloparaffin or naphthene, from which a side chain may be eliminated as a paraffin hydrocarbon. The olefine also yields erythrene which partly polymerises; finally hydrogen and carbon are produced from the olefine and may unite to form methane. Acetylene is produced from ethylene at about 570° C., and may give rise to aromatic hydrocarbons. Bone and Coward's theory of nascent radicals (this J., 1908, 886) is of importance in cracking operations at high temperatures since $\cdot\text{CH}_3$, $\cdot\text{CH}_2$, and $\cdot\text{CH}$ may give rise to aromatic, hydroaromatic, and paraffin hydrocarbons respectively. Finally there may be condensation of two or more molecules of a hydrocarbon with loss of hydrogen. The production of yellow resinous explosive substances when cracked oils are stored is due to the presence of diolefines, which are produced to a greater extent the higher is the temperature.—F. C.

Paraffin hydrocarbons: Stability of — G. Egloff and R. J. Moore. Met. and Chem. Eng., 1917, 16, 47—51.

AS the result of cracking at 700° C., five successive fractions of a paraffin-base petroleum, the third fraction, boiling between 200° and 250° C., and consisting mainly of paraffins ranging from $\text{C}_{12}\text{H}_{26}$ to $\text{C}_{14}\text{H}_{30}$, was found to be the least affected; while the first fraction, boiling up to 150° C. and composed of much simpler hydrocarbons, was the most changed. The general belief as to the greater stability of the simpler hydrocarbons at high temperatures is thus no longer tenable.—W. E. F. P.

Naphthenes: Action of sulphur on — under pressure. W. Friedmann. Petroleum, 1916, 9, 978—982. Z. angew. Chem., 1916, 29, Ref., 531.

FRACTIONAL distillation *in vacuo* of the product of the action of sulphur on cyclohexane under pressure gave a first fraction, considered to be cyclohexadiene, giving *m*-dinitrobenzene with a nitrating mixture, a second fraction containing thiophenol, considered to be formed from cyclohexene *via* cyclohexadiene, and a residue containing phenyl sulphide. A thiocresol was isolated from the products of the action of sulphur on methylcyclohexane under pressure. In the case of dimethylcyclohexane (octonaphthene), in addition to the formation of hydroxylenes and thioxylenol, xylene itself is produced at one stage and gives *mm*-dimethyldibenzyl. It follows that the presence of aromatic hydrocarbons in petroleum can scarcely be due to the action of sulphur on naphthenes under pressure, as no sample has yet been found to contain thiophenol or a homologous aromatic mercaptan.—F. W. A.

Absorption of gases. Hempel. See I.

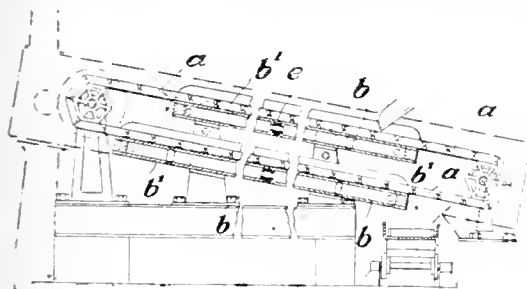
Utilisation of waste heat for steam generating purposes. Pratt. See I.

Some physical properties of the two chief mineral constituents of coke-oven bricks. Fearnside. See VIII.

PATENTS.

Coal; Apparatus for extracting water from —. C. Burnett, Bath. Eng. Pat. 103,031, Mar. 3, 1916. (Appl. No. 3201 of 1916.)

COAL is supplied to the lower end of the upper plate of an inclined hollow steam-heated element, *b*. An endless conveyor, *a*, moves the coal along



the heater till it falls over the edge on to a similar lower heater, along which it is conveyed by the returning part of the conveyor. The heating elements are composed of a series of compartments connected by short conduits, *c*, which have their edges bevelled to accommodate asbestos packing plates, *b'*. The apparatus may be used in conjunction with that described in Eng. Pat. 6911 of 1915 (this J., 1916, 683).—W. F. F.

Coal and other materials; Means for the gradation of —. W. Yates, H. W. S. Martin, and Matthews and Yates, Ltd., Manchester. Eng. Pat. 103,230, Apr. 18, 1916. (Appl. No. 5669 of 1916.)

COAL falls from a hopper in a stream close to the vertical dividing wall between two similar adjacent receptacles. An aperture in the dividing wall immediately below the hopper is adjustable in size by a sliding plate, and air is drawn through the falling stream of coal and through the aperture into the adjoining receptacle. The coarser grade of coal falls into the first receptacle and the lighter portions pass through the aperture. A hinged guide-plate below the outlet of the hopper varies the distance of the stream from the dividing wall, and a curved plate on the farther side of the aperture deflects the lighter portions of coal downwards. The air current is withdrawn by a fan through a pipe opening into the top of the second receptacle, carrying with it the fine coal, which passes into a separator and is collected. The medium grade remains in the second receptacle.

—W. F. F.

Briquettes; Presses for the production of —. E. R. Sutcliffe, Leigh, and Pure Coal Briquettes, Ltd., Cardiff. Eng. Pat. 13,796, Sept. 28, 1915.

IN the operation of presses consisting of a series of cylinders in axial alinement having connected pistons, one of the pistons is balanced by the admission of motive fluid on each side. Towards the end of the forward stroke, the motive fluid in front of this piston is released to augment the pressure on the common piston rod. The movement of the piston is transmitted by hydraulic means to the main plunger of the press. In the event of an abnormal stroke due to shortage of material in the mould, communication with an accumulator is established and the requisite pressure maintained.—J. E. C.

Briquettes; Presses for the production of —. E. R. Sutcliffe, Leigh, and Pure Coal Briquettes, Ltd., Cardiff. Eng. Pat. 102,918, Sept. 28, 1915. (Appl. No. 15,601 of 1916.) (See also Eng. Pat. 20,679 of 1911; this J., 1916, 297.)

IN a vertical hydraulic press, after compression of the briquette, the main plunger is raised by means of a subsidiary superimposed hydraulic cylinder. The liquid from the upper portion of the subsidiary lifting cylinder is forced to an abutment ram cylinder which ejects the briquette from the mould. Means are provided for applying lateral pressure in the mould and for releasing this pressure to allow an upward movement of the abutment ram.—J. E. C.

Fuel; Process of burning —. E. Pohl, New York. U.S. Pat. 1,270,099, Dec. 26, 1916. Date of appl., Feb. 2, 1916.

THE vapour from an exposed surface of a liquid or solid fuel is ignited, thereby heating the fuel and increasing its rate of vaporisation. The flame is then extinguished by a cap enclosing the vapour evolved, which is burnt under pressure in a series of independent jets, the heat from which is utilised to cause continued rapid vaporisation of the fuel.—J. E. C.

Coke ovens or the like; Charging and gas-withdrawing means for —. A. Roberts, Chicago, U.S.A. Eng. Pat. 103,169, Jan. 18, 1916. (Appl. No. 815 of 1916.)

IN a coke oven, a series of charging openings are connected by side branches to a common gas-collecting main. During charging operations a substantially air-tight joint is produced by the insertion of a funnel or equivalent device, to separate the coke-oven chamber from the gas-collecting main.—J. E. C.

Coke ovens and the like, and treatment of gases therefrom. A. Roberts, Chicago, U.S.A. Eng. Pat. 103,243, Jan. 18, 1916. (Appl. No. 7034 of 1916.)

IN connection with the gas-collecting main described in the preceding abstract, a series of sprays is arranged for preliminary treatment of the gases with oil, emulsion, or the like. The sprays are preferably arranged in staggered relation to one another, and a trap or the like is fitted for the removal of excess fluid.—J. E. C.

Coke-oven construction. *Coke-oven.* G. E. Thackray, Westmonthorough, Pa. U.S. Pat. (A) 1,211,502 and (B) 1,211,503, Jan. 9, 1917. Dates of appl. (A) Oct. 28, 1913, and (B) Sept. 2, 1916.

(A) IN a horizontal coke oven with vertical heating flues, a series of regenerators extends longitudinally under each oven, the regenerators under the end portions being shorter than those under the central portion. Separate gas supplies are admitted to the sections supplied by the various regenerators. (B) The lower end of each heating flue rests upon a base block, a burner being formed in each block, and there is a recess beneath the burners on the under side of each base block. Gas is fed to these burners by distributing pipes of varying lengths, whilst air is admitted by side ports decreasing in size from the ends of the oven. The floor of the oven is formed of blocks separated from the side walls to form expansion joints.—J. E. C.

Coke-oven gases; Treatment of —. J. I. Brunn, Assignor to Rombacher Hüttenwerke, Rombach, Germany. U.S. Pat. 1,211,395, Jan. 9, 1917. Date of appl., Oct. 11, 1916.

A COMPRESSED gas for lighting, heating, and welding is produced from previously treated coke-

oven gases by passing the latter through a substance capable of absorbing carbon dioxide, then through one capable of absorbing ethylene, then liquefying the remaining gases with the exception of hydrogen and nitrogen.—J. E. C.

Gaseous mixtures; Complete combustion of —. A. C. Ionides, jun., London. Eng. Pat. 102,983, Jan. 1, 1916. (Appl. No. 129 of 1916.) (See also Eng. Pat. 15,758 of 1913; this J., 1911, 821.)

IN a multi-burner heating device the separate constituents of a self-burning gaseous mixture are fed from capacious conduits to a series of adjustable mixing devices. Means are provided in at least one of these conduits for adjusting the flow, whilst the mixing devices comprise means for creating vortices in the current of mingled fluids.—J. E. C.

Gas producer. J. A. Herrick, New Rochelle, N.Y. U.S. Pat. 1,210,171, Jan. 2, 1917. Date of appl., Sept. 26, 1913.

IN a gas producer having two rotatable sections, means for driving one of the sections and for coupling the sections together at will are provided. One section encloses the combustion zone, the other the ash zone, and a non-circular tuyere-box extends into the ash zone.—J. E. C.

Oils; Vaporising for use in high speed internal combustion engines. W. A. Hall, London. Eng. Pat. 102,388, Jan. 6, 1916. (Appl. No. 231 of 1916.)

LIQUID fuel, such as paraffin oil, is passed through a coil surrounding the exhaust pipe of the engine. This coil is housed in a chamber, packed with a fusible salt or alloy, the latent heat of solidification of which is utilised during low load periods.—J. E. C.

Petrol; Refining of—by distillation. C. A. Kühn, Williamsburg, Ont., Canada. Eng. Pat. 102,903, Aug. 10, 1916. (Appl. No. 11,306 of 1916.)

A METHOD of refining petrol by distillation consists in heating it in a tank surrounded by a water jacket, the latter being provided with means for indicating the steam pressure. Vapours from the petrol are condensed in a refrigerating chamber.—J. E. C.

Gas retorts; Charging of —. A. E. White, London. From Riter-Conley Manufacturing Co., Leedsdale, Pa., U.S.A. Eng. Pat. 103,137, Jan. 7, 1916. (Appl. No. 335 of 1916.)

Gas retorts; Machines for charging and discharging —. Apparatus for charging and discharging retorts. Riter-Conley Manufacturing Co., H. A. Carpenter, R. L. Hibbard, and A. W. Warner, Leedsdale, Pa., U.S.A. Eng. Pats. 103,138 and 103,139, Jan. 7, 1916. (Appl. Nos. 336 and 337 of 1916.)

Gas retorts; Machines for discharging and charging —. A. A. Guest, Gibbons Bros., Ltd., and J. Wigley, Lower Gornal, Staffs. Eng. Pat. 103,143, Jan. 11, 1916. (Appl. No. 132 of 1916.)

Coke-ovens or the like; Recuperators for —. A. Roberts, Chicago, U.S.A. Eng. Pat. 103,168, Jan. 18, 1916. (Appl. No. 811 of 1916.)

SEE U.S. Pats. 1,193,066 and 1,193,069 of 1916; this J., 1916, 958.

Asphalt-like masses; Process for manufacture of—and derivatives therefrom. L. Landsberg, Nuremberg, Germany. U.S. Pat. 1,211,721, Jan. 9, 1917. Date of appl., Apr. 28, 1913.

SEE Fr. Pat. 457,051 of 1913; this J., 1913, 1000.

Apparatus for feeding pulverulent fuel to furnaces. Eng. Pat. 13,067. See 1.

Furnaces fed with pulverulent fuel. Eng. Pat. 103,097. See 1.

Gas-fired crucible furnaces. Eng. Pat. 103,232. See 1.

Apparatus for purifying, cooling, and mixing gases. Eng. Pat. 103,133. See 1.

Production of ammonia [from Mond or producer gas]. Eng. Pat. 103,118. See VII.

Revivifying and utilising spent oxide. U.S. Pat. 1,211,713. See VII.

Surface mixture for pavements and other structures. U.S. Pat. 1,209,238. See IX.

IIb.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

PATENTS.

Fuel; Apparatus for distilling —. H. F. Wallmann, Chicago, Ill. U.S. Pat. 1,210,388, Dec. 26, 1916. Date of appl., May 9, 1912.

THE apparatus comprises a distillation conduit having two stationary side walls and two movable side walls on opposite sides which can be moved so as to agitate the fuel in the conduit. The fuel is heated in its passage through the conduit, and distillates of varying character are removed at different points by separate mains.—J. E. C.

Brown coals of all kinds; Treatment of —. P. Schroeder, Hamburg. Ger. Pat. 295,296, July 3, 1911.

THE coal, ground or not, is mixed with water and treated with superheated steam under pressure in a vessel fitted with a powerful stirrer. The mass is subsequently diluted with a large quantity of water, whereby a colloidal solution or suspension of the coal is produced, from which the insoluble impurities can be separated by filtration or the like. Sufficient mineral acid is added to the filtrate to coagulate the coal, which is then separated by filtration or the like, washed free from soluble salts, and dried; if necessary from 0.75 to 3% of alkali salts may be added before treating with acid. The yield of purified coal is 50–75%. The purified coal has a higher calorific value than the original material, and when carbonised yields from three to four times the quantity of by-products otherwise obtained.

Wicks; Indestructible —. O. Imray, London. From T. W. Glines, Waseca, Minn., U.S.A. Eng. Pat. 103,079, Aug. 11, 1916. (Appl. No. 11,370 of 1916.)

AN indestructible wick for heating and cooking stoves is made up of comparatively thin inner and outer sheets of asbestos or other non-combustible material and an interposed carbonised body portion. The latter is saturated with a solution before being carbonised so as to obtain a finely divided non-combustible mineral substance evenly distributed throughout the carbonised material.—J. E. C.

Cathode ray device. X-ray tube. W. D. Coolidge, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pats. (A) 1,211,091 and (B) 1,211,092, Jan. 2, 1917. Dates of appl., (A) Sept. 8, 1913, renewed Sept. 26, 1916, (B) June 5, 1915.

(A) A RÖNTGEN ray tube is composed of an evacuated envelope, pervious to X-rays, and a stem which is provided with a tip of heat-resisting

insulating material projecting into the envelope. The tip is joined to refractory supports, carrying the anode and cathode, the latter being in the form of a flat wire spiral, disposed substantially in a plane perpendicular to an axis passing through the electrodes, and having a diameter smaller than the working face of the anode. The cathode, which is independently heated, is surrounded by a static focussing ring for focussing the cathode rays upon the anode. The envelope and electrodes are freed from ionisable gas to such an extent that the tube may be operated by an electron discharge from the cathode, independently of gas ionisation. (B) The charge-receiving face of the anode is in part surrounded by a conductive member admitting the electron discharge from the cathode, whereby an electric field is established suppressing the emanation of an electron discharge from the face of the anode.—B. N.

Apparatus for recicifying char. U.S. Pat. 1,207,178. See I.

III.—TAR AND TAR PRODUCTS.

Benzene and toluene; Electrochemical chlorination of—F. Fichter and L. Glantzstein. *Ber.* 1916, 49, 2173–2187.

THE chlorination of benzene and toluene by the electrolysis of hydrochloric acid had previously been performed under disadvantageous conditions on account of the heterogeneous nature of the electrolyte, but with a common solvent, such as glacial acetic acid, homogeneous solutions of hydrocarbon and aqueous hydrogen chloride may be electrolysed with satisfactory results by the use of a platinum anode. The progressive stages in the electrolytic chlorination of benzene may be tabulated as follows: chlorobenzene, *p*-dichlorobenzene, *symm.*-tetrachlorobenzene, hexachlorobenzene, and pentachlorophenol. It does not seem possible to prevent the formation of phenolic derivatives by oxidation, and chloranil is always present as a by-product; the use of acetic acid also complicates matters by the partial conversion of the phenols into their acetic esters, and pentachlorophenol acetate is only saponifiable with difficulty. Phenols of a lower degree of chlorination are not obtained, and pentachlorophenol is only produced after the tetrachlorobenzene stage has been reached; chloranil, on the other hand, is formed at all stages. The factors favourable to a high yield of chlorinated products are: high current density, low concentration of benzene, and high temperature; under these conditions crystals of hexachlorobenzene are formed on the walls of the clay cell at the anode and may be separated in an almost pure condition. Anodes of other material than platinum give poor results; light has little influence. The electrolytic chlorination of toluene is far more complicated because substitution takes place both in the ring and in the side-chain; the influence of light gives the reaction an undesirable direction, and the electrolysis should be carried out in the dark. The stages may be formulated approximately as follows:—*o*- and *p*-chlorotoluene, 2,1-dichlorotoluene, 2,4,5-trichlorotoluene, pentachlorotoluene and 2,4,5-trichlorobenzylidene chloride, pentachlorobenzyl chloride, and 2,4,5-trichloro-3,6-dihydroxybenzylidene chloride, and hexachlorobenzene. As in the case of benzene, the degree of chlorination is determined mainly by the current density, but substitution in the side chain does not begin until the nucleus has taken up 3 atoms of chlorine and presents a certain degree of resistance to further chlorination. It would appear that the chlorination of the nucleus is effected primarily by the nascent

atomic chlorine liberated electrolytically and that accumulations of molecular chlorine are responsible for the attack on the side chain.—J. F. B.

p-Cresyl carbonate: Nitration of—A. F. Holleman and J. M. A. Hoeflake. *Rec. Trav. Chim. Pays-Bas*, 1917, 36, 271–280.

THE authors have investigated the nitration of *p*-cresyl carbonate, which was found by Meister, Lucius, u. Brünig to yield the *m*-nitro-derivative, instead of a mixture of ortho and para derivatives, as was to be expected. By comparing the proportions of *o*-, *m*-, and *p*-derivatives formed when phenyl carbonate, toluene, and *p*-cresyl carbonate are nitrated, it was found that, although the free hydroxyl group has a far greater influence than the methyl group in determining the position taken up by a new substituent, if the hydrogen of the hydroxyl group is replaced, as in *p*-cresyl carbonate, its directing influence disappears, and the influence of the methyl group preponderates.—F. Sp.

Ketones: Action of alcoholic caustic potash on—
IV. *Action of alcoholic caustic potash on halogenated aminobenzophenone.* P. J. Montagne. *Rec. Trav. Chim. Pays-Bas*, 1917, 36, 258–270.

IN studying the reduction of benzophenones to benzhydriols by boiling them for two days with alcoholic caustic potash, it was found that 3-aminobenzophenone is not completely reduced, proving that the single amino group inhibits the reaction. If halogens are introduced in the meta position, the inhibitory influence of the amino group is destroyed, so that the following compounds are completely reduced:—4-chloro-3-aminobenzophenone, 4-bromo-3-aminobenzophenone, 4-chloro-3-aminobenzophenone, 4-bromo-3-aminobenzophenone, 4,1'-dichloro-3-aminobenzophenone, 4,1'-dibromo-3-aminobenzophenone. Of these compounds, 4-chloro-3-aminobenzophenone and 4,1'-dichloro-3-aminobenzophenone lose only a little halogen during the reactions, the others losing more. The corresponding benzhydriols also lose halogen if boiled with alcoholic caustic potash, 1-chloro-3-aminobenzhydriol losing the least, and 1-bromo-3-aminobenzhydriol the most.—F. Sp.

Pyrogenesis of hydrocarbons. Lomax and others. See IIA.

PATENTS.

Pitch: Process for preparing hard commercial—R. P. Perry, Montclair, and E. F. Stewart, Woodliffe, N.J., Assignors to Barrett Manufacturing Co., New York. U.S. Pat. 1,210,697, Dec. 26, 1916. Date of appl., Feb. 16, 1916.

HARD pitch is obtained in small particles by introducing water and molten pitch independently into a vessel in which they are subjected to independent centrifugal action. The pitch is caused to take an upwardly curved path, and to pass through the centrifuged water, with which it is subsequently mixed.—F. Sp.

Mono-alkylated aromatic amines (N-alkylaryl amines); Manufacture of—G. T. Morgan. London. Eng. Pat. 102,831, Jan. 12, 1916. (Appl. No. 514 of 1916.)

N-ALKYLARYLAMINES are prepared from aniline or naphthylamines or their homologues or simple substitution products (other than nitro-compounds), by treating the amine with an aliphatic aldehyde in the presence of a reducing agent in a medium not possessing a strongly acid character. The anhydroadaldehyde-amine or Schiff base produced from the amine and aldehyde is simultaneously reduced to the alkyl aromatic amine. *Example*:—60 parts of aniline and 66 parts of 10% formaldehyde are added slowly and con-

currently to 300 parts of 31% caustic soda solution (sp. gr. 1.37) containing 90 parts of zinc dust in suspension. The addition of the reagents should take about two hours, and the mixture should be well stirred and kept at 90° C. The heating and stirring are continued for 6 hours longer, during which 40 parts of 10% formaldehyde is slowly added. When the percentage of methylaniline has reached a maximum, the mixture is steam distilled and the methylaniline obtained from the distillate in any of the usual ways.

—F. Sp.

Sulphonic acid of an aromatic hydrocarbon: Method of separating— from sulphuric acid, and of converting the sulphonic acid into a salt. L. M. Dennis, Ithaca, N.Y. U.S. Pat. 1,211,923, Jan. 9, 1917. Date of appl. July 14, 1916.

A MIXTURE of a sulphonic acid of an aromatic hydrocarbon and sulphuric acid is treated with a solvent, e.g., benzene, which only dissolves the sulphonic acid, and the solution is subsequently treated with a suitable compound to form the salt.

—F. W. A.

Sulphonation of hydrocarbons. D. Tyrer, Stockton. U.S. Pat. 1,210,725, Jan. 2, 1917. Date of appl. May 22, 1916.

HYDROCARBONS boiling below 200° C., e.g., benzene, are sulphonated by passing them in the form of vapour through strong sulphuric acid, which is heated gradually from 100° to 185° C., until the hydrocarbon vapour ceases to be absorbed.

—F. Sp.

Phenol: Manufacture of—. D. Tyrer, Stockton. U.S. Pat. 1,210,726, Jan. 2, 1917. Date of appl. May 22, 1916.

(A) CALCIUM benzenemonosulphonate is treated with sodium sulphate, forming calcium sulphate and sodium benzenemonosulphonate, and the latter is fused with caustic soda. (B) A mixture of calcium carbonate and calcium sulphite is treated with sodium bisulphate, forming sodium sulphate, sulphur dioxide, and carbon dioxide. (C) The gases from (B) are passed into a solution of the melt from (A), liberating phenol and forming sodium sulphite and sodium carbonate, which are treated with lime, forming caustic soda, and a mixture of calcium carbonate and calcium sulphite.

—F. Sp.

Phenols: Process of producing—. A. S. Ramage, Assignor to Bestaph Engineering Co., Detroit, Mich. U.S. Pat. 1,208,833, Dec. 19, 1916. Date of appl. Apr. 20, 1916.

PHENOLS are produced from high boiling tar acids by spraying a material containing them, by means of a jet of hydrogen, into a chamber containing a catalyst, e.g., nickel, at 600°–650° C., and condensing the phenols produced.—F. Sp.

Sulphonating hydrocarbons. D. Tyrer, Stockton. Eng. Pat. 103,204, Jan. 12 and Mar. 1, 1916. (Appl. Nos. 3091 and 3078 of 1916.)

SEE U.S. Pat. 1,201,725 of 1916; preceding.

IV.—COLOURING MATTERS AND DYES.

Cutch production in Burma.

THE demand in the United States for crude dyes is being met, in part, by increased shipments of cutch from Burma. In 1915, 1,234,140 lb. of cutch was exported, in contrast with 237,140 lb. in 1914.

In the manufacture of cutch no scientific process is employed, the industry being carried on exclusively by natives. It is obtained from the

Acacia catechu the trees being felled while green, the bark taken off, and the timber chopped up and boiled in large cauldrons. The resultant liquid is drained off and solidifies as it cools. In the better qualities of cutch only the heart-wood of the tree is utilised. Cutch is brought to the market in several forms, the three principal ones being: (1) Tablets—small rectangular blocks weighing from 1 lb. to 2 lb.; (2) blocks—more or less square blocks weighing from 28 lb. to 56 lb.; (3) baskets—a soft cutch of a thick consistency. Tablet cutch is the best quality and basket cutch the lowest. Block and basket cutch usually contain more impurities than tablet cutch, but in recent years a larger business has been done in basket quality than in the other two, probably because basket is the cheapest of the three. On arrival in Rangoon the cutch is packed in wooden cases (usually containing 1 cwt. net) and is then ready for export.

Cutch trees are found throughout the whole of Burma, but the question of transportation makes cutch-boiling unprofitable in many districts. Licences for cutch manufacture are granted annually by the Government, and the industry is more or less of a stand-by to the population in seasons of bad harvests. The Burmese Government increases or reduces the number of licences as necessity indicates. The principal producing districts in Burma are Prome, Thayetmyo, Myingyan, Minbu, Pegu, Yamethin, and Pyin-mana.

Cutch is used largely as a dye, but in addition to this it is employed in some countries for tanning and as a preservative. In Burma it is used to preserve fishing nets and sails.

Sulphide dyestuffs: Chemistry of the—. F. M. Rowe. J. Soc. Dyers and Col., 1917, 33, 9–17.

A SUMMARY of published work on the probable thiazine constitution of certain sulphide dyestuffs is followed by a discussion of the possible existence of other sulphur-containing rings in sulphide dyestuffs. It appears probable that the blue and black sulphide dyestuffs are thioldiphenylamine derivatives related to the Methylene Blue type, whereas those of the yellow and brown classes are thiazole derivatives more analogous to dehydrothiolumidine or Primuline base. Only those compounds of a Methylene Blue type, e.g., Immedial Pure Blue and Immedial Indone, have been obtained in a sufficiently pure condition for analysis, and as the dyestuffs approach the real sulphide dyestuff type the possibility of crystallisation decreases. There is not sufficient data regarding the breaking-down of the molecule of sulphide dyestuffs to enable any reliable general conclusions to be drawn, and the synthesis of sulphide dyestuffs is limited to the simpler members of the series. Reference is made to the work of Vidal, Bernthsen, Gnehm and his collaborators, Green, Meyenberg, and Wichelhaus in investigating the mechanism of sulphide dyestuff formation. In discussing Vidal's formulae representing the condensation of thioldiphenylamine derivatives to form blue dyestuffs and subsequent elimination of ammonia to form black dyestuffs, it is emphasised that they do not take into consideration whether the dyestuffs are quinonoid compounds, nor is it evident why the dyestuffs contain only four benzene rings; still less do they explain the solubility or insolubility of the dyestuffs in alkalis or acids respectively. Structures other than those of a thiazine type have been advanced for sulphide dyestuffs in addition to Vidal's tetraphenylthiazine structure; certain dyestuffs derived from azines may contain one or two phenazine rings combined with the thiazine rings. In black-brown sulphide dyestuffs made from certain diphenylamine derivatives, the thiazine ring may be united to the

thiazole ring. The formation of thianthrene rings, alone or united with thiazine rings—bodies derived from diphenylenedisulphide—is not yet proved, but the formation of a thiopyrone ring in the dyestuff from diaminodiphenylmethane, and in the dyestuffs derived from Fluorescein is highly probable. The presence of the thio-benzidine ring, alone or united with the thiazole ring, in yellow sulphide dyestuffs prepared with addition of benzidine is also probable. The piazthiole ring is considered by Ris to be present in the black sulphide dyestuff obtained by the action of sulphur dioxide on *o-p*-diaminodiphenylamine, and the same worker assumes the presence of the acritiole ring in the yellow sulphide dyestuffs derived from *m*-toluylendiamine and phthalic acid; the evidence advanced is not considered convincing by the present author, as the analytical results would be better explained by the presence of the thiazine ring. The thiazole ring is considered to be present in the brown sulphide dyestuffs obtained from Primuline.

The solubility of sulphide dyestuffs in sodium sulphide is generally considered to be due to the presence of free mercaptan groups: other groups, such as COOH, SO₂H, OH, are suitable for imparting solubility in alkali, but in presence of such groups alone the colour is not fixed on the fibre on dyeing from an alkaline bath, whereas this is the case with the mercaptan group, owing to the formation of an insoluble disulphide on oxidation. Friedländer has disproved the view of Vidal that the solubility of the sulphide dyestuffs is due to their phenolic character and that mercaptan groups influence the shade of the dyestuffs. The experimental evidence of the thiozone theory advanced by Erdmann is considered to be very slight. The polysulphide theory of Mohlau, elaborated by Schultze and Beyschlag is discussed. —F. W. A.

Dyestuffs of the Methylene Blue group. III. Limited action of fatty amines on phenazthionium salts. F. Kehrmann. Ber., 1916, 49, 2831—2838.

IN previous communications (this J., 1916, 353, 732) it has been shown that not only aromatic but also fatty amines, notably dimethylamine, react with phenazthionium perchloride to give alkyl-substituted thionines. This reaction may be limited to the introduction of one amine residue, and methods are given for the preparation of thiazine (3-aminophenazthionium), and its dimethyl and diethyl compounds by the action of ammonia, dimethyl- and diethyl-amine respectively. The absorption spectra follow those normally expected.—F. W. A.

Anthraquinone-1-diazonium halides. A. Schaarschmidt. Ber., 1916, 49, 2678—2681.

THE diazonium salts of the anthraquinone series are characterised by their comparatively great stability, many of them undergoing at 100°C. scarcely any decomposition. Anthraquinone-1-diazonium chloride was prepared by diazotising a suspension of 1-aminoanthraquinone in concentrated hydrochloric acid at 30°—10° C., dissolving the precipitated substance in boiling water, and slowly adding saturated brine, when the compound separated in glittering leaflets. Still more stable is 4-chloroanthraquinone-1-diazonium chloride which on account of its solubility in water was isolated by diazotising in acetic acid solution with amyl nitrite, and precipitating from the filtered solution by addition of ether. In the same way anthraquinone-1,4-bis-diazonium chloride was prepared and purified by precipitation from hot aqueous solution with brine. The anthraquinone-2-diazonium salts were prepared by similar methods but are less stable.—G. F. M.

α -Styryl-benziminazoles and their related azo-dyestuffs. O. Kym and S. Jurkowski. Ber., 1916, 49, 2681—2697.

THE introduction of the styryl or substituted styryl group for the phenyl group in the α -phenylaminobenziminazoles produces a considerable deepening in the colour and strengthening of the affinity for cotton in the corresponding azo-dyestuffs. These styryl derivatives were prepared by treatment of diaminomoyl- α -phenylenediamines with alkali, or better by condensation of α -methylbenziminazole with benzaldehyde or its substitution products. The affinity for cotton is already in evidence in the styryl-*m*-nitro- and *m*-amino-benziminazoles, which give pale yellow shades, whilst α -(*p*-nitro-styryl)-*m*-nitrobenziminazole and the corresponding diamino-derivative give pale orange dyeings on cotton. The azo-dyestuffs formed from the mono- and diamino-styrylbenziminazole bases by diazotising and coupling with β -naphtholdisulphonic acid R give deep reddish violet shades on cotton, compared with light violet or lilac shades given with the phenylbenziminazole azo-dyestuffs. In addition to the condensation products of α -methylbenziminazole with benzaldehyde, similar compounds with ketones were prepared. Isatin gave in this way a red condensation product of normal composition, whilst with phenanthraquinone a green substance was obtained, the analysis of which indicated that the reaction had taken an abnormal course. (See also Ger. Pat. 288,490 of 1914; this J., 1916, 355.)—G. F. M.

Nitrocarbocyclic compounds: Action of sulphuric acid on certain —. I. Action on nitrobenzene. M. L. Crossley and C. B. Ogilvie. J. Amer. Chem. Soc., 1917, 39, 117—122.

A MIXTURE of 161 grms. of nitrobenzene with 144 grms. of sulphuric acid, heated slowly to 195° C. in a 2-litre flask under a reflux condenser, produced a vigorous reaction controlled with difficulty. The product yielded 83 grms. of unchanged nitrobenzene, 52 grms. of a black amorphous solid resembling melanin, and 12 grms. of *p*-amino-phenol-*o*-sulphonic acid. The black substance was completely soluble in sodium hydroxide solutions, partially soluble in strong sulphuric acid, and slightly soluble in nitrobenzene, pyridine, quinoline, trimethylamine, and aqueous ammonia, yielding brown or purplish solutions. Similar but not identical black substances are formed when sulphuric acid and nitrobenzene are heated together with anthraquinone, β -aminoanthraquinone, or anthracene. In all cases the black products can be reduced to form vat dyes which dye cotton. The product from nitrobenzene and anthraquinone, like that from the former alone, dyes cotton a steely grey. That from nitrobenzene and β -aminoanthraquinone gives a brown vat oxidising on cotton to a heliotrope, whilst that from anthracene is less readily reduced than the others and dyes cotton brown. These dyes are not fast to boiling alkalis. The reaction appears to be general for nitrocarbocyclic compounds. —J. H. L.

Thioxanthone- and benzophenonesulphone series: Studies in the —. F. Ullmann and O. van Glenck. Ber., 1916, 49, 2487—2514.

IT has been established that the introduction of hydroxy groups into the thioxanthone molecule gives rise to mordant dyestuffs: in the present work a study has been made of derivatives in which auxochrome groups are situated in the *ortho* position relatively to the chromophoric carbonyl group, in order to compare this series with the similarly constituted anthraquinone- and benzophenonesulphone series. The starting point was the product of the condensation of

thiosalicic acid with *p*-chlorotoluene: the crude product behaved on recrystallisation as a pure substance, with sharp melting point, but its further condensation reactions showed it to be a mixture of 60% of the 1-chloro-1-methylthioxanthone with 10% of the 1-methyl-1-chloroisomeride: on fractional distillation under 4 mm. pressure the 1-chloro derivative was concentrated in the residue. This 1-chloro-1-methylthioxanthone condenses with anthranilic acid on prolonged heating with copper acetate and potassium carbonate in amyl alcoholic solution, with elimination of hydrogen chloride, yielding 4-methylthioxanthonyl-1-anthranilic acid, which on elimination of water gives the corresponding yellow acridone; a similar condensation is effected with thiosalicic acid, leading to methylthioxanthone. When the chloro derivative is fused with copper, chlorine is eliminated, giving a dithioxanthonyl derivative. Its behaviour with hydrazine hydrate, yielding the internal anhydride of the hydrazine derivative, confirms the constitution of this chloro compound, showing that the chlorine must be in *ortho* position to the carbonyl. By condensing thiosalicic acid with other toluene derivatives, members of the thioxanthone series were prepared containing amino and methoxy groups; 6-chloro-1-methyl-3-methoxybenzene yields a single condensation product with the chlorine in *ortho* position to the carbonyl; the aniline derivative of this is decidedly redder in shade than the corresponding derivative of methylthioxanthone; its sulphonic acid dyes wool orange. Members of the benzophenonesulphone series were prepared by the oxidation of the chloromethylthioxanthones, preferably with hydrogen peroxide, or else with potassium persulphate in presence of strong sulphuric acid. The acridone derivative prepared from the condensation product of 1-chloro-1-methylbenzophenonesulphone has a fine red colour; it is reducible as a vat dyestuff but only dyes cotton a pale yellow in this manner. The sulphone obtained by oxidising methylthioxanthone is also reduced by alkaline hydrosulphite, but is not a dyestuff.—J. F. B.

Pyrrrole black. A. Angeli and L. Alessandri. *Gazz. Chim. Ital.*, 1916, 46, 279—282, 283—300.

On oxidising pyrrole in an acetic acid solution, chilled with ice, by means of hydrogen peroxide, it yields a product with the properties of succinimide, together with a black compound for which the name of "pyrrole black" is suggested. This substance is insoluble in most solvents, but is sparingly soluble in pyridine. It is very similar to the melanins of animal pigments both in composition (C, 60.01; H, 4.87; N, 15.91%) and in properties, and, like them, is soluble in solutions of alkalis and ammonia. The mother liquors from which the black substance has been separated yield other oxidation products, including a yellowish white substance, which melts at 161°C., and has a tendency to form compounds of a blue colour. —C. A. M.

Colour and degree of dispersion of particles in coloured solutions: Relation between—. W. Harrison. *J. Soc. Dyers and Col.*, 1917, 33, 7—9.

From the similarity in the colour-changes of a number of colloidal solutions, Wo. Ostwald (*Kolloid Beihefte*, 1911, 2, 409) concluded that in all cases of colloidal solutions the colour would change in the direction of yellow, red, and blue, as the size of the particles increased, provided chemical changes in the dispersed substances did not occur. The author (*Koll. Zeits.*, 1912, 10, 45; *J. Manch. Sch. Techn.*, 1913, 6, 205) showed that a colloidal solution of Alizarin changed from yellow to violet on adding caustic soda, while the size of the particles decreased. Later Ostwald (*Koll.*

Zeits., 1912, 10, 97, 132) stated that this rule applied to most dyestuffs, even in case chemical action takes place, e.g., Night Blue was changed by acids from blue to green and yellow with gradual increase in the size of the particles. Repeating Ostwald's experiment with pure Night Blue and also with Victoria Blue B, Nile Blue, Acid Violet 7B, and Formyl Violet 81B, the author found that a very small amount of acid precipitated the dye from solution without change in colour; subsequent additions dissolved this precipitate and produced a change in colour through green to yellow. It is shown that the cause of the change in colour of dyestuffs is quite separate from the cause of precipitation, although the two phenomena may occur at the same time, in some cases in accordance with Ostwald's rule. Maxwell Garnett (*Phil. Trans.*, 1905, 205, 283) concluded that the mean distances between adjacent molecules was an important factor in causing the colour, and showed that in metallic films a change in colour was accompanied by a change in the density of the metal; it is therefore probable that change in colour is due to change in the molecular arrangement, and not merely to change in the size of the aggregate, although they may occur together.

—F. W. A.

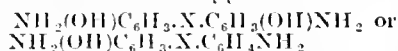
β-[Camphorylidene-3]-propionic acid (methylene-camphoracetic acid). Rupe and Bueckhardt. *See XX.*

Relation between the chemical constitution of organic compounds and their capacity to coagulate acid gold hydrosols. Cann. *See XXIV.*

PATENTS.

o-(Hydroxy azo dyestuffs; Manufacture of direct ——. O. Imray, London. From Soc. Chem. Ind. in Basle, Switzerland. Eng. Pat. 102,881, May 13, 1916. (Appl. No. 6872 of 1916.)

DIRECT *o*-hydroxyazo dyestuffs are obtained by coupling the tetrazo-compound of an *o*-aminophenol derivative of the type:



(where X is a diphenyl linking or a CH_2 , NH.CO.NH , or CO group) with 2 mols. of 2-amino-5-naphthol-7-sulphonic acid or a derivative thereof, or with 1 mol. of this acid and 1 mol. of any other dyestuff component, or with 2 mols. of any dyestuff component. (Reference is directed, in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pats. 11,795 of 1889, 15,386 of 1892, and 20,216 and 30,284 of 1910; this J., 1890, 172; 1893, 754; 1911, 678, 1006.)

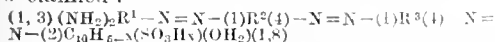
—F. W. A.

[Azo] dyestuffs; Manufacture of direct cotton ——. O. Imray, London. From Soc. Chem. Ind. in Basle, Switzerland. Eng. Pat. 103,251, June 12, 1916. (Appl. No. 8292 of 1916.)

DIRECT cotton dyestuffs are obtained by combining tetrazo-*p*-diphenyl or a derivative with 1 mol. of an acidyl-1-8-aminonaphtholsulphonic acid and 1 mol. of an acidyl- or aryl-2,5,7-aminonaphtholsulphonic acid, or with 2 mols. of an acidyl-2,5,7-aminonaphtholsulphonic acid, the combinations with benzoyl-1-8-aminonaphthol-5-sulphonic acid and with phenyl-2,5,7-aminonaphtholsulphonic acid (Eng. Pat. 4609 of 1901; this J., 1902, 337) being excluded. After-treatment with copper salts changes the tint of dyeings produced with these dyestuffs towards blue-violet to red-violet, and improves the fastness, especially towards light.—F. W. A.

Trisazo dyes. R. Haugwitz, Assignor to Akt.-Ges. f. Anilinfabr., Berlin. U.S. Pat. 1,209,151, Dec. 19, 1916. Date of appl., July 24, 1916.

TRISAZO dyes of the following general constitution are claimed:



in which R^1 , R^2 , and R^3 are radicals of the benzene series. The trisazo dye from 1,1-phenylenediamine-azo-3-amino-1-methoxy-1-methylbenzene, 1,8-dihydroxynaphthalene-3,6-disulphonic acid, and 1,3-phenylenediamine is specially claimed: it dyes cotton violet tints which become black on treatment with 1-nitrodiazobenzene.—F. W. A.

Sulphur dyestuffs; Manufacture of —. Akt.-Ges. f. Anilinfabr., Berlin. Ger. Pat. 295,251, Jan. 22, 1914.

DYESTUFFS fast to washing and scouring are obtained by the action of sulphur on a mixture of amino-, diamine-, nitroamino-, nitrohydroxy-, and aminohydroxy-compounds with C-alkylated diamines of the benzene and naphthalene series, e.g., *m*- or *p*-tolylenediamine, xylylenediamine or their N-aryl derivatives, or with the corresponding nitroamino-compounds.—F. W. A.

Vat dyestuffs and process of making same —. B. Homolka, Frankfurt. Assignor to Farb. vorm. Meister, Lucius, und Brünig, Höchst, Germany. U.S. Pat. 1,209,163, Dec. 19, 1916. Date of appl., July 30, 1915.

VAT dyestuffs are obtained by heating *para*-quinones with arylaminoacetic acids in a suitable solvent. The product—



is specially claimed: it forms a brown crystalline powder (m. pt. 232° C. with decomposition), insoluble in water, dilute acids, and alkalis, practically insoluble in alcohol, ether, and benzene, soluble with an orange-yellow colour in boiling xylene and glacial acetic acid, and with a red colour in concentrated sulphuric acid, and yielding a colourless vat with alkaline hydrosulphite from which it gives yellow tints on animal fibres.—F. W. A.

Seleno-phthalins and their halogen derivatives; Manufacture of —. Farb. vorm. Meister, Lucius, und Brünig. Ger. Pat. 295,253, Dec. 8, 1911. Addition to Ger. Pat. 290,549 and 291,883 (this J., 1916, 595, 922).

IN place of the phthalins specified in the previous patents, their O-acetyl compounds or O-acetyl compounds of phthalins are used in indifferent solvents. The products are different from those obtained by the action of selenium on fluoresceins in aqueous alkaline solution according to Ger. Pat. 279,549 (this J., 1915, 271).—F. W. A.

Vat dyestuffs or initial products of same; Manufacture of —. M. P. Schmidt, Assignor to Kalle and Co., Biebrich, Germany. U.S. Pat. 1,209,212, Dec. 19, 1916. Date of appl., Apr. 28, 1916.

VAT dyestuffs or initial products are obtained by heating arylamino derivatives of halogenised benzoquinones with a metal powder in presence of a suitable solvent or diluent. The products obtained from dichloroanilidobenzoquinones and copper powder give with alkaline reducing agents a vat from which wool is dyed yellowish-brown tints.—F. W. A.

Logwood dyes; Purifying —. I. Kitsee, Assignor to Dye Patents Co. of the United States, Philadelphia, Pa. U.S. Pat. 1,210,918, Jan. 2, 1917. Date of appl., Nov. 5, 1915.

LOGWOOD dyes are purified by subjecting them to the chemical action of a sulphur oxide, e.g., sulphurous acid.—F. W. A.

Indoxyl and derivatives; Method of making —. L. E. H. Cone, Assignor to The Dow Chemical Co., Midland, Michigan. U.S. Pat. 1,211,413, Jan. 9, 1917. Date of appl., June 21, 1916.

INDOXYL and its derivatives are obtained by heating a phenylglycine derivative with a mixture of caustic alkali, e.g., caustic potash or a mixture of caustic soda and potash, alkaline-earth oxide, e.g., lime, and metallic sodium; or the phenylglycine may be added to the molten mixture; the fused product is passed into water.—F. W. A.

Sulphur dyestuffs; Manufacture of —. Farb.-fabr. vorm. F. Bayer und Co., Ger. Pat. 295,101, Oct. 18, 1914. Addition to Ger. Pat. 293,101 (this J., 1916, 922).

INSTEAD of the ethylated amines of the benzene, diphenyl, or naphthalene series specified in the main patent, their sulphonic or carboxylic acids are used.—F. W. A.

Ortho(hydr)oxazo dyestuffs; Substantive - - and process of making same —. E. Anderwert, H. Fritzsche, and H. Schobel, Assignors to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,210,751, Jan. 2, 1917. Date of appl., Oct. 8, 1915.

SEE Eng. Pat. 102,881 of 1916; preceding.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Cotton fabrics; Some effects of the action of ultra-violet light on —. C. Dorcé and J. W. W. Dyer. J. Soc. Dyers and Col., 1917, 33, 17—19.

SINGLE-PLY cotton fabric, specially scoured and bleached for use in the manufacture of airship envelopes, was exposed continuously at 30°—35° C. to the light from a Cooper-Hewitt mercury vapour lamp placed centrally about one foot above the fabric, which was spread flat on a sheet of 3-ply wood. The upper surface of the fabric became biscuit yellow in colour, which shaded off from the centre, and was not affected by dilute caustic soda, in which the exposed fabric possessed a high solubility; the exposed material also possessed high cupric-reducing power and capacity for absorbing basic dyestuffs (Methylene Blue), and gave a comparatively large yield of furfural. Ultra-violet light in presence of air and moisture may not improbably act in two ways: by some specific physical action causing disintegration of the cellulose, and by the probable development of ozone—known to convert celluloses into acidic, alkali-soluble products having the properties of oxycelluloses. Comparison of the exposed fabric and a hydrocellulose, prepared by the action of dilute sulphuric acid on cotton, showed considerable differences, whereas the properties of the exposed material closely resembled those of oxycellulose. The strength in the affected portions of the exposed fabric had entirely gone; the appearance of transverse cracks with occasional swollen places similar to the effects produced by excessive action of alkali, were noted. The affected part was much more absorbent and wetted out more readily than the unaffected part of the fabric.—F. W. A.

PATENTS.

Linen yarns and fabrics; Process of scouring —. J. B. Marshall, Ltd., and S. H. Higgins, Perth. Eng. Pat. 102,892, July 17, 1916. (Appl. No. 9990 of 1916.)

THE raw goods are treated with volatile solvents to extract oils and waxy matters before scouring; by this treatment the process of boiling with lime may be omitted and the goods scoured with soda

only. (Reference is directed, in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pats. 1052 of 1871, 15,012 of 1892, 16,889 and 23,964 of 1895, 18,720 of 1901, 10,951 of 1908, and 28,291 of 1913; this J., 1892, 928; 1901, 1011; 1905, 798; 1909, 211; 1911, 1153.)
—J. F. B.

Flax plants: Process for treating — J. Brodin, Sioux Falls, S.D., Assignor to L. E. Baker, Baker, Mont. U.S. Pat. 1,209,516, Dec. 19, 1916. Date of appl., Aug. 21, 1916.

IN the case of flax plants grown for seed, the heads are removed from the stalks at maturity at such a point that rain may penetrate the tubular stalks, which are still left standing exposed to the action of the weather, until a natural rotting has taken place and the fibre is loosened. The stalks are then cut and harvested, and the fibre removed by hackling.—J. F. B.

Animal filaments, fibres, or threads: Process of finishing — H. R. Anders, Perth Amboy, N.J., Assignor to The Roessler and Hasselcher Chemical Co., New York. U.S. Pat. 1,210,391, Jan. 2, 1917. Date of appl., Dec. 10, 1914.

ANIMAL fibres, filaments, threads, or hair, e.g., human hair, are shaped into any desired form, which is then made permanent by treating the material in the wet state with formaldehyde.
—J. F. B.

Paper and process of making same. Glazed paper and coating composition therefor. N. Statham, Boonton, N.J., Assignor to Industrial Chemical Co., New York. U.S. Pats. (A) 1,209,221 and (B) 1,209,222, Dec. 19, 1916. Date of appl., Apr. 26, 1916.

(A) PAPER of high bulk is made by incorporating uniformly throughout its mass over 20% of light precipitated chalk as a loading material, the weight of which in the dry state does not exceed about 18 lb. per cub. ft. and the presence of which in the finished paper does not substantially increase the weight of a sheet of standard thickness. (B) Glazed paper is prepared with a coating composed of an organic sizing material, such as an alkaline solution of casein, and an inorganic pigment consisting largely of light precipitated chalk as above.
—J. F. B.

[*Paper:*] *Process and apparatus for drying* — E. P. Butts, Springfield, Mass. U.S. Pat. 1,212,014, Jan. 9, 1917. Date of appl., Sep. 11, 1915.

IN a paper-making machine, the web of paper passes over a series of drying drums supplied with a heating medium, and then over a pair of parallel rollers spaced apart. The rollers are connected with a source of electrical energy so that a current passes through the moist paper substance. The current, according to the variation in the conductivity of the paper, also controls an electromagnetic device for operating the valve which admits the heating medium to the drums. The temperature of the drying drums is thus automatically maintained constant.—W. F. F.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Sizes and finishes: Analysis of some — M. C. Lamb and A. Harvey, J. Soc. Dyers and Col., 1917, 33, 19—21.

ANALYSES have been made of a large number of animal and vegetable products used in the sizing and finishing of various textile fabrics, leather, etc., and certain standards are suggested. Egg and blood albumin should be completely soluble in 1%

caustic soda and should dissolve readily in water at 45 C.; albumin is liable to adulteration with gelatin (readily detected by means of 1—2% tannic acid), and zinc salts are often added to solutions to increase the viscosity and act as antiseptics. *Carrageen* (*Irish moss*), employed as a thickening agent, should contain 1.4—2.5% N. *Alginate*, obtained by extracting *laminaria* with caustic alkali, and adding alginate acid to the extract, is employed as a substitute for Irish moss; it should contain 1—6% of alginate anhydride. *Gum tragacanth* of good quality gives saponification values from 100—180, water 18—22%, and mineral ash 2.5—3.0%; Indian gum tragacanth gives an acid, transparent mucilage, whereas the genuine gum gives a neutral opaque mucilage (viscous in 1% solution) and a blue coloration with iodine not given by the Indian gum; a higher percentage of volatile acid on hydrolysis than 1.8—2.4% indicates adulteration with the Indian or other gums. *Gum acacia* (*gum arabic*) varies from white and soluble (African) to dark and insoluble (Indian), the usual adulterant being dextrin; it gives a precipitate with basic lead acetate solution not given by gum tragacanth; the acidity is 2.5—3% of free arabic acid. *Gum tragacanth* is extracted from the locust bean as a substitute for gum tragacanth. *Casein* is analysed for moisture, fat (0.2—0.6%), and nitrogen.
—F. W. A.

PATENTS.

Stoving and bleaching flannel: Apparatus for — T. Woolfenden, Rochdale, Eng. Pat. 103,093, Oct. 9, 1916. (Appl. No. 11,317 of 1916.)

AN apparatus for stoving and bleaching flannel with sulphur fumes consists of a closed wooden chamber with apertures in the ends for the introduction and withdrawal of the flannel, and containing a number of rollers over which the flannel passes in a zig-zag path. A hood provided with a fan is placed above the chamber to collect escaping fumes.—F. W. A.

Mercerising yarn: Machines for — B. E. D. Kilburn, London, From Sulzer Frères Soc. Anon., Winterthur, Switzerland. Eng. Pat. 102,891, July 5, 1916. (Appl. No. 9177 of 1916.)

IN a machine for mercerising yarn in skeins or hanks, the rollers receiving the yarn are supported by an oscillating member with which they are swung into and out of their working positions, the distance between their axes being reduced as they are taken out of the working position so that the skeins or hanks may be readily removed and replaced. During the introduction of the rollers into their bearings, one roller may be pressed against a pressure roller, the gear of the rollers being at the same time automatically coupled for the purpose of rotating them, and the direction of rotation of the one roller being such that it is assisted into its bearings by the action of the pressure roller.—F. W. A.

Weighting of silk: Process for the — Gebr. Schmid, Basle, Switzerland. Ger. Pat. 295,272, Apr. 27, 1916. Addition to Ger. Pat. 291,009 (this J., 1916, 596).

BY using tin chloride in place of the zinc chloride or zinc chloride-tin chloride baths claimed in the main patent, the elasticity of the silk is not damaged to such a great extent.—F. W. A.

Dyeing machines. H. W. McL. Christie, Glasgow, and W. Farquhar, Alexandria, N.B. Eng. Pat. 103,239, May 5, 1916. (Appl. No. 6462 of 1916.)

IN dyeing machines of the type in which poles to receive the hanks are arranged above and/or in dye-vats and rotated during the dyeing operation, to avoid the necessity of removing the poles and

thus facilitate the placing in position and removal of goods, the poles driven from one end are so supported and articulated by means of hinge or universal joints to the driving means that the other ends may be tilted upwards without the poles being disconnected from the driving gear. Guides are provided to prevent the poles from being displaced sideways while being tilted.

—F. W. A.

Batik work; Method of producing special effects in —. A. E. Diener, Fürstenberg, Germany. U.S. Pat. 1,210,279, Dec. 26, 1916. Date of appl. Dec. 29, 1914.

To produce special effects in batik work, the fabric is prepared by treating with a dye containing a wax-repelling substance, e.g., water, in the form of a design, afterwards applying to the fabric wax or the like, and finally breaking the wax and dyeing in the usual way.—F. W. A.

Dyeings fast to washing; Production of —. Farbenfabr. vorm. F. Bayer und Co., Ger. Pat. 295,072, Oct. 18, 1914.

RED, violet, to blue dyeings, fast to washing, are obtained by treating on the fibre with formaldehyde the dyestuffs obtained by coupling tetrazotised diamines with one molecule of an aminonaphtholsulphonic acid or a derivative thereof, and one molecule of an amino-substituted derivative of 2,5,7-aminonaphtholsulphonic acid containing a free amino-group.—F. W. A.

Dyeings and prints; Production of fast — by chroming. Stolle und Kopke, Rumburg, Bohemia. Ger. Pat. 295,354, July 8, 1915.

IMPROVED effects are obtained by using in place of pure chromates mixtures of chromates with suitable per-salts, e.g., persulphates or perborates.—F. W. A.

Lustre of silk in hanks and woven goods; Process for increasing the —. W. Reidemeister, Berlin. Ger. Pat. 295,070, July 21, 1914.

SILK in a stretched condition is treated with highly concentrated fatty acids or their anhydrides or mixtures thereof, with addition of glycerin, then washed and dried; or the silk may be treated with these substances and subsequently stretched. Formic acid of 60–70% concentration or even weaker produces a good lustre, but other acids or their anhydrides or mixtures thereof are not so effective.—F. W. A.

Dyeing; Impts. in —. W. Somerville, Auburn, Victoria, Australia. Eng. Pat. 18,059, Dec. 28, 1915. Under Int. Conv., Dec. 31, 1914.

SEE U.S. Pat. 1,193,838 of 1916; this J., 1916, 960.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Hydrogen halogen acids; Action of light on the formation and decomposition of the —. A. Cohn and K. Stuckardt. Z. physik. Chem., 1916, 91, 722–744; J. Chem. Soc., 1917, 412, ii., 5–6.

THE authors have investigated the action of light on the gaseous systems hydrogen iodide, hydrogen bromide, hydrogen chloride, and their components. The reactions have been effected by means of a mercury lamp in both quartz and uviolet glass apparatus. In all three cases equilibrium has been reached from both sides. In quartz apparatus the decomposition proceeds to the extent of 92.3% in the case of hydrogen iodide, and this is reached in ten minutes; the formation

proceeds to 7.6%. In both uviolet glass and ordinary glass there is a decomposition of 100% and no formation in the case of hydrogen iodide. With hydrogen bromide there is 100% decomposition in quartz, 20% in uviolet glass, and no decomposition in glass. The amount of formation of hydrogen bromide is zero in quartz, 80% in uviolet glass, and 100% in glass. In the case of hydrogen chloride there is 0.42% decomposition and 99.58% formation in quartz and 100% formation with no decomposition in uviolet glass and ordinary glass. In the case of hydrogen bromide the reaction is complete in four hours and with hydrogen chloride in less than five minutes. The use of the three types of apparatus shows the effect of the different spectral regions; in quartz, light down to 220 μ is active, in uviolet glass to 251 μ , and in Jena glass down to 300 μ .

Supply of sulphate of ammonia; Appointment of Committee on —.

THE Food Controller announces that, with the concurrence of the Agricultural Departments of Great Britain and Ireland, he has approved of an arrangement whereby, as from 12th February, sulphate of ammonia is to be sold at the price of £16 per ton, 24½% basis, in makers' bags, net cash, delivered at the consumer's station in any part of the United Kingdom. The price to consumers who take delivery at the producers' works for conveyance otherwise than by railway remains at £15 10s. per ton. In the event of purchasers experiencing difficulty in obtaining supplies locally, they should apply to the Secretary, Sulphate of Ammonia Advisory Committee, 84, Horseferry Road, London, S.W.

The Food Controller has appointed, with the concurrence of the Agricultural Departments of Great Britain and Ireland, the following Committee of Manufacturers of Sulphate of Ammonia to advise him with regard to questions affecting its production and distribution, and to give effect to an approved scheme for regulating the distribution of supplies to farmers in all parts of the United Kingdom:—Chairman, Mr. D. Milne Watson, of the Gas Light and Coke Co.; Mr. Wm. Fraser, of the Pumphreyston Oil Co., Ltd.; Mr. E. J. George, of the Consett Iron Co., Ltd.; Mr. W. R. Hann, of the Powell Duffryn Steam Coal Co., Ltd.; Mr. N. N. Holden, of Messrs. Hardman and Holden, Ltd.; Mr. A. K. McCosh, of Messrs. Wm. Baird and Co., Ltd.; Alderman F. S. Phillips, of the Salford Corporation Gas Department; and Mr. A. Stanley, of Messrs. Simon-Carves, Ltd. The Secretary of the Committee is Mr. F. C. O. Speyer.

Rare-earths; Observations on the —. E. W. Engle and C. W. Balke. J. Amer. Chem. Soc., 1917, 39, 53–68.

THE authors have investigated some separation methods which might be suitable for the isolation of the various individual rare-earths, more particularly those of the yttrium group, and for the preparation of dysprosium material of sufficient purity for the determination of the atomic weight of that element. It was found that the bromate method of separating the rare earths of the yttrium group (this J., 1908, 518) is efficient for concentrating erbium, yttrium, and dysprosium material. A comparative study of the permanganate method (Gibbs, Amer. Chem. J., 1893, 15, 546) and the sulphuric acid volumetric method (Holden and James, J. Amer. Chem. Soc., 1914, 36, 638) for control analyses, showed that they give practically the same results in earth mixtures having bromates with a solubility near that of yttrium bromate. Dysprosium material of very high purity was obtained by fractional crystallisation of the rare earth bromates, followed by

fractional crystallisation of the ethylsulphates. The mean of five consecutive determinations gave the value 164.228 for the atomic weight of dysprosium, which is considerably higher than the one now in the International table. The specific gravity of dysprosium oxide was found to be 7.81. J. B. C. K.

Chemical reactions in isoamyl alcohol solutions.
H. A. Curtis and R. M. Burns, J. Amer. Chem. Soc., 1917, 39, 33—38.

THE authors have studied the reactions between anhydrous inorganic salts dissolved in dry isoamyl alcohol, precautions being taken to exclude moisture. The following are some of the results obtained:—*Cobalt chloride* dissolves readily in isoamyl alcohol to form a deep blue solution. Hydrogen sulphide partially precipitates the cobalt as a black cobalt sulphide. This settles readily leaving a blue supernatant liquid. Ammonia produces a pale rose-red precipitate containing cobalt, ammonia, and chlorine. After drying in the air, the compound has the composition: $\text{CoCl}_2 \cdot 3\text{NH}_3$. *Mercuric iodide* is slightly soluble in cold isoamyl alcohol, but dissolves readily in the hot alcohol. Hydrogen sulphide produces an orange-yellow precipitate. Ammonia has no effect on the cold isoamyl alcoholic solution, which contains but little dissolved iodide, but if ammonia be passed into the hot concentrated solution a lemon-yellow precipitate is obtained. *Mercuric chloride* dissolves in isoamyl alcohol to form a colourless solution. Hydrogen sulphide produces a yellow precipitate which becomes brown and finally black if the stream of hydrogen sulphide be long continued. Ammonia produces a white precipitate containing mercury, chlorine, and ammonia in the ratio of approximately $2\text{Hg} : 6\text{Cl} : 3\text{NH}_3$. *Copper chloride* dissolves in isoamyl alcohol to form a dark green solution. Warming the solution changes the colour to a brownish green, the solution becoming almost opaque. Hydrogen sulphide precipitates black copper sulphide, the reaction being quantitative. Addition of calcium bromide solution causes the copper chloride solution to become deep brown in colour. Copper bromide dissolves in isoamyl alcohol to form a solution which has the same deep brown colour. Ammonia precipitates from the chloride solution at first a green compound, but this changes to a blue compound if the ammonia stream be continued for a few minutes. The blue compound is not stable in the air but liberates ammonia and changes into the green compound. This green compound, dried in the air, has the composition, $\text{CuCl}_2 \cdot 2\text{NH}_3$. The reactions with *cobalt nitrate*, *zinc chloride*, *cadmium iodide*, *ferric chloride*, *selenium dioxide*, and *ammonium thiocyanate* were also studied. *Methyl orange* dissolves sparingly in isoamyl alcohol to form a yellow solution. If ten c.c. of this solution be shaken with an equal volume of $\text{N}/2$ aqueous hydrochloric acid, both the water layer and the alcohol layer become pink. If, however, the concentration of the acid used be $\text{N}/8$, the water layer will become pink, but the alcohol layer will remain yellow.—J. B. C. K.

Kelp: Occurrence of free carbon monoxide in—
S. C. Langdon, J. Amer. Chem. Soc., 1917, 39, 149—156.

THE gas in the floaters of the giant kelp of the Pacific coast (*Neoreocystis luteoventris*) was found to contain amounts of carbon monoxide ranging from 0 to 12%; carbon dioxide was only occasionally present, and then in very small amounts (maximum 1.2%).—J. H. L.

Graphite: Colloidal—in oil. D. Holde, Deutsche Bunsen Ges., Dec., 1916, Chem.-Zeit., 1917, 41, 32—33.

THE efficiency of colloidal graphite lubricants depends on the purity of the graphite, the proportion of this element present, and the stability of the colloidal state on standing. A method devised by Freundlich (this J., 1916, 590) for estimating the graphite consists in the addition of benzene and a suitable electrolyte to cause flocculation. After standing 6 to 7 hours, the graphite can be filtered off. A more rapid method devised by the author consists in adding benzene to the mixture, and without further standing, filtering through a Gooch crucible packed with a finely divided powder such as fullers' earth. The filter is then washed with carbon tetrachloride or chloroform, so as to remove soluble impurities separated from the oil. The stability of the suspensions varies with the viscosity and nature of the oils, and can be measured by allowing a column of the mixture to stand for a prolonged interval, and determining the amount of separation by observing the loss of opacity in the top layer, or by analysis. The settling can be accelerated by diluting with an oil of low viscosity.—J. N. P.

Melting zirconia, and production of ware therefrom.
Podszus, See VIII.

PATENTS.

Sulphuric acid; Apparatus for concentrating—
T. Kilroy, Bayonne, N.J. U.S. Pat. 1,211,594, Jan. 9, 1917. Date of appl., Aug. 18, 1915.

A DESCENDING, finely divided stream of sulphuric acid meets an ascending stream of hot flue gases. The operation is conducted in a tower or a series of towers each composed of metallic sections with a packing of refractory material, and having a removable lead pan at the bottom and distributing apparatus at the top. The acid is fed in at the top of the tower at one end of the series, being pumped from the bottom of one tower to the top of the next, and the hot flue gases enter at the bottom of the tower at the other end of the series and pass along a connecting pipe from the top of one tower to the bottom of the next. The lead pan at the bottom of the tower, where the flue gases enter, is heated.—B. V. S.

Acetic acid: Method of purifying—A. Gorhan, Liesing, Austria-Hungary. U.S. Pat. 1,210,792, Jan. 2, 1917. Date of appl., May 21, 1915.

FORMIC acid and empyreumatic substances are removed from acetic acid by distilling a mixture of equal parts of the crude acid and 70% sulphuric acid. Acetic acid distils over from this mixture at a temperature above the decomposition point of formic acid, but below that of acetic acid.

—B. V. S.

Nitrogen compounds: Process for the manufacture of—Norsk Hydro-Elektrisk Kvaestofaktieselskab, Christiania, Norway. Eng. Pat. 100,099, Feb. 8, 1916. Under Int. Conv., Feb. 23, 1915. (Appl. No. 1884 of 1916.)

NITROGEN compounds are produced by the oxidation of nitrogen in an electric arc furnace and subsequent absorption of the resultant nitrous gases, the oxidation and absorption being effected in a closed system in which the gases are circulated under pressure. The circulating gases are maintained at their original volume and pressure by supplying a compressed gas mixture of suitable composition and quantity, at a certain point. To prevent accumulation of impurities, a portion of the residual gases leaving the absorption system may be withdrawn previous to the introduction of fresh compressed gas. The gas withdrawn is relatively rich in argon, etc., and may be utilised

for the manufacture of argon. The gaseous mixture most favourable to the reaction is $O_2 : N_2 = 1 : 1$.
—T. H. B.

Gaseous reactions with the aid of air rich in oxygen; Process for carrying out —. Norsk Hydro-Elektrisk Kvaestofaktieselskab. Fr. Pat. 480,205, Nov. 12, 1915. Under Int. Conv., Nov. 28, 1914.

IN gaseous reactions in a closed system, such as the fixation of atmospheric nitrogen, the necessity of using an airtight system is avoided by working under diminished pressure, and compensating for the increase of volume due to leakage by withdrawing a part of the gases after removal of the products of reaction. The gas withdrawn from the system, being relatively rich in oxygen, is purified, and then used for producing oxygen to be added to the air supplied to the system to make up for the loss of oxygen in the reaction. The method of withdrawing a portion of the circulating gases may also be applied to closed systems working under pressure (see preceding abstract).

Ammonia; Production of —. F. Perry, Tipton, Staffs. Eng. Pat. 103,118, Jan. 12, 1916. (Appl. No. 538 of 1916.)

AMMONIA is produced by passing Mond or producer gas through iron pipes heated to 650° to 700° C.; or a mixture of either gas with steam may be passed through a furnace of iron or refractory material containing coke or similar carbonaceous material at 650° to 700° C. After removal of the ammonia by means of sulphuric acid, the residual gas may be subjected to the same treatment until the whole or greater part of the available nitrogen is removed.—B. V. S.

Condenser for ammonia. L. Bloek, Mamaroneck, N.Y. U.S. Pat. 1,210,142, Dec. 26, 1916. Date of appl., Dec. 2, 1912.

THE condenser consists of a vertical series of double, concentric pipes connected at the ends to form a continuous coil, the ammonia passing upwards in the inner tube and cooled water downwards in the outer tube. A check valve prevents the backward passage of the gas, and means are provided to carry along condensed liquid with the uncondensed gas, and to pass uncondensed gas from the top of the coil back to the bottom.—B. V. S.

Base-exchanging silicates; Manufacture of —. H. Kriegsheim, Assignor to The Permutit Co., New York. U.S. Pat. 1,208,797, Dec. 19, 1916. Date of appl., Mar. 21, 1916.

A BASE-EXCHANGING material is obtained as a precipitate by mixing an alkaline solution of alumina with the solution obtained by leaching an alkaline melt containing silica and alumina.
—B. V. S.

Magnesium chloride and the like; Method of making —. E. O. Barstow, Assignor to The Dow Chemical Co., Midland, Mich. U.S. Pats. (A) 1,209,245 and (B) 1,209,246, Dec. 19, 1916. Dates of appl., Mar. 13 and Apr. 17, 1916.

(A) BRINE containing sodium, calcium, and magnesium chlorides is treated with magnesium sulphite in sufficient amount to react with the calcium chloride present, precipitating calcium sulphite, and leaving a solution of sodium and magnesium chlorides which are separated by crystallisation. The magnesium sulphite is prepared from magnesium hydroxide obtained by treating a quantity of the brine with lime. (B) Magnesium hydroxide is mixed with the brine and sulphur dioxide passed through to form magnesium chloride and a precipitate of calcium sulphite.—T. H. B.

Uranium oxide; Process for the manufacture of —. H. A. Seil, Assignor to Standard Chemical Co., Pittsburgh, Pa. U.S. Pat. 1,210,714, Jan. 2, 1917. Date of appl., Apr. 20, 1916.

By heating a mixture of alkali uranate and sulphuric acid to drive off excess acid, a mixture of alkali sulphate and uranium oxide is produced from which the latter is obtained by washing away the sulphate with water.—B. V. S.

Spent oxide; Revivifying and utilising —. E. B. King, Oak Park, and E. C. Wescott, Sacramento, Assignors to Pacific Gas and Electric Co., San Francisco, Cal. U.S. Pat. 1,211,713, Jan. 9, 1917. Date of appl., May 27, 1916.

SPENT oxide from gas-works is treated with unslaked lime and hot water or steam, and a soluble compound of lime and sulphur extracted.—B. V. S.

Oxygen from atmospheric air; Furnaces for production of —. H. G. Ross, Merton Abbey, Surrey, and W. S. Edwards, Bridport, Dorset. Eng. Pat. 18,221, Dec. 31, 1915.

AIR and steam are allowed alternately to react with a suitable chemical reagent in heated horizontal tubes or chambers in a furnace, the oxygen being withdrawn from the air by the reagent and given off on treatment with steam. The furnace tubes are provided with an inner pipe for admission of air and steam, this pipe being perforated throughout its length, in such a manner that the air or steam passes into intimate contact with the reagent. Three tiers of furnace tubes are preferably employed, and each tier receives in succession a current of steam while the remaining two tiers are supplied with air; thus the reagent in two tiers absorbs oxygen while oxygen is being given off in the third tier.—T. H. B.

Argon; Apparatus and process for concentrating —. G. R. Fonda, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pat. 1,211,125, Jan. 2, 1917. Date of appl., Oct. 12, 1915.

A LIQUID containing about 94% oxygen and 4% argon, obtained by the fractionation of liquid air, is subjected to further fractionation on the counter-current principle in a special rectifying column, argon being concentrated at the top of the column and oxygen at the bottom.—B. V. S.

Carbonic acid compounds of ammonia; Manufacture of —. C. Bosch, Assignor to Badische Anilin u. Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,211,393, Jan. 9, 1917. Date of appl., Apr. 8, 1915.

SEE Eng. Pat. 8763 of 1915; this J., 1915, 904.

Catalyser [for oxidation of ammonia to nitrogen oxides]. C. Bosch, A. Mittasch, and C. Beck, Assignors to Badische Anilin u. Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,211,394, Jan. 9, 1917. Date of appl., Apr. 8, 1915.

SEE Eng. Pat. 13,848 of 1914; this J., 1915, 799.

Antimonates; Production of —. P. Eyer, Halberstadt, Assignor to R. Koepp und Co., Oestrich, Germany. U.S. Pat. 1,211,564, Jan. 9, 1917. Date of appl., July 21, 1915.

SEE Eng. Pat. 11,083 of 1915; this J., 1916, 839.

Cuprous oxide; Process for production of — electrolytically. B. Hunt, Glasgow. U.S. Pat. 1,212,062, Jan. 9, 1917. Date of appl., Oct. 7, 1916.

SEE Eng. Pat. 14,310 of 1915; this J., 1916, 1156.

Aluminium nitride; Process of producing—O. Serpek, Assignor to Soc. Gén. des Nitrures, Paris, U.S. Pat. 1,212,119, Jan. 9, 1917. Date of appl., Apr. 14, 1915.

SEE Eng. Pat. 11,271 of 1915; this J., 1916, 115.

Means for packing the pistons of nitric acid vacuum pumps. Eng. Pat. 102,527. See 1.

Process of fractional elutriation of simple or mixed substances. Ger. Pat. 294,908. See 1.

Production of stable colloidal solutions. Ger. Pat. 295,164. See 1.

Process of making cement and by-products [from felspar, etc.]. U.S. Pats. 1,209,135, 1,209,219, and 1,209,220. See 1X.

Electrolysis of water with gas-holders dipping into the electrolyte. Ger. Pat. 294,909. See XI.

VIII.—GLASS; CERAMICS.

Society of Glass Technology.

AT a meeting of this Society, held on Jan. 18th last, Mr. W. F. J. Wood, President, in the chair, the Rules and Constitution of the Society were passed. The Society is to consist of three classes of members, viz., collective members, i.e., firms engaged in the manufacture, distribution, or use of glass (annual subscription, £3 3s.); ordinary members, i.e., persons (not being either representatives of collective members or student members) who are interested in glass technology (sub., £1 1s.); and student members, i.e., registered students who are attending a course or courses of technical instruction in the United Kingdom (sub., 2s. 6d.). Applications for membership should be sent to the Secretary, Society of Glass Technology, The University, Sheffield.

Papers on British glass sands were read by Dr. P. G. H. Boswell and Mr. C. J. Peddle, abstracts of which are given below.

British glass sands; their location and characteristics. P. G. H. Boswell. Soc. Glass Tech., Jan. 18, 1917.

THE analysis of British sands has proved their value. The analysis of sand can be carried out in three ways—(1) chemical, (2) mechanical, (3) mineral. *Chemical analysis* proves the value of a sand by determining its silica content, which must be high, and its iron content, which must be low. In the past, sands with higher iron oxide content than 0.02%, were regarded as useless for the best types of glass, but recent work has shown a higher iron content to be permissible, and so British sands can be used for good glass. *Mechanical analysis* determines the grading of the sand, the best for glass being that with the largest percentage of grains of diameter 0.25 to 0.5 mm. *Mineral analysis* is important in the laboratory for controlling consignments of sands, and also gives an indication of impurities to be expected.

The relative value of crushed rock was discussed, and it was shown that, after crushing, screening and washing were necessary to remove the larger grains and the fine material. By means of a geological map the position of English sand deposits and their situation relative to the centres of the glass industry was illustrated. The paper closed with a consideration of the transport question, and the need for development of the canal system together with a cheapening of railway rates.

British glass sands; the substitution of foreign sands by British sands for high grade glass making. C. J. Peddle. Soc. Glass Tech., Jan. 18, 1917.

THE author summarised the essentials of a good glass sand from the manufacturer's point of view, and showed that it must contain a high percentage of silica and a low percentage of impurity, particularly iron oxide. It must be evenly graded, and the grains should be angular. In addition, a sand should always be true to sample, and consignments should not vary, nor should there be any treatment necessary at the hands of the manufacturer. All these essentials are fulfilled by Fontainebleau sand, but not all by any British sand as at present supplied. That some British sands compare favourably with Fontainebleau, both as regards purity and grading, has been established by the author, whose results in general are in agreement with those of Dr. Boswell. In addition, a long series of melts also support this view, and on this account the statements of Dr. Rosenhain as to the non-availability of British sands for good glass are to be criticised. Excellent results are obtainable with British sands which have been properly treated, and numerous specimens of glasses made from British sands were exhibited side by side with the sands. Several of these glasses could not be distinguished from similar melts made with Fontainebleau sand, being just as brilliant and colourless. The question of treatment was then discussed, and the necessity for washing and grading was demonstrated. The need of proper scientific treatment of British sands and the necessity of putting them into the manufacturer's hands ready for immediate use was emphasised, and it was pointed out that unless this treatment was forthcoming, together with attention to mode of delivery, British sands could not hope to compete favourably with Fontainebleau sand.

Glass; Production of blue, green, black, and gold colours on—L. Springer. Keram. Rundschau, 1916, 24, 211–212. Z. angew. Chem., 1916, 29, Ref., 526.

THE author concludes that so far as present knowledge goes, satisfactory colours can be burnt on to glass only by the use of compounds of copper and silver, and possibly gold and platinum. A black is produced by burning on copper compounds in the ordinary way with a subsequent burning under reducing conditions. A third burning under ordinary conditions gives a red colour. The first burn with copper compounds gives a green. A yellow, burnt on in the usual way, is converted into a bright golden colour by a second burn under reducing conditions. Blues cannot be produced by burning cobalt compounds on to glass. Compounds of other elements also gave negative results.—H. J. H.

Coke-oven bricks; Some physical properties of the two chief mineral constituents of—W. G. Fearnside. Coke-oven Managers' Assoc., Jan. 27, 1917. Gas. J., 1917, 137, 253–254.

COKE-OVEN bricks are manufactured from fireclay alone or a mixture of fireclay and crushed siliceous rock. The refractory properties need not be as highly developed as in bricks for steel furnaces, whilst the durability is dependent on the physical stability of the body and the chemical inertness of the mineral constituents in the presence of certain fluxes at temperatures between 800°C. and 1100°C. From the results of chemical examination, etc., it is generally agreed that the base of fireclay is similar to the kaolinite of china clay. The value of a fireclay would be appraised by comparing its analysis with that of the mineral kaolinite with 39.5% Al_2O_3 , 46.5% SiO_2 , and

about 14% H_2O . any other bases, especially alkalis, being detrimental to the quality of the material. Mellor (this J., 1911, 804; 1913, 195; 1916, 1218) has shown that on heating kaolin, entangled water is given off at temperatures just above 100°C . but the combined water does not come away till 500°C . is passed, the heat absorption during this dissociation retarding the rise of temperature considerably. The temperature then rises steadily to 800°C . at which temperature there is an exothermic reaction, with a more rapid increase in temperature. Beyond 1200°C . a new chemical rearrangement of molecules occurs, and what Mellor regards as a mixture of $\text{Al}_2\text{O}_3 + 2\text{SiO}_2$ recombines as $\text{Al}_2\text{O}_3 \cdot \text{SiO}_2 + \text{SiO}_2$, and the mineral sillimanite begins to crystallise. According to Mellor the heating curves of fireclay are similar to those of kaolin. When air-dried fireclay is heated it expands a little whilst water is given off, but then contracts continuously right up to the higher temperatures. The contraction at lower temperatures is correlated with loss of water, giving rise to increased porosity. Above 900°C . the density is further increased, probably due to the fluxing of silica and feldspathic minerals. As the temperature rises more fluxing occurs until the mass may be described as vitrified. Contraction and other vitrification effects can only be controlled by fixing the rate of rise of temperature above the lower limit of fluxing temperature. When bricks consisting of clay or kaolinite burnt to the point of vitrification are examined microscopically, the bonding material appears to consist of glass. Next to kaolinite, quartz is the most abundant mineral in the fireclays of this country. When quartz is heated it expands up to 870°C ., and above this temperature, if time be allowed, and the environment be suitable, it breaks down, expanding abruptly and considerably, and passing into a substance similar to tridymite, a mineral of a density less than 2.33, compared with the 2.66 of quartz. At higher temperatures, up to 1470°C ., the tridymite changes to cristobalite of a density about 2.27. Any pair of chemically related substances heated to the melting point of one of them react to form new compounds or to some extent dissolve each in the other, forming an eutectic of lower melting point than either. Pure kaolin does not melt as a single substance, but heated to 500°C . gives up its water, and at about 1200°C . the dehydrated residue changes into a mixture of sillimanite and probably tridymite, which on further heating passes into cristobalite. This mixture on cooling forms an eutectic, with a melting point, as determined by Rankin, of 1600°C . From this it appears quite evident that kaolin and quartz cannot flux each other and may be mixed in any proportion with little loss of refractory properties.—J. E. C.

Zirconia; Melting — and production of ware therefrom. E. Podszus. Z. angew. Chem., 1917, 30, 17—19. (See also this J., 1917, 85.)

RAW zirconia is an unsatisfactory material for the production of refractory articles as they crack readily and soon fall to pieces. If a bond is used to prevent this, the refractoriness of the articles is seriously impaired. The author has found that zirconia which has been heated to above 2000°C ., and especially fused zirconia, is free from this objection and is excellent for the manufacture of refractory ware. The use of a carbon resistance furnace or of an ordinary electric arc for fusing the zirconia is unsatisfactory on account of the formation of carbide. The best results are obtained by embedding a carbon electrode in coarsely ground calcined zirconia, heating the latter with the arc formed from a second carbon electrode and thus partially melting the zirconia with

formation of some carbide. The latter then acts as an electrode and the zirconia fuses and continues to do so when the upper carbon electrode is slowly withdrawn. After a time, the arc becomes quiet and the fusion proceeds rapidly. Arcs 30 cm. long, accompanied by a molten mass of zirconia 15 cm. in diameter, have repeatedly been obtained in half an hour with a current of 50 amps. at 220 volts, the resulting blocks of zirconia being pure, and white, with a yellowish sheen in parts, due to traces of iron. The fused zirconia is ground for 100 hours or more in a steel ball mill and any iron taken up from the latter is removed by treating the powder with acid. The zirconia is moulded or pressed into articles, with or without the addition of an organic bond. By reducing a part of the zirconia to the colloidal form it is possible to render the whole material plastic and to manufacture articles from it by "slip-casting" in plaster moulds in the same manner as porcelain. Crucibles made by this process are as fine as those made of porcelain. Attempts to cast articles from molten zirconia have, hitherto, been unsuccessful. The articles are burned at 2300°C — 2400°C . until they cease to contract; if properly burned they should "ring" clearly when struck. The burning temperature may be reduced to 2100°C . by adding a little boric or phosphoric acid to the zirconia before making it into articles, but this is not recommended. The oven used is constructed chiefly of fused zirconia; it is cylindrical in shape, with internal dimensions of 20 cm. by 30 cm., and is of the injector type. The fuel is either town's gas, petroleum, or acetylene supplied with a blast of air and, later, with oxygen. The author's furnace has been in use for 200 hours without requiring any repairs. A uniform yet very high temperature and an oxidising atmosphere can be obtained without difficulty, so that ovens of this type may be useful for testing the fusibility of refractory materials up to 3000°C . The shrinkage of the articles during drying and burning varies with the size of the particles of zirconia. If a finely ground material is used, the total shrinkage is about 20%. Fused zirconia resembles fused quartz in some respects, but when cooled rapidly it forms an opaque mass of minute crystals and not a clear glass. The crushing strength of cold fused zirconia is many times that of cold quartz, so that it is exceedingly difficult to grind. Such zirconia has a high thermal endurance and is not affected when heated to redness and then plunged into cold water. A large block may be heated irregularly by an oxy-hydrogen blowpipe without showing any signs of spalling. A block of fused zirconia maintained at 2200°C . for 30 hours showed no signs of disintegration when cold. Hence, fused zirconia appears to be a refractory material of extraordinary value. It has a hardness between quartz and corundum, a specific gravity of 5.89, a porosity below 1%, and a melting point—determined with a Lummer-Kurlbaum pyrometer—between 2950° and 3000°C ., but 0.5% of impurity reduces this by 100° .—A. B. S.

Absorption of gases. Hempel. See 1.

PATENTS.

Glass; Non-scatterable — and the process of making it. A. Roosevelt. Assignor to Glass Founders' Corporation, New York. U.S. Pat. 1,201,987, Jan. 2, 1917. Date of appl. June 3, 1915.

A SOLUTION of gelatin and one of cellulose material are applied successively to a sheet of glass, at least one of the solutions containing a solvent of both the gelatin and cellulose material, such as formic acid.—A. B. S.

Firebricks: Plastic composition for making — E. V. Wagner, Scranton, Pa., Assignor to Wagner Firebrick Co., Helena, Mont. U.S. Pat. 1,209,784, Dec. 26, 1916. Date of appl., Aug. 5, 1916.

The firebricks are made of a mixture of coal ashes 100 lb., alumina 2 lb., and water 2–2½ galls.

—A. B. S.

Tiles: Composition for — P. C. Boying, Philadelphia, Pa. U.S. Pat. 1,240,756, Jan. 2, 1917. Date of appl., July 19, 1915.

A mixture of ground, burned clay, calcined magnesite, and magnesium chloride solution is made into a paste, dried to a moist powder, and compressed in moulds to form tiles.—A. B. S.

Grog in dust form: Production of — as shortening material. M. Bertram, Neustädte, Ger. Pat. 295,290, Apr. 13, 1916. Addition to Ger. Pat. 288,721 (this J., 1916, 424).

THE process described in the original patent, when applied to the more fusible clays, may give rise to fritting or even melting if the development of heat by combustion of admixed material is excessive. If the mixtures be distilled in closed vessels before burning in a kiln, even the most fusible clays give a satisfactory product.—H. J. H.

Glass surfaces: Joining together — A. Hilger, Ltd., F. Twyman, R. G. Parker, and A. J. Dalladay, London, Eng. Pat. 103,233, Apr. 20, 1916. (Appl. No. 5839 of 1916.)

SEE U.S. Pat. 1,206,177 of 1916; this J., 1917, 85.

Process of fractional elutriation of simple or mixed substances. Ger. Pat. 291,908. See 1.

IX.—BUILDING MATERIALS.

Concrete specimens: Tests of — in sea water at Boston Navy Yard. R. E. Bakenhus, Proc. Amer. Soc. Civ. Eng., 1916, 42, 1571–1601.

TWENTY-FOUR specimens of concrete, made from cement, sand, and stone (broken trap rock), each 16 ft. long and 16 in. square, were hung suspended from a pier and immersed in sea water for 7 years in order to determine the action of the water on wet and dry concretes of various proportions, made of materials from various sources. The results seem to show that the specimens richer in cement were the most durable. Thus, the 1:1:2 mixture was superior to the 1:2½:4½, and the 1:2½:4½ was in turn superior to the 1:3:6. The wet mixtures were superior to the dry mixtures. The effects of magnesia or alumina in varying proportions were not very marked, and followed no apparent law, although the two most durable specimens were those lowest in alumina content. Extra care in mixing produced decidedly beneficial results. Hydrated lime was of no benefit, but rather a detriment. The addition of Sylvester wash was harmful. In this case, 3 lb. of alum was added to each bag of cement used and the materials were mixed dry. Instead of then mixing them with plain water, Sylvester wash was substituted. This consists of 1¼ lb. soap dissolved in 12½ galls. of water. The addition of 1½ lb. of clay to each bag of cement had a slightly beneficial result. The deterioration was most marked at mid-tide, little deterioration being observable with non-immersed and continuously immersed specimens. The experiments are too limited to warrant drawing more definite conclusions.—A. B. S.

Absorption of gases. Hempel. See 1.

Utilisation of waste heat for steam generating purposes. Pratt. See 1.

PATENTS.

Paving: Process for treating fibrous material for manufacture of compositions suitable for — J. E. Clark, Toronto, Canada. Eng. Pat. 102,826, Jan. 7, 1916. (Appl. No. 313 of 1916.)

STRAW, corn-stalks, sugar cane, wood chips, or other coarse fibrous material (but not wood pulp or dust) is boiled with water. The juices and excess of water are removed by passing the material between rollers, and the product is then immersed in a bath of asphalt, bitumen, or other binder, heated to 200°–400° F. (93° to 204° C.). The product is withdrawn mechanically, rolled or otherwise compressed, and allowed to harden under the action of the sun. It is resilient, dustless, sanitary, waterproof, and non-slipping.

—A. B. S.

Cement and by-products: Process of making — [from felspar, etc.]. E. C. Eckel and A. C. Spencer, Washington, D.C. U.S. Pats. (A) 1,209,135, (B) 1,209,219, and (C) 1,209,220, Dec. 19, 1916. Dates of appl., Jan. 4, 1911, June 6, 1910, and May 18, 1912.

CEMENT is made by heating a comminuted mixture of (A) potash felspar, or a potash silicate of the (B) glauconite, or (C) nephelite or mica type with calcareous materials (e.g., limestone) to a temperature sufficient to vaporise the potash and then to form cement clinker, but not to cause fusion. The potash is recovered in the flue-dust.—A. B. S.

Pavements and other structures: Surfacing mixture for — F. H. Welsh, Richmond, Cal. U.S. Pat. 1,209,238, Dec. 19, 1916. Date of appl., Feb. 21, 1916.

AN asphaltic surfacing composition is made by mixing steam-distilled, crude petroleum asphalt with 20% of a product obtained by heating crude petroleum with air under pressure without removing its volatile constituents.—A. B. S.

Furnace lining. G. S. Davison, Assignor to A. S. Davison Co., Pittsburgh, Pa. U.S. Pat. 1,210,431, Jan. 2, 1917. Date of appl., July 7, 1916.

A FURNACE lining is made of a mass of granular, basic refractory material, the pores in the particles of which are impregnated with a small amount of silicious and ferruginous material, such as basic slag. The faces of the particles are substantially free from such silicious material.—A. B. S.

Wood: Process of artificially seasoning — M. Kleinstück, Dresden, Germany. U.S. Pat. 1,210,491, Jan. 2, 1917. Date of appl., Mar. 19, 1914.

WOOD is treated with a gaseous primary oxidation product of an alcohol, e.g., an aldehyde, and a catalytic agent, such as a volatile amine, so as to transform the tannins, albumins, and carbohydrates into high-molecular compounds.—A. B. S.

Portland cement and similar products: Apparatus for the manufacture of — W. H. Mason, Easton, Pa. U.S. Pat. 1,210,510, Jan. 2, 1917. Date of appl., May 21, 1914.

AN unground mixture of cement-forming materials is calcined in one section of a rotary kiln and is passed through a grinding section and then through a second burning section where it is converted into clinker. The three sections of the kiln are in a straight line with a continuous closed passage through them, but each can be rotated separately.—A. B. S.

Roofing and waterproofing materials; Manufacture of flexible bituminous—. C. N. Forrest, Rahway, N.J., Assignor to R. L. Fowler and M. S. Darrow, Perth Amboy, and E. B. Rosevear, Boonton, N.J. U.S. Pat. 1,211,837, Jan. 9, 1917. Date of appl., Feb. 26, 1916.

A HIGHLY absorbent, flexible sheet composed of fibres of cotton or wool and leather scrap felted together and saturated with a bituminous material.—A. B. S.

Artificial slates; Production of— from cement and asbestos. E. Imer-Schneider, Geneva, Switzerland. Ger. Pat. 295,268, Feb. 23, 1916. Under Int. Conv., Feb. 16, 1916.

ASBESTOS is mixed with vegetable fibres previously treated with cold dilute alkali to preserve their binding properties towards the cement. Such fibres may replace at least two-thirds of the asbestos otherwise necessary.—H. J. II.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Cast-iron: with special reference to engine cylinders. J. E. Hurst. Manchester Assoc. Eng., Dec., 1916. Engineering, 1917, 103, 40—41, 51—54, 75—76.

THE worn surface of cast-iron cylinders and pistons of steam and internal combustion engines is covered with small pits or holes. Microscopic examination shows the harder constituents, such as cementite and the phosphide eutectic, standing in relief. This is brought about by the polishing action of detached material suspended in the film of lubricating oil; eventually these projections become detached and cause gradual disintegration of the cylinder. After a cylinder has been in use for a time, especially if the metal is high in manganese, it is known to work more satisfactorily, and this is found to coincide with a peculiar glazed appearance of its inner surface. Microscopic examination reveals that in many cases the original coarse-grained structure has become much more finely granular, while hardness has increased. This is attributed to the absorption of carbon from the lubricant, or detached graphite, or both, by the surface of the cylinder, under influence of the high temperature, with formation of hardenite. Experience has shown that the most satisfactory bearing-metal alloys consist of at least two constituents of very different physical properties, one embedded in the other, and cast-iron probably owes its peculiar anti-frictional properties to a similar structure: the harder constituents serve as a support for the greater part of the load, while the depressions produced by the wearing away of the softer constituents serve as distributing reservoirs of the lubricant. The determination of hardness by Brinell's method gives no satisfactory guide as to the resistance to wear of cast-iron cylinders, the true wear depending upon the resistance to deformation of the individual component grains. As regards the effect of machining on the resulting surface, the quality of the finish is known to improve as the cutting speed decreases. In spite of the slow rate of machining cylinders and liners, due to the great accuracy required, small cracks and holes are liable to form; the more recent method of internal grinding is therefore preferable. The growth, or permanent increase in volume, of cast-iron when heated for several hours to 650°—750° C., which is due to the absorption of furnace gases along the graphite plates with oxidation of the silicon and iron, has been observed in the piston tops of internal combustion engines.—W. R. S.

Iron; Influence of cobalt, nickel, and copper on the atmospheric corrosion of pure commercial—. H. T. Kalmus and K. B. Blake. Amer. Inst. Chem. Eng., Jan., 1917. J. Ind. Eng. Chem., 1917, 9, 123—136.

As measured by the loss in weight per unit of surface exposed, after removing the rust by means of ammonium citrate solution, the atmospheric corrosion of pure iron was retarded by copper, nickel, and cobalt which, in the present investigation, were alloyed separately with the iron in proportions ranging between 0.25 and 3%. On exposure, all the alloys became coated with a protecting layer of oxides by which the rate of corrosion was subsequently decreased. The cobalt and nickel alloys, generally, suffered 50—25% less corrosion than pure iron; and the relative corrosions of the 3% and 0.5% alloys were as 3:4. The oxide coating on the cobalt alloys was darker and more dense and tenacious than those on the corresponding nickel and copper alloys, but, over the period of investigation, appeared to be no more advantageous than the latter. Alloys containing 0.25—0.75% Cu were more resistant than pure iron to atmospheric corrosion. In all cases the amount of corrosion varied with the carbon content of the alloy.—W. E. F. P.

Steels; Corrosion and electrical properties of—. R. Hadfield and E. Newbery. Proc. Roy. Soc., 1917, A 93, 56—67.

IN order that a metal may dissolve in an acid, the sum of the single potential of the metal and the overvoltage must be less than the single potential of the hydrogen electrode. The first value is the potential (usually negative) acquired by the metal through contact with its surrounding medium. The overvoltage is the potential required to overcome the resistance offered, in varying degrees, by all metal surfaces to the liberation of gas. The potential of the hydrogen electrode refers to an electrolyte of the same composition as the medium surrounding the metal. Measurements were made with different samples of steels, including silicon-, chromium-, nickel-, and tungsten-steels. Determinations were made of the single potential differences of prepared samples of the metals in dilute acid solutions, of the overvoltage by the back E.M.F. method, and of the rate of corrosion in acid and when exposed to the atmosphere. The corrodibility as determined by the sum of the single potential and the overvoltage gave results parallel to those measured by the rate of solution in acid. The degree of atmospheric corrosion with different alloys was, however, more closely in agreement with the values obtained by the electrical method than with those given by measurement of the rate of solution in acid. This is attributed mainly to the fact that corrosion, like overvoltage, is determined largely by the nature of the surface, which necessarily undergoes great changes during solution of the metal in acid. Since the electrical measurements are capable of being made with precision, and of distinguishing between the two determining factors, this method offers certain advantages over the acid test for determining corrodibility. It should also be possible to ascertain in this way how far the addition of certain elements can be made with the object of raising the overvoltage, and of others with the object of lowering the negative potential in order to attain the ideal of a rustless steel.—J. N. P.

Steel springs; Investigation of the brittleness produced in— by electroplating. M. De K. Thompson and C. N. Richardson. Met. and Chem. Eng., 1917, 16, 83—84.

THE brittleness produced in spring steel, by using the latter as cathode in a hot cyanide bath,

was found to be more pronounced with sodium cyanide than with sodium cuprocyanide, and not to occur when the spring was used as anode, or suspended in the solution without the passage of electricity, or when the steel was previously annealed. The brittleness was not due to the liberation of hydrogen on the metal, or characterised by any change in carbon content or crystalline structure; it was produced whether the steel was coiled or not. Brass and bronze were not similarly affected.—W. E. F. P.

Gold ore; Flotation experiments on a Transvaal —.
F. Wartenweiler. J. Chem., Met., and Min. Soc., S. Africa, 1916, 17, 87—90.

PYRITIC gold ore containing arsenic, from Barberton, crushed to -150-mesh and cyanided, gave a maximum extraction of 45%; amalgamation proved a failure. Roasting followed by cyaniding gave 82.5% recovery, but the high working costs militated against roasting. Concentration on a Deister table, with subsequent cyaniding of the concentrate, yielded 70% recovery. Laboratory flotation tests were successful under the following conditions: The ore, crushed to pass a 90-mesh screen, was mixed with water in the ratio of 1:5, lime being added to produce an alkalinity of not more than 0.005% CaO. The pulp was agitated for 15 min. with a mixture of wood creosote and paraffin oil. The middling and tailing were easily cyanided direct, the recovery being 22.4%. The concentrate was roasted, then amalgamated and cyanided, with an extraction of 65.0%. Allowing for volatilisation losses on a commercial scale, the total extraction on this ore would be 84%. W.R.S.

Countercurrent decantation [in the cyanide process].
L. B. Eames. Amer. Inst. Min. Eng., Feb., 1917. Met. and Chem. Eng., 1917, 16, 91—99.

THE chief factors affecting countercurrent decantation—namely, grade of ore, ratio of solution precipitated to ore treated, thickness at which the pulp can be discharged, cost of chemicals, rapidity of dissolving the gold and position in the circuit at which solution takes place, and efficiency of precipitation—are considered, and the effects of variations in the first three shown by means of curves based on the assumption that 75% of the gold is dissolved during grinding and the remainder during agitation. Various mechanical devices for pumping and thickening the pulp and measuring the volume of solution precipitated are also discussed, and a brief description is given of the decantation plant of the Hollinger Co. At this plant, during the 12 weeks ending on April 21, 1916, 85,854 tons of ore was treated by the countercurrent system at a total cost for decantation of 0.0209c. (0.01015d.) per ton, this figure being about 40% of the cost of filtering with leaf filters at about the same daily tonnage. The extraction and recovery of gold over this period compared very favourably with that obtained from filter plants and, as in the latter case, a reasonably accurate forecast could be made of results obtainable under specified conditions.—W. E. F. P.

Platinum; Microchemical estimation of small quantities of — in presence of gold and silver.
M. Van Breukelen. Rec. Trav. Chim. Pays-Bas, 1917, 36, 285—288.

The following method is recommended for the recognition and determination of small amounts of platinum in ingots of gold and silver. A sample of the alloy in the form of foil is freed from silver by heating it with sulphuric acid. If it originally contains less than four parts of silver to one part of gold, a sufficient amount of silver free from

platinum must be added to bring the proportion up to this value. After removal of the silver, the gold and platinum are dissolved in *aqua regia*, and the solution is evaporated to dryness. All the nitric acid is removed by evaporation with a little hydrochloric acid, and the auric chloride is converted into insoluble aurous chloride by heating for 15—30 minutes at 170°—190° C. To the residue is added 2 drops of N/3 hydrochloric acid, and a spot of the solution is placed on a cover-glass with a trace of solid potassium chloride. The drop is examined under a magnification of about 110 diameters, and, if platinum is present, yellow octahedra of potassium chloroplatinate are seen to form. By continuing to add 2 drops of hydrochloric acid to the residue and repeating the procedure, the number of drops is found at which the octahedra cease to form, owing to their solubility in the dilute acid. By determining this number for alloys of known platinum content, the method can be applied to determine platinum quantitatively when present in small amounts in gold and silver alloys.—F. Sp.

[Copper smelting.] Ore treatment at the Falcon Mine (Rhodesia). H. R. Adam. J. Chem., Met., and Min. Soc., S. Africa, 1916, 17, 91—96.

THE Falcon mine, which has been producing for two years, treats 11,000—15,000 tons of sulphide and 5000 tons of oxide ore per month; the output is given as 600,000 lb. of blister copper, 3000 oz. of gold, and 6000 oz. of silver. The sulphide ore (Cu 2½%, Au 6 dwt. per ton) is crushed to 2½ in. diameter and hand-picked on a belt conveyor, yielding 9% of picked smelting ore. The rest is crushed to ½ in. size and concentrated by vanning; the tailings, ground in tube-mills, are passed over vanners followed by blanket tables. The final tailing is classified into underflow which returns to the tube mill, and overflow which is thickened and concentrated by flotation in a plant of the Minerals Separation type. The oxidised ore is stamped, vanned, the tailings re-ground in a tube-mill and passed over vanners and blanket tables. The total extraction by concentration is 80% of the gold and 90% of the copper. The mill concentrate is sintered in 12 blast-roasting pots, each of which holds 8 tons, a charge requiring about 8 hours' treatment. The two blast-furnaces have a cross-section of 120 × 46 in. at tuyere-level and a capacity of 300 tons per 24 hours. The fuel is a mixture of coke and coal. The matte (32—35% Cu) is blown in upright converters of 15 tons capacity per 24 hours. The blister copper carries 10 oz. of gold and 20 oz. of silver per ton; the smelting recovery is 96% of the gold and 90% of the copper. The flues from the sintering and smelting plants lead into two settling chambers from which a 900 ft.-flue extends to the stack.

—W. R. S.

Copper refining; Current efficiency in —. L. Addicks. Met. and Chem. Eng., 1917, 16, 23—25.

Loss of current efficiency in copper refining by the multiple system is caused by (1) current leakage to the ground, through the electrolyte, or between the electrodes; (2) reactions involving deposition of impurities, "gassing," or change in valency of the copper; and (3) cathode shrinkage due to re-solution of deposited copper by sulphuric acid (sulphatising) or ferric salts, or to the mechanical separation of nodules, etc., from the deposit. Complete disregard of conditions may result in an efficiency of only 60%, and poor work in 85%; while 92% may be obtained by well balanced operating, and 99% by working for efficiency without regard to expense.—W. E. F. P.

Copper; Vaporisation of — in wirebar furnaces.
A. Butts. Met. and Chem. Eng., 1917, 16, 85—86.

IN the operation of a 200-ton reverberatory furnace equipped with waste heat boilers and economisers, 79.6 kilos. of copper was found to pass from the furnace into the flue apparatus during the melting of each charge, and it appeared probable that the whole of this loss was due to vaporisation of the metal. The maximum possible loss of copper by evaporation was calculated as 466 kilos. per charge, the vapour tension of the metal at the working temperature ($1120^{\circ}\text{C}.$) being about 0.28 mm. and the volume of gas passing through the furnace 440,000 cub. m. (at N.T.P.) per charge. The percentage saturation of the furnace gases with copper vapour was thus about 17% in the actual melting operation, assuming the loss to be due entirely to vaporisation. The copper vapour began to condense at $1005^{\circ}\text{C}.$ (about 55° above the temperature at the entrance to the waste heat boiler), and was collected, largely as copper sulphate, in the dusts obtained from the boiler, economiser, and stack. These dusts contained 28, 18, and 15% Cu. of which about 60, 85, and 90%, respectively, was soluble in water.—W. E. F. P.

Babbitt metal and alloys of tin, antimony, lead, and copper; Analysis of —. E. W. Hagmaier. Met. and Chem. Eng., 1917, 16, 84—85.

Antimony. 1 grm. of the sample (filings) is heated with 10 c.c. of water and 25 c.c. of sulphuric acid until no black particles remain. The cooled solution is then diluted with 100 c.c. of water and 10 c.c. of hydrochloric acid, boiled for 10 mins. to expel sulphurous fumes, and titrated with potassium permanganate after being cooled and further diluted with 100 c.c. of water. *Tin.* 0.5 grm. is dissolved in hydrochloric acid (with potassium chlorate if necessary) and the tin determined by titration with $N/10$ iodine solution after reduction with soft iron and hydrochloric acid. *Lead.* Solution is effected by dilute nitric acid in the presence of a large excess of tartaric acid. Sulphuric acid is then added and the solution boiled sufficiently to expel all nitric fumes but without charring the tartaric acid; after which the lead sulphate is filtered off, dissolved in ammonium acetate solution, and the lead reprecipitated and weighed as chromate. *Copper.* Solution is effected as in the preceding case and the filtrate from the lead sulphate is further acidified with hydrochloric acid and heated with pure aluminium. The precipitated copper is filtered off and redissolved in dilute nitric acid for determination by the electrolytic or iodide method.—W. E. F. P.

American mercury industry. Bull. U.S. Geol. Survey, U.S. Commerce Reports, No. 298, Dec. 20, 1916.

THE American mercury industry continued to be of more than usual interest throughout 1915, owing to the large consumption of the metal in the manufacture of war supplies and the generally prevailing high prices resulting from the great demand. Owing to foreign embargoes on the exportation of metals, domestic producers largely controlled the market in the United States, although several shipments were received from Italy (made, it is reported, under contracts drawn prior to the disturbed conditions abroad). Prices for the metal became so high in February and March, 1916, that certain foreign Governments permitted the shipment of some mercury, and thus, to a small but important extent, competition in the home market between domestic and foreign

supplies was re-established, and prices fell from \$300 per flask in February, 1916, to \$75 in August, 1916. In the fiscal year ending June 30, 1916, the United States imported for consumption 554,792 pounds of mercury, valued at \$595,007, and exported 232,763 pounds, valued at \$274,086. Although, owing to the efforts of producers to make capacity output, some stocks have doubtless accumulated, the price of mercury abroad will probably justify exports from this country, and cause reduction of stocks if the domestic quotations run much below \$70. The mercury mines and prospects of the United States were under active development in 1915. Additions to reduction plants were made at old mines and retorts were put in operation at promising prospects. Including small prospects, there were 39 producers of mercury in the United States in 1915, against 30 in 1914 and 24 in 1913. Thirty-two of the producers in 1915 were in California, 4 in Nevada, and 1 producer each in Arizona, Oregon, and Texas. The output was 21,033 flasks of 75 pounds each, against 16,548 flasks in 1914 and 20,213 flasks in 1913. At the average sales price reported by the producers of \$86.86 per flask for 1915 the output was valued at \$1,826,912, against \$1,680 in 1914 (average per flask, \$19.05) and \$813,171 in 1913 (average per flask, \$40.23). Compared with 1914 the yield for 1915 showed an increase of 27 per cent. in quantity and 125 per cent. in value.

A full statement of the world's output cannot be expected during the progress of the war in Europe. The production of Spain and of Italy has been increasing since the outbreak of the war. The famous Santa Barbara deposits of Huancavelica, Peru, have passed into new hands and may be re-opened. The production of mercury from low-grade ores at Punitaqui, Chile, is reported. Deposits of cinnabar have been noted in Mexico, but no reports of recent operations have come to hand. The Terlingua field, of Brewster County, Tex., is said to extend for a considerable distance into Mexico, with promise of workable ore bodies similar to those on the Texas side of the border.

Tungsten; Electrolytic behaviour of —. W. E. Koerner. Amer. Electrochem. Soc., Sept., 1916. Met. and Chem. Eng., 1917, 16, 40—47.

THE single potentials of tungsten in $N/1$ solutions of acids, alkalis, and normal salts were calculated from E.M.F. measurements and found to be lowest in alkalis and highest in neutral salts. For the alkaline solutions the order of increasing potential was KCN, KOH or NaOH, NH_4OH (the potential in KOH or NaOH corresponding to that of thallium in a solution of thallium chloride of $N/1$ Tl ion concentration); for the acid solutions, H_2SO_4 , HCl, HNO_3 (the value in the last corresponding to that of copper in a solution of cupric chloride of $N/1$ Cu ion concentration); and for the neutral salts, KNO_3 , KF, KBr, KCl, K_2SO_4 , KI. The electrochemical equivalent of tungsten was found to be 0.3173 mgrm. per coulomb, a value corresponding closely with the theoretical. Tungsten occurs as cation in acid and anion in alkaline solutions. Tungstic acid is hydrolysed, and dissolved as $\text{W}(\text{OH})_6$ by mineral acids, being most soluble in nitric and least in hydrochloric acid; $\text{W}(\text{OH})_6$ in water is an electrolyte and not a colloid. Tungsten dissolves anodically, and becomes passive, in aqueous and non-aqueous solutions of alkalis, acids, and salts. In aqueous solutions of acids and salts passivity occurs at low current densities, and the active state is maintained only at very low current densities; but in aqueous solutions of alkalis, in a solution of hydrogen chloride in absolute alcohol, in hydroxylamine, and in methyl-, ethyl-, and propyl-ammonium hydr-

oxides, passivity occurs only at very high current densities. The passivity of tungsten is due to adherent films of hydrated tungsten oxides which may be readily dissolved and the passivity destroyed. The films appearing on the anode vary in colour from brown, through blue to yellow, and the degree of passivity varies with the colour of the film. In experiments on the use of tungsten in storage cells, the potential difference between the brown oxide (positive) and the blue oxide (negative) was found to be +0.75 volt.—W. E. F. P.

Ruthenium; Action of oxygen on —. A. Guthrie, G. A. Leuchs, H. Wiessmann, and O. Maisch. Z. anorg. Chem., 1916, 96, 182—206. J. Chem. Soc., 1917, 112, ii., 38. (Compare Guthrie and Ransohoff, Z. anorg. Chem., 1905, 45, 243.)

FINELY powdered ruthenium oxidises rapidly when heated in oxygen, the maximum absorption of oxygen corresponding very closely with the formula RuO_2 . The value actually obtained is very slightly lower, owing to volatilisation. It is independent of temperature between 700° and 1000° C., although the rate of oxidation varies considerably. The formation of the volatile tetroxide begins at 600° C., and then increases rapidly, being 4000 times as great at 1200° as at 700° C. Crystals of the dioxide are observed in the sublimate. Metallic ruthenium is rendered more compact by heating at 800° C. Previous heating at a high temperature in hydrogen reduces the velocity of oxidation.

Utilisation of waste heat for steam generating purposes. Pratt. See 1.

PATENTS.

[Steel] rails; Treating —. E. F. Kenney, Westmont Borough, Pa. U.S. Pat. 1,205,998, Nov. 28, 1916. Date of appl., Mar. 20, 1916.

THE rails are finished at a temperature of 1400°—2000° F. (740°—1090° C.), quenched in a vertical or slightly inclined position so as to cool them to a temperature not less than 400° F. (205° C.), again heated to above 800° F. (425° C.) but not higher than their recalcrescent temperature, and straightened before they have cooled to less than 600° F. (315° C.).—W. R. S.

[Iron and steel.] Rust-proofing metal; Process for —. W. H. Allen, Assignor to Parker Rust Proof Co. of America, Detroit, Mich. U.S. Pat. 1,206,075, Nov. 28, 1916. Date of appl., Aug. 21, 1915.

ARTICLES of iron or steel are rendered rust-proof by immersing them in a saturated phosphoric acid solution of manganese phosphate until hydrogen ceases to be evolved.—W. R. S.

Furnace [for treating steel]. F. J. Ardner, Detroit, Mich. U.S. Pat. 1,206,077, Nov. 28, 1916. Date of appl., Feb. 3, 1916.

A FURNACE for treating steel comprises an annular conduit of refractory material, the bottom of which is formed by a rotating table consisting of connected metallic segments having channelled flanges at their edges, and covered with refractory material. Refractory projections are disposed in the channel of the flanges so as to retain the refractory material upon the table.—W. R. S.

Steel; High-speed —. J. M. Flannery, Assignor to Standard Chemical Co., Pittsburgh, Pa. U.S. Pats. (A) 1,210,625, (B) 1,210,626, (C) 1,210,627, Jan. 2, 1917. Dates of appl. (A and B) Feb. 19, 1916, (C) Sept. 7, 1916.

(A) URANIUM, in the proportion 0.05 to 5%, is

added as sole toughening agent to the steel. (B) Uranium is added to replace part of the tungsten in tungsten steel, so as to give approximately 8% tungsten and 3% uranium. (C) Uranium is added to molybdenum steel to give approximately 3 to 10% of molybdenum and 3% uranium.—B. N.

Metal insulated against electrolysis and corrosion; Manufacture of rigid pieces of —. P. M. Stewart, New York. Eng. Pat. 18,947, Dec. 28, 1915.

THE metal is cleaned, then heated, a layer of bituminous composition is applied to the heated surface, and, whilst the bitumen is soft, a layer of fibrous insulating material, such as asbestos paper, is pressed into firm contact with it. (Reference is directed, in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pat. 27,101 of 1911.)—B. N.

Cobalt-silver alloy; Electrolytic deposition of —. P. Marino, London. Eng. Pat. 102,828, Jan. 7, 1916. (Appl. No. 346 of 1916.)

THE electrolyte is prepared from aqueous solutions of a salt or oxide of each of the metals, such as cobalt acetate and silver nitrate, each of these being added to separate solutions of sodium thiosulphate or bisulphite; the two solutions are then mixed in relative proportions corresponding to the composition of the alloy to be deposited.—B. N.

Anodes for electroplating. G. Jones, Birmingham. Eng. Pat. 102,897, July 29, 1916. (Appl. No. 10,745 of 1916.) Addition to Eng. Pat. 17,328, Dec. 10, 1915 (this J., 1916, 895).

SHEETS of perforated celluloid are secured to wood separating pieces, or to a wood frame, by insulated or protected screws, rivets, or the like, so as to form the container for the nickel or cobalt pellets. Conductors of a similar metal are connected to the bottom contact strip, upon which the anode metal rests, and the strip is secured between the pieces of the frame.—B. N.

Plating metals [iron and steel with nickel]; Process for —. C. W. Parker, Assignor to Parker Rust Proof Co. of America, Detroit, Mich. U.S. Pat. 1,211,218, Jan. 2, 1917. Date of appl., July 31, 1916.

IRON and steel articles are immersed in a solution of phosphoric acid mixed with manganese oxide, and then cleaned mechanically, the articles being afterwards suspended in a nickel-plating bath containing nickel sulphate.—B. N.

Pyrometers for metallurgical and like operations. F. C. Fairholme, W. R. Barclay, and G. E. M. Stone, Sheffield. Eng. Pat. 103,048, Apr. 3, 1916. (Appl. No. 4855 of 1916.)

THE pyrometer consists of (a) a vertical outer tube, the lower end of which is made of silica and the upper end of metal. The metal portion is surrounded by a second tube which slides over it and can be adjusted to any required position by means of slots and set-screws, (b) a vertical rod, fitting loosely inside the tube, the lower part being made of silica or other refractory material and the upper part of metal. The lower end of this rod rests on a piece of fusible metal at the bottom of the tube; its upper end passes through a hole in the cap covering the top of the tube and is pivoted to a lever of the first order which acts as a pointer. The free end of the pyrometer is immersed in the contents of the crucible, or other material of which the temperature is to be

ascertained; as soon as the temperature of the latter is sufficiently high, the metal at the bottom of the pyrometer fuses, the rod resting on it falls, and the free end of the pointer rises. The pyrometer is then withdrawn, the end of the pointer is depressed by hand and kept down by a spring catch so that the lower end of the vertical rod may be kept clear of the fusible metal until the latter has again solidified. The fusible metal used is selected in accordance with the temperature to be indicated. In the manufacture of crucible steel, it may consist of an alloy similar to that being manufactured, but rather less fusible, so as to indicate the pouring temperature and not the melting point of the product to be tested.

—A. B. S.

Sintering-machines; Ignition furnace for —. F. W. Yost, New York, and B. G. Klugh, Cleveland, Ohio, Assignors to American Ore Reclamation Co., New York. U.S. Pat. 1,206,397, Nov. 28, 1916. Date of appl., March 11, 1915.

THE furnace has a combustion chamber and supply connections leading to different sources of fluid fuel which may be used independently or in admixture. A transverse fuel-distributing chamber provided with burner orifices at its base is situated above the combustion chamber.—W. R. S.

Tungsten; Method of producing malleable —. A. Helfgott, Uj-Pest, Hungary, Assignor to General Electric Co., New York. U.S. Pat. 1,206,704, Nov. 28, 1916. Date of appl., July 16, 1913.

FINELY pulverised tungsten, which has been heated in a reducing atmosphere to free it from oxide while maintaining its fineness unimpaired, is mixed with coarsely granular tungsten and the mixture pressed into a coherent mass which is subsequently sintered.—W. R. S.

Aluminium; Flux for soldering —. C. F. Kriews, Assignor to F. C. Kriews, Cleveland, Ohio. U.S. Pats. (A) 1,208,798 and (B) 1,208,799. Dec. 19, 1916. Dates of appl., Feb. 10 and Apr. 21, 1916.

(A) A GLYCERIDE of a fatty acid, e.g., olive oil, or (B) a fatty acid such as oleic, palmitic, or stearic, obtained from animal fats, is used as a flux for soldering aluminium.—W. F. F.

Electric welding; Method of and apparatus for —. F. H. Neff, Assignor to The Electric Railway Improvement Co., Cleveland, Ohio. U.S. Pat. 1,209,871, Dec. 26, 1916. Date of appl., June 15, 1915.

A RAIL is homogeneously united to a smaller metal bond, having a lower fusing point and greater conductivity for heat, by holding the two in contact, and heating the bond directly by pressing an electrode, composed of a number of electrically separated resistance elements, against it. An electric current is passed in recurring cycles successively through different pairs of the resistance elements and the bond arranged in series, whereby the bond and the contacting surface of the rail are brought to a welding temperature.—B. N.

[Ores and] *matte; Process and apparatus for converting [smelting]* —. S. R. Garr, Garfield, Utah, Assignor to American Smelting and Refining Co. U.S. Pat. 1,209,282, Dec. 19, 1916. Date of appl., Oct. 21, 1915.

A CONVERTER for the treatment of ore or matte is provided with a cooled conduit extending through the upper part of its wall, through which silica

is blown into the closed space above the material and allowed to settle uniformly on the surface.—W. F. F.

Ores; Method of recovering valuable constituents of —. H. G. C. Thofelm, Pittsburgh, Pa. U.S. Pat. 1,210,724, Jan. 2, 1917. Date of appl., Mar. 3, 1915.

AN electrical field is maintained between electrodes in a mixture of comminuted ore and water, and a compressed gaseous mixture of nitrogen pentoxide and air is injected into the field in such a manner as to cause a circulation and agitation of the liquid through the reaction zone between the gas and water.—W. F. F.

Precious metals; Process for separating — from their ores. W. H. Aghan, Burke's Flat, Victoria, Australia. U.S. Pat. 1,210,880, Jan. 2, 1917. Date of appl., Dec. 9, 1914.

THE ore is neutralised with lime and then treated with a solution of sulphuric acid, corrosive sublimate, and common salt, with or without potassium cyanide. Other reagents capable of modifying the action of the bath are excluded.—W. F. F.

Cementing or case-hardening material. R. B. Corey, Edgewood Park, Pa. U.S. Pat. 1,211,093, Jan. 2, 1917. Date of appl., Mar. 29, 1916.

CARBONACEOUS material is mixed with 10% of its weight of magnesium oxide, or a mixture or compound reducible by heat to the oxide, such as a mixture of magnesium oxide and carbonate.—B. N.

Preparing metal for painting; Method of —. J. H. Gravel, Philadelphia, Pa. U.S. Pat. 1,211,138, Jan. 2, 1917. Date of appl., July 22, 1916.

A STRONG solution of phosphoric acid, mixed with alcohol, is applied to the surface of the iron to be cleansed, and the metal is then washed with a limited quantity of water to form a relatively weak solution of phosphoric acid, whilst also removing the products of the cleansing action.—B. N.

Metal wires; Apparatus for production of —. J. Pintsch A.-G., Berlin. Ger. Pat. 293,238, Sept. 5, 1914. Addition to Ger. Pat. 291,994 (see Fr. Pat. 469,212; this J., 1915, 36.)

THE apparatus described in the original patent is so modified as to allow of the heating of several wires at once. Care must be taken to prevent contact of the wires, with resultant fritting together in the heated zone. For the same expenditure for heat and labour, a much increased output is possible.—H. J. H.

Thickening and agitating [ore] pulp; Apparatus for —. J. Van N. Dorr, Denver, Colo. U.S. Pat. 1,211,828, Jan. 9, 1917. Date of appl., June 26, 1913.

SEE Eng. Pat. 22,411 of 1913; this J., 1914, 950. Several of the vessels are arranged in series, the agitating chamber of one vessel being connected with the settling space of another.

Steel; Manufacture of —. G. J. B. Chetwynd, West Riding. U.S. Pat. 1,211,545, Jan. 9, 1917. Date of appl., Jan. 2, 1914.

SEE Eng. Pats. 1306, 11,778, 12,961, 14,431, and 16,821 of 1913; this J., 1914, 597.

Lead alloys; Manufacture of —. F. C. Frary, Niagara Falls, N.Y., and S. N. Temple, St. Paul, Minn. Eng. Pat. 101,086, July 19, 1916. Under Int. Conv., July 31, 1915. (Appl. No. 10,152 of 1916.)

SEE U.S. Pat. 1,158,672 of 1915; this J., 1915, 1256.

Lead alloys; Manufacture of —. F. C. Frary, Niagara Falls, N.Y., and S. N. Temple, St. Paul, Minn. Eng. Pat. 101,087, July 19, 1916. Under Int. Conv., Aug. 2, 1915. (Appl. No. 10,153 of 1916.)

SEE U.S. Pat. 1,158,673 of 1915; this J., 1915, 1256.

Method of and apparatus for treating slimes. U.S. Pats. 1,205,326 and 1,205,327. See I.

XI.—ELECTRO-CHEMISTRY.

Electrochemical chlorination of benzene and toluene. Fichter and Glantzstein. See III.

Electrolytic behaviour of tungsten. Koerner. See X.

PATENTS.

Furnace; Electric —. J. W. Moffat, Toronto, Canada. U.S. Pat. 1,208,817, Dec. 19, 1916. Date of appl., Mar. 21, 1916.

THE furnace is composed of a stationary stack, closed below by a plate provided with a number of openings adapted to register with similar openings in the top of a reduction chamber, the latter and a crucible being in fixed relationship with each other, and adapted to be tilted as a unit. The stack is provided with means for pre-heating the charge by the gases from the reduction chamber. The stack and reduction chamber are normally in communication, but communication with the stack is cut off when the reduction chamber and crucible are tilted.—B. N.

Treating materials electrolytically; Process of —. W. E. Greenawalt, Denver, Colo. U.S. Pat. 1,209,835, Dec. 26, 1916. Date of appl., May 13, 1913.

METALLIC salts in a finely-divided condition are electrolysed, the anode electrolyte being separated from the cathode liquor by a diaphragm, and both liquids being simultaneously agitated to keep the material in suspension during the electrolysis, whilst maintaining a relative motion between the electrodes and the finely-divided material. The electrolyte is withdrawn from one compartment, and passed through the other, but without allowing it to mingle with the liquid in the latter compartment. The material is subjected to the action of a direct current, using insoluble anodes, thus causing a disintegration of the anode material, and the loosening of the disintegrated anode material is facilitated by the action of an alternating current working in conjunction with the direct current.—B. N.

Electrolysis of water with gasholders dipping into the electrolyte. Elektrizitäts Akt.-Ges. vorm. Schuckert und Co., Nuremberg. Ger. Pat. 291,909, Sept. 1, 1914.

THE lower parts of the gasholders are provided with openings so arranged that in the event of the gas pressure becoming excessive, gas escaping from one holder cannot get into the other one and irregularities in the liberation of the gas do not affect the pressure at the outlet.—B. V. S.

Platinum electrodes. Chem. Fabr. Grünau Landshoff und Meyer Akt.-Ges., and E. Bürgin, Grünau. Ger. Pat. 295,178, May 24, 1914.

ALUMINIUM is used as a support and conductor for platinum electrodes. The platinum may be in the form of wide-mesh gauze of fine wire, large surface and great stability and reliability of action being still obtained. Even with aluminium at the anode, there are no counter currents, the "valve" action of the aluminium being still retained. There is no corrosion even at the points of contact of the aluminium and the platinum, although the aluminium is not completely covered by the platinum nor protected from the liquid. The aluminium may be in the form of a tube carrying a stream of water and it may be coated with a layer of Bakelite or similar insulating material.—B. V. S.

Electric furnaces. M. M. Kohn, New York. Eng. Pat. 103,062, May 17, 1916. (Appl. No. 7014 of 1916.)

SEE U.S. Pat. 1,187,630 of 1916; this J., 1916, 897.

Manufacture of rigid pieces of metal insulated against electrolysis and corrosion. Eng. Pat. 18,047. See X.

XII.—FATS; OILS; WAXES.

Duclaux's method for the estimation of volatile fatty acids. De Vries. See XX.

New method of steam distillation for the determination of volatile fatty acids, including a series of colorimetric qualitative reactions for their identification. Dyer. See XX.

PATENTS.

Fatty acids of high purity and melting point; Process for producing —. J. Starrels, New York. U.S. Pat. 1,209,512, Dec. 19, 1916. Date of appl., Mar. 1, 1916.

LIQUID glycerides or semi-solid fats (lard, etc.) are hydrogenated in presence of nickel until their iodine value is reduced to about 0 and their melting point is raised to about 62° C., and the resulting solid glycerides are hydrolysed (e.g., by means of Twitchell's process). Finally hydrocarbons and colouring matters formed during the hydrogenation are removed, by means of a solvent or otherwise, from the fatty acids.—C. A. M.

Fatty product from fixed oils and fats and process of manufacturing same. E. Klein, New York. U.S. Pat. 1,209,723, Dec. 26, 1916. Date of appl., Jan. 12, 1916.

OIL-BEARING material is agitated with potassium and sodium hydroxides, sodium carbonate, and a solution of a salt (sea salt, rock salt, natural or artificial Seignette salt), while being heated and subjected to the action of hot compressed air and steam, which are injected into the mass at the bottom of the tank. At the same time a cooling medium is applied to maintain the temperature at about 58° C., and, after 2 hours, the mixture is left to separate into layers. The uppermost layer is decanted and again treated in a tank so as to separate the higher fatty acids, and, after admixture with fibre, the unsolidified mass is decanted and heated indirectly by steam, while steam and hot compressed air are injected into it at about 93° to 110° C. Subsequently the mass is agitated first alone and then with a decolorising and

bleaching agent (constituents of powdered oyster shells and coal ashes), accompanied by hot compressed air, while heated by indirect superheated steam (about 110° C.), and, after settling, is decanted. The resulting product is a tasteless, odourless, neutral and permanently colourless liquid, which solidifies at -2° to +3° C., and has a sp.gr. of 0.901 to 0.914 at 15.5° C. It does not absorb oxygen or moisture from the air and therefore does not become rancid; it decomposes when distilled *in vacuo*, and is sparingly soluble in alcohol, but readily soluble in ether.—C. A. M.

Unsaturated [fatty acids and esters]; Conversion of — into saturated compounds. E. B. Higgins, Wallasey. U.S. Pat. 1,211,704, Jan. 9, 1917. Date of appl., Apr. 19, 1913.

SEE Eng. Pat. 18,282 of 1912; this J., 1913, 917.

Production of stable colloidal solutions. Ger. Pat. 295,164. See I.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

PATENTS.

Pigment and paint; Magnesium-containing —. O. W. Pickering, Springfield, Mass., Assignor to Pickering Paint and Pigment Co. U.S. Pat. 1,211,346, Jan. 2, 1917. Date of appl., June 2, 1916.

FLOCCULENT magnesium aluminate is incorporated with a drying oil, with or without driers, or with other suitable medium.—C. A. M.

Resin or other material; Apparatus for heating or melting and delivering —. C. W. Goodyear, Dudley. Eng. Pat. 102,835, Jan. 13, 1916. (Appl. No. 561 of 1916.)

THE apparatus in which the resin, etc., is melted by means of a steam coil or the like is provided with one or more delivery conduits, through each of which the heating medium is made to circulate in a separate conduit system returning to the heating tank. The apparatus is particularly suitable for varnishing the interior of shrapnel or other shells.—C. A. M.

Phenolic condensation product. W. B. Jones, Perth Amboy, N.J., Assignor to General Bakelite Co., New York. U.S. Pat. 1,209,165, Dec. 19, 1916. Date of appl., Mar. 5, 1913.

A COATING composition contains a phenolic condensation product, *e.g.*, an ester, and a cellulose ester, and a solvent containing a chlorinated hydrocarbon, *e.g.*, tetrachloroethane.—F. W. A.

Plastic composition and process of making same. L. V. Redman, Lawrence, Kans., Assignor to Redmanol Chemical Products Co., Chicago, Ill. U.S. Pat. 1,209,333, Dec. 19, 1916. Date of appl., Apr. 4, 1912.

AN amorphous condensation product is obtained by the anhydrous interaction of a phenolic or hydroxy-aromatic compound with an active methylene compound containing nitrogen (*e.g.*, solid hexamethylenetetramine), and a hydroxylated aromatic compound of the general formula R.X, where R represents an aromatic radicle, and X a non-reactive group. Heat may be used to promote the reaction, in which the nitrogen is liberated as ammonia.—C. A. M.

Resin-like condensation products; Process for the production of —. F. Pollak, Berlin. U.S. Pat. 1,210,982, Jan. 2, 1917. Date of appl., June 4, 1912.

SEE Fr. Pat. 447,969 of 1912; this J., 1913, 436.

Process of fractional elutriation of simple or mixed substances. Ger. Pat. 294,908. See I.

Production of stable colloidal solutions. Ger. Pat. 295,164. See I.

Method of preparing metal for painting. U.S. Pat. 1,211,138. See X.

XV.—LEATHER; BONE; HORN; GLUE.

Hide and leather fibres; Structure of —. W. Möller. *Collegium*, 1916, 16—26, 51—68, 92—118, 127—151, 180—208, 236—247, 270—291, 317—330, 349—355. *Z. angew. Chem.*, 1916, 29, Ref., 519.

EACH hide fibre consists of a great number of fibril complexes, each complex containing an undetermined number of fibrils, between which gelatin is found in swollen hide. During swelling and falling, the fibrils and their complexes undergo alterations of position, etc., including twisting, the fibrils of fallen hide however being straight. The interfibrillary penetration of alkali during swelling is easily recognised with the ultra-microscope. Chrome, aldehyde, and chamois leathers show a closer structure of fibres than vegetable-tanned leathers, and are naturally less easily acted upon by boiling with water. Whilst the unswollen hide fibre is more or less optically empty, the leather fibre shows a distinct ultra-microscopic structure, which with vegetable-tanned leather gives information as to the subdivision and amount of tannin taken up, and which can be brought into relation with the physical properties of the leather. The fibrillary structure of gelatin is proved by the ultra-microscope to be a network.—F. C. T.

Tannin colloids; Vegetable —. A theory of their constitution and mode of action. W. Möller. *Ledertechn. Rundschau*, 1915, 441—457; 1916, 1—16, 43—50, 81—92, 125—127, 175—180, 227—235, 266—269, 311—317. *Z. angew. Chem.*, 1916, 29, Ref. 519. (See also this J., 1915, 807.)

ALL vegetable tanning materials contain a peptiser and a peptisable substance, the proportions of which determine the colloidal properties of the aqueous extract. The tannin is the peptiser, the peptisable substances including polymerised tannin, ellagic acid, catechin, and phlobaphenes, according to the nature of the material. The peptiser forms a solid solution with the hide substance and plays a double rôle in the tanning process, first converting suspensions into colloidal emulsions, and then bringing the peptised particles to the fibril surfaces where the depeptisation takes place. The resistance of the leather to water is in inverse proportion to the amount of peptiser taken up in the solid solution. The shape and size of tannin particles have an important influence on the yield of leather, and hide has a selective power with regard to sub-microns. The phenomena of tanning result solely from irreversible colloidal actions, there being no purely chemical changes. The ancient process of bark tanning is an example of slow peptisation taking place during the tanning. By the use of liquors peptised matter is more regularly brought

to the hide fibres, and in drum tannage this is not only accelerated but the peptised matter comes to the fibre in liquid form.—F. C. T.

Quebracho extract manufacture in Argentine and Paraguay. Board of Trade J., Feb. 15, 1917.

ARGENTINE and Paraguayan manufacturers of quebracho extract have recently concluded an agreement for the purpose of limiting production. The increased demand for tanning extract due to the war, brought about a steady rise in price, until, early in 1916, the figure of 230 pesos gold per metric ton had been reached. The result was that extract factories considerably increased their output. But, later, with the increasing use of substitutes, such as oak and chestnut extracts, the price of quebracho extract dropped to 100 pesos gold per metric ton. The object of the agreement is the reduction of the output of extract factories to meet the estimated world's consumption. Extract will be delivered at a uniform price to one selling company which will distribute profits *pro rata* among producers. Six Companies in Argentina and four in Paraguay, having a total output of 165,000 metric tons of extract, are reported to have entered the combine. The capital invested in the quebracho industry in Argentina alone is estimated at 100,000,000 pesos currency. Exports of quebracho extract from Argentina rose from 80,153 metric tons in 1914 to 100,213 metric tons in 1915, and will probably show a further increase during 1916. Following the conclusion of the agreement, the price of quebracho extract rose to 150 pesos gold per metric ton.

NOTE:—Peso gold = 4s. (par rate). Peso currency = 1s. 9d. (about).

Artificial leather and leather substitutes: Examination of —. R. Lauffmann. *Kunststoffe*, 1916, 6, 54—56, 66—68, 82—84, 93—94. *Z. angew. Chem.*, 1916, 29, Ref., 520.

FATS and unsaponifiable fatty matter, incompletely sulphonated oils, and part of the caoutchouc, gutta-percha, oxidised oils and resins, pitch, tar, or asphalt present, are removed by extraction with ether and petroleum spirit, and glue, etc., gums, starch, tannin, glycerol, alkali soaps, and soluble inorganic matter removed from the residue by extraction with water. The residue from this treatment is treated with hydrochloric acid and shaken with ether to extract the fatty or resin acids of insoluble soaps, the bases and other inorganic matter being found in the aqueous layer. A further extraction with acetone removes cellulose esters, nitro- and acetylcellulose, as well as free sulphur and part of any vegetable fibrous matter present. Fully sulphonated oils, oxidised oils, decomposition products of leather and hide, and further portions of pitch, etc., are removed by alcoholic potash, and from the residue further portions of caoutchouc and gutta-percha and the remainder of the pitch, etc., are extracted by pyridine. A final extraction with toluene completely removes caoutchouc and gutta-percha, leaving a residue containing only plant fibre, etc., and insoluble inorganic matter. Details for the examination of the various extracts are given in the original paper.—F. C. T.

Cutch production in Burma. See IV.

Analysis of some sizes and finishes. Lamb and Harvey. See VI.

PATENTS.

Waterproofing of flexible and porous material [e.g. leather]. J. W. Barber, Newton, Mass., U.S.A. Eng. Pat. 102,813, Jan. 3, 1916. (Appl. No. 64 of 1916.)

WATERPROOFING substances such as colophony,

petroleum jelly, paraffin wax, ozokerite, etc., singly or in mixture, are dissolved in naphtha or other suitable solvent, or melted, and leather or other material is impregnated by a short immersion at a suitable temperature not above 60° C. Two baths are used, the second consisting of harder materials than the first, for the purpose of preventing subsequent exudation.—F. C. T.

Fur skins; Process in tanning —. R. Nasse, Assignor to A. Prohofskey, St. Paul, Minn. U.S. Pat. 1,210,968, Jan. 2, 1917. Date of appl., Jan. 3, 1916.

SKINS are treated with a mixture of an aqueous solution of inorganic substances such as potash alum, salt, and sodium borate, with a fermented or unfermented aqueous solution of wheat flour, yeast, and alcohol.—F. C. T.

Casoin; Process for manufacture of horny substances from —. A. Bartels, Harburg, Germany. U.S. Pat. 1,211,526, Jan. 9, 1917. Date of appl., Dec. 28, 1915.

SEE Eng. Pat. 10,019 of 1915; this J., 1916, 935. The moistened casoin may be mixed with an aqueous solution of hexamethylenetetramine and glycerin.

XVI.—SOILS; FERTILISERS.

Soil; The organic matter of the —. I. Some data on humus, humus carbon, and humus nitrogen. R. A. Gertner. *Soil Sci.*, 1916, 2, 395—442.

THE total nitrogen and total carbon contents of eight mineral soils, of three peats, of a strongly acid "muck" soil, and of five different kinds of unchanged vegetable materials, were determined on air-dried, unheated samples. The matter extracted by 4% ammonia (calculated as NH_4OH) solution was analysed for carbon, humus, and nitrogen, and that removed by 4% sodium hydroxide solution for carbon and soluble nitrogen, these estimations being performed on samples which had, and which had not, been previously leached with 1% hydrochloric acid. The residues from the sodium hydroxide extraction were leached with acid, again extracted with the alkali, and the carbon and nitrogen in the extracts determined; these elements were also determined in the 1% acid extract and in the liquid obtained by leaching the residues from the last process with water. The analytical data led to the following conclusions: The so-called "humus" extracted from soils and peats is not a typical soil product, for similar extracts are obtained from undecomposed vegetable matter. The "*matière noire*" of Grandeau contains much colourless material, the presence of which is masked by the black compound or compounds. The "humus" from sphagnum-peat, from brown peat, and from unchanged vegetable materials has a reddish-brown colour which in concentrated solutions appears black. A 4% solution of sodium hydroxide does not extract the same matter from a soil as a corresponding ammonia solution, nor does it extract the same quantity: hence results obtained with the two different solvents are not comparable. The ammoniacal extract of soil (after leaching with 1% hydrochloric acid) contains less carbon and has a deeper colour than that obtained with sodium hydroxide. In general, soil nitrogen is very similar to the nitrogen in undecomposed vegetable matter (e.g., oak leaves, sweet fern

leaves, oat plants, alfalfa hay), but it differs from it in being much less soluble in 1% hydrochloric acid, and also much less of it goes into solution in 4% sodium hydroxide. All the mineral soils, and a calcareous peat, contained an intensely black pigment which was absent from the acid peats and the vegetable materials. This pigment contained relatively little of the soil nitrogen, and it probably has little to do with soil fertility, *per se*. It is a true soil product and may be of bacterial origin: in amount it rarely exceeds 40% of the so-called humus extracted by alkalis. Humus determinations based on alkali extractions are valueless, and should be superseded by determinations of total organic carbon.—E. H. T.

Soil; The organic matter of the ——. II. A study of carbon and nitrogen in seventeen successive extracts. The black soil pigment. R. A. Gortner. *Soil Sci.*, 1916, 2, 539—548.

Two attempts were made by slightly different methods to isolate the black pigment of the soil, but without success, the separated materials containing 37.47% and 51.17% of ash. The pigment is soluble in ammonia solution and in very dilute sodium hydroxide, but insoluble in a 4% solution of the last-named, and use was made of these facts in attempting the isolation. The first six extractions with sodium hydroxide removed relatively more nitrogen than carbon from the silt loam soil employed, but the subsequent extractions, as well as the pigment solutions obtained after purification by precipitation with acid and flocculation of the clay, contained relatively more carbon than nitrogen. The ratio of carbon to nitrogen was much higher in the final soil residue than in the original soil. The impure pigment first isolated was a hard, black solid, from which extraction with alcohol in a Soxhlet apparatus removed a colourless, crystalline substance which has not yet been investigated. Purified in this way, the pigment resembled anthracite in colour and hardness, but the high ash content indicated the probable presence of much colloidal clay. On an ash-free basis, the purer product contained: C 61.3%, H 4.3%, N 2.8%, and O 31.6%. With the exception of the high nitrogen content, these figures are practically identical with those obtained by Detmer for his "humic acid" (1871). The substance forms a black solution in sulphuric acid, and intensely black solutions in ammonia solution and very weak alkali solutions, from which it is precipitated by acids and by solutions of the heavy metals; it is insoluble in all the ordinary organic solvents.—E. H. T.

Soil; Influence of salts on the bacterial activities of ——. J. E. Greaves. Soil Sci., 1916, 2, 443—480.

A rich sandy loam soil, well supplied with all plant nutrients except nitrogen, and possessing ammonifying and nitrifying powers about equal to the average soils of the arid regions, was treated in 100-grm. portions with 2 grms. of dried blood and measured amounts of salts, the whole being then incubated at 28°—30° C. for 4 days, and the ammonia determined by distilling with magnesia and collecting in standard acid. The salts employed were the chlorides, nitrates, sulphates, and carbonates of sodium, potassium, calcium, magnesium, manganese, and iron. It was established that their toxicity towards ammonification was determined chiefly by the nature of the acid radical, and that as a general rule the chlorides were the most harmful, and the carbonates the least toxic, nitrates and sulphates occupying the intermediate positions. No general relation was found between the concentration and the toxic power, and the latter varied with the nature of the

salt. The degree of inhibition caused by the added salt is to some extent connected with the increased osmotic pressure exerted, but is probably mainly due to the action of the salt on the living protoplasm of the cells. Those salts which are normally found in alkali soils (*e.g.*, NaCl, CaCl₂, Na₂SO₄) are among the most harmful to ammonification. With the exception of the chlorides of calcium and potassium, the nitrates of calcium and magnesium, and the sulphates of sodium and potassium, all the salts used produced stimulating effects in certain concentrations. Thus sodium chloride in the concentration of 7.2 parts of sodium per million of soil increased ammonification, and only began to become toxic when 14.4 parts was present; the chlorides of magnesium, ferric iron, and manganese, were stimulating up to 1.9, 23.2, and 31.3 parts of metal per million, respectively. Calcium sulphate stimulated in all concentrations up to 200 parts per million, and became toxic at 400 parts per million. With the possible exception of manganous chloride, all the manganese salts could stimulate ammonification, the sulphate being the most powerful. In low concentrations, the iron compounds were all beneficial; ferric chloride exerted its maximum effect at 2.9 parts per million, ferric nitrate and sulphate and ferrous carbonate requiring double the amount. The carbonates showed the stimulating effect through the widest range of concentrations: the maximum amounts of sodium, potassium, magnesium, and iron (Fe⁺⁺) which the soil could carry without diminished ammonification were 2300, 3128, 60.8, and 186.0 parts per million respectively. Manganese and calcium as carbonates showed no toxic action in any of the concentrations employed. The extent of stimulation appears to be determined largely by the nature of the metal present. The amounts of sodium, calcium, potassium, and magnesium chlorides required to reduce ammonification by one-half are roughly the same as those necessary to diminish the growth of wheat to the same extent. Salts most active in stimulating higher plants are also most effective in stimulating bacteria, the causal sequence being probably, bacterial stimulation, increased available plant-food, plant stimulation.—E. H. T.

Ammonification and nitrification [in soils]; The nature of ——. K. Miyake. Soil Sci., 1916, 2, 481—492.

THE curves showing the rates of increase of ammonia and nitric acid produced in a soil are very similar to the curve of an autocatalytic chemical reaction in which one of the products accelerates the change. Experimental results obtained by Lipman and Warrington on the rates of increase of ammonification and nitrification, respectively, are shown to be in full accordance with this view. The maximum increase of ammonia and nitric acid per unit of time is found to occur when these processes are half-completed; and the relationships can be expressed by the equation: $\log \frac{x}{A-x} = K(t-t_1)$,

where x is the amount of product produced at time t , A is the total amount produced, K is a constant, and t_1 is the time at which the processes are half-completed.—E. H. T.

Soils: Sulphur oxidation in —, and its effect on the availability of mineral phosphates. J. G. Lipman, H. C. McLean, and H. C. Lint. *Soil Sci.*, 1916, 2, 499—538. (See also this J., 1916, 1268.)

VARYING amounts of sulphur (flowers or precipitated) [S], of a very finely ground Tennessee brown rock phosphate (so-called "floats") [P],

and of a mixture of these two [S + P], were added to 100-grm. portions of sea sand inoculated with a soil infusion, of a manured greenhouse soil, and of a sandy loam (Sassafras) soil, contained in glass tumblers, which were then incubated at 22–24° C. for 30 weeks, the moisture content being kept constant. At intervals of two weeks determinations were made of the available phosphoric acid by the ammonium citrate method, of the water-soluble phosphoric acid, of the relative acidity, and of the sulphate present. In the sand cultures, the presence of either sulphur or of phosphate alone did not appreciably affect the amounts of available phosphoric acid, but a very great increase (about 800%) resulted from the combined [S + P] treatment. The acidity remained nearly constant in the control and [P] samples, increased about 14 times in the [S] vessels, and about 130 times in the [S + P] portions. In the greenhouse soil similar changes took place, but in the [S + P] tumblers the available phosphoric acid increased about 29 times, and the acidity about 436 times at the end of 30 weeks; the acidity in [S] increased 938 times in 18 weeks. It follows from this that in the [S + P] mixture, much of the increased acidity due to the oxidation of the sulphur was neutralised by the tricalcium phosphate, phosphoric acid being set free. The greenhouse soil was much superior to the sand as a culture medium. The results with the Sassafras loam soil were similar in nature but different in degree, indicating that the biological changes throughout the experiments were affected by the physical and chemical nature of the media. The water-soluble phosphoric acid content increased greatly in all cases where sulphur and "floats" were applied together; the greatest accumulation took place in the greenhouse soil and the least in the loam. The amount of sulphur oxidation increased *pari passu* with the liberation of available phosphoric acid, and generally, the results confirmed Lipman's theory that the micro-organic oxidation of sulphur in the soil renders available the phosphorus of mineral phosphates. The phosphate not only functions by neutralising the acid formed but also by supplying energy to the sulphur organisms. The most favourable water content of the soil is about $1\frac{1}{4}$ times the optimum (i.e., 50% of the water-holding capacity); unduly high or low moisture contents inhibit the oxidation and the liberation of available and water-soluble phosphoric acid. Soil, whether previously sterilised or not, became more active after inoculation with soil well supplied with sulphur-oxidising organisms. The amounts of sulphur and "floats" used in the experiments were in the ratio 1 : 3; in farm practice the ratio could be reduced to 1 : 2, but the proportion of fertilisers to soil should be relatively high.—E. H. T.

Soils; Ferrification in ———. [Determination of iron in soils.] P. E. Brown and G. E. Corson. Soil Sci., 1916, 2, 549–573.

The total iron content of a soil is satisfactorily determined by heating 5 grms. of soil with 15 grms. of sodium peroxide in a nickel crucible to a low-red heat, treating with hydrochloric acid, and making up the solution to 500 c.c. After heating 100 c.c. of this liquid with nitric acid to the boiling point, the iron is precipitated with ammonia, the filtered and washed hydroxide is dissolved in sulphuric acid, and after reduction with zinc, the ferrous solution is titrated with permanganate. Alternatively, the 100 c.c. of solution may be boiled with 20 c.c. of sulphuric acid, reduced with stannous chloride, treated with 10 c.c. of mercuric chloride solution, allowed to stand for 10 mins., and finally titrated with permanganate in presence of 25 c.c. of manganese sulphate solution. Since

the determination of the "ferrifying" power of a soil—i.e., the extent to which ferrous iron is oxidised to ferric—should involve the estimation of ferrous compounds in presence of ferric, a large number of attempts were made to devise a satisfactory method, but without success, failure being due to the adsorption of ferrous compounds by the soil and the action of organic matter in either oxidising or reducing the iron content. When soil is extracted with acids in a neutral atmosphere, the organic matter carried through disturbs the permanganate titration; and water does not dissolve the ferrous carbonate. Hence the ferrifying power had to be determined by means of water and sand cultures. In the former 100 c.c. of sterile water was treated with 0.1 gm. of ferrous carbonate and a soil infusion, fresh or sterile. After incubation the culture was filtered until clear, then treated with stannous chloride and titrated with permanganate. Ferrification was considered to have taken place if the iron content of the solution was greater in the bacterial culture than in the sterile, deferrification if it was less. For the sand cultures 100 grms. of clean, sterilised quartz sand was inoculated with fresh or sterile infusion and 0.1 gm. of ferrous carbonate added. The moisture content was kept at the optimum, and after the incubation the sand was shaken with water, filtered, and the iron in the filtrate determined. Both ferrification and deferrification were found to take place, and the extent of these processes appeared to vary with the content of organic matter, the temperature, and other factors. The infusion of a cultivated soil produced the greatest ferrification. The ferrifying bacteria flourished best in the water cultures, but no relation was observed between ferrifying power and content of organic matter. In the sand cultures, however, the conditions more nearly approximated to those of the field; and it was found that a high percentage of organic matter was related to increased ferrification; when organic matter was low, deferrification ensued. In addition to the iron bacteria, pure cultures of common organisms like *B. coli* and *B. pyocyaneus* were able to induce ferrification, as were also some of the common moulds.—E. H. T.

Potash in certain orthoclase-bearing soils; Availability of — as affected by lime or gypsum. L. J. Briggs and J. F. Breazeale. J. Agric. Res., 1917, 8, 21–28.

HEAVY applications of lime and gypsum are sometimes made to the soils of California on which citrus plants are grown, with the object of liberating the potash from the orthoclase and pegmatite in those soils. In the authors' experiments finely-ground samples of these minerals and of a virgin soil of granitic type were shaken for several days with solutions of calcium hydroxide and sulphate in graduated concentrations. The calcium hydroxide solutions did not materially affect the solubility of the potash in either pegmatite or orthoclase, but the gypsum solutions reduced the solubility of the potassium in orthoclase to an extent increasing with the concentration of the calcium sulphate. Neither addition had any appreciable effect upon the solubility of the potassium in the virgin soil, but gypsum reduced the solubility of the potassium in a citrus soil which had been under cultivation for some time. Wheat seedlings showed no increase of potassium when grown in water containing finely-ground orthoclase and calcium sulphate, over the amount in the wheat grown in water containing only orthoclase, whilst wheat seedlings grown in a citrus soil to which calcium sulphate had been added showed a decreased absorption of potassium.

—C. A. M.

Nitrogenous fertilisers; A vegetation experiment on the availability of— in an arid soil. C. B. Lipman and W. F. Gericke. *Soil Sci.* 1916, 2, 575—581.

LIPMAN'S method of determining the efficiency of nitrogenous fertilisers by the laboratory incubation test (this J., 1916, 1168) was checked by pot experiments on barley growing in Oakley blow-sand soil treated with (1) dried blood, (2) steamed bonemeal, (3) cottonseed meal, (4) ammonium sulphate, (5) sodium nitrate, and (6) calcium nitrate. In the first series these fertilisers were applied in amounts equivalent to those used in the incubation tests (i.e., 1% for the organic manures), and in the second the quantities used contained an amount of nitrogen equivalent to that in dried blood applied at the rate of 800 lb. per acre. The former series was a failure; the latter gave results closely resembling those obtained in the incubation tests. The order of efficiency was: for grain and straw-yields, 4—3—2—1—5—6; for total dry weight, 4—3—2—5—1—6; for roots, 4—3—5—6—1—2. In the last case 4 and 3 were much superior to the rest. In answer to the criticism of Kelley (this J., 1917, 94)—that the incubation tests are invalid owing to the use of excessive quantities of fertilisers—it is admitted that the laboratory conditions are dissimilar to those obtaining in the field, and also that better results would be obtained by using less of the fertilisers, but it is contended that even with the large quantities of the latter, the results are sufficiently accurate to show their relative fertilising powers.—E. H. T.

PATENTS.

Seeds, crops, plants, etc.; Treatment of growing—. A. J. Grinberg, New York. Eng. Pat. 2941 of 1915; date of appl., Jan. 20, 1916.

THE vitality of plants, whether in health, sickness, or disease, can be greatly improved by the use of a mixture containing bran, sawdust, and lime, to which is added ammonia liquor, corn (maize) starch, water, and scrap iron to generate heat by oxidation. It is best applied when mixed with 800 parts of soil, and during the autumn or winter; the roots absorb certain bacteria which enter the sap and promote health or cure disease. The liquid portion, e.g., starch $\frac{1}{2}$ oz., ammonia liquor $\frac{1}{2}$ oz., and water 1 quart, may be applied, separately and periodically, to the roots by means of pipes. Treated with this preparation, it is stated that grain crops can be doubled, and diseases due to insects and parasites, as, e.g., phylloxera, can be eradicated.—E. H. T.

Manure; Manufacture of— by means of bacteria. W. Thompson, Wexford. Eng. Pat. 103,142, Jan. 11 and Aug. 9, 1916. (Appl. Nos. 428 and 11,222 of 1916.)

PEAT is saturated with the effluent from a septic tank (or from farmyard manure) which has, preferably, been exposed to the air, at 20°—30° C., and treated with a very little milk. In this way the peat is broken down by aerobic organisms, the action of which is furthered by spreading the mixture in thin layers on trays. If a liquid manure be required, the freshly treated peat is mixed with twice its bulk of soft water and allowed to stand, more water being added subsequently if desired. After the aerobic treatment, dry, finely powdered slaked lime (or soil, or sand) is added to render the material neutral, to accelerate the drying, and to prevent "coagulation," i.e., setting to a tough mass on drying. Setting can also be prevented by stirring or blowing in air

from below. A more active manure can be obtained by inoculating the prepared material with special aerobic cultures. The finished product should be allowed to stand for 18—20 days before it is put on the land.—E. H. T.

XVII.—SUGARS; STARCHES; GUMS.

Sugar dealings; Restrictions on —.

THE Food Controller has issued three new Orders relating to sugar. The Dealings in Sugar (Restriction) Order, 1917, provides that no person shall on or after the 15th February, 1917, without a permit issued under the authority of the Royal Commission on the Sugar Supply, either on his own behalf or on behalf of any person:—(a) buy, sell, or deal in, or (b) offer or invite an offer, or propose to buy, sell, or deal in, or (c) enter into negotiations for the sale or purchase of or other dealing in, any sugar outside the United Kingdom, whether or not the sale, purchase or dealing, is or is to be effected in the United Kingdom.

The other two Orders relate to brewing sugar. The Brewers' Sugar Order, 1917, provides broadly that no brewers' sugar may be delivered from any warehouse except under the authority of the Food Controller, and that all brewers' sugar now in transit must be delivered into a warehouse. Certain exceptions, however, to this provision are made, especially as regards sugar sold to a brewer or brewers' sugar manufacturer, and to sugar imported for brewing purposes under special licences issued by the Royal Commission on the Sugar Supply. It is further provided that no brewing sugar shall be sold retail at prices exceeding current retail prices for granulated sugar.

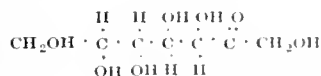
The Brewers' Sugar (Returns) Order, 1917, requires persons who, at 8th February, 1917, own or have power to dispose of stocks of brewers' sugar exceeding three tons in weight to make a return on or before 22nd February to the Food Controller on a form to be obtained on application to the Ministry of Food, Grosvenor House, W.

"Brewers' sugar" is defined as sugar not above 89° of polarisation.

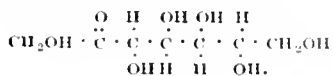
In connection with these two Orders the Royal Commission on the Sugar Supply announces that the granting of licenses for the importation of sugars under 89° of polarisation is suspended until further notice. This announcement does not apply to sugar already afloat, or to British West Indian Grocery Crystallised, British West Indian Muscovados, or British West Indian Grocery Syrup Sugar.

Sugar from the avocado; d-Mannoketoheptose, a new —. F. B. La Forge. *J. Biol. Chem.*, 1917, 28, 511—522.

FROM 3.5 kilos. of the pulped fruit of *Persa gratissima* (avocado or alligator pear), which is the source of *d*-perceitol, the author isolated 50 grms. of a new sugar, *d*-mannoketoheptose. It occurs in the free state in the fruit and is the first heptose isolated from a natural source. It melts at 152° C. (uncorr.) without decomposition, is not fermentable, has $[\alpha]_D^{20}$ = about +29 in aqueous solutions, and exhibits no mutarotation. The *p*-bromophenylhydrazone melts at 179° C. and the phenylosazone at 200° C. Its configuration is



and on reduction with sodium amalgam it yields the two corresponding heptitols, perseitol (*d*-α-mannoheptitol) and *d*-β-mannoheptitol (cp. Peirce, *J. Biol. Chem.*, 1915, 23, 327). Perseulose, produced from perseitol by *Bact. xylinum* (see Bertrand, this J., 1908, 869; 1909, 919) probably has the configuration



—J. H. I.

Molasses; Colouring matter of —. II. H. Stoltzenberg. *Ber.*, 1916, 49, 2675–2677. (See also this J., 1916, 1169.)

AFTER the removal of the colouring matter, $\text{C}_{26}\text{H}_{24}\text{N}_2\text{O}_8$, and a hygroscopic acid from the lead acetate precipitate obtained from the portion of molasses insoluble in alcohol, a syrup of bitter astringent taste remained. This contained a further quantity of colouring matter, which was removed by benzooylation in presence of sodium hydroxide, and precipitation with sulphuric acid. From the yellow filtrate a bitter principle in the form of a brown resinous acid of the composition, $\text{C}_{34}\text{H}_{40}\text{N}_2\text{O}_{15}$, was isolated. It is insoluble in benzene, soluble in absolute alcohol, and sparingly soluble in water. It melts on mercury at 61° C. to resinous globules. It is an excellent adhesive. —G. F. M.

Autolysis of starch. Biedermann. See XVIII.

Rate of turbidity in beverages containing maltose, glucose, or maltose and glucose. Homberger and Marvel. See XVIII.

PATENT.

Apparatus for revivifying char. U.S. Pat. 1,207,178. See 1.

XVIII.—FERMENTATION INDUSTRIES.

Malt; Dealings in and manufacture of —.

THE Food Controller has issued an Order, under date 3rd February, which provides that, except under the authority of the Food Controller, (a) no maltster or dealer in malt shall, on or after the 10th February, 1917, agree to sell any malt to any brewer for sale, or make delivery to any brewer for sale of any malt, other than malt deliverable under contracts made before that date; (b) no brewer for sale shall, on or after the 10th February, 1917, agree to buy any malt or to take delivery of any malt other than malt deliverable under contracts made before that date; and (c) no brewer for sale shall manufacture any malt from any barley agreed to be bought on or after the 10th February, 1917.

Malt diastase; Influence of the hydrogen ion concentration on the activity of —. L. Adler. *Biochem. Zeits.*, 1916, 77, 146–167. *J. Chem. Soc.*, 1917, 112, i., 61–62.

THE optimal hydrogen ion concentration for the action of malt diastase is $\text{pH}=4.9$. Its action is very effective between the limits pH 4.6 and $\text{pH}=5.2$. As the hydrogen ion concentration passes these limits in either direction, the activity of the enzyme rapidly decreases. Neutral salts are not without action on the diastatic activity, but this influence is small compared with that of the hydrogen ion concentration.

Fermentation; Studies in —. II. Autolysis of starch. W. Biedermann. *Fermentforschung*, 1916, 1, 474–504. *J. Chem. Soc.*, 1917, 112, i., 62.

THE author has previously shown that dilute boiled starch solution can be hydrolysed with comparative rapidity by saliva ash, and that this effect is due to an enzyme liberated from the starch under the conditions of experiment. It is now shown that a similar hydrolysis (autolysis) occurs without any addition if the starch solution is made at 70°–90° C. Reaction occurs considerably more rapidly at 35°–45° C. than at the ordinary temperature, and only the portion of starch which remains in solution suffers autolysis. Solutions which have been actually boiled generally become hydrolysed after a much longer period; extracts prepared by grinding starch with water do so much more rapidly. The diastatic power of such an extract is similar to that of a very dilute saliva solution, and transforms starch completely into sugar. Of the salts contained in saliva, the chlorides, particularly calcium chloride, promote diastatic action. The marked action of saliva ash in promoting the decomposition of starch solutions which have been subjected to prolonged boiling suggests that this mixture of salts promotes the new formation of the diastase (amylase) from starch. The action of the ash is much more pronounced than that of the individual chlorides (CaCl_2 , NaCl , KCl) contained in it; artificial mixtures of salts of similar activity have not been obtained up to the present time.

Fermentation; Activators of —. H. Euler and H. Hammarsten. *Biochem. Zeits.*, 1916, 76, 314–320. *J. Chem. Soc.*, 1917, 112, i., 71–72.

IT has been shown by Euler and Cassel (this J., 1913, 762) that the addition of ammonium formate and other substances increases the fermentation of yeast. It is now found that the formate does not also increase the amount of yeast formed. It is also found that the addition of phosphates, which increases the rate of fermentation in acid (but not in alkaline) solutions, does not cause a parallel increase in the growth of the yeast.

Albumin; Formation of — by yeast from different sources of carbon. T. Bokorny. *Munch. med. Woch.*, 1916, 63, 791–792. *J. Chem. Soc.*, 1917, 112, i., 72. (See also this J., 1916, 612.)

IN the large-scale production of yeast the carbon nutriment is the most difficult problem. Although urea can serve as a source of nitrogen, its carbon is not assimilated by yeast. According to the investigations of Naegeli and others, organic acids (citric, acetic, tartaric), as well as glycerol, asparagine, peptone, mannitol, and other carbohydrates, can be used as sources of carbon for yeast, and the nature of the latter determines the utility of the different sources. Pentoses are unfermentable, but, in suitable circumstances, can serve as sources of carbon. Dextrins are scarcely fermented by yeast cultures, but readily by crude yeast. Alcohol is utilised as a source of carbon by many moulds and bacteria. The growth of many yeasts is more vigorous in solutions containing alcohol than in sugar solutions. Brewers' yeast requires the presence of sugar during cultivation because the fermentation is a protection against bacteria. The development of other moulds is checked by the rapid formation of alcohol. Attempts to replace a portion of the sugar by methyl alcohol were unsuccessful, but good results were obtained with glycerol.

Enzymes: Poisoning of—*in the living [yeast] cell.* H. and B. Euler. *Fermentforschung*, 1916, 1, 465—470. *J. Chem. Soc.*, 1917, 112, i., 72—73.

THE authors have endeavoured to determine to what extent yeast suffers permanent damage after its fermentative power has been lessened by poison. Resorcinol has been used in the latter capacity, since that part of it which has not penetrated into the cell can be readily removed. In 0.5% solution the fermentative power of yeast is not completely destroyed in 24 hours, but this effect is produced by a 2% solution; all the cells are not killed, however, since fermentation sets in to some extent when the yeast is transferred to a non-poisonous sugar solution. 0.5% resorcinol, unlike a similar amount of toluene, does not promote the fermentation of sodium pyruvate by yeast. The degree of poisoning probably depends on the amount of poison absorbed. The activity of yeast is increased by minute quantities of resorcinol, a maximum action being observed at a concentration of about 0.0015%.

Beverages containing maltose, glucose, or maltose and glucose: Rate of turbidity in—A. W. Homberger and C. S. Marvel. *J. Amer. Chem. Soc.*, 1917, 39, 156—162.

THE authors investigated the behaviour, on storage, of pure aqueous solutions containing 0—3% of alcohol and 1.25% of sugar consisting of maltose, dextrose, or equal quantities of both. The solutions were prepared by dissolving the sugar in boiling distilled water, then adding the alcohol, and transferring the liquid to bottles previously heated for an hour in boiling water. Half of the bottles were closed with paraffined corks and sealing wax, whilst still hot; the others were cooled in an ice safe and similarly sealed after the contents had been saturated with carbon dioxide. The solutions containing only maltose as sugar, remained clear for six weeks, but all those containing dextrose showed turbidity and sediment, and in some distinct mould growths were visible. In some cases turbidity became apparent after 1—2 days. The sediments, examined under the microscope, showed an organised structure resembling the mycelia of a mould, and when transferred to nutrient solutions they produced growths of *Penicillium glaucum*. The authors conclude that the turbidity was due to partial development of spores of *P. glaucum*, which were not completely destroyed by the method of sterilisation employed, and that dextrose, but not maltose, acts as a chemical stimulus to spores of the mould, enabling them to develop to some extent even in absence of nitrogenous and mineral substances.—J. H. L.

Restrictions on sugar dealings. See XVII.

Determination of alcohol in dilute solutions (0.1—1.0%), and its application to urine. Villedieu and Hébert. *See XX.*

PATENTS.

Mash filters. P. Reichardt. Schmölln, Germany. Eng. Pat. 8899, Apr. 8, 1914. Under Int. Conv., June 4, 1913.

SEE Fr. Pat. 473,131 of 1914; this J., 1915, 505.

Removal of bitter flavour from yeast and yeast products. Eng. Pat. 102,855. *See XIXA.*

Method and apparatus for manufacturing alcohol from garbage. U.S. Pat. 1,210,250. *See XIXB.*

XIXA.—FOODS.

Milk: Chemical changes produced by the addition of lime-water to—A. W. Bosworth and H. I. Bowditch. *J. Biol. Chem.*, 1917, 28, 431—435.

THE addition of lime-water to milk, which normally contains a quantity of insoluble dicalcium phosphate, results in the precipitation of more calcium phosphate, the insoluble phosphates under these conditions being a mixture of di- and tricalcium phosphates; at the same time, the acidity of the milk is reduced. When milk to be used for feeding infants is treated with lime-water and then diluted with water to twice its original volume, or more, the soluble calcium and phosphorus may be reduced to amounts less than those present in human milk.—W. P. S.

Blood: Determination of amino-acid nitrogen in—J. C. Bock. *J. Biol. Chem.*, 1917, 28, 357—368.

ETHYL and methyl alcohols are unsuitable for the precipitation of blood proteins previous to the determination of the amino-acid nitrogen (see Greenwald, this J., 1915, 689). The Greenwald method of precipitating the proteins by means of trichloroacetic acid is, however, satisfactory. Coagulation of blood at a boiling temperature in slightly acid solution does not increase the quantity of nitrogen in the filtrate, provided that the traces of protein which escape coagulation are properly removed.—W. P. S.

Iron and alumina [in foods]: Determination of small quantities of—R. Berg. *Chem.-Zeit.*, 1917, 41, 50—52.

THE estimation of traces of iron and alumina present in food and animal matter can be carried out, with an error not greater than 0.03 mgrm. Fe_2O_3 , by the following method:—After combustion of the organic matter the ash is dissolved in acid, the solution made alkaline with ammonia, and just acid with hydrochloric acid. A few drops of ammonium acetate are added, the solution heated to boiling, and the precipitate filtered off. After washing several times with a hot, very dilute ammonium sulphate solution, the precipitate is dissolved in hydrochloric acid and again precipitated as above. The precipitate is dissolved in hydrochloric acid, ammonia added, and the precipitate, which contains silica and iron and aluminium phosphates, is dried, ignited, and weighed. By fusion with potassium bisulphate and extraction with acidulated water, the silica is left as a residue, and after weighing, the amount of iron and aluminium phosphates is determined by difference. Ammonia is added to the filtrate and the precipitate obtained is washed and dissolved in hydrochloric acid. The solution is placed in a stoppered conical flask. Zinc chloride and sodium hydroxide are added, the solution is made just acid with hydrochloric acid, and potassium iodide added. The flask is then well stoppered and kept at 60—65° C. in a water bath for 20 minutes. Starch solution is added and the liberated iodine titrated with N/250 sodium thiosulphate. The liberation of iodine is in accordance with the equation: $\text{Fe}_2\text{Cl}_6 + 2\text{KI} = 2\text{FeCl}_2 + 2\text{KCl} + \text{I}_2$. The alumina is estimated by difference, and manganese, calcium, and magnesium can be estimated in the filtrate from the first precipitation of iron and aluminium phosphates.—J. N. P.

Impure picric acid as a source of error in creatine and creatinine determinations. Folin and Doisy. *See XX.*

PATENTS.

Food for poultry and animals; Manufacture of —. R. Mason and W. C. Buchanan, Glasgow. Eng. Pat. 102,815, Jan. 4, 1916. (Appl. No. 131 of 1916.)

WASTE and bad eggs, with or without their shells, are broken up, mixed with about 1% of their weight of formaldehyde or boric acid, then heated at 240° F. (116° C.), and powdered.—W. P. S.

Feast or yeast products; Removal of bitter flavour from —. A. G. Salamon and L. J. Riley, London. Eng. Pat. 102,855, Mar. 4, 1916. (Appl. No. 3262 of 1916.)

DRIED yeast is extracted about 10 successive times with alcohol containing not less than 10%, or more than 20%, of its volume of water. The extraction is carried out at 70–75° C., and the alcohol may contain 5% or more of methyl alcohol. The extracted yeast is then dried, and the alcohol may be recovered from the extracts.—W. P. S.

Extract from fish or other aquatic animals; Process of producing a nutritious —. W. V. Coons and B. Hewitt, Victoria, British Columbia. U.S. Pat. 1,209,399, Dec. 19, 1916. Date of appl., Nov. 6, 1915.

CLEANED fish is minced and extracted several times with cold water and then with hot water. The fat is removed from the latter extract, the cold water extract is added, and the mixture boiled. The albumin in the cold water extract is thus coagulated and removes impurities from the mixture; the clear liquid portion is then drawn off and evaporated.—W. P. S.

Butter; Process of renaturing —. H. B. Eigelbner, Oak Park, Ill. U.S. Pat. 1,210,918, Jan. 2, 1917. Date of appl., Mar. 2, 1915.

THE butter is washed with hot water containing lime, then with water alone, and next agitated for several hours with hot saturated sodium chloride solution containing a small fraction of 1% of zinc chloride. The fat is finally separated, again washed with hot water, and dried.—W. P. S.

XIXF.—WATER PURIFICATION; SANITATION.

Drinking water; Removing the taste due to algae in —. A. C. Houston, Brit. Med. J., 1916, 2, 817. Pharm. J., 1917, 98, 139.

POTASSIUM permanganate, added in quantities of 2·5 to 5 lb. per million gallons, has proved much more effective than hypochlorites in removing the nauseous taint due to the growth of algae in the reservoirs under the control of the Metropolitan Water Board. The use of hypochlorites involves the risk of merely replacing one taste by another, or even of introducing a superadded taste.

Typhoid and paratyphoid bacilli in faeces and water; Search for —. F. Dénert and G. Mathieu. Comptes rend., 1917, 164, 121–126.

IN using the Malachite Green method for the separation of the typhoid group of bacilli from the coligroup, the divergent result frequently obtained are due to variations in the purity of commercial Malachite Green. The suitability of the dye can be tested by making a 1 in 3000 solution in peptone-water; in this medium the paratyphoid B bacillus should develop and cause decolorisation in 24

hours. In examining faeces by this method, typhoid and paratyphoid bacilli were always isolated in those cases in which blood cultures were positive, and sometimes both varieties of paratyphoid bacilli were isolated when blood cultures had shown one only. The water of the river Seine, when examined by this method, was found to contain paratyphoid bacilli.—J. H. J.

Carbon dioxide in air; Colorimetric method for determining —. H. L. Higgins and W. McK. Marriott. J. Amer. Chem. Soc., 1917, 39, 68–71.

IF a current of air containing carbon dioxide be passed through a solution of sodium bicarbonate until the solution is saturated, the reaction (hydrogen-ion concentration) of the solution will depend on the relative amounts of alkali bicarbonate and free carbonic acid present. This, in turn, will depend on the partial pressure of the carbon dioxide in the air with which the mixture has been saturated, and will be independent of the volume of air blown through, provided saturation has once been attained. High pressures of carbon dioxide change the reaction of the solution toward the acid side. Low pressures have the reverse effect. Hence the reaction of such a solution is a measure of the partial pressure of carbon dioxide in the air with which it has been saturated. The reaction of such a solution may be determined by adding to it an indicator such as phenolsulfonephthalein, which shows over a considerable range of reaction definite colour changes, and comparing the resulting colour with solutions of known reaction containing the same amount of indicator. Solutions of a given reaction may be prepared by mixing acid and alkaline phosphates in definite proportions. Such solutions owing to their high "buffer" value, may be kept unaltered for long periods of time, and can be used as standards for comparison. The method is not applicable in the presence of acid or ammonia fumes. As outdoor air always contains practically the same percentage (0·03%) of carbon dioxide, the standard bicarbonate solution may be easily checked.

—J. B. C. K.

Lime-sulphur animal dips; Chemical composition of —. R. M. Chapin. U.S.A. Dept. Agric., Bull. No. 451, Dec. 14, 1916, 1–16.

APPLICATION of the methods of analysis previously described (this J., 1916, 486, 705) has shown that in the preparation of lime sulphur solutions the main reactions which take place are as follows:—

- (1) $3\text{Ca}(\text{OH})_2 + 12\text{S} = 2\text{CaS}_3 + \text{CaS}_2\text{O}_3 + 3\text{H}_2\text{O}$.
- (2) $10\text{CaS}_3 + 3\text{Ca}(\text{OH})_2 = 12\text{CaS}_4 + \text{CaS}_2\text{O}_3 + 3\text{H}_2\text{O}$.
- (3) $\text{CaS}_4 + \text{S} = \text{CaS}_5$.

The second reaction does not occur until practically the whole of the free sulphur has been dissolved. Hydrolytic decomposition of polysulphides takes place in all lime-sulphur solutions in accordance with the equation:—(4) $\text{CaS}_x + 2\text{H}_2\text{O} \rightleftharpoons \text{Ca}(\text{OH})_2 + \text{H}_2\text{S} + (x-1)\text{S}$, the tendency to change from left to right increasing with the rise of temperature. The products on the right hand side also react as in equation (1), the final result in the case of CaS_3 being—(5) $\text{CaS}_3 + 3\text{H}_2\text{O} = \text{CaS}_2\text{O}_3 + 3\text{H}_2\text{S}$. The equilibrium of the solutions thus depends on the presence of an excess of hydrogen sulphide, the necessary amount of which excess varies with the temperature and concentration of the solutions. When exposed to the air lime-sulphur solutions are oxidised—(6) $\text{CaS}_x + 3\text{O} = \text{CaS}_2\text{O}_3 + (x-2)\text{S}$, whilst above a certain concentration of the hot solution (between 3·33 and 3·95% of mono-sulphide sulphur) the following reaction tends to progress from

left to right—(7) $\text{CaS}_2\text{O}_3 \rightleftharpoons \text{CaSO}_3 + \text{S}$. A well-boiled solution can never show a final excess of calcium hydroxide over monosulphide, unless such excess was originally present. As lime is only sparingly soluble at any stage, it would seem advisable to increase the time of boiling with an increase in the concentration. The effect of making the solutions concentrated is not only to decompose the thiosulphate, but also probably to utilise both lime and sulphur less completely, and to cause the polysulphides to contain a smaller proportion of pentasulphide. Finished solutions if kept on the sediment containing free lime will slowly undergo the changes represented in (1) and (2). If decanted from the sediment, and protected from air, the liquid will tend to change in accordance with equation (5), until a certain concentration of hydrogen sulphide is reached, when equilibrium will be established as in (4). For the practical preparation of animal dips on the basis of these data, it is suggested that 8 lb. of commercial quicklime (98.3% calcium oxide) or 10.5 lb. of commercial hydrated lime should be boiled for 1 hour with 10 lb. of fine sulphur and rather more than 10 galls. of water, so that the final product amounts to 10 galls. The final solution should contain nearly 18% (grms. per 100 c.c.) of sulphide sulphur, and should be diluted with 9 to 10 vols. of water for dipping sheep, and with 7 to 8 vols. of water for cattle.—C. A. M.

New method for the estimation of nicotine in tobacco.
Tingle and Ferguson. See XX.

PATENTS.

Liquids; Appliance for purification of ——. E. A. Pratt, New York. U.S. Pat. 1,208,830, Dec. 19, 1916. Date of appl., Apr. 22, 1915.

THE liquid to be purified is passed through a conduit provided with several "sterilising lamps" in one side and a photo-sensitive cell in the opposite side. There is an electrical connection between the lamps and the sensitive cell and a source of electricity. When the lamps are in action, the varying opacity of the liquid causes variations in the conductivity of the sensitive cell, which variations are arranged, by means of the electrical connection, to control the action of the lamps.

—J. H. J.

Air; Machine for subjecting — to violet and ultra-violet rays. N. W. Davis, Assignor to E. M. Markel, Des Moines, Iowa. U.S. Pat. 1,209,132, Dec. 19, 1916. Date of appl., Jan. 11, 1916.

A BRUSH electric discharge is produced between a silicon disc and a glass disc covered with conducting material. An air conducting tube is connected with the space between the discs, so that the air current which passes through the apparatus is subjected to violet and ultra-violet rays generated from the brush discharge. The apparatus may be composed of several units, each consisting of a glass disc, with a backing of non-conducting material, spaced from a silicon disc by non-conducting blocks, the space between the discs being connected to a tube. Each unit is provided with an electric circuit. The tubes from the units run to a common receiving tube which has means for drawing a regulated air current through one or all the tubes. When the electric circuit is closed, the air current is subjected to violet and ultra-violet rays and is ozonised.—J. H. J.

Sewage-water; Apparatus for purifying ——. G. P. Breddin, Cologne, Germany. U.S. Pat. 1,210,759, Jan. 2, 1917. Date of appl., Feb. 7, 1914.

THE apparatus consists of an inclined rotating

sieve of conical form, provided with blades round the periphery, and with a floor under the descending side of the sieve and a cover over the ascending side. There is also a rotating brush, driven by the axis of the sieve, for cleaning the top of the sieve.

—J. H. J.

Alcohol from garbage; Method of and apparatus for manufacturing ——. F. E. Young, Canton, Ohio. U.S. Pat. 1,210,250, Dec. 26, 1916. Date of appl., Aug. 9, 1915.

THE garbage is cooked in a closed tank by forcing steam through it, grease is separated from the steam, and the alcohol carried over by the steam is condensed. The residual garbage is pressed, grease is separated from the press-water, and the latter fermented. The pressed garbage is dried and the vegetable matter is separated and converted into glucose; the latter is then fermented with the above fermentation liquid, and the alcohol is distilled off.—J. H. J.

Water; Treatment of — for softening, sterilising, and like purposes. H. J. Magrath, London. U.S. Pat. 1,211,735, Jan. 9, 1917. Date of appl., July 21, 1915.

SEE Eng. Pat. 18,867 of 1914; this J., 1915, 1030.

Furnace for burning refuse. W. Piernay, Assignor to Stettiner Chamotte-Fabr. A.-G. vorm. Didier, Stettin, Germany. U.S. Pat. 1,211,875, Jan. 9, 1917. Date of appl., May 16, 1914.

SEE Fr. Pat. 471,411 of 1914; this J., 1915, 418.

Anti-parasitic composition for the treatment of plants. C. Vecelli, Cinadolmo, Italy. Eng. Pat. 9949, July 8, 1915.

SEE Fr. Pat. 179,097 of 1915; this J., 1916, 1130.

Manufacture of base-exchanging silicates. U.S. Pat. 1,208,797. See VII.

Manufacture of manure by means of peat. Eng. Pat. 103,142. See XVI.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Morphine alkaloids; Investigation of the ——. W. J. von Braun and K. Kindler. Ber., 1916, 49, 2655—2663.

ATTEMPTS were made to reproduce the physiological properties of codeine by introducing the supposed physiologically active groups into other positions of the molecule by syntheses from cyan-normorphine and cyan-norcodeine (Ber., 1914, 47, 2312), and also by reproducing them in the much simpler molecule of a reduced tertiary quinoline base. For this purpose *p*-aminobenzyl-carbamino-nor-morphine, diamino-phenyl-nor-codeine, dimethylamino-N-hydroxyethyl-nor-codeine, and N-methyl-8-hydroxymethylthalline were synthesised, but in every case an indifferent substance resulted, or one of weak physiological action dissimilar to codeine.—G. F. M.

Suprarenin [adrenalin]; Content of — in the ordinary commercial preparations, and the methods of estimation. F. Johannessohn. Biochem. Zeits., 1916, 76, 377—391. J. Chem. Soc., 1917, 112, ii., 55.

ADRENALINE can be estimated colorimetrically

by Folin's phosphotungstic reagent (this J., 1913, 159), and biologically by the perfusion method of Löwen and Tröndeleburg when present by itself, but not in the presence of novocaine or alpin. When these substances are present, however, the colorimetric method of Frankel, Allers, and Bayer can be used (iodic acid in the presence of sulphuric acid). This method has been employed for estimating the adrenaline content of various commercial preparations and of the conditions under which these may be preserved without loss of the adrenaline.

Nicotine in tobacco: New method for the estimation of —, A. Tingle and A. A. Ferguson. Trans. Roy. Soc. Canada, 1916, [iii], 10, 27—31. J. Chem. Soc., 1917, 112, ii., 55—56.

BASED on results already given (this J., 1917, 45), the authors have worked out a new method for the estimation of nicotine in tobacco. A mixture of 20 grms. of tobacco, 40 grms. of barium hydroxide, and 150 c.c. of water is distilled with steam into a 500 c.c. flask until the distillate gives no alkaline reaction with phenolphthalein. To the distillate 20 c.c. of sulphuric acid is added, and the liquid evaporated to about 50 c.c. This solution is made strongly alkaline with potassium hydroxide, a few drops of baryta water being added for clarification. The solution is then made up to 100 c.c., the precipitate allowed to settle, the supernatant liquid filtered, and its rotation then determined in the polarimeter. In a modification of the method, the nicotine is extracted from the steam distillate by chloroform. These two methods gave concordant results, higher than those obtained, using the same specimen of tobacco, by the methods of Töth and of Kissling.

Alkaloids: Chemical and physiological detection of several — in the same solution. E. Philippi. Arch. Farm. Sperim., 1916, 22, 120—130. J. Chem. Soc., 1917, 112, ii., 56.

THE characteristic reaction of strychnine with sulphuric acid and potassium bichromate is not shown by 1 mgrm. of strychnine nitrate in the presence of 0.04 grm. or more of quinine bisulphate, a transitory, garnet-red coloration being produced, which becomes green or greenish-grey; with smaller quantities of quinine, the reaction is distinct, but transient. The same effect is observed when salts of the alkaloids with the same acid or the free alkaloids are used. Crystals of strychnine picrate can be obtained in the presence of a large excess of quinine, but they are not then characteristic. The alkaloids are most simply and certainly separated by the use of sodium potassium tartrate; quinine tartrate is insoluble in solutions of alkali sulphates and tartrates, whereas the strychnine salt is soluble. Mixtures which do not give the characteristic reaction with potassium bichromate do not cause the characteristic symptoms in the frog.

Saponin from Yucca filamentosa. L. H. Chernoff, A. Viehoever, and C. O. Johns. J. Biol. Chem., 1917, 28, 437—443.

THE rootstocks of *Yucca filamentosa* yielded about 6% of a new saponin, $C_{41}H_{60}O_{14}$, which is soluble in water, phenol, and glacial acetic acid, and is not precipitated from its aqueous solution by lead acetate, basic lead acetate, or barium chloride. Haemolysis was observed after 15 mins. in a 1:20,000 solution of the saponin containing rabbit's blood and kept at 37° C. Hydrolysis of the saponin yielded a crystalline sapogenin, m.pt., 175° C., and dextrose; glucuronic acid also

appeared to be formed. The saponin occurs as brownish amorphous masses in the fibro-vascular bundles of the roots and leaf bases. —W. P. S.

Chrysarobin. O. Hesse. Annalen, 1917, 418, 350—378. (Compare Tutin and Clewer, this J., 1912, 253; 1913, 1126.)

THE composition of samples of commercial chrysarobin (using Hesse's nomenclature) is as follows:—

	A.	B.	C.	D.
Insol. in benzene (chrysarobol, etc.)	3.5	6.6	16.7	3.7
Chrysophanic acid	1.2	4.4	8.3	1.3
Emodin methyl ether	0.2	0.6	3.0	trace.
Emodin	—	0.3	0.8	—
Chrysophanol	29.0	31.1	20.6	33.3
Emodin methyl ether	28.3	28.4	20.2	20.4
Emodinol	25.7	20.6	18.9	22.3
Other substances, loss	11.2	8.0	11.5	10.0

The figures in columns A and B resulted from the analysis of four and two samples respectively of chrysarobin (German Pharm. V), and C and D are English samples (acidum chrysophanic). The formation of iodine by the action of hydriodic acid on chrysarobin is due to the presence of chrysophanic acid and similar anthraquinone derivatives. Extraction with benzene (b.pt. 80°—90° C.) is preferable to using petroleum spirit (30°—50°). Chrysophanol and emodin are readily isolated from the product crystallised from benzene or benzene-benzene and demethylated by means of hydriodic acid. Contrary to the statements of Tutin and Clewer (*loc. cit.*) ararobinol and dehydroemodinanthranolmonomethyl ether are not present. A method is outlined for increasing the therapeutic effect of chrysarobin by extracting the warm benzene solution with N/5 caustic potash in absence of air and carbon dioxide, and rapidly evaporating the benzene solution exposed to air. The composition of a sample of araroba powder has also been investigated.—F. W. A.

β -Amino- β -methylhydrindene from o-xylylene cyanide. Investigations in the indene series. III. J. von Braun, O. Kruber, and E. Danziger. Ber., 1916, 49, 2642—2651.

IN addition to the corresponding diamine, o-xylylene cyanide gives on reduction with sodium and alcohol a hydrindene derivative in about 36% yield, which, separated by fractional distillation from the reaction product, forms a colourless oil of b.pt. 118°—119° C. at 18 mm. pressure. It forms a hydrochloride, m.pt. 241° C., and a crystalline hydrobromide m.pt. 290°—293° C. It is characterised by its notable physiological action in increasing the blood pressure to a greater extent even than β -phenylethylamine or *p*-hydroxyphenylethylamine, and, particularly by subcutaneous injection, it has a powerful stimulating action on the respiratory and motor centres. Reasons are given for assigning to the base I constitution of a β -amino- β -methylhydrindene.

—G. F. M.

Urotropine [hexamethylenetetramine]: Reactions of —, P. Carles. Ann. Chim. Analyt., 1917, 22, 8—9.

HEXAMETHYLENETETRAMINE is soluble in water, the solution being neutral to litmus; the substance should volatilise completely when gently ignited, and its 5% aqueous solution, after the addition of nitric acid, should not yield any reactions for chlorides or sulphates. A red coloration is obtained when 0.1 grm. of hexamethylenetetramine

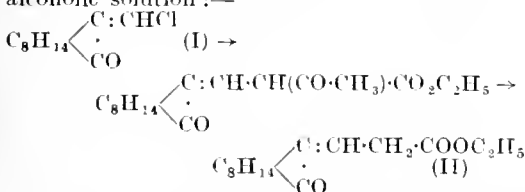
is mixed with 0.1 grm. of salicylic acid and 5 c.c. of sulphuric acid and the mixture heated. If an aqueous hexamethylenetetramine solution is treated with sodium hypobromite solution and the mixture then neutralised with dilute hydrochloric acid, a yellow precipitate forms.—W. P. S.

Hexamethylenetetramine ; Bromine and iodine compounds of —. K. Sugimura and K. G. Falk. *Biochem. Bull.*, 1916, 5, 17—21. *J. Chem. Soc.*, 1917, 112, ii., 54.

A METHOD of estimation of hexamethylenetetramine can be based on the formation of the tetraiodide.

β -[Camphorylidene-3]-propionic acid (methylenecamphoracetic acid). H. Rupe and E. Burekhardt. *Ber.*, 1916, 49, 2547—2563.

THE ethyl ester of methylenecamphoracetic acid (II) is produced by the action of sodium acetate on methylenecamphor chloride (I) in alcoholic solution:—



Hydrolysis of the ester with fuming hydrochloric acid yields the free acid, m.pt. 106°C ., which can be oxidised by ozone to camphorquinone, and reduced by sodium amalgam to an acid of m.pt. 51°C — 52°C . Methylenecamphoracetic acid is converted by caustic potash into the potassium salt of β -[hydroxy-3-camphoryl-3]-propionic acid, the lactone of which melts with decomposition at 207°C . With concentrated sulphuric acid, a δ -lactone, m.pt. 66°C ., is produced. When heated alone to 160°C . under reduced pressure, or if the ester is heated to 160°C . with water, methylenecamphoracetic acid loses carbon dioxide and forms ethylenecamphor, boiling at 101°C — 102°C . under 10 mm. pressure, which appears to be the *trans*-isomer corresponding to the *cis*-isomer prepared by Haller and Minguin (*Comptes rend.*, 1904, 138, 578) by removing hydrogen bromide and carbon dioxide from the bromine derivative of camphocarbonic acid. Diazonium salts in alkaline solution combine with methylenecamphoracetic acid to produce highly coloured formazyl derivatives. By coupling methylenecamphoracetic acid with diazobenzenesulphonic acid in presence of alkali, a red solution is obtained, which, when made faintly acid with acetic acid, dyes silk a bright wine-red and wool deep red ("Tango"); wool completely exhausts the bath. —F. Sp.

Vitamine ; Fractionation of the phosphotungstic acid precipitate with acetone for the preparation of — from yeast. C. Funk. *Physiol. Abstr.*, 1916, 1, 42. *J. Chem. Soc.*, 1917, 112, i., 52.

THE phosphotungstates from an alcoholic yeast extract are largely soluble in acetone; the bulk of the vitamine is, however, contained in a small fraction insoluble in acetone. Phosphotungstates may be decomposed with lead acetate, instead of barium hydroxide; this new method yields clear solutions, facilitates purification, and avoids the use of alkali.

Guanidine ; Preparation of —. J. S. Sharpe. *J. Biol. Chem.*, 1917, 28, 399—401.

A GOOD yield of guanidine may be obtained by

heating 100 grms. of dry ammonium thiocyanate in a short-necked Jena flask, immersed in an oil-bath, to 190°C — 200°C . for 20 hours. The mass is cooled, extracted with hot water, and filtered. The filtrate, which contains guanidine thiocyanate, is evaporated to dryness and weighed, and for each 1 part by weight 0.58 part of potassium carbonate dissolved in sufficient water is added. The whole is evaporated to dryness again, potassium thiocyanate is removed by repeated extraction with 90% alcohol, and crude guanidine carbonate is left. It may be purified by dissolving it in a little water, adding six times the volume of 90% alcohol, and allowing to crystallise. Yield, 15—20 grms. of pure guanidine carbonate.—F. Sp.

Creatine and creatinine determinations ; Impure picric acid as a source of error in —. O. Folm and E. A. Doisy. *J. Biol. Chem.*, 1917, 28, 349—356.

ATTENTION is directed to the fact that certain specimens of picric acid, particularly those sold in the wet condition, contain some impurity, and, owing to the more or less intense coloration they give when neutralised with sodium hydroxide, are quite unsuitable for use in the colorimetric determination of creatinine. When 20 c.c. of saturated picric acid solution is treated with 1 c.c. of 10% sodium hydroxide solution, the coloration obtained and observed after 15 minutes should be not more than about twice as deep as the colour of the saturated picric acid solution.—W. P. S.

Glycollic acid ; Preparation of —. E. J. Witze-mann. *J. Amer. Chem. Soc.*, 1917, 39, 109—112.

120 GRMS. of commercial barium carbonate was added slowly to a filtered solution of 50 grms. of commercial monochloroacetic acid in 500 c.c. of water, and the mixture was heated on a water bath under a reflux condenser for about 40 hours, or until no more carbon dioxide was evolved, being thoroughly agitated every few hours towards the last. The excess of barium carbonate was filtered off, and the hot solution treated with 52.1 grms. of 95% sulphuric acid (95% of the calculated amount necessary for complete precipitation of the barium as barium sulphate). After filtering off the barium sulphate and washing, the filtrate and washings were treated with small amounts of sulphuric acid until the solution showed only a slight positive test for barium. The solution was filtered again and concentrated *in vacuo*. A small amount of barium sulphate separated and was filtered off. The concentration was continued as long as water was distilled over at the bath temperature used at the beginning. The concentrated solution, which smelled strongly of hydrochloric acid, was heated on the steam bath in an evaporating dish for two hours, and yielded 40 grms. of a thick straw-yellow syrup (calculated yield of glycollic acid 40 grms.). A drop or two of this syrup was induced to crystallise by scratching with a glass rod and was used to inoculate the syrup. 16.5 grms. (41%) of the crystallised acid was separated in the first crop. In another experiment, using 100 grms. of monochloroacetic acid, the almost colourless syrup crystallised spontaneously, and the first crop of crystals weighed 30 grms. (37.5% of the calculated yield). When concentrating the aqueous solution on the water bath the evaporation must be interrupted in time or no crystals can be obtained. In case of failure to obtain crystals, the syrup may be treated with excess of barium hydroxide, heated until it remains permanently alkaline, and treated as before, using greater care at the final stage of the evaporation.—J. B. C. K.

Lactic acid in biological products; Identification and determination of —. L. I. K. Phelps and H. E. Palmer. J. Amer. Chem. Soc., 1917, 39, 136—149.

*RACEMIC, *d*- and *l*-lactic acids were prepared and their quinine and guanidine salts studied. After separation from other acids, lactic acid may be accurately determined as guanidine or quinine salt, and quinine lactate may be separated from quinine propionate and butyrate owing to its much smaller solubility in carbon tetrachloride. Lactic acid can be quantitatively converted into ethylester, and in this form separated by fractional distillation from the esters of acetic and formic acids, which boil at much lower temperatures, and from those of citric and tartaric acids which boil at much higher temperatures. The following is an outline of procedure, based on these facts, by which the authors succeeded in separating lactic acid (about 0.1 grm.) from equal or smaller amounts of formic, acetic, propionic, butyric, and citric acids, and recovering it as quinine salt with a loss of less than 4% as a rule. The mixed acids, suspended in vaseline at 100°—110° C. in a small Wurtz flask connected with a condenser, were esterified by vapours of absolute alcohol containing dry hydrochloric acid, with zinc chloride as second catalyst. From the distillate, containing ethyl formate, acetate, lactate, propionate, and butyrate, the first two were completely and the last two partially removed by distillation with use of a Hempel column filled with glass beads. The residue containing ethyl lactate with some propionate and butyrate, was freed from hydrochloric acid by means of silver carbonate, the esters were hydrolysed by barium hydroxide, and after the excess of the latter had been removed as carbonate the filtered liquid was evaporated to dryness and the mixed barium salts were quantitatively decomposed by quinine sulphate. After filtration from barium sulphate the solution was freed from water by distillation with alcohol under 15 mm. pressure. The quinine propionate and butyrate were extracted from the residue with carbon tetrachloride, and the lactate was dissolved in chloroform, the solution filtered, and evaporated to dryness, and the residue dried *in vacuo* at 75° C. and weighed.—J. H. L.

Volatile fatty acids; New method of steam distillation for the determination of — including a series of colorimetric qualitative reactions for their identification. D. C. Dyer. J. Biol. Chem., 1917, 28, 445—473.

IN the steam distillation method described, the volume of the solution from which the acids are distilled is maintained constant at 150 c.c. throughout the distillation. Under these circumstances, the distilling constants (proportions distilling over in succeeding fractions) are indicated by straight lines when plotted on a simple logarithmic chart, whilst the distilling variables of mixtures of these acids are indicated on the same chart by curved lines. With neighbouring acids the curves are very flat, and the further the acids comprising the mixture are removed from each other (in the series), the greater will be the curvature of the graph. The lowest acid of the series in a mixture may be identified with certainty, since the line representing the distilling constant will eventually reach a point where it will begin to run parallel to some straight line on the chart which represents that acid. This same point indicates where the other acid of the mixture has run out, and the probable nature of this second acid may be found by reference to a table which is given. The qualitative tests described for the identification of the volatile acids depend on the different solubilities of the iron and copper salts of the acids in amyl alcohol, ether, and petroleum spirit.—W. P. S.

Volatile fatty acids; Duclaux's method for the estimation of —. F. W. J. Boekhout and J. J. O. de Vries. Centr. Bakt. Par., 1916, ii, 46, 505—513. J. Chem. Soc., 1917, 112, ii., 50.

THE authors have investigated Duclaux's method (Ann. de l'Inst. Pasteur, 1895), and confirm the figures given in his tables for formic, acetic, and propionic acids; in the case of butyric and valeric acids, the results obtained were somewhat different from those recorded by Duclaux. It is shown that if the differences between the quantities of acid found in each successive fraction of the distillate are calculated into percentages of the acid remaining in the flask at the commencement of the distillation of each fraction (this quantity of residual acid being first calculated into 110 c.c. of the solution), a constant number is obtained for each fraction and is the same for each individual acid. This number is 3.5 for formic acid, 5.9 for acetic acid, 11.8 for propionic acid, 19.1 for butyric acid, and 26.0 for valeric acid. This method may be applied to the analysis of mixtures of the acids.

[Organic] acids; Identification of —. E. E. Reid. J. Amer. Chem. Soc., 1917, 39, 124—136.

THE preparation of *p*-nitrobenzyl esters is suggested as a means of characterising organic acids. The author describes the preparation of a number from alkali salts of the acids and *p*-nitrobenzyl bromide (*e.g.*, about 1 grm. of each in the case of monobasic acids) by boiling for 1—2 hours in just sufficient 63% alcohol to dissolve the reacting substances. The melting points of the esters were determined after systematic recrystallisation from dilute alcohol.—J. H. L.

Aldehydes; Colour reactions of aromatic —. P. Pooth. Schweiz. Apoth. Zeit., 1916, 54, 377—382. J. Chem. Soc., 1917, 112, ii., 52. (Compare Häussler, Z. anal. Chem., 1913, 53, 363, 691.)

THE condensation of aromatic aldehydes with sulphonated aromatic amino-compounds leads to the formation of characteristic, distinctly coloured azomethines, which can be employed in the identification of aldehydes. Aromatic aldehydes yield more distinct colorations with naphthionic than with sulphanilic acid; in most cases, the azomethine separates directly on cooling. The test is performed as follows: 3—4 c.c. of an aqueous solution of sodium sulphanilate or naphthionate (10%) is heated in a porcelain dish on the boiling-water bath; a boiling alcoholic solution of the aldehyde is added, which causes the appearance of a pale yellow to red coloration, and the solution is evaporated to dryness, the colour generally being deepened thereby. Before evaporation, a few drops of the solution are removed, diluted with water, cooled, and treated with a few drops of dilute sulphuric acid; in many cases the colour is deepened, in others completely changed. Certain of the reaction products, particularly those derived from nitro-aldehydes, are sensitive to daylight. The products obtained from substituted aldehydes are less stable.

Mercuric lactate and its aqueous solutions; Stability of —. Preparation of mercuric lactate. M. François. J. Pharm. Chim., 1917, 15, 33—41.

SOLUTIONS of mercuric lactate undergo spontaneous reduction on keeping, at the ordinary temperature, with formation of mercurous lactate, which is regarded therapeutically as far more toxic than the mercuric salt; at the same time, free lactic acid, acetaldehyde, and carbon dioxide are produced. The decomposition is more rapid, the higher the concentration of the salt and, whereas

in a 0.1% solution only 1.25% of the mercuric lactate present suffered decomposition in 3 months. in a 1.0% solution 11.52% had been reduced in the same time. It is therefore not permissible to prepare the medicinal 0.1% solution by the dilution of a concentrated stock solution of the salt. In the presence of an excess of mercuric oxide, the decomposition of mercuric lactate becomes extremely rapid, even in the case of highly dilute solutions. On the other hand, crystalline mercuric lactate is perfectly stable, and the solid salt may be kept apparently indefinitely. The decomposition of the solutions may be determined by precipitating the mercurous compound by sodium chloride, collecting the precipitate of mercurous chloride, drying, and weighing. To prepare mercuric lactate, 100 grms. of lactic acid is diluted with 400 c.c. of water, a little pumice added, and the solution boiled until 180 grms. of water has evaporated. The anhydrides are thereby hydrolysed and the solution, after cooling, is treated with 105 grms. of yellow mercuric oxide, added in small portions. After standing some time, with frequent agitation, the solution is filtered and the filtrate placed in shallow dishes to a depth of 1 cm. Crystallisation is started by adding a crystal and rubbing; the crystalline mass is broken up every day until the liquid has evaporated. The crude salt, containing traces of mercurous lactate, is washed by trituration of 50 grm. portions with 10 c.c. of water, draining, and rinsing with two portions of 5 c.c. each of water. Mercurous lactate may be prepared by heating together 100 grms. of lactic acid, 400 of water, and 100 of mercuric oxide on the boiling water-bath for 1½ hours, filtering, and digesting the filtrate at 100°C. for 8–10 hours. The deposit of sparingly soluble mercurous lactate is filtered off after standing all night, and the digestion is repeated daily with the filtrate until the whole of the mercuric lactate has been reduced to the mercurous salt.—J. F. B.

Glycerin for medicinal purposes.

On February 12th the Ministry of Munitions issued a memorandum in the following terms as to restrictions in the use of medicinal glycerin:—

The Ministry of Munitions announces that owing to additional demands for glycerin for war purposes, it has become necessary to place further restrictions on the issue of medicinal glycerin, and that supplies in future will be reserved for the manufacture of the preparations of the British Pharmacopœia and for such uses of special importance as may be sanctioned by the Ministry of Munitions. Those supplies will, however, be small, and must be used with the utmost economy.

Applications for permit to obtain supplies should be addressed to:—The Director of Propellant Supplies, 32, Old Queen Street, Westminster, S.W., and should give the following particulars: 1. Quantity applied for. 2. Stock of glycerin held. 3. Purpose for which supply is required. (In case of extra British Pharmacopœia preparations formulæ should be given.) 4. Applicant's average yearly consumption of glycerin for above purposes. 5. Name and address of proposed suppliers.

The medical profession have been informed of the need for economy in prescribing glycerin, and it is anticipated that the requirements for dispensing will be greatly reduced. The stocks of glycerin in the hands of pharmacists should be sufficient to meet these reduced requirements, and, therefore, no glycerin will be issued for dispensing meantime. The surplus stocks held by pharmacists and all stocks held by retailers who are not in a position to use them for those restricted purposes should be disposed of either to other pharmacists who are short of stock or to wholesale houses for making B.P. preparations.

Ethyl alcohol in dilute solutions (0.1 to 1.0%): Method for determination of —, and its application to urine. Villedieu and Hébert. J. Pharm. Chim., 1917, 15, 41–44.

ETHYL alcohol in dilute solutions (0.1–1.0%) may be determined by conversion into iodoform, the results being calibrated by determinations made with standard alcohol solutions under identical conditions. 100 c.c. of the dilute alcohol solution is mixed with 10 c.c. of caustic soda prepared by diluting commercial caustic soda lye (sp. gr. 1.35) with an equal volume of water. This mixture is treated gradually with iodine solution (105 grms. of iodine and 108 of potassium iodide per litre) until a coloration indicates an excess of iodine. The solution is allowed to stand for 3 hours, a few drops more of iodine are added to restore the colour, and the liquid is left for 18 hours in a cool place. After crystallisation of the iodoform, if necessary by rubbing and allowing to stand for a longer time, the deposit is collected on a filter, washed with cold water, dried on blotting paper, and placed together with the filter in 30 c.c. of alcoholic potassium hydroxide with which it is boiled for 20 mins. The iodoform is converted into potassium iodide which is determined, after acidification with nitric acid, by the addition of 20 c.c. of N/100 silver nitrate solution and titration of the excess with N/100 thiocyanate. The results of determinations made with standard solutions of alcohol, expressed in terms of c.c. of N/100 silver solution consumed = y , may be plotted in the form of a straight line represented by an equation of the form of $y = ax + b$ where x = the percentage of alcohol by vol., $a = 7.50$ and $b = 1.25$.

Hence $x = \frac{y - 1.25}{7.50}$. In applying the method to

the determination of alcohol in urine, 200 c.c. of the sample is distilled with 1 c.c. of phosphoric acid and the test carried out on the first 100 c.c. of distillate. The liquid to be tested must not reduce Fehling's solution nor produce a colour with Schiff's reagent; the absence of acetone should also be verified by Legal's or Denigès' test.

—J. F. B.

Determination of amino-acid nitrogen in blood. Bock. See XIXA.

Determination of total nitrogen. Accurate method of estimating ammonia volumetrically after destruction of organic matter in presence of mercury. Justin-Mueller. See XXIII.

PATENTS.

Hydrogen peroxide; Stable product containing — and method of making the same. F. W. Weber, Perth Amboy, N.J., Assignor to The Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,210,570, Jan. 2, 1917. Date of appl. May 8, 1915.

A STABLE solid product containing urea, hydrogen peroxide, and hippuric acid is obtained by dissolving hippuric acid in a solution of urea, evaporating the solution to dryness, adding the residue to hydrogen peroxide, and separating the resulting crystals.—T. H. B.

Hog cholera; Process of manufacturing a vaccine for the prevention of — and product therefrom. C. W. Duval, Assignor to M. J. Couré, New Orleans, La. U.S. Pat. 1,210,053, Dec. 26, 1916. Date of appl., Mar. 22, 1916.

A VACCINE product for the prevention of hog cholera is produced by removing from an infected hog parts containing the virulent virus, desiccating

and powdering the mass, attenuating the virus of the powder, mixing it, while suspended in sterile water, with desiccated and powdered inactivated antitoxic serum, and sensitising it.—F. Sp.

Medicinal compound. [Triglyceride of ricinoleic ozonide.] W. J. Knox, Assignor to General Research Laboratories, New York. U.S. Pat. 1,210,949, Jan. 2, 1917. Date of appl. July 30, 1911.

THE toxic property of the ricin constituent of castor oil is destroyed by treating the oil with ozone, forming the ozonide of ricinoleic triglyceride.—F. Sp.

Essential oils; Extracting——. E. J. Sheehan, Assignor to W. S. McKay, Pasadena, Cal. U.S. Pat. 1,211,969, Jan. 9, 1917. Date of appl. Feb. 8, 1915.

ESSENTIAL oil is extracted from a material containing it by rupturing the oil-bearing cells and extracting the oil from them with a solvent obtained by distilling and condensing the volatile constituents of an essential oil of the same character. The material is then drained, and subjected to the action of heated vapours to remove the remaining solvent and essential oil. The vapours are condensed, and the essential oil is separated and combined with the solution obtained by the extraction and with the non-volatile residue of the oil from which the solvent was obtained.—F. Sp.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

PATENT.

Photographic developers; Renewal of——. K. Pape, Danzig-Neufahrwasser. Ger. Pat. 295,236, Mar. 14, 1916.

THE activity of used or stale developer is renewed by treatment with an alkali or alkali carbonate.—B. V. S.

XXII.—EXPLOSIVES; MATCHES.

PATENTS.

Guncotton and similar products; Washing device for——. H. Jakob, Ebenhausen, Assignor to Selwig und Lange, Brunswick, Germany. U.S. Pat. 1,211,450, Jan. 9, 1917. Date of appl. Apr. 1, 1916.

GUNCOTTON is washed by passing it along a conveying tube into which, in two different places, water is supplied tangentially and obliquely downwards in the direction in which the guncotton is moving. Between the two water inlets is a chamber provided with a perforated wall forming part of the conveying tube; the wash-water passes through the perforations to a drainage pipe outside.—F. Sp.

Nitro-starch; Process for the manufacture of——. S. S. Sadtler, Springfield, Pa. U.S. Pat. 1,211,761, Jan. 9, 1917. Date of appl. Jan. 31, 1916.

STARCH is treated with a solution of caustic soda "adapted for swelling it and removing impurities." It is then washed, treated with an oxidising agent capable of liberating nascent oxygen to remove

further impurities, washed again, nitrated, freed from excess of acid, and boiled in the presence of a small amount of residual acid.—F. Sp.

Solids with liquids of very low boiling point [e.g. liquid oxygen]; Apparatus for impregnating——. L. Sieder, Munich. Ger. Pat. 295,270, Mar. 23, 1915.

THE apparatus is particularly intended for soaking easily oxidised solids with liquid oxygen to make explosive cartridges. It consists of a Dewar vessel, closed with a stopper through which passes the stem of a tap funnel and a short tube reaching just below the stopper. By applying pressure through the latter, liquid can be forced up from the Dewar vessel into the funnel wherein the material to be soaked is placed. The two tubes may be combined in a suitably bored double tap which controls both tubes at the same time.—H. J. H.

Blasting cartridges. W. Weber, Hayingen, Germany. Eng. Pat. 9485, June 29, 1915. Addition to Eng. Pat. 8606, June 10, 1915.

SEE U.S. Pat. 1,157,270 of 1915; this J., 1916, 276.

Vacuum mixing machine for substances sensitive to pressure and friction. Ger. Pat. 294,776. See I.

XXIII.—ANALYSIS.

Nickel; Determination of—— in the presence of zinc and iron. S. Rothschild. Chem.-Zeit., 1917, 41, 29–30.

THE estimation of nickel by electrodeposition from an ammoniacal solution cannot be carried out accurately in presence of zinc or manganese, nor with a sodium sulphite solution, when cobalt is present. It was found that precipitation of nickel sesquioxide by alkali and bromine water does not serve entirely to exclude zinc. A separation can be brought about by dimethylglyoxime, but nickel precipitated in this way is contaminated by iron if this is present in the solution. This contamination by iron occurs even in presence of a large excess of citric acid and was found to be due to adsorption. To overcome these objections in the estimation of nickel, it is recommended to precipitate with dimethylglyoxime, dissolve the precipitate in nitric acid, heat for several minutes together with hydrogen peroxide, add a large excess of ammonia, and electrolyse in the usual manner.—J. N. P.

Nitrogen; Determination of total——. Accurate method of estimating ammonia volumetrically after destruction of organic matter in the presence of mercury. E. Justin-Mueller. Bull. Sci. Pharmacol., 1916, 23, 167–169. J. Chem. Soc., 1917, 112, ii., 39–40.

WHEN organic substances are destroyed in the presence of mercury according to Kjeldahl's method, a portion of the ammonia remains combined in the form of mercury ammonium compounds, and is not estimated by the method of Ronchère (this J., 1907, 841). Low results are also obtained after addition of sodium sulphide or hypophosphite, but, according to the author, the results are accurate when potassium arsenite is used to decompose the mercury-ammonium compounds. The estimation is performed in the following manner: urine (10 c.c.) is heated with concentrated sulphuric acid (5 c.c.) and mercury (ca. 0.1 grm.). If the urine contains sugar the quantity of acid is increased in the ratio of 10%

of the sugar content. As soon as the solution becomes colourless, the heating is discontinued, the solution cooled, and diluted to 50 c.c. with water. Five c.c. of the dilute solution is mixed with 10 c.c. of the arsenite solution and 5 drops of phenolphthalein, and neutralised by sodium hydroxide (10%); the precipitate is allowed to settle for a few seconds, filtered, the residue washed three times with water, and the ammonia estimated in the filtrate by the formaldehyde method of Ronchès. The potassium arsenite solution is prepared by dissolving arsenious oxide (5 grms.) with the help of potassium hydroxide (11.20 grms.) or N/1 potassium hydroxide (200 c.c.) and making up the solution with water to 1000 c.c.

Analysis of some sizes and finishes. Lamb and Harvey. See VI.

Colloidal graphite in oil. Holde. See VII.

Microchemical estimation of small quantities of platinum in presence of gold and silver. Van Breukeleveen. See X.

Analysis of Babbitt metal and alloys of tin, antimony, lead, and copper. Hagmaier. See X.

Examination of artificial leather and leather substitutes. Lauffmann. See XV.

Ferrification in soils. [Determination of iron in soils.] Brown and Corson. See XVI.

Determination of amino-acid nitrogen in blood. Bock. See XIXA.

Determination of small quantities of iron and alumina [in foods]. Berg. See XIXA.

Search for typhoid and paratyphoid bacilli in faeces and water. Dienert and Mathieu. See XIXB.

Colorimetric method for determining carbon dioxide in air. Higgins and Marriott. See XIXB.

New method for the estimation of nicotine in tobacco. Tingle and Ferguson. See XX.

Chemical and physiological detection of several alkaloids in the same solution. Philippi. See XX.

Content of suprarenin [adrenaline] in ordinary commercial preparations, and methods of estimation. Johannessohn. See XX.

Reactions of urotropine [hexamethylenetetramine]. Carles. See XX.

Bromine and iodine compounds of hexamethylenetetramine. [Determination of hexamethylenetetramine.] Sugiura and Falk. See XX.

Fractionation of the phosphotungstic acid precipitate with acetone in the preparation of vitamin from yeast. Funk. See XX.

Impure picric acid as a source of error in creatine and creatinine determinations. Folin and Doisy. See XX.

Identification and determination of lactic acid in biological products. Phelps and Palmer. See XX.

New method of steam distillation for the determination of volatile fatty acids, including a series of colorimetric qualitative reactions for their identification. Dyer. See XX.

Duculan's method for the estimation of volatile fatty acids. De Vries. See XX.

Identification of [organic] acids. Reid. See XX.

Colour reactions of aromatic aldehydes. Pooth. See XX.

Determination of alcohol in dilute solutions (0.1—1.0%), and its application to urine. Villedieu and Hébert. See XX.

PATENTS.

Thermo-electric couple. W. H. Bristol, Assignor to The Bristol Co., Waterbury, Conn. Re-issue 14,243, Jan. 9, 1917, of U.S. Pat. 811,819, Feb. 6, 1906. Date of appl., Apr. 1, 1916.

In a thermo-electric couple, with its hot and cold ends separable, the cold junction is mounted permanently at a point not substantially affected by variations in the temperature to be measured. The hot section may be mounted directly on the cold one.—A. B. S.

Pyrometer. J. W. Weitzenkorn, Assignor to Gibb Instrument Co., Pittsburgh, Pa. U.S. Pat. 1,209,915, Dec. 26, 1916. Date of appl., Mar. 24, 1916.

A COLOURED illuminated surface for comparison with the colour of heated metal at various temperatures is formed by superposing two translucent films, one fixed and of orange colour and the other movable and having a diffused black surface of varying intensity. A lamp is provided to illuminate the films with white light.—W. F. F.

Pyrometers for metallurgical and like operations. Eng. Pat. 103,048. See X.

XXIV.—MISCELLANEOUS ABSTRACTS.

Organic compounds: Relation between the chemical constitution of— and their capacity to coagulate acid gold hydrosols. J. A. Gann. Koll. Chem. Beihfte. 1916, 8, 251—298. J. Chem. Soc., 1917, 112, ii., 21—22.

THE coagulating capacity of a large number of substances has been examined by measuring the "gold number" (Zsigmondy, this J., 1902, 192), the substances investigated including albumoses, peptones, polypeptides, dyes, alkaloids, amines, and various heterocyclic compounds. The results obtained show that the coagulating capacity of these nitrogen compounds depends on the presence of basic nitrogen groups, but that, apart from this, it varies considerably with the constitution of the substance. The auxochromic hydroxyl group increases the activity, although its effect is less marked than that of the amino-group. Certain configurations, such as those peculiar to the azines, thioazines, oxazines, and acridine derivatives also increase the coagulating activity, whilst chromophoric groups have the opposite effect, and this is the more pronounced the more strongly acid the chromophoric group is. The less active a substance is found to be, the greater is the effect which is produced by the introduction of a new group. With certain exceptions, the gold number for a particular substance is almost inde-

pendent of the concentration of the coagulant. It varies, however, to some extent with the degree of dispersity, the concentration, and the acidity or alkalinity of the gold solution. The coagulation process is in most cases to be regarded as brought about by ions, although in the case of the albumins it may be due to the mutual interaction of oppositely charged colloidal particles. The behaviour of gelatin shows that it may act either as a protective colloid or as a coagulant, and the actual results which have been obtained with this substance are discussed in detail with special reference to its amphoteric character.

Trade Report.

Prohibited exports.

By virtue of Orders in Council, dated Feb. 2nd and 19th, exportation of the following from the United Kingdom to all destinations is prohibited:—Bones in any form and bone ash; anthracene oil, creosote, creosote oils (except wood tar oil), green oil, and mixtures and preparations containing these; zinc oxide; guano; compound and organic manures; apatites, phosphates of lime and alumina; zinc dust; albumen; gas carbon; casein and its preparations; acetic anhydride; potash, muriate, nitrate, sulphate, and crude manurial potash salts, and mixtures containing any of these substances; dextrin; glucose; tantalum, tantalum alloys and ores containing tantalum; coconut oil, cotton seed oil, ground nut oil, and palm kernel oil; oleomargarine; lard and imitation lard; malt; malt sugar; margarine; extract of meat; starch; refined tallow.

Exportation of the following is prohibited to all destinations abroad other than ports and destinations in British Possessions and Protectorates:—Potash salts and mixtures containing such salts, not otherwise prohibited; all animal and vegetable fats and oils (not including essential oils), and articles and mixtures containing these, not otherwise prohibited; goods made wholly or partly of rubber, gutta-percha, or balata.

Books Received.

STANDARD METHODS OF GAS TESTING. U.S. Bureau of Standards, Circular No. 48. Second Edition. Government Printing Office, Washington. 202 pages, 10×7 in. Price 40 cents. (See this J., 1915, 201.)

HEALTH CONSERVATION AT STEEL MILLS. By J. A. Watkins. U.S. Bureau of Mines, Technical Paper 102. Government Printing Office, Washington. 36 pages, 9×5½ in. Price 5 cents.*

A SERIES of suggestions in regard to eliminating unhealthful conditions in steel mills.

SAFE PRACTICE AT BLAST FURNACES. By F. H. Willcox. U.S. Bureau of Mines, Technical Paper 136. Government Printing Office, Washington. 73 pages, 9×5½ in. Price 20 cents.*

This paper, which is described as "a manual for foremen and men," gives an account of the dangers of the different kinds of work about blast-furnaces, pointing out how the risk of accident may be lessened or avoided. Suggestions on methods of organising and conducting "safety work" are included. The pamphlet contains 43 illustrations.

UNDERGROUND WASTES IN OIL AND GAS FIELDS AND METHODS OF PREVENTION. By W. F. McMurray and J. O. Lewis. U.S. Bureau of Mines, Technical Paper 130. Government Printing Office, Washington. 28 pages, 9×5½ in. Price 5 cents.*

A DISCUSSION of the methods of avoiding waste in oil and gas fields due to dissipation into other strata, invasion of water, use of improper methods of drilling or recovery, etc.

ORE SAMPLING CONDITIONS IN THE WEST. By T. R. Woodbridge. U.S. Bureau of Mines, Technical Paper 86. Government Printing Office, Washington. 96 pages, 9×5½ in. Price 15 cents.*

A DESCRIPTION of the methods employed in sampling ores in the Western part of the United States, prepared in the hope of improving and ultimately standardising the methods in use.

METHODS OF SAMPLING DELIVERED COAL, AND SPECIFICATIONS FOR THE PURCHASE OF COAL FOR THE GOVERNMENT. By G. S. Pope. U.S. Bureau of Mines, Bulletin 116. Government Printing Office, Washington. 64 pages, 9×5½ in. Price 15 cents.*

A REVISION of Bureau of Mines Bulletin 63 on the same subject.

THE HISTORY AND DEVELOPMENT OF GOLD DREDGING IN MONTANA. By H. Jennings. With a chapter on placer-mining methods and operating costs, by C. Janin. U.S. Bureau of Mines, Bulletin 121. Government Printing Office, Washington. 63 pages, 9×5½ in. Price 30 cents.*

THESE papers were read at the Second Pan-American Scientific Congress held in Washington, Dec. 27, 1915, to Jan. 8, 1916. The bulletin contains 30 illustrations.

THE TECHNOLOGY OF MARBLE QUARRYING. By O. Bowles. U.S. Bureau of Mines, Bulletin 106. Government Printing Office, Washington. 174 pages, 9×5½ in. Price 30 cents.*

A FULLY illustrated description is given of the most efficient and economical methods now in use for producing and preparing marble.

LARKSPUR POISONING OF LIVE STOCK. By C. D. Marsh, A. B. Clawson, and H. Marsh. U.S. Dept. of Agriculture, Bulletin 365. Government Printing Office, Washington. 91 pages, 9×5½ in. Price 25 cents.*

AN account of experiments carried out for three years in Colorado. Larkspur was found to be poisonous to horses and cattle, but not to sheep; horses in pasture or on the range do not eat sufficient to produce ill-effects, however, so that losses of stock from larkspur poisoning are confined to cattle.

PRODUCTION OF EXPLOSIVES IN THE UNITED STATES DURING 1915. By A. H. Fay. U.S. Bureau of Mines, Tech. Paper 159. Government Printing Office, Washington. 24 pages, 9×5½ in. Price 5 cents.*

FIGURES are given showing the amount of explosives, excluding exports, produced in the United States in 1915. Notes on coal-mine accidents due to explosives, and lists of permissible explosives, lamps, and motors tested prior to May, 1, 1916, are included.

* A certain number of these publications can be obtained free on application to the respective Government Departments. In the case of the U.S. Government publications, when this supply is exhausted copies can be obtained at the prices mentioned from the Superintendent of Documents, Washington, D.C., U.S.A.

Journal of the Society of Chemical Industry.

No. 5. VOL. XXXVI.

MARCH 15, 1917.

No. 5, VOL. XXXVI.

Official Notices.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY.

The first volume of these reports will be issued at the end of this month. The manuscript of some of the sections not having come to hand, the volume will not be as comprehensive as was at first proposed, but it was decided to present an incomplete volume rather than delay publication any further.

CROSS AND BEVAN ESSAY PRIZE OF £20 AND LATHAM RESEARCH GRANT OF £300.

The Council have pleasure in announcing that a gift of £20 has been made by Messrs. Cross and Bevan as a prize for an essay on "The Interconnection of Economic Botany and Chemical Industry."

A further sum of £300 has also been presented by their friend, Mr. T. P. Latham, of Weybridge, to be paid in three annual instalments to such one of the competing essayists as may be judged to be of conspicuous ability, as a grant towards his expenses, on the condition that he apply himself, during three years, to research of approved character on a subject cognate with that discussed in his essay.

The immediate object of the donors is to promote the study of economic botany with special reference to its bearing on chemical industry, giving the widest possible interpretation of the relationship.

They desire, under the auspices of the Society, to assist in forming public opinion in this direction and to discover and further the career of a student of promise who may wish to devote himself to work in such a field.

The Essay Prize will be open to all members of the Society who are British subjects. The Research Grant will be limited to competitors under 25 years of age at the time of sending in the essay.

Essays are to be submitted to the Council of the Society not later than the close of the year 1917. The awards will be made promptly. Neither the prize nor the first grant will be given unless the essayist or essayists shall be deemed to have real merit. The Latham Research Student will be required to submit a report at the close of each year, to satisfy the Council that he has made and is likely to make proper use of the grant.

Edinburgh Section.

Meeting held at Edinburgh on Tuesday, February 13th, 1917.

PROF. JAMES WALKER IN THE CHAIR.

WIREDRAWING

BY A. T. ADAM.

That wire is not a purely modern product is evident from the frequent mention of it in ancient writings. The earliest record dates as far back as 1700 B.C. Gold wire is mentioned in the 39th Chapter of Exodus as having been used to decorate the holy garments of Aaron. We find reference to it also in Homer and Pliny. Metal heads with

imitation hair made of wire were recovered from the ruins of Herculaneum. Wire ropes also were not unknown to the ancients. The excavations at Pompeii brought to light a piece of bronze wire rope nearly 15 feet long and about 1 inch in circumference. This rope is now in the Museo Borbonico at Naples. It consists of three strands laid spirally together, each strand being made up of 15 wires twisted together. Its construction does not therefore differ greatly from that of wire ropes made to-day. It would seem, however, that these early specimens of wire were made by hammering metal (*i.e.* gold, silver, and bronze) into thin sheets and cutting these into fine threads. The first mention of wire drawing occurs in the "History of Augsburg," dated 1351, and in the "History of Nuremberg," dated 1360, where we find the word "Drahtzieher" (wire-drawer). We hear of it soon after in France, but the first mention of it in Britain is in 1565 when a Saxon, named Christopher Shultz, and Caleb Bell came over with a number of foreigners, under the permission granted by Queen Elizabeth, to draw wire through drawing-plates and dig for metals. Caleb Bell had charge of a wire mill which was driven by a water wheel at Holywell, from which mill he supplied toilet pins to Queen Elizabeth.

In the reign of Charles I. the production of wire had attained considerable proportions and an attempt was made by that monarch to introduce protection for the home industry by prohibiting the importation of foreign wire.

At the present day the world's output of wire is enormous. The proportion of the total steel product of the United States of America absorbed in the manufacture of wire rods has been estimated at no less than 20 per cent. Wire in all shapes and sizes is met with at every turn: in fences, nets, telegraph and submarine cable wires, railway signal wires, ropes, springs, pins, needles, bicycle spokes, musical instruments, etc., etc.

In this paper we are dealing chiefly with steel wire, and the following account of the processes involved in manufacture, has reference only to this commodity. The raw material of the wire mill consists of wire rods in coils which are obtained from the steel "ingot" and "billet" respectively by hot-rolling. It is difficult to define clearly a wire rod, because plants are now in operation which are drawing or rolling cold bars in round, square, or hexagon, etc., up to 2½ inches in diameter at least, probably more. In speaking of a wire rod, however, one generally means material which has been rolled hot to about ½ inch diameter and under.

Before the rods can be drawn through a die they must be freed entirely from scale or oxide. It is extremely important that every particle of scale be removed, otherwise the hole through which the wire is drawn will be torn out. The rods are therefore pickled in sulphuric or hydrochloric acid. The strength of the acid used depends on the conditions of working. When the coils are dipped in the pickling tank, it is usual to have a solution containing anything from 2 to 8% of free acid, in which case the operation of cleaning takes about two hours. Slow cleaning is almost essential when the gauge of the wire is small. A strong solution can be used when the gauge is large or when the wire is drawn through the bath continuously instead of being dipped in the form of a coil. The process of pickling may be hastened by using a hot bath. The acid bath works best when it has been in operation a few days, *i.e.* when the specific gravity has been increased by sulphate or chloride of iron. If the specific gravity be too

high, however, the cleaning action will cease unless heat is used. I have found the percentage of free acid in a spent tank as high as in a freshly made up tank. The specific gravity of the former was 1.28, and of the latter 1.03.

Mechanical means have been tried to assist the acid in cleaning the higher class wires, but without much success. This is unfortunate because acid is apt to make the wire brittle unless great care is taken to remove it completely. When all the scale has been removed from the wire it is thoroughly washed with water from a hose. The cheaper qualities of wire are then dipped in hot lime and dried, but with the higher grade wires, which have to receive several passes through the draw-plate without annealing, it is necessary to give them a water coat. This is done by keeping the coils continually under a spray of water until a brown rust is formed; during this operation the wire must not be allowed to become dry. The wire is lined to neutralise any acid remaining and to prevent corrosion. The coil is then dried in a bluing oven at 100° C. where the last traces of acid should be driven off. The wire is then ready for cold drawing. The cleaning operation has to be performed not only on the raw wire rod, but on the drawn wire, each time it has been annealed to facilitate further drawing.

The cleaned wire is taken to the wire-drawer's bench. This consists of a series of drums, technically known as "blocks," tapered from the bottom upwards. Each block revolves on a vertical spindle which projects through the top of the bench and all are driven by means of bevel wheels from one horizontal line shaft running beneath the bench. Each block can be started or stopped independently without stopping the line shaft. One end of the wire is pointed to enable it to be put through the die, the end is then gripped, and a short length is pulled through. The diameter or gauge of this piece is accurately measured before starting. If correct a sufficient length of wire is pulled through to go round the drum or block which is at present out of gear. The point end of the wire is gripped in a vice at the top of the block which is then dropped into gear, and the whole coil is drawn through from a swift near the bench. The reduction effected at each pass through the die varies from 5% to 20% of the diameter according to the nature of the material. The draw-plates are made from the so-called "self hardening steels," *i.e.*, steels which do not require to be tempered, but harden when cooled in air. They contain a high percentage of carbon (about 2%). Some of the alloy steels are used nowadays for draw-plates of special make: for example, one well-known make contains 14% Cr and 3% C; these elements form a very hard double carbide with the iron. The hole in the draw-plate through which the wire passes is first punched hot, then sized and shaped correctly when cold with hardened and tempered tapered punches. Very fine wires are drawn through jewelled dies, diamonds and rubies being chiefly used. Before the wire enters the die it passes through tallow or olive oil soap which acts as a lubricant. Some wires are drawn wet, in which case a liquid lubricant is used. Various "secret" lubricants are in vogue for the wet process, sour beer being a favourite ingredient of most of them. When the wire is to be drawn wet it is polished, to give a bright metallic surface, and is then coated with copper by immersion in a bath of copper sulphate. The copper being softer than the steel forms a kind of cushion between it and the die. It is drawn into the wire and gives it a yellow colour. The process of drawing is repeated until the wire is finished or too hard to be drawn further without heat-treatment.

An improvement in the process of wire-drawing

was made some time ago with the introduction of the continuous mill. In this plant the wire passes through one die after another without being run on to the "block" after each pass, the number of dies employed being limited by the amount of reduction possible before the wire requires annealing. In order to take up the strain, a power-driven barrel is placed between adjacent dies, and the wire is wound two or three times round each barrel in succession.

A pull is thus obtained from each revolving barrel sufficient to draw the wire through the die placed behind it.

The process of drawing metals into wire has a very marked effect on their physical properties. The metal loses ductility and becomes harder and more brittle with each pass through the die. The tensile strength is increased while the percentage elongation is decreased. The elastic limit is also raised, but within the limit of elasticity the modulus remains unchanged. The extent to which these changes take place naturally varies with the material. The most striking change is the extraordinary increase in tensile strength and elasticity. The hardness and brittleness do not increase in the same proportion. Steel which contains more than 0.5% C if quenched in water from a red heat becomes glass-hard and brittle, but even the most severely drawn wire never becomes so hard and brittle as this, although the ultimate strength of hard drawn wire is much higher than that of quenched steel. The tensile strength of the finished wire varies from about 40 tons to 170 tons per sq. inch according to the nature of the steel. A piano wire 0.0284 inch diameter, tested at Watertown Arsenal, showed the enormous strength of 211 tons per sq. inch. Such wires receive special heat treatment in order to enable them to stand the excessive cold work to which they must be subjected.

The hardening effect due to drawing sets a limit to the reduction that can be effected without annealing. Annealing alters the internal structure of the wire and completely obliterates the hardening effect of drawing, making the wire quite ductile again. It is not necessary to heat wire above the critical point of the steel, where the crystalline structure undergoes a complete transformation (this point lies between 700° and 800° C.). The effects of cold work can be almost entirely removed by heating to 600° or 650° C., but for high class work it is usual to anneal completely. Various modifications of the ordinary annealing process are in operation which constitute the more or less "secret processes" of the trade. The most important of these is what is technically called the "patenting process." In this process the wires are passed continuously through a long furnace, each wire having a separate flue or channel and cooled in air or sometimes in a lead bath. The main object in these processes is to produce in the steel the constituent known as "sorbite" which is tougher than the constituent known as "pearlite" found in slowly cooled steel. "Sorbite" is really a phase of "pearlite" produced by more rapid cooling. During these annealing processes the wire is oxidised and scale forms, which necessitates further pickling and causes considerable loss of metal. To minimise this many manufacturers exclude air during the heating operation either by annealing in sealed pots or by introducing non-oxidising gases to the furnace.

In hot rolling the crystalline grains of a metal are not permanently elongated but merely broken up into a large number of smaller grains. The effect of cold drawing on the crystalline grains is quite different from this. The grains of a wire are elongated and, after several passes through the die, the structure, as seen in a longitudinal section, is quite fibrous in nature. If the wire were semi-

transparent and could be viewed by transmitted light the structure would doubtless resemble that of some hemp fibres, *i.e.*, the elongated grains would be seen as parallel bundles or even running into one another, giving an interlacing structure.

It is not generally realised that hard and rigid bodies like the common metals possess a considerable degree of plasticity at atmospheric temperature. The fact that metals could be made to flow and to behave in other respects like fluids of high viscosity, such as pitch or glue, has been demonstrated in various ways, notably by Tresca, Spring, and Tammann. It is not, however, the most plastic or malleable metals which are most readily drawn into wire. According to Desch "the order of plasticity revealed by some of the most familiar metals is—K, Na, Pb, Tl, Sn, Bi, Cd, Zn, Sb," but these are not the most ductile metals. The order of ductility of the more important metals is given by Sir Roberts Austen as: Au, Ag, Pt, Fe, Ni, Cu, Zn, Sn, Pb. If this be true it would seem that wire drawing does not depend entirely on plasticity. Indeed, as we have said above, the constituent called "sorbite" in steel is said to be more suitable for wire drawing than the more plastic constituent called "pearlite." However, the rate at which traction is applied has great influence in testing plasticity and ductility.

The plastic deformation involved in drawing a hard crystalline solid like iron or steel into wire is not identical with that of an amorphous substance like pitch. The flow of pitch has been shown to be that of a fluid of high viscosity, while the microscope has shown that the flow of crystalline bodies is of quite a different nature.

The studies of Tyndall and Forbes on the behaviour of glaciers were the first attempts to throw some light on the subject. It is well known that glaciers move like highly viscous fluids. This movement was explained by Forbes as being due to the plastic flow of ice-crystals under the action of slowly applied stresses. Tyndall opposed this view and stated that the flow was due to regelation, that is, the pressure on the ice, by lowering the melting point, caused the formation of a small quantity of liquid water which carried the grains of ice along with it, freezing and consequent cementing of the mass taking place as soon as the stress was relieved. For long controversy raged over the cause of glacier flow, and some metallurgists applied the regelation theory to explain the flow of metals. That regelation, under pressure, occurs in some metals such as bismuth is possible, but this is hardly a feasible explanation of the flow of such a metal as iron or steel. Nor is the probable existence of slight plasticity of the metal crystals themselves sufficient explanation of the rapid flow which occurs in wire drawing, swaging, or punching.

The discovery of "slipbands" in crystalline bodies by Ewing, Rosenhain, and others, together with the researches of Sir George Beilby on the nature of polish, indicate the most plausible explanation of the facts. If a piece of metal with a smooth polished surface be strained or bent, a number of fine lines appear running in definite directions in each separate grain. These lines have been shown to be stepped in character, and their occurrence exactly resembles the production of step faults in geological strata. The direction of these "slipbands" is along the cleavage planes of the crystals. When a metal is subjected to alternating stresses these slipbands increase and finally form fissures, ultimately causing fracture of the material. In this way the phenomenon of "fatigue" in metals is explained; but it is well known that "fatigued" metals are hard and brittle like cold-drawn wire, and the experiments of Beilby offer an excellent explanation of this. These have shown that the effect of

polishing is to cause a surface flow of the substance being polished, and have proved the existence of a thin layer of flowed structureless material strongly resembling in its behaviour a highly viscous fluid. It would seem then that when a wire is drawn through a die slipping takes place in the metal along innumerable gliding planes, and sufficient viscous matter is formed to carry the crystalline material with it. When the traction is removed this sets in the form of an amorphous cement around the crystals. It is impossible by the most severe treatment to convert the whole mass into the amorphous modification. Hence, as already explained, there is a limit to the hardening effect of drawing. The hard amorphous material is not a stable modification and therefore cannot be truly called a phase. When the rigidity of the metal is decreased by heating, even to comparatively low temperatures like that of boiling water, partial recrystallisation takes place, and this is more marked when the temperature is raised to 400° to 500° C. The examination of the micro-structure of steel wire affords considerable support to this amorphous cement theory, and this, taken in conjunction with the physical properties, seems to place the matter beyond doubt.

The author exhibited several specimens of wire and wire rope and a number of photomicrographs of sections of wire, expressing his indebtedness for the use of these to Messrs. W. N. Brunton and Son, of Musselburgh.

MOTOR SPIRIT.

BY J. G. ANNAN, B.S.C., F.I.C.

Within the last few years the enormous expansion of the applications of the petrol engine to the motor car and to transport vehicles generally has led to an unprecedented general interest in the sources and methods of manufacture of motor spirit, and this interest has been greatly stimulated by the enormous absorption of motor spirit for war purposes, and by the recent restrictions which have been rendered necessary on that account.

It appeared that it might be of interest to give a general account of the principal methods, the rapid development of which, in the United States at least, greatly minimised the threatened shortage due, amongst other causes, to the enormous consumption for war purposes and to the supplies from several of the European petroleum fields being cut off from this country and its allies by belligerent operations.

Leaving out of account a moderate but rapidly growing annual contribution from Mexico, amounting to something like 10,000,000 gallons, the bulk of the 165,000,000 gallons of motor spirit imported by this country last year has been derived from the United States and from the Dutch Indies in nearly equal proportions.

As regards the Dutch Indies, the petroleum from this source is unusually rich in the lighter fractions, and probably on that account a large increase in the motor spirit supplies was possible without departing from the usual methods of manufacture.

It was otherwise with the United States, where an immediate increase in the exports of motor spirit was rendered difficult mainly because the domestic consumption had greatly increased while the production of motor spirit showed, temporarily at least, a decided tendency to diminish. The increase in domestic consumption was caused by the great expansion in the number of motor cars in use in the United States, the number registered increasing from about 1,800,000 at the end of 1915 to over 3,000,000 at the close of 1916—this being in addition to the growth in the application of the petrol motor in other directions. The

falling off in production was due to the rapid decline of the Cushing field in Oklahoma, which from producing 12 million gallons daily of crude oil, containing 25% to 30% of motor spirit, fell to less than 2½ million gallons daily. The new production brought in to replace this only contained 15% to 17% of motor spirit.

The position was, therefore, that the United States had to meet a greatly increased and urgent export demand and was at the same time faced with a rapidly increasing domestic consumption combined with a serious falling off in the crude oil supplies which were richest in motor spirit.

There appeared to be three methods, all of which had fortunately advanced well beyond the experimental stage, by which the motor spirit yields from the existing crude oil supplies could be materially augmented:—

(1) By widening the motor spirit cut so as to take in portions of the distillate which were formerly included in the burning oil or kerosene, whereby larger yields of motor spirit could be obtained, although the specific gravity of the latter would be raised thereby.

(2) By extending the casinghead gasoline industry, which consisted in collecting the hydrocarbon or casinghead gas which is ejected with the petroleum from the well, and recovering the heavier hydrocarbon constituents in liquid form by suitable methods, the product being termed "casinghead gasoline."

(3) By "cracking" the relatively less valuable heavy oils whereby they are converted into lighter spirit.

As a matter of fact, all three methods have been applied and have materially assisted in maintaining and even increasing the supplies of motor spirit sent to this and the allied countries.

Widening of the motor spirit cut: In the early years of the petrol driven motor car, motor spirit consisted of an article having a specific gravity of about 0.680 and having a distillation range of from about 95° to about 270° F. (35° to 132° C.) Such a spirit consisted mainly of pentane, hexane, and heptane, with some butane, octane, and decane, and owing to its low boiling point had the great advantage of volatilising readily even in carburettors of the most primitive type. Any attempt at that time to supply a spirit appreciably heavier for the then existing carburettors and engines invariably gave rise to more or less vigorous complaint. As engine and carburettor design progressed and the demand for motor spirit increased, and doubtless as the motoring public advanced in knowledge and experience of the petrol engine, the specific gravity of the spirit manufactured and satisfactorily used very slowly increased until, with carburettor and engine of most modern design, a very much heavier spirit is now more easily consumed than was formerly believed possible.

The figures obtained in fractionations of a series of representative samples of motor spirit bought within the last few weeks at random on the open market are shown on p. 246 under heading Nos. 2 to 12 inclusive, from which it appears that the specific gravity of the best brands of motor spirit averages about 0.725, and that all the members of the paraffin series from butane up to hexadecane are now present.

Column headed No. 1 shows a fractionation of a sample of the motor spirit in use about seventeen years ago and mentioned above as containing all the members of the hydrocarbon series from butane up to decane. Columns headed Nos. 2 to 6 inclusive give the fractionation results of well known foreign makes of motor spirit which have been produced by a straightforward distillation of petroleum in the ordinary way. Column headed No. 7 shows a fractionation of a spirit made by the "cracking" of a heavy oil, this process being

operated to a certain extent in this country. Columns Nos. 8 to 12 inclusive give fractionations of current qualities of Scotch shale spirit.

Probably the increase of motor spirit supplies due to the more recent increase in the specific gravity does not exceed 10%, but the actual increase in volume of motor spirit arising from the widening of the motor spirit cut is more important than appears because it could be, and was, adopted by practically all manufacturers, no special provision being necessary in the way of extra plant and expenditure, while as a matter of fact for various reasons the recovery of casinghead gasoline and the "cracking" of heavy oils attained their greatest development in the United States.

Casinghead gasoline.—Casinghead gas is the name given to the hydrocarbon gases which issue with the crude oil from the petroleum wells. In the early days of the petroleum industry the casinghead gas was regarded and treated as a waste product, which after being utilised as far as possible for local heating and other purposes, was simply burned as the easiest method of disposal in enormous jets which incidentally provided a tropical climate in the immediate vicinity and illumination of the surrounding country on an unnecessarily lavish scale.

The composition of the gas varies from well to well, and two different qualities of gas are recognised and distinguished by the terms "dry" and "wet." The "dry" casinghead gas may consist almost entirely of hydrogen, methane, ethane, propane, and butane, while the "wet" gas may contain these and in addition the pentanes, hexanes, and heptanes, the only normally liquid constituents of crude oil which at ordinary underground temperatures have vapour pressures of such magnitude that they are distilled in quantity from the crude oil, whence we expect pentane, hexane, and heptane to form the principal constituents of casinghead gasoline.

Generally speaking, the amount of gas from an average well will amount to several thousand cubic feet per 24 hours, and several such wells have to be grouped in order to provide a volume of gas large enough to render the gasoline extraction remunerative.

There are two systems of casinghead gasoline extraction, termed respectively the "compression" and the "absorption" process.

The compression process is most commonly used at present, but as the drier gases come to be dealt with the absorption process must be also utilised to a corresponding extent. For gases yielding less than 1½ gallons of gasoline per thousand cubic feet the absorption process is preferred. In the compression process the gas from several wells is piped to a convenient centre where one or more single or double stage compressors are installed which force the gas at a pressure of from 50 to 300 lb., depending on the nature of the gas, through a series of water-cooled metal condenser coils, whereby the casinghead gasoline separates out and is collected in suitable tanks also under pressure, while the incondensable gases are piped away to the point of consumption. One single unit compressor plant costs from £2400 to £3000 to instal and will handle about 500,000 cubic feet of gas per day.

The absorption process consists in passing the casinghead gas, usually under pressure, through a series of perforated pipes immersed in heavy oil contained in tanks, whereby the heavier constituents of the gas are dissolved and retained by the heavy oil while the unabsorbed "permanent" gases pass away to the point of consumption as before. By a steam distillation of the heavy oil the casinghead gasoline is subsequently recovered and stored in tanks under pressure.

The composition of casinghead gasoline is more

complicated than might be imagined from its method of recovery. The physical changes occurring under compression and cooling comprise not only condensation of vapour and liquefaction of gases but also the solution of the residual gases in the liquids so produced. Generally speaking, however, the condensate going to the tanks consists principally of pentane, hexane, and liquefied butane, but some heptane and liquefied propane are also present.

The yield of casinghead gasoline varies with the composition of the gas, and ranges from eight gallons for a rich gas down to a fraction of a gallon per thousand cubic feet for a poor gas which would not repay the cost of gasoline recovery. The average yield, however, amounts to about $2\frac{1}{2}$ gallons per thousand cubic feet. The total production of casinghead gasoline, which amounted to only a few thousand gallons in 1904 and to 30,000,000 gallons in 1913, rose to an estimated production of about 80,000,000 gallons in 1916.

At one time much of the casinghead gasoline was shipped as such, but owing to its excessive volatility it was unsuitable as a motor spirit and somewhat dangerous to transport on account of the pressure liable to develop under weather conditions which were by no means abnormal. Such pressures, amounting sometimes to about 50 lb. per square inch were, considering the nature of the material, not desirable.

One method of minimising this objection was to "weather" the gasoline by exposing it more or less freely to the atmosphere, whereby the more volatile constituents were dissipated, but the losses incurred thereby were very excessive and often amounted to 50% in twenty-four hours' exposure.

The method now generally followed, however, is to mix the casinghead gasoline with heavy naphtha in suitable proportions, whereby the objectionable excessive volatility is largely reduced, and the mixture can be shipped and marketed as motor spirit.

The specific gravity of casinghead gasoline is often as low as 0.630 and occasionally as low as 0.609 from a second stage compressor. Taking, however, an average figure of 0.645 to 0.648, the gasoline is mixed with naphtha of about 0.753 to 0.761 specific gravity in equal proportions, giving a blended gasoline or motor spirit having a specific gravity of about 0.700 to 0.705. Such a spirit would, as far as specific gravity and general appearance are concerned, be indistinguishable from a "straight" or normal refinery product, but the great difference in composition would be disclosed by the results of a fractional distillation. Where the blending has been unskillfully carried out a motor spirit of unsuitable quality might be easily obtained, and the uncertainty regarding this has led the United States authorities to investigate the advisability of fixing a standard of quality to which motor spirit should conform in that country, and this investigation is now proceeding.

"Cracking" processes.—The idea of converting the heavier hydrocarbons into lighter hydrocarbons by distilling the former under pressure appears to have originated with James Young, jun., who, in 1865-1866, patented a method of distilling heavy shale oil under pressure, the particular object in view being to increase the burning oil yields—at that time perhaps the most lucrative product of the shale oil industry. The plant patented consisted of a pot still and condenser of the ordinary type, the former being fitted with a safety valve and also a valve at the vapour outlet whereby the vapours emerging from the still could be throttled so as to maintain any desired pressure on the still. The vapours passing this valve escaped freely to the condenser and were there condensed.

In 1886 Benton took out a patent for an appara-

tus which bears some resemblance to several of the more modern forms of tube "cracking" plant.

In 1889 Dewar and Redwood patented an arrangement similar to Young's, but with, however, the important difference that the valve was placed at the condenser exit instead of the still exit, thus securing that both distillation and condensation were effected under pressure, while free communication existed between still and condenser. It was also specified in this patent that the still and condenser space not occupied by liquid should be filled with carbon dioxide or other inert gas under pressure.

Within the last few years much experimental work has been done with a view to devising commercially applicable methods for the conversion of the relatively less valuable heavy oils into motor spirit. The list of patents in connection therewith is a long one, and is being added to at frequent intervals. Broadly speaking these patents may be arranged in three groups:—

First, those in which the heavy oil is subjected to a temperature considerably above its boiling point under a pressure which is sufficient to maintain the contents of the still in the liquid condition.

Second, those in which the oil is vaporised and "cracked" in a vaporous condition; and

Third, those in which attempts have been made to "crack" at atmospheric pressure by distilling the heavy oils in contact with various catalytic agents such as aluminium chloride; but the principal objections have been the cost of recovery of the expensive catalytic agent from the still residue, and the difficulty of maintaining intimate contact between the heavy oil and the catalytic agent.

The best known process of the first of the groups mentioned above is that of Burton, one of the directors of the Standard Oil Company of Indiana, U.S., who in 1913 took out a patent for a process which is practically a reproduction of that patented by Dewar and Redwood about twenty-five years ago, and already mentioned. Burton's process has been adopted by the Standard Oil Company of Indiana and successfully developed by them on a large scale, whence its use has extended to practically all the Standard Oil Companies in the United States. The practical disadvantages attending the operation of a plant such as that patented by Burton are great, though not insuperable, as has been proved by its commercial success in the hands of the Standard Oil Company.

Generally speaking it is considered desirable to raise the oil to a high temperature in order to attain the maximum "cracking" efficiency, but the pressures required to maintain the heavy oil in the liquid state reach their safe limit at a comparatively low temperature with this type of plant. The carbon which separates in large quantity as a necessary result of the "cracking" distillation compacts to a non-conducting layer on the interior surface of the still bottom, and renders the still liable to over-heating, and the still bottom liable to frequent failure.

The results of such a failure under the pressures and temperatures applied in the Burton process, 700° to 800° F. (370° to 426° C.) and about 80 lb. per square inch, must be difficult to localise. Practical considerations of this kind have limited the Burton process to a size of still small enough to enable the results of such a failure to be kept within manageable limits.

Since the difficulties referred to appear to be inseparable from the distillation of large volumes of hydrocarbons under the high pressures necessary to attain even a moderately favourable "cracking" temperature, many more or less successful attempts have been made to vaporise the oil continuously and to "crack" the resulting vapour in a "cracking" chamber of limited size.

As described by Dr. Rittman in a recent patent.

specification, such a plant in its simplest form may consist of a 10 to 15 ft. length of 10 inch diameter metal pipe set vertically in a furnace so arranged that the temperature of the pipe gradually increases from the top to the bottom. Heavy oil continuously injected under pressure at the upper end of the tube instantly vaporises at the temperature existing there, and the resulting vapour passing down the tube through the region of higher temperature is "cracked" and finally the "cracked" products pass, still under pressure, through the condenser from which the liquid and gaseous products are distributed to the tank and gasometer respectively. The temperatures and pressures recommended as giving the best results with such a plant are as high as 900 to 1300 F. (480 to 705 °C.), and up to and over 300 lb. per square inch.

The vapour "cracking" type of plant has the advantage that the temperature and pressure can, within limits, be adjusted independently at values for which the maximum yields are obtained, and this confers an advantage which is not shared by the process of distillation in bulk under pressure.

While with the tube "cracking" process the element of danger always present in the bulk distillation process is largely removed, the former process is embarrassed to a much greater degree by the carbon accumulations both from the liability to blocking of the tubes and from the brittleness set up by the case-hardening effect of the continuous heating of the metal in contact with the carbon deposits whereby replacements and repairs are rendered difficult.

In the United States, "cracking" plant and casinghead gasoline plant are now largely worked in conjunction with one another, the former supplying the heavy naphtha and the latter the very light spirit for the production of the blended motor spirit.

The crude product from a "cracking" distillation contains in general a certain proportion of highly unsaturated hydrocarbons which render it in consequence not marketable in its original condition. The crude product is foul smelling, has a yellow colour which intensifies on standing, and when used in a petrol engine gives unsatisfactory results and excessive carbon deposits.

Specific gravity of spirit at 60° F.		1		2		3		4		5		6	
		0.679		0.728		0.744		0.767		0.7225		0.741	
No.	Fraction.	Temp.	S.G.	Temp.	S.G.	Temp.	S.G.	Temp.	S.G.	Temp.	S.G.	Temp.	S.G.
	1st drop over at ...	° F.		° F.		° F.		° F.		° F.		° F.	
	1% over at	97.98		134		156		152		132		142	
				158		180		178		154		174	
1.	5% ..	126	0.6440	171	0.6775	193	0.7015	194	0.7085	166	0.6780	188	0.6935
2.	10% ..	130	0.6178	178	0.6850	200	0.7108	202	0.7195	172	0.6850	195	0.7040
3.	15% ..	133	0.6510	186	0.6925	206	0.7170	210	0.7285	178	0.6915	201	0.7105
4.	20% ..	136½	0.6545	191	0.6988	210	0.7235	216	0.7370	184	0.6970	206	0.7165
5.	25% ..	140	0.6581	196	0.7055	216	0.7277	222	0.7435	188	0.7025	211	0.7215
6.	30% ..	143	0.6615	201	0.7105	220	0.7320	228	0.7495	193	0.7072	216	0.7260
7.	35% ..	146	0.6650	206	0.7160	224	0.7355	236	0.7545	198	0.7120	220	0.7302
8.	40% ..	149½	0.6685	212	0.7205	228	0.7386	242	0.7595	202	0.7162	224	0.7340
9.	45% ..	153	0.6722	218	0.7243	232	0.7414	248	0.7625	206	0.7195	229	0.7378
10.	50% ..	157	0.6756	224	0.7280	236	0.7445	254	0.7655	210	0.7232	234	0.7408
11.	55% ..	161	0.6788	230	0.7318	240	0.7475	262	0.7690	214	0.7265	238	0.7440
12.	60% ..	165½	0.6830	236	0.7350	244	0.7500	268	0.7720	219	0.7295	244	0.7468
13.	65% ..	170	0.6855	241	0.7382	250	0.7525	274	0.7750	223	0.7327	249	0.7498
14.	70% ..	175½	0.6899	248	0.7420	256	0.7545	282	0.7780	229	0.7359	256	0.7520
15.	75% ..	181	0.6933	256	0.7455	262	0.7570	290	0.7810	236	0.7380	262	0.7565
16.	80% ..	188	0.6971	266	0.7490	268	0.7592	298	0.7855	243	0.7422	270	0.7598
17.	85% ..	198½	0.7020	278	0.7530	278	0.7620	308	0.7914	252	0.7460	280	0.7643
18.	90% ..	215	0.7055	294	0.7590	292	0.7662	322	0.7976	265	0.7502	294	0.7690
19.	95% ..	240	0.7200	326	0.7685	314	0.7720	340	0.8045	292	0.7585	318	0.7778
20.	All in vapour	260	0.7340	361	0.7839	347	0.7904	376	0.8120	336	0.7772	358	0.7930

Specific gravity of spirit at 60° F.		7.		8.		9.		10.		11.		12	
		0.716		0.722		0.7265		0.7050		0.7315		0.7300	
No.	Fraction.	Temp.	S.G.	Temp.	S.G.	Temp.	S.G.	Temp.	S.G.	Temp.	S.G.	Temp.	S.G.
	1st drop over at ...	° F.		° F.		° F.		° F.		° F.		° F.	
	1% over at	136		122		146		97		142		123	
		166		150		165		128		176		170	
1.	5% ..	176	0.6833	161	0.6823	176	0.6890	136	0.6600	192	0.7005	180	0.6903
2.	10% ..	182	0.6883	168	0.6890	182	0.6990	142	0.6670	197	0.7070	186	0.6985
3.	15% ..	186	0.6925	172	0.6935	186	0.7030	147	0.6730	200	0.7123	192	0.7035
4.	20% ..	191	0.6962	176	0.6985	191	0.7085	152	0.6780	206	0.7153	197	0.7085
5.	25% ..	194	0.6998	180	0.7020	196	0.7120	157	0.6830	210	0.7185	202	0.7130
6.	30% ..	198	0.7025	181	0.7060	200	0.7155	162	0.6875	215	0.7218	207	0.7165
7.	35% ..	202	0.7060	188	0.7095	204	0.7180	168	0.6920	218	0.7244	212	0.7200
8.	40% ..	206	0.7090	192	0.7125	208	0.7205	172	0.6960	222	0.7270	216	0.7230
9.	45% ..	210	0.7120	196	0.7150	212	0.7230	177	0.7000	226	0.7300	221	0.7255
10.	50% ..	214	0.7150	200	0.7189	216	0.7255	182	0.7040	230	0.7312	225	0.7280
11.	55% ..	218	0.7170	204	0.7205	220	0.7280	187	0.7080	234	0.7336	231	0.7305
12.	60% ..	223	0.7200	209	0.7235	224	0.7305	191	0.7115	238	0.7355	236	0.7330
13.	65% ..	228	0.7230	214	0.7260	230	0.7332	196	0.7150	243	0.7375	243	0.7355
14.	70% ..	233	0.7260	220	0.7285	236	0.7355	202	0.7180	248	0.7395	251	0.7385
15.	75% ..	239	0.7290	226	0.7310	242	0.7375	207	0.7215	254	0.7415	254	0.7410
16.	80% ..	246	0.7320	232	0.7340	250	0.7405	215	0.7245	259	0.7437	259	0.7445
17.	85% ..	254	0.7355	240	0.7370	260	0.7440	223	0.7285	266	0.7467	283	0.7490
18.	90% ..	264	0.7398	252	0.7410	270	0.7480	238	0.7335	277	0.7509	298	0.7540
19.	95% ..	282	0.7460	272	0.7465	290	0.7535	258	0.7390	297	0.7550	335	0.7615
20.	All in vapour	320	0.7610	316	0.7570	336	0.7650	275	0.7500	338	0.7645	378	0.7795

Skilful and energetic refining treatment is required to remove these objectionable characteristics; refining losses are high, and refining costs are consequently higher than with the ordinary refinery product.

In the more modern developments of the cracking process it should be noted that great importance is attached to both condensation and distillation being carried out under pressure of the gaseous products of decomposition. It is claimed that the yield of liquid products is increased thereby and that the proportion of unsaturated hydrocarbons contained therein is correspondingly reduced as compared with, *e.g.*, Young's original method, in which the "cracked" products are freely discharged to the condenser under atmospheric pressure. This claim appears to be supported by obvious theoretical considerations, because condensation under pressure is equivalent to increasing the concentration of the gaseous products in the system, whereby the equilibrium must move in the direction of increasing the formation of condensate and of saturated hydrocarbons and decreasing the formation of gaseous products.

It has been estimated that the production of "cracked" spirit in the United States rose from 80,000,000 gallons in 1915 to 200,000,000 gallons in 1916.

Glasgow Section.

Meeting held at Glasgow on Tuesday, 30th January, 1917.

MR. JAMES MACLEOD IN THE CHAIR.

THE PREPARATION OF CHEMICALS FOR LABORATORY USE.

BY WILLIAM RINTOUL.

The purity and reliability of reagents and materials constitute one of the main factors essential to accuracy in chemical analysis and research. In the past Germany has enjoyed a monopoly of the supply of these bricks and mortar of our science, and that we have been content that this should be so provides an example of the grounds on which posterity may justly base its inevitable reproach and censure on our national neglect of science and of industries intimately connected with scientific development. Practically the whole of the energies of the limited number of chemists qualified for this work were occupied in carrying on those industries which had already been established and no spare force was available for extension. In fact, the chemists in this country were and are in the position of an army without reserves.

To this cause is due the neglect in this country of such industries as the manufacture of pure chemicals for laboratory use. So long as our energies were fully occupied in keeping alive existing industries, and so long as the quality of our supplies of imported materials remained satisfactory, we had no choice but to accept the position which had arisen. Of late years, however, the quality of supplies from these sources has been degenerating and this degeneration has been coincident with a material growth in importance of the industry involved. For these reasons, and because of the imperative necessity that in future we must be independent of Germany as far as possible, it is clear that the time has now arrived when the British Empire must consider her posi-

tion with regard to the supply of materials necessary for the proper control of so many of her industries.

With one or two exceptions, the raw materials employed in the preparation of laboratory reagents, that is to say, a wide range of chemical substances of a commercial or technical standard of purity, can readily be obtained within the Empire, and if the scientific knowledge and skill necessary for the elaboration of the methods and plant requisite for their purification can be made available, there is little doubt that this growing industry need not long remain in foreign hands, in so far as this country's requirements at least are concerned.

The difficulties to be overcome in establishing an industry such as this must not be minimised. In the case of an entirely new industry one is often hampered by the lack of available information and by the fact that each step has to be fully investigated before general principles can be established. In the case under consideration, the difficulties are of an opposite nature. An enormous literature has already grown up dealing with the preparation and properties of chemical substances, and unfortunately much that has been written is either inaccurate or misleading. This is true to such an extent that in many cases the published statements are embarrassing rather than helpful. Especially in text books is this the case, probably because of the extensive copying which has taken place, writers of such books being rather prone to accept as correct statements that have appeared in earlier works. Even when a statement which has acquired weight by reiteration alone is disproved, it is sometimes extremely difficult to persuade an author of a subsequent text book to take the responsibility of giving the corrected version the weight of his approval.

An instance of the misleading statements which find their way into the literature is to be found in the method for the preparation of dimethylaminobenzaldehyde described in one of the most recent German text books. Repeated experiments, in which the directions given were most carefully followed, failed to produce the result claimed by the author, and it was only after a considerable amount of research that a successful method for the preparation of this substance was evolved. Again, in the preparation of phthalic acid, if, as is laid down in the literature, the mixture of naphthalene, sulphuric acid, mercuric sulphate, and water is slowly heated, nearly 50% of the naphthalene distils unchanged and a low yield results, whereas if the naphthalene and sulphuric acid are first of all heated together until sulphonation is complete and then the mercuric sulphate and water are added, a much more economical yield is obtained.

At the outset, therefore, when the reagents to be prepared have been selected, it is first of all necessary that the literature dealing with each of them should be read in a carefully discriminating spirit. Only after this, can a programme of experimental work be drawn up with the object of testing the truth of the various statements which have been selected as possibly correct and so finally arriving at a definite conclusion as to the methods best suited for the preparations required. All this necessitates such a volume of experimental and research work that it is obvious from the beginning that this is not an industry which lends itself to immediate adoption on a large scale. If it is to be successful in its final condition it must be allowed to grow as the knowledge and experience on which it must be based becomes available.

Practically every new substance prepared will entail a certain amount of research work, sometimes more, sometimes less, and in order that this work may be carried out expeditiously it is necessary that a fully equipped and staffed research laboratory should be available. At the same time the

demand for research work will fall off as the industry grows, and, though it will never cease, it will become spasmodic. When a demand arises for a number of preparations which have not hitherto been investigated, a large research staff will be fully occupied, and when the final reports on this work have been compiled, other work will have to be found for the research staff while the manufacturing laboratories are developing, on a requisite scale, the processes which have been evolved. Considerations such as these suggest that it would be preferable that the preparation of pure chemicals should be undertaken under conditions which would permit of use being made of one or other of the research laboratories at present in existence in connection with certain of our principal chemical industries, rather than that the new industry should be saddled with the expense of a large, and at times partially employed, research section.

The research work required in this connection need not be confined to a technical laboratory. There exists at present throughout this and other countries a strong feeling that everything possible should be done to encourage a closer association between the University on one hand and the industry on the other. With many industries a grave difficulty will be found to exist in the highly specialised knowledge and experience necessary to accomplish useful development work, while at the same time it is exceedingly undesirable that such close specialisation should be introduced into the work of the University. In the case of pure chemicals, however, this difficulty does not exist. The work required is of a general and not a specialised nature and can readily be adapted to suit academic conditions. It possesses moreover the further advantage that the University as well as the industry would benefit by association in this work, because it can be used both as an educational implement and as a means for the solution of technical problems, and would constitute a bond not only between the University and the industry of fine chemicals but between the University and many chemical industries. The work to be carried out under the auspices of the University would be embodied in reports describing in detail the best method which had been selected or devised for the preparation of particular chemical substances, having always in view the purity of the product and—a feature often overlooked by academical workers—the comparative economy of all the methods examined. Investigations of this nature carried out by students under the guidance of their professor would inculcate the necessity of making use of the literature of a subject and engender the ability to do so. They must be carried out under the best conditions as regards purity and yield of product and economy generally, and each stage then becomes essentially an accurate operation in quantitative analysis in which not only the main reaction but also all secondary reactions must be closely followed with the view of promoting the former and discouraging the latter. The educational value of such work is obvious and that there is room for its adoption will be granted when it is considered that the analytical knowledge and skill possessed by the average University graduate when he leaves his college is at present far from satisfactory.

The importance of the purely scientific investigations which, in the past, have been the main object of University research is not to be challenged, but if some of the rather pointless communications of doubtful scientific value were replaced by authoritative statements on even the comparative value of various existing methods for the preparation of important compounds, the net result would be a material gain in useful knowledge. Now that our Universities are endeavouring to turn out graduates well equipped for technical work,

investigations having some practical bearing will probably become more general than formerly, and this again should render subjects of the nature suggested more acceptable.

It would, of course, be necessary that those responsible for the industrial policy should be kept informed as to the progress of each investigation, and thereby a further advantage would be gained. Manufacturers would for the first time be brought into touch with students approaching the end of their University training and would be in a much better position ultimately to select the men who best suit the special requirements of their business than they are at present.

The ease with which the work can be selected so as to afford subjects of greater or less difficulty should render it attractive both to Universities and to Technical Colleges, as enabling them to grade the work allotted to students in different stages of the training.

In addition to its educational value, co-operation between this industry and the Universities would doubtless result in the discovery of valuable commercial processes. The successful solution of the immediate problems arising directly out of the preparation of pure chemicals might not in themselves be of great financial value because the total quantities involved are not large and the amount of money to be invested in the industry is small in comparison with other commercial undertakings; but not the least of the charms of research work is the infinite possibility underlying it, and there are instances innumerable where a subsidiary and unlooked for discovery has dwarfed into insignificance the successful solution of the original problem. In properly organised research on the preparation of pure chemicals there is undoubtedly a great possibility of making discoveries of value in greater industries and this should provide an incentive of no mean order to those undertaking the work. The question of the ownership of discoveries arising out of a study, by the University, of problems suggested by an industry, constitutes one of the preliminary questions upon which an agreement must be arrived at; but it should not be difficult to devise a working arrangement which would be satisfactory to both parties. Again, the value of many discoveries has been lost or their useful application delayed owing to the inventor's want of knowledge as to where, and in what connection, his discovery can best be made use of; the industrial partner should provide a solution of this difficulty. The experts engaged in and responsible for the working of one industry cannot fulfil their functions properly without possessing a fairly intimate knowledge of the conditions and requirements of many other industries connected, directly and indirectly, with that in which they are engaged. They should therefore be in a particularly favourable position to bring any new discovery before the people who are awaiting it most anxiously.

Now, as regards the products of this industry; all chemicals for laboratory use must possess a known and sufficient degree of purity, and in this connection the pamphlet on "Reagents for Analytical Purposes" issued by the Institute of Chemistry and the Society of Public Analysts last year, is a step in the right direction.

Nothing is more annoying to the chemist than to find, after he has spent much time and energy on an investigation, that his work is valueless and that his results must be discarded because one of the reagents used contained an unsuspected impurity. To quote a particular example, it was only after much work had been done and valuable time expended that a quantity of so-called "pure" phenanthrene which had been purchased from a German firm and accepted on its melting point and on the authority of a well-known label, was found to contain some 70% of anthracene. That it

gave the correct melting point of phenanthrene may or may not have been a coincidence!

To ensure satisfactory purity in the output in a manufacturing laboratory such as is required for this work, it is necessary to institute a much more accurate control than suffices for ordinary manufacturing operations. As an indication of the refinements that are possible in this direction it may be of interest to quote an instance from the records of the Nobel Research Laboratories at Ardeer. Some years ago certain discrepancies in analytical results were observed and, on a rigorous investigation, it was found that these could only be ascribed to variations in the degree of purity of the substances then used for the preparation of volumetric solutions. It was decided that this question should be set at rest once and for all by the selection of some one particular substance which could be obtained or prepared in a condition of great purity. This substance was to be termed the "Ultimate Standard," as far as these laboratories were concerned, and the purity of all other chemicals used was to be determined in relation to this standard. After careful study of the problem and consultation with the authorities of the National Physical Laboratory, who were of the greatest assistance, it was finally decided that metallic silver was the substance best suited for adoption as the ultimate standard. Silver cannot, however, be used directly for the standardisation of acids or of oxidising or reducing substances, and it was therefore decided to employ subsidiary standards for general purposes of control. The substances selected for these purposes and referred to as "Working Standards" were sodium carbonate and iodine. As it is only in the determination of atomic weights that the purity of a substance undergoes a rigorous examination, the work of preparing the ultimate and working standards and correlating their purity was carried out under conditions suitable for atomic weight determinations. The purest silver obtainable was first of all electrolysed, then washed with sulphuric acid and water, and fused in lime crucibles in a current of hydrogen. The silver buttons were polished, washed with ammonia solution and water, dried, and kept in hermetically sealed glass tubes.

The electrolytic method of purification removes all metals except gold and platinum, and the absence of these as well as of carbon is proved by the complete solubility of the silver in nitric acid. No trace of copper could be detected although this metal was present in the original silver to the extent of 0.0007%.

The iodine for the working standard was purified by mixing commercially pure resublimed iodine with 10% of potassium iodide and 5% of calcium oxide and slowly resubliming the iodine in a special apparatus. The iodine collected was then resublimed twice in the same apparatus without addition. In the last sublimation a residue of 4 mgrms. was obtained from 350 grms. of iodine. The iodine from the last sublimation was powdered and kept over phosphorus pentoxide for two months and the dry iodine sealed up in small glass tubes each containing 5 or 10 grms.

The preparation of pure sodium carbonate gave much trouble, and the final product was not satisfactory as regards absolute purity. One preparation only need be described. 700 grms. of commercially pure anhydrous sodium carbonate was dissolved in 2.5 litres of distilled water at 25°. The solution was filtered into a narrow-necked flask and carbon dioxide passed into it. The carbon dioxide was previously washed with solutions of ammoniacal silver nitrate, dilute sulphuric acid, and sodium bicarbonate. After the air above the solution had been replaced the flask was closed so that only the carbon dioxide passed into it which was required to take the

place of that absorbed to form bicarbonate. When the process of saturation was complete at ordinary temperature, the solution was cooled to 0°, filtered by suction through hardened filter paper, and the precipitated bicarbonate washed with ice-cold water. The bicarbonate so obtained was then stirred in small quantities at a time into distilled water at 80°, until the solution was saturated. The solution was then allowed to cool until a small quantity of the salt had crystallised out. The mixture was then filtered quickly through a silver cone with fine holes. These first crystals contained all the mechanical impurities and were discarded. The solution was then cooled to 10°, the further crop of crystal collected in a funnel containing a silver cone and washed with small quantities of cold water. The mother liquor was concentrated three times in successive stages and each crop of crystals collected separately, the mother liquor from the last crop being evaporated to dryness. The purity of these fractions, after they had been heated in silver capsules at 250° to 300° C. until constant in weight, was determined in terms of the ultimate standard. The sodium carbonate content was as follows:—

	%
1st crop of crystals	99.906
2nd crop of crystals	99.877
3rd crop of crystals	99.896
4th crop of crystals	99.891
Residue from final mother liquor	99.857

The purest fraction, that of the first crystallisation, was again recrystallised with the following results:—

	%
Crystals	99.901
Residue from mother liquor	99.902

From this it was concluded that the limit of purification possible by this means had been reached although the final product still contained impurity to the extent of about 0.1%.

In the determination of the silver-iodine ratio the iodine was reduced to hydriodic acid by hydrazine and precipitated by a known quantity of silver. Six determinations gave the following results for the ratio of iodine to 100 parts of the ultimate standard silver: 117.691, 117.673, 117.657, 117.653, 117.650, 117.661. Mean 117.664. The following values for this ratio have been obtained by other operators:—Merignac, 117.533; Stas, 117.534; Baxter, 117.656; calculated from international atomic weights, 117.650. This agreement was considered satisfactory, and for purposes of standardisation in the Ardeer laboratories the ultimate standard is assumed to be of 100% purity. On this basis the working standard iodine contains 99.99% of iodine and the working standard sodium carbonate 99.93% of the pure substance. A supply of these standards has been prepared sufficient to last for many years and the work can be accurately repeated at any time.

It is now proposed to utilise the organisation which has grown up in the Ardeer Laboratories for the purpose of rendering available to other laboratories a supply of certain chemicals the quality of which can be absolutely relied upon.

As the principal object to be aimed at in these preparations is a high degree of purity, it is not intended that any of the operations shall be carried out on a manufacturing or large scale. The size of a working batch will be limited so that the accuracy of laboratory practice rather than of manufacture may be obtained, and in order that the products, may be characterised by their homogeneity as well as freedom from impurity. A special manufacturing laboratory has been equipped for this work. It has been furnished with all the items of plant likely to be useful in work of this nature and can command the services of all the general factory workshops and tools.

Each final operation in this laboratory results

in the preparation of a quantity of a finished material which, whatever its size may be, is given a lot number to identify it as a unit. After thorough blending, a sample of each lot is submitted to the analytical laboratory for examination, just as if the material had been purchased from an outside source. If the analytical report is satisfactory, the lot is passed for issue, and the essentials of that report are printed on the labels of the bottles containing it. These tested chemicals are issued to the usual chemical dealers for disposal. The simplest analytical report which could be issued would be a statement of the percentage of the particular substance which any preparation purports to be, leaving it to be assumed that the difference from 100 represents the impurity content. It is considered, however, that it is more useful to define the impurities which have been detected and leave the assumption to be made in the other direction. It is too much to hope that every impurity present in such a wide range of substances can be detected and its proportion determined, but the examination is made as thorough as possible and, where it is known that particular impurities interfere with the use of any reagent for a specific purpose, these of course receive special attention, both as regards elimination and detection.

London Section.

Meeting held at Burlington House on Monday, February 5th, 1917.

MR. A. R. LING IN THE CHAIR.

ARTIFICIAL FERTILISERS—THEIR PRESENT USE AND FUTURE PROSPECTS.

BY EDWARD JOHN RUSSELL, D.S.C.

(Director of the Rothamsted Experimental Station).

Artificial fertilisers are simple salts which are added to the soil to help in the nutrition of plants; they are called "artificial" because they have usually undergone some manufacturing process. There are three classes: nitrogen compounds, phosphates, and potassium compounds; it is useful also to add a fourth: organic matter; almost anything containing these constituents will serve, provided always that the substance is not toxic to the plant, and that it is capable of going into solution in the soil water directly or as the result of decomposition in the soil, so that it can enter the plant roots. In practice, however, a third condition is essential, the price must be sufficiently low, and this rules out so many substances that the actual list of artificial fertilisers is short, and is—

Nitrogenous.—Nitrate of soda, sulphate of ammonia, calcium cyanamide, and calcium nitrate.

Phosphatic.—Superphosphate, basic slag and bone manures.

Potassic.—The Stassfurt salts.

Organic.—Excretions from animals fed on imported feeding stuffs, guano, fish and meat meals, and other manufacturing residues.

These four classes have very different properties, and they are in no sense interchangeable.

In laboratory experiments, sand cultures, etc., all the three first-named constituents are necessary for plant growth but in field practice the soil supplies something, so that artificial fertilisers are needed only to make up deficits or to raise the level of production. The only way of finding out

what is wanted is by actual trial; the hope once entertained that soil analysis would give a short and easy indication of the deficit has not been realised.

Moreover each of these different classes, besides contributing to the general nutrition of the plant, has certain specific effects which can only be discovered by trial.

The fertilisers are mainly simple salts, in other words, electrolytes; and the soil owes most of its important properties to its colloidal constituents. Now electrolytes profoundly change some of the properties of colloids, and the effects cannot always be predicted; usually they have to be discovered by direct experiment.

Further, some of the fertilisers undergo remarkable changes in the soil; nitrate of soda, for example, changes to carbonate of soda, which, as an alkali, has a strong deflocculating action on the clay, thereby greatly modifying the texture of the soil; sulphate of ammonia gives rise under certain conditions to an acid, which changes the reaction of the soil, and, as every bacteriologist knows, a change in reaction of the medium may profoundly affect the growth of organisms and of plants.

In dealing with artificial fertilisers, therefore, it is necessary to take into account not only their effect on the plant and their price, but also the changes they are likely to undergo in the soil, and the effect the products will have on the soil and on the plant. These are so complex that they can usually only be determined by direct trial.

The phosphatic fertilisers.

These present the simplest case because there is usually no complication arising from secondary actions in the soil, even rain has very little effect: phosphates applied one year will persist unchanged and can be taken up in the following year. At Rothamsted, Hall and Amos* were able to account for all the phosphates added during the preceding 55 years:—

Phosphorus balance-sheet, Hall and Amos.

P ₂ O ₅ , lb. per acre.	Broadbalk plots.		Hoosfield plots.	
	5.	7.	2.	4.
Supplied in manure	3960	3810	3390	3390
Removed in crop	790	1370	1200	1240
Balance expected in soil ..	3170	2440	2190	2150
Balance found in soil	3000	2470	2315	2000

Besides contributing to the nutrition of the plant, phosphates stimulate growth in the early stages of plant life and cause a great development of root, which makes them indispensable for potatoes, swedes, turnips, and root crops generally. Further, they help materially in grain production, hastening on the ripening processes.

Of all the phosphatic fertilisers by far the commonest is the so-called superphosphate, a mixture of calcium sulphate and monocalcium phosphate.

Superphosphate is made by treating calcium phosphate with sulphuric acid. In principle the manufacture is perfectly simple: in practice, however, it is complicated by the necessity for making the sulphuric acid on the spot, owing to difficulties of transport, and by the need for turning out a fine dry product of uniform composition. These difficulties have been successfully overcome by adjusting the quantity and strength of the acid to the mineral phosphate, and the product turned out by our best manufacturers is very satisfactory. A good deal of bone is used in ad-

* Trans. Chem. Soc., 1906, 89, 205.

mixture with mineral phosphate to make the so-called "bone super."

There has been a progressive improvement in the composition of superphosphate as shown in the following analyses of the ordinary samples on the market :—

	P ₂ O ₅ per cent.	Equivalent to Ca ₂ H ₂ (PO ₄) ₂ .
30 or 40 years ago	9.1	20
20 years ago	11.8	26
Modern samples	13.6	30
	16.0	35

This improvement in composition is largely due to the use of richer mineral phosphates, and it effects a considerable saving in freight.

The industry was founded in this country, but we have not kept our lead: before the war Germany, France, and Italy had all passed us, and Belgium was beginning to catch us up. Few of our makers have the mechanical dens, the electrical power, and other appliances of the modern Continental factories. The output of the leading countries is given in Table I.

Further, phosphatic fertilisers are wanted wherever bullocks or sheep are being produced. The addition of phosphates to the crop increases the feeding value. In many cases, however, basic slag serves as well as super for this purpose.

Large amounts are also needed in horticulture, where it proves very valuable in inducing hard growth in plants that are becoming sappy.

Taking all these circumstances into account we can safely assume that a much higher proportion could be absorbed in this country if more intense cultivation methods were adopted.

When we turn to other countries the possibilities are even greater. Professor Priamishnikow, the eminent Russian agriculturist, states† that great areas in Russia need phosphatic fertilisers; and although Russia possesses phosphatic deposits our superphosphate manufacturers ought still to be able to help in the agricultural development that may be expected in that country.

But it is in our own Empire that the need for superphosphate is greatest. Large areas of land in Australia only become fertile when superphosphate is added; thus the following results were obtained at the Roseworthy Agricultural College‡ :—

TABLE I.*

Production of superphosphate in metric tons. 1903—1910.

	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.
France	1,053,000	1,234,800	1,314,000	1,320,300	1,632,600	1,848,600	1,641,600	1,634,400
Germany	765,000	831,600	873,000	837,000	1,105,200	1,191,600	1,267,200	1,353,600
Italy	392,400	453,600	455,400	395,800	797,400	1,020,600	928,800	896,400
United Kingdom†	655,200	689,400	772,200	786,600	900,000	937,800	807,300	756,900
Belgium	208,800	223,200	234,000	208,800	234,000	334,800	349,200	394,200
Holland	208,800	280,800	288,000	274,500	286,200	354,600	352,800	385,200
Total Europe	3,559,500	4,043,880	4,321,980	4,451,400	5,563,080	6,402,500	6,008,400	6,105,600
Total America	1,452,600	1,665,000	1,710,000	1,632,400	2,046,600	2,210,400	2,304,000	2,858,400
World's total	5,130,900	5,863,500	6,281,024	6,463,440	8,003,880	9,158,300	8,710,200	9,604,260

* Data extracted from "Production et Consommation des Engrais Chimique dans le Monde," Inst. Internat. d'Agric., Rome, 1914.
† The quantity is not known precisely, and some put it as high as one million tons per annum. The higher figure is arrived at as follows: we import annually about 550,000 tons of mineral phosphate and we also import and produce about 100,000 tons of bone. Assuming this is all made into superphosphate it would yield 1,200,000 tons. Before the war we exported 200,000 tons, leaving one million tons for home consumption.

Thus the production has gone up enormously during the period; I do not think it has nearly reached its limit yet. In this country we used before the war about 600,000 tons per annum. Our cultivated area in the United Kingdom is 47 million acres, so that if divided up equally the consumption would be about $\frac{1}{2}$ to $\frac{1}{3}$ cwt. per acre. But this is not a fair way of procedure, because superphosphate is not applied to all crops. The better plan is to take the crops to which it is usually given, viz., swedes, turnips, mangolds, potatoes, of which we grow 3.5 million acres, so that if all the super were given to them, the average dressing would be about $3\frac{1}{2}$ to 6 cwt. per acre. The lower amount would not be an over-dressing; good practical men often give 4 cwt., and in some cases (*e.g.*, for potatoes in Lincolnshire, in the Fens, and in the Channel Islands), up to 10 cwt. per acre. Large quantities are consumed in the eastern counties where there are great areas of these crops. But in addition considerable quantities can advantageously be used for some of the wheat, barley, and oats, of which we grow nearly 8 million acres.

The special effect of encouraging root production and of hastening maturity is very valuable on heavy soils everywhere, but especially in wet districts. Thus, in Central Wales superphosphate proves extremely valuable, and is indeed often the only fertiliser needed.

Roseworthy Agricultural College. Wheat. 1910.

	Total produce per acre.	Grain per acre.	Value of grain at 3/6 per bush.	Cost of manure.
	tons, cwt. lb.	bush, lb.	£ s. d.	s. d.
No manure	1 7 47	15 20	2 13 8	—
$\frac{1}{2}$ cwt. super	1 13 13	21 43	3 16 0	2 0
1 cwt. "	1 18 38	22 45	3 19 8	4 0
2 cwt. "	2 0 61	22 15	3 17 11	8 0
3 cwt. "	2 0 64	22 14	3 17 10	12 0

In this case the crop only responds to about 1 cwt. per acre of super. Elsewhere, however, larger quantities give better results. The areas involved are very great, and it is impossible to form an estimate of the total amount that will finally be wanted in Australia.

South Africa also is likely to need considerable quantities of superphosphate. Holm and Watt have both shown that it greatly increases the yield of maize. Watt obtained still further increases when nitrate of soda was added as well, but Holm did not. Their results were:—

† Landw. Versuchs-Stat., 1912, 77, 399.
‡ Roseworthy Ag. Coll., 4th Annual Rept., 1904-11, p. 40

South African maize.

	Watt.*	Holm.†
	lb. per acre.	lb. per acre.
	1907.	1906-09.
Unmanured	120	778
Superphosphate alone	360	2897
Sulphate of ammonia alone ...	220	—
Nitrate of soda alone	—	718
Superphosphate and nitrate of soda	1345	1898

* Transvaal Ag. Journ., 1908, 6, 550. Experiments made on a sandy soil east of Pretoria.

† *Ibid.* 1910, 8, 369-384 (the figures are taken from p. 381). These experiments were made at the Experimental Farm, Potchefstroom.

Canada has not yet begun to use superphosphate, and might if necessary make it herself, or import it from the States. But in view of its great value for grain production I think one might safely hazard a prediction that superphosphate will sooner or later be wanted, especially as the cultivation belt is pushed further north, and the scheme of farming becomes more generalised.

India has hardly begun to use superphosphate yet, but there are indications that it is much needed for some of the crops. Mann and Paranjpe* find that superphosphate gives good results with cotton on black soils in Western India where the water supply is satisfactory, while other Indian soils appear on analysis to be so deficient in phosphates as to justify the expectation that they would respond to phosphatic fertilisers if used.

Egypt has made a beginning in the use of superphosphate: during 1912 nearly 6000 tons were imported and applied mainly to the cotton crop. Experiments with cotton are very difficult to carry out, and there is no clear indication that superphosphate is always necessary.

It has been already pointed out that superphosphate encourages ripening, and this is a very great advantage in grain production. Early ripening is not always helpful for other crops, however. In glasshouse production it is sometimes detrimental, and at the Lea Valley Experimental Station phosphates actually reduced the yield of some of the crops. In Louisiana superphosphate has sometimes diminished the yield of cotton on poor soils: the cotton is said to "burn out."† For the sugar crop also superphosphate does not seem to be wanted. Harrison's extended trials in British Guiana‡ gave no sensible increase for additions of super, and only a small increase for basic slag:—

Tons of canes per acre. Average for three years 1909-10-11.

No phosphate.	Superphosphate.	Basic slag.
20.5±0.5	21.5±0.5	24.1±0.7

In the Barbados experiments which lasted over 20 years the application of phosphates was always ineffective, indeed in some cases the yields were actually reduced.§ Thus, at Dodds the results over the 16 years, 1891-1909 were:—

Sugar cane expts., Dodds, Barbados, 1891-1909.

	Tons of cane.	Lb. of sucrose per acre.
No phosphate	30.63	8314
Superphosphate 40 lb. per acre	28.93	7851
" 80 " " "	28.72	7716
" 120 " " "	28.98	7885

Other cases will no doubt be revealed as the result of experiment.

Summing up we may say that large and increasing amounts of superphosphate are required in this country for swedes, potatoes, and corn crops: other countries can also absorb great amounts for grain and meat. Leaving out the chief superphosphate producing countries as being able now or in the near future to satisfy their own requirements, enormous amounts will be wanted for wheat in Russia, and probably also Roumania, in Australia, and I think we shall one day say Canada as well, and for maize in South Africa. The meat-producing countries of South America will also require phosphatic fertilisers. Shall we be able to supply these wants. Apart from considerations of freight, this depends mainly on whether we have enough cheap sulphuric acid: if we have, and if our manufacturers improve their processes and their works, we ought to be able to play a good part in supplying this need.

Basic slag.—This is a by-product in the manufacture of Bessemer steel. It is difficult to determine precisely how much is produced, but assuming that 250 kilos. of slag is obtained in the preparation of one ton of steel, then the amounts produced in 1910 are estimated by the International Institute of Agriculture, Rome, to be as follows:—

Production of basic slag 1910.

	Metric tons.
Germany	2,007,500
France	534,000
Belgium	488,000
United Kingdom	160,000
Austria-Hungary	74,000
Sweden	12,345
Total	3,275,845

The figures are certainly wrong for the United Kingdom, since we use 286,000 tons per annum, almost all of which is produced at home, and we also export a certain amount, but probably the order of placing the countries is correct.

Slag is extremely beneficial for grass land. Again and again experiments have shown remarkable gains, especially on heavy land. The best known results are those obtained at Cockle Park: slag improved the herbage more than the feeding of cake to the animals. The live weight increases of sheep in lb. per acre per annum were:—

	No cake. No manure.	Decorticated cake.* No manure.	No cake. Basic slag. (10 cwt. in 1897 & 1905).
1st 9 years, 1897-1905 Increase due to manuring	Plot 6. 37	Plot 1. 106.5	Plot 3. 117
2nd 6 years 1906-1911 Increase due to manuring	23	69.5 42.5	80 117
	—	19.5	94

* 597 lb. cake per acre in 1897-8, in 1903 and 1904.

These experiments have been repeated at numerous centres, and almost always with similar results. At the Midland Agricultural College the milk yield was largely increased by the use of basic slag. Slag has often proved as good as feeding cakes, and considerably cheaper.

* Bombay Bull., 76, 1915. Nitrogen also gave good results but not potash. The authors state that these dressings should be supplementary to farmyard manure.

† Louisiana Sugar Expt. Stat. Bull. No. 6, 1891.

‡ British Guiana Dept. of Agric. Rept.: a good summary is given by Professor Harrison in the West Indian Bulletin, 1913, 13, 95-218.

§ Barbados Rep. on Sugar Cane Expts., 1907-9, p. 8. Harrison finds that if the soil contains 0.008% of P_2O_5 soluble in 1% HNO_3 or 0.002% soluble in $N/200$ HCl , there will be no response to phosphates.

The War has greatly stimulated the use of slag, because feeding cakes have to be imported, and have therefore risen in price, whilst slag is a home product. Its prices per unit of phosphate have been :—

Pre-war price, 1s. 5d.	Nov., 1916. 2s. 10d.	Jan., 1917. 2s. 10d.
---------------------------	-------------------------	-------------------------

In the United Kingdom there are 34 million acres of grass. Dividing the 286,000 tons of slag consumed in this country over this area we obtain $\frac{1}{2}$ cwt. as an average dressing. A good dressing is 10 cwt. in the first year, and then 5 cwt. after an interval of 2 or 3 years. Further, slag can be profitably used on other crops as well. There is therefore a great future for it in this country.

Other countries outside Europe have hardly begun to use it: the United States does not make it. The steel is there manufactured by the open-hearth process, which gives an acid phosphatic slag, and not a basic slag. This process is also in use in this country. One of the great problems of the future is to find a way of using these acid slags: at present they are simply going to waste.

The nitrogenous manures.

Nitrogenous manures present a rather more complex case than phosphates for two reasons. In the first place practically all the nitrogen compounds hitherto tested change in the soil to ammonia, and then to nitrate. It does not always appear that the change is necessary: plants can take up ammonium compounds, although not nearly as easily as they take nitrates. But the soil bacteria are too active for them: before they have the chance to use the ammonia it is seized by the nitrifying organisms and converted into nitrate.

Thus, in practice all nitrogenous manures, except the nitrates, have to undergo a preliminary decomposition in the soil. It is therefore necessary in all cases to know whether this change will proceed easily or not. The ease of decomposition is spoken of as the "availability" of the manure.

Secondly, as has already been pointed out, the nitrogenous manures nearly all have some secondary effect on the soil; in consequence the action is not always quite what would be expected on general grounds.

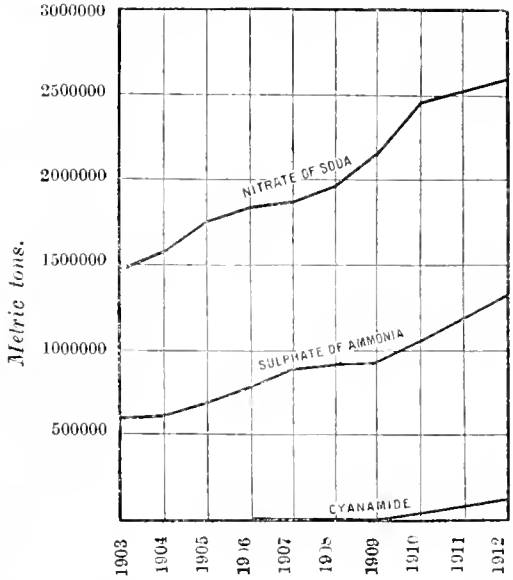
The general effects of nitrogenous manures are to increase leaf development and growth generally. They are therefore useful for all crops, indeed they are of more general application than any of the other fertilisers.

The artificial nitrogenous fertilisers, however, are not the only source of nitrogen to the farmer: he can also use farmyard manure, clover crops, and imported feeding stuffs, to increase his supply; he does this to a large extent. These other sources are serious competitors with the artificial fertilisers.

Nitrate of soda.—This is the most popular of the nitrogenous fertilisers, prior to the war the world's annual production, almost entirely from Chile, being about 2½ million tons per annum. The Chilean Government estimate that at this rate the deposits will last at least another 136 years: the production, however, has been steadily increasing as shown by the curve in Fig. 1: this also shows how much the production of nitrate of soda exceeds that of sulphate of ammonia.

Nitrate of soda owes its popularity as a fertiliser to the circumstance that it is ready for use by the crop, and has no further change to undergo: it is therefore the quickest in action of all nitrogenous fertilisers. In temperate climates this rapidity of action has two advantages; the fertiliser is less exposed to the wasting processes in the soil, and it produces an immediate effect on the crop. Thus, in cold wet weather a dressing of nitrate of soda at once improves the crop, and may make all the difference between success and failure. No other fertiliser has quite so good an effect, and we can never hope to do without an ample supply of nitrates.

World's production of nitrogenous fertilisers.



In this country, therefore, nitrate of soda is rather better than sulphate of ammonia. The results of long-continued experiments at Rothamsted are given in Table II.

Thus the superiority of nitrate of soda amounts to about 5% for barley and hay crops, and is greater for wheat and mangolds. Taking all things into account if one puts the effect of nitrate

TABLE II.
Comparison of sulphate of ammonia and nitrate of soda as fertilisers, Rothamsted.

	Wheat, 26 years (1885—1911).		Barley, 60 years (1852—1911).		Mangolds, 34 years (1876—1911).		Hay, 57 years (1856— 1912).
	Grain, bushels per acre.	Straw, cwt. per acre.	Grain, bushels per acre.	Straw, cwt. per acre.	Dung supplied, Roots, tons per acre.	No dung.	cwt. per acre.
Complete minerals + no nitrate .	14.0	11.3	19.7	11.1	18.9	5.0	40.9
43 lb. N as NaNO ₃	26.5	26.0	42.7	27.3	—	—	—
43 lb. N as sulphate of ammonia	22.7	20.6	41.5	25.0	—	—	—
86 lb. N as NaNO ₃	33.8	37.9	—	—	26.6	17.7	56.9
86 lb. N as sulphate of ammonia	31.2	32.8	—	—	24.4	14.8	54.2

of soda at 100, that of sulphate of ammonia would be between 90 and 95.

Part of its effect arises from the circumstance that the sodium has a beneficial effect as well as the nitrogen. It has been shown that the sodium economises the use of potassium partly by replacing some of the potassium in the plant, and also by liberating potassium from complex compounds in the soil.

As already stated nitrate of soda tends to change in the soil to sodium carbonate, which deflocculates the clay rendering it very sticky. This does no great harm on light soils or loams, but it is a disadvantage on heavy soils. Nitrate of soda is therefore not desirable on such soils, nor is it on alkali soils, *e.g.*, in the Deccan, or wherever the texture of the soil is easily damaged. On lighter soils deficient in calcium carbonate, however, this formation of sodium carbonate may be beneficial. At the Rhode Island Experiment Station Wheeler started with a soil so "deficient in carbonate of lime that only an occasional clover plant could withstand the existing conditions." By the long continued use of nitrate of soda the productiveness was markedly improved, even without the use of lime.*

At Rothamsted the conserving effect of nitrate of soda on the lime in the soil lessens the rate of loss by 200 to 300 lb. per acre per annum.

Lastly, nitrate of soda is very easily washed out from the soil; unlike sulphate of ammonia it is not absorbed in the slightest degree by soil, and the whole dressing may be washed out in a single heavy rainfall. This only rarely happens in our country, but it is not uncommon in tropical and sub-tropical countries, and in consequence, as we shall see, sulphate of ammonia in these cases proves on the whole a better fertiliser.

A further disadvantage of nitrate of soda is that in absence of oxygen it is reduced by certain soil bacteria to nitrites, which are toxic to plants, and finally to gaseous nitrogen. The necessary conditions rarely arise in this country, but they do in the swampy soils of the paddy rice fields of India and Japan. In such cases nitrate of soda not only has no good effect, but may even depress the yield by reason of the toxicity of the nitrite.

TABLE III.

Consumption of nitrate of soda for all purposes.
Metric tons.

Europe and Egypt:—		1911.	1912.
Germany	743,412	911,962	
France	338,706	354,517	
Belgium	303,780	309,817	
Holland	114,652	189,924	
England	92,362	101,081	
Italy	53,616	14,545	
Scotland	40,569	36,334	
Egypt	19,018	23,981	
Spain	8,977	13,554	
Austria-Hungary	5,281	7,114	
Denmark	3,438	4,825	
Switzerland	2,371	5,198	
	1,756,182	1,993,852	
United States:—			
East	513,029	386,016	
West	55,197	55,931	
	568,136	441,947	
Asia and Africa, etc.:—			
Japan	23,495	21,717	
Hawaii	14,166	20,152	
Cape Colony	12,866	14,174	
Natal	6,505	11,164	
	57,032	67,507	
Other countries	20,042	28,239	
Total	2,401,392	2,530,615	

* Wheeler, Manures and Fertilisers, 1913, p. 141.

Most of the nitrate of soda is used in Europe and North America, the tropical countries and Asia only taking very little. Of recent years its use has begun in Egypt, mainly for the wheat crop. In 1912 no less than 21,000 tons was imported, most of which was for wheat, and the remainder for cotton and maize.

Table III. gives the total consumption in the different countries. Figures are not obtainable for the agricultural consumption, but in the country it amounts to about 80% of the whole in normal peace times.

Other nitrates.

Synthetic calcium nitrate.—As a fertiliser calcium nitrate closely resembles sodium nitrate, but it appears to be free from the disadvantage of making heavy soils sticky. Further experience is needed before any very definite statements can be made, but so far as present knowledge goes nitrate of lime is a promising addition to the list of nitrogenous manures.

The first samples to be placed on the market were not easy to use as they so readily absorbed moisture and became converted into a sticky pasty mass, but this difficulty is gradually being overcome, and samples coming to hand before the war showed considerable improvement.

Potassium nitrate.—This substance is dearer than a mixture of nitrate of soda and sulphate of potash supplying the same ingredients, and therefore it is not used in this country. Being much less bulky than the mixture it finds considerable application in countries where valuable crops are raised and freights are high; thus it is used in the Canary Islands and elsewhere under similar conditions.

Commercial nitrate of potash contains nearly 14% of nitrogen.

Ammonium nitrate.—Ammonium nitrate is the most concentrated nitrogenous fertiliser available, containing no less than 35% of nitrogen, and this would be a valuable recommendation wherever freight is any consideration. But unfortunately it is highly soluble and deliquescent, and seriously damages the young leaves wherever it touches them. The crop may, of course, get over the injury, but there is always a risk that it may not, and this circumstance rather militates against the use of ammonium nitrate.

Trials at Rothamsted in 1911 gave the following results:—

	Potatoes, tons per acre.	Mangolds, tons per acre.
Dung and minerals alone	7.2	17.5 18.1
Dung and minerals + nitrate of ammonia	9.0	18.3 19.1
Dung and minerals + nitrate of lime	8.6	20.1 21.8
Dung and minerals + nitrolim	8.7	17.9 18.8

Owing to the drought the mangolds did not grow well.

Sulphate of ammonia.—Sulphate of ammonia is obtained as a bye-product from coal; it is largely produced from gas works and coking ovens. The official statistics of production in this country for the year prior to the war are as follows:—

1913.	
Gas works	182,180
Coke and carbonising works and producer gas	167,421
Iron works	19,956
Shale works	63,061
Total	432,618*

* The figures are taken from the Alkali Inspector's Report, 1915, where the data for 1912 and 1914 are also given. For convenience all compounds of ammonia and ammonia itself are expressed as sulphate and included in this table. It is understood, however, that only about 85% of this total is actual sulphate, the remainder being ammonia liquor, etc.

In a good gas works 1 ton of sulphate of ammonia is produced for every million cubic ft. of coal gas, and in a carbonising plant 22 to 34 lb. of sulphate of ammonia is made for every ton of coal carbonised. There is little doubt that these figures, especially the lower ones, could be improved upon. It is also possible to obtain ammonia from peat, though as a matter of fact little if any is so obtained in this country.

The world's production of ammonia increased considerably during the 10 years prior to the war, as shown in Table IV.

Similar results are obtained in Java, and in consequence sulphate of ammonia is used there almost exclusively. In 1912 the imports were valued at :—

Sulphate of ammonia	£5,233,000
Nitrate of soda	37,900
Sulphate of potash	2,400
Other fertilisers	1,720,000

With less rainfall the results do not always work out like this. At Barbados* the results are sometimes one way and sometimes the other. In

TABLE IV.

Production of sulphate of ammonia during the years 1903-12. Metric tons.

	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Germany	160,000	173,000	190,000	235,000	287,000	313,000	330,450	373,000	418,000	492,000
United Kingdom	237,520	250,050	273,550	294,170	318,400	350,450	354,729	373,468	391,135	394,521
United States	38,000	43,600	69,250	68,000	90,120	79,500	66,600	105,143	115,245	149,700
France	42,000	43,000	47,300	49,100	52,700	52,600	53,600	57,300	62,000	68,500
Belgium	19,000	16,000	18,000	26,000	27,000	29,000	34,600	35,600	40,700	43,700
Other countries*	85,686	60,337	56,306	67,800	103,592	109,254	109,393	109,483	171,283	179,087
Total	582,206	591,987	654,406	740,070	878,812	933,804	949,572	1,053,994	1,198,362	1,327,508

* The figures for "other countries" include some round figure estimates.

But this increase has failed to keep pace with the consumption, and in consequence prices have risen.

Sulphate of ammonia is largely used in this country for potatoes, the dressings varying from 1 or 2 cwt. on ordinary farms up to 6 cwt. in the Channel Islands. It is also used to an increasing extent as a spring dressing for corn with very good results. Altogether some 60,000 tons are used annually in the United Kingdom, but there is little doubt that this figure could profitably be greatly increased.

Sulphate of ammonia has two important properties that give it a definite advantage over nitrate of soda in certain special circumstances.

1. It does not easily wash out from the soil: it is readily absorbed, and in this state resists even tropical rainfall; it is therefore used in tropical countries in preference to nitrate of soda.

In these countries sugar is the chief crop to which it is applied. Harrison summarises his numerous trials with sugar in British Guiana as follows :—

BRITISH GUIANA EXPERIMENTS WITH CANE SUGAR.

Tons of canes per acre.

	Series A.	Series B.	Series C.
No nitrogen	18.0 ± 0.4	17.7 ± 0.5	17.4 ± 0.6
Sulphate of ammonia	29.0 ± 0.7	30.3 ± 1.3	28.3 ± 1.3
Nitrate of soda	—	—	20.8 ± 1.3
Nitrate of lime	23.6 ± 0.6	22.5 ± 1.4	22.6 ± 1.4
Nitrolim	22.6 ± 0.6	20.9 ± 1.3	20.8 ± 1.3
Dried blood	—	20.4 ± 1.3	—

Another way of putting the result is that 10 lb. of nitrogen in the various substances gave the following increases in tons of cane :—

	1910-11.	Tons of cane.
Sulphate of ammonia	1.9 ± 0.23	
Nitrate of lime	0.87 ± 0.25	
Nitrolim	0.62 ± 0.21	
Nitrate of soda	0.57 ± 0.29	
Dried blood	0.45 ± 0.29	

Rainfall 6 months Oct., 1909—March, 1910 = 46.9 inches.
Rainfall 6 months Feb., 1911—July, 1911 = 58.8 inches.

1911-13 nitrate of soda came out better than sulphate of ammonia.

	Tons of cane.	Sucrose, lb. per acre.
Sulphate of ammonia	19.42	5433
Nitrate of soda	19.97	5558
Nitrate of lime	19.60	5433
Nitrolim	18.52	5169

In other years, however, sulphate of ammonia has given the best results, and on the whole it is preferred by the planters.†

At Antigua and St. Kitts‡ there was no difference in action between sulphate of ammonia and nitrate of soda. But the rainfall for the whole year was only between 40 and 60 in.—not nearly as heavy as in British Guiana.

Cotton.—At Barbados chemical fertilisers produced no notable results at first, but afterwards yields began to fall off, and the experiments were then repeated. It was found that fertilisers were now effective as shown in Table V. (p. 256.)

Table V. shows that additional nitrogen increases the yield considerably, and to some extent additional phosphorus also does, but not so much.

In Louisiana.§ away from the tropical rains, nitrate of soda proved if anything better than sulphate of ammonia.

2. It suffers no loss and gives rise to no toxic products under anaerobic conditions: it is therefore superior in these conditions to nitrate of soda, which, as already stated, breaks down with formation of toxic nitrite or with evolution of gaseous nitrogen, representing a dead loss of material. For this reason it is more suitable for paddy rice, i.e., rice grown in swamp soils: thus in Japan sulphate of ammonia is therefore used in preference to nitrate of soda for the rice crop, the imports for the three years 1909, 1910, and 1911, being in metric tons :—

* Barbados Rept., 1913, p. 6.
† Barbados Rept., 1913, pp. 21—24.
‡ West Indian Dept. of Agric.: Antigua and St. Kitts Rept.
§ Louisiana Bull., 2, 1891.

	1909.	1910.	1911
Sulphate of ammonia	34,682	37,121	42,300
Nitrate of soda	7,402	14,116	9,595

TABLE V. *Yield of cotton seed, lb. per acre. Barbados experiments.**

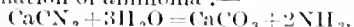
	Increased dressings of :-								
	Nitrogen as sulphate of ammonia.			Phosphorus as super-phosphate.			Potash as sulphate of potash.		
	Basal dressing.	Dressing of nitrogen.	Yield of cotton seed per acre.	Basal dressing.	Dressing of phosphate.	Yield of cotton seed per acre.	Basal dressing.	Dressing of potash.	Yield of cotton seed, lb. per acre.
No manure	<i>Nil</i>	0	427	<i>Nil</i>	0	427	<i>Nil</i>	0	427
Complete fertilisers, standard quantities of two with variable amounts shown of the third	K and P	0	477	N and K	0	542	P and N	0	588
		10	586		20	537		10	644
		20	537		40	580		20	537
		30	711		60	537		30	564
					80	662			

* West Indian Dept. of Agric.; Barbados Rept., 1913.

Calcium cyanamide or nitrolim; sometimes called simply cyanamide.

When gaseous nitrogen is passed over heated calcium carbide direct union takes place and a substance CaCN_2 is produced. This is the calcium salt of an acid usually called cyanamide on the view that its constitution is $\text{CN}\cdot\text{NH}_2$, but which is more probably a tautomeric substance, the acidic form being the di-imino compound, $\text{NH}:\text{C}:\text{NH}$.

The calcium salt rapidly decomposes in the soil with formation of ammonia :—



which then nitrifies in the usual way. The change, however, does not easily take place in the laboratory except at elevated temperature.

For a long time it was supposed that this decomposition was brought about by bacteria. Of recent years, however, unknown changes have been attributed to colloids, and the decomposition is now put down to them. The question is of great practical importance because the rate of conversion into ammonia determines the value of the substance as a fertiliser. If the decomposition is brought about by the soil colloids we should expect the substance to have more fertilising value on clays and loams than on sands where little colloidal matter is present.

The calcium cyanamide of commerce is not a pure product but contains considerable amounts of impurity. The crude product first obtained contains about 1 or 2% of unchanged calcium carbide, which might be dangerous in the store. It is therefore decomposed by spraying with water. The resulting product is known as dusty nitrolim, and is stated to have the following composition :—

Mean composition of nitrolim.

	%
* Calcium cyanamide	53.5
† Dicyanodiamide	0.3
Calcium oxide	24.0
Free carbon	12.0
Calcium carbide	0.2
Oil	3.0
Moisture	4.0
‡ Other substances	3.0

100.0%.

* Total nitrogen

18.8%.

† The percentage of dicyanodiamide is usually higher than this in samples obtained in this country.

‡ Including silica, iron and alumina, and traces of sulphur and phosphorus.

In this form the material is in too fine a powder for use on the farm; it gets into the eyes, mouths and noses of the men and causes endless grumbling; moreover, on a windy day it blows away. The material is therefore granulated by further treatment with water and subsequent drying. The

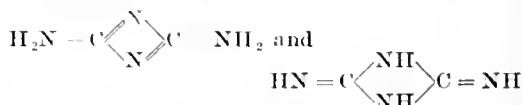
percentages of nitrogen in the various products is as follows :—

	%
Chemically pure CaCN_2	35
Calcium cyanamide, raw product, about	20
Calcium cyanamide, after hydration, about	19
Calcium cyanamide, after granulation, about	15

A certain amount of lime is invariably present, and in presence of water this has a very interesting and somewhat unfortunate effect. Under its influence (and that of other alkalis and of acids) cyanamide readily polymerises to dicyanodiamide :—



which, like cyanamide, is considered by Werner to be a tautomeric substance, the constitution of the tautomers being :—



Dicyanodiamide, however, is neither basic nor acidic and does not form salts. Unfortunately for agriculturists, it is toxic to plants, so that it has no beneficial or even a bad effect as manure, at any rate in pot experiments. It is also rather stable in the soil and only slowly breaks down, so that the bad effect is liable to persist. The following results have been obtained in our laboratory :—

	Amount of dicyanodiamide present expressed as percentage of the nitrogen.	Pot expt. Yield of mustard. Dry matter, grams per pot. 50 mgs. N per kilo. of soil.	Laboratory expt Percentage of added nitrogen converted into nitrate in 35 days.
Control	—	16.7	—
Cyanamide I. ..	7	46.0	54
Cyanamide II. ..	25	40.5	17
Cyanamide III. ..	78	18.8	8
Dicyanodiamide ..	100	18.8	1

Similar results have been obtained by Brioux with buckwheat and flax. In his experiments

* For the literature, and a discussion of the mechanism of this change, see Morrell and Burgen, *Trans. Chem. Soc.*, 1913, **105**, 576-589, and Werner, *ibid.*, 1915, **107**, 715-726.

oats and mustard suffered no depression, but they were no better than the controls.*

Neither this difficulty, nor the physical one of distribution, is insuperable, and it is reasonable to expect that both will ultimately be overcome.

Comparison of the new fertilisers with the older ones.

A number of trials have been made to compare the new fertilisers with the old, some of which are summarised in Table VI. (p. 258).

Organic nitrogen compounds, including those contained in feeding stuffs, etc.—Although these are not artificial compounds they come into the discussion because in practice they are very serious competitors. Their value depends on the important and interesting fact that their constituents can be used twice over: the imported feeding stuffs are given to cattle to fatten them for the butcher, and then the animal excretions, which contain the most important fertilising constituents, can be used to fertilise crops. For this reason many farmers prefer these feeding stuffs to artificial fertilisers. Moreover the organic matter is itself of great value, having important physical effects on the soil. On light soils these organic substances may prove more effective than the inorganic substances. Extreme cases arise where artificial fertilisers are of practically no value, while the organic manures lead to considerable increases in crop: such cases are not common in this country and are usually confined to dry sands, but they are not infrequent in sub-tropical conditions, as, for example, in Madras, Java, etc. Here neither nitrates, potash, nor phosphates give profitable crop increases, while the oil cake residues have considerable fertilising value. Thus Knight shows† that safflower cake gives better results than sulphate of ammonia with sugar cane in Western India: his results are given in Table VII.

now being made with them. Oil cakes and farmyard manure have hitherto been the chief fertilisers and they will probably always play an important part, but it is now demonstrated that artificial manures can in many instances be used with advantage. The results of the experiments made in Western India have been collected by Mann and Paranjpe.*

Thus tobacco gave the following results in lb. per acre:—

	Satara district.	Gujarat.
Complete artificials	1535	2069
Nitrogen (nitrate of soda) and potash only	1297	1514
Nitrogen only	1152	1758
Farmyard manure (local practice)	1116	1468

In this country, however, organic matter cannot be regarded as necessary for crops, however desirable it may be from the point of view of getting a tilth. Large crops of wheat, barley, mangolds, and grass are regularly grown at Rothamsted on land which for 70 years has received no organic manure and the crops show no signs of falling off. A strict comparison was made by the Hansens on a light loam and on a sand at Askor (S. Jutland) where farmyard manure was compared with a dressing containing equal amounts of nitrogen, potash and phosphates in the form of artificials (nitrate of soda, superphosphate, and kainit) and almost always gave poorer results.† (Table VIII., p. 259).

Potassic fertilisers.

By far the largest deposits of potassium salts occur at Stassfurt in Germany and no other sufficient source is yet in sight. Agriculture and horticulture are undoubtedly suffering from the deficiency brought about by the war.

TABLE VII.

Sugar cane experiments: Cake and sulphate of ammonia (Knight).

	Deccan black soil.	Lighter sandy soils.
	Cane, lb. per acre.	Cane, lb. per acre.
750 lb. ammonium sulphate containing 150 lb. nitrogen	62,304	54,860
1200 lb. safflower cake containing 75 lb. nitrogen + 375 lb. sulphate of ammonia containing 75 lb. nitrogen	80,336	58,674
2400 lb. safflower cake alone containing 150 lb. nitrogen	—	60,945

This result is very common when the water supply is irregular. A further illustration is afforded by Mann and Paranjpe's experiments on the manuring of cotton in Western India.‡

"Again and again," they say, "we have applied manures to the crop in its earliest stages: the cotton plants have immediately responded (as they always will) and grown much more vigorously than the adjoining plots. A drought has followed: the better grown plants have required more water than the smaller unmanured plants, and it has not been present: the results have been that the manured plants have never recovered from the check received, and the crop finally obtained is no better than that which has grown more regularly without the manure."

They also report that on the black soils where the moisture supply is more satisfactory fertilisers do act.

Elsewhere also in India artificials are proving of great value and a number of experiments are

One or two supplies are coming on to the market the sources of which are not publicly disclosed: two of them have the following composition:—

	Sample No. 32.	Sample No. 45.
K ₂ O soluble in water	13.0	25.8
Further amount extracted by 2% citric acid	<i>Nil</i>	<i>Nil</i>

These substances of course are very good and if they were available in sufficient quantities at reasonable prices would prove of great value.

Many attempts have been made to utilise other potassium minerals of which vast quantities are available. Voelcker at Woburn‡ experimented with felspar, granite and phonolit, but found them all ineffective. Prianschnikow§

* Ann. Sci. Agronom., 1910 [fil], 5.

† Bombay Dept. of Agric. Bull. 61, 1914.

‡ Bombay Bull. 76, 1915.

* Dept. Agric. Bombay, Bull. 76, 1915.

† Fr. Hansen and J. Hansen, Tidsskrift for Landbrugets Planteavl, 1913, xx, 345.

‡ Woburn Repts. Journ. Roy. Agric. Soc., 1915, 76, 362—3.

§ Landw. Versuchs-Stat., 1912, 77, 400—411

TABLE VI.—*Comparison of the various nitrogenous fertilisers.*

No.	Crop.	Year.	Yield per acre.							Station.
			Control.	Basal dressing.	Nitrate of soda.	Nitrate of lime.	Nitrate of ammonia.	Nitrolim.	Sulphate of ammonia.	
1	Mangolds (yield in tons)	1912	—	17.8	—	20.0	18.7	18.3	—	Rothamsted Expt. Station.
2	Mangolds (yield in tons)	1911	—	—	28.5	26.25	—	—	—	Newton Rigg, Penrith (Reports 1911—1916)
	—	1912	—	—	19.25	23.0	—	—	21.5	
	—	1913	—	—	20.75	19.5	14.75	—	—	
	—	1914	—	—	23.5	25.5	21.5	—	—	
	—	1915	—	—	21.5	21.25	—	—	20.0	
3	Mangolds (yield in tons)	1916	—	—	37.2	37.2	—	21.25	31.1	
4	Oats-grain (yield in bushels)	1911	—	—	24.65	25.7	—	19.6	26.75	County Agricultural Expt. Station, Cockle Park, Northumberland, (Bull. 18, 1912)
	—	1910	31.0	—	43.0	43.5	—	32.55	39.0	
	—	1911	49.0	—	57.0	52.0	—	34.5	47.5	
5	Hay (yield in cwt.)	1910	36.25	—	44.5	46.75	—	49.0	50.0	
6	Hay (yield in cwt.)	1909	39.0	—	—	—	—	—	—	
7	Sweedes (yield in tons)	1912	32.5	—	56.75	—	—	—	—	
	—	Mean:	6.0	—	26.06	25.75	—	—	—	Newton Rigg, Penrith, (Reports 1911—1916)
	—	1911	—	—	—	—	—	—	—	
	—	1912	—	—	—	—	—	—	—	
	—	1913	—	—	—	—	—	—	—	
8	Turnips (yield in tons)	1907	9.0	—	19.25	25.0	—	29.25	23.0	Aberdeen and North of Scotland Coll. of Agric. (Leaflets Nos. 9 and 11)
	—	1908	—	—	—	17.15	—	15.85	16.6	
	—	1909	—	—	—	19.55	—	19.05	19.8	
9	Potatoes (yield in tons)	1912	—	—	23.55	24.35	—	24.45	24.65	Rothamsted Expt. Station, Aberdeen and North of Scotland Coll. of Agric. (Leaflets Nos. 9 and 11)
10	Potatoes (yield in tons)	1907	—	7.2	—	8.6	—	8.7	6.5	
	—	1908	4.6	5.75	6.55	6.45	—	6.1	10.6	
	—	1909	8.55	9.25	10.6	11.05	—	10.3	11.25	
	—	1913	—	9.9	10.4	10.4	—	10.15	11.25	
11	Wheat-grain (yield in cwt.)	1913	—	19.75	22.0	26.75	—	25.1	23.5	Jersey Committee of Tech. and Instr. Agric. (Report 1913).

• In another expt, ammonium phosphate was used, yielding 2.3 tons per acre.

Weights of manurial dressings per acre.

No.	Crop.	Year.	Basal manures.	Nitrate of soda.	Nitrate of lime.	Nitrate of ammonia.	Nitrolim.	Sulphate of ammonia.
1	Mangolds	1912	12 tons dung, 3 cwt. superphosphate, $\frac{3}{4}$ cwt. muriate of potash, $\frac{1}{2}$ cwt. of salt.	—	220 lb.	80 lb.	175 lb.	—
2	Mangolds	1911	20 loads dung, 14 cwt. kalcit, $\frac{1}{2}$ cwt. superphosphate.	13 cwt.	—	—	—	—
		1912	Farmyard manure.	160 lb.	200 lb.	—	—	120 lb.
		1913	Farmyard manure.	—	—	—	—	—
		1914	Farmyard manure.	—	—	—	—	—
		1915	20 tons farmyard manure per acre.	—	—	—	—	—
3	Mangolds	1910 and 1911	2 cwt. basic slag, 300 lb. sulphate of potash, 2 cwt. salt per plot.	—	—	—	—	—
4	Ones	1910 and 1911	—	—	—	—	—	—
5	Hay	1910	—	—	—	—	—	—
6	Hay	1909 and 1912	—	—	—	—	—	—
7	Swedes	1910	3 cwt. superphosphate.	—	—	—	—	—
		1911	2 cwt. superphosphate per plot.	1 cwt.	14 cwt.	—	—	—
		1912	2 cwt. superphosphate per plot.	1 cwt.	14 cwt.	—	—	—
		1913	2 cwt. superphosphate per plot.	1 cwt.	14 cwt.	—	—	—
		1914	2 cwt. superphosphate per plot.	1 cwt.	14 cwt.	—	—	—
		1915	2 cwt. superphosphate per plot.	1 cwt.	14 cwt.	—	—	—
8	Turnips	1907 and 1908	54 cwt. superphosphate, 14 cwt. potash manure salts.	—	—	—	—	—
		1909	54 cwt. superphosphate, 14 cwt. potash manure salts + dung.	—	—	—	—	—
9	Potatoes	1912	12 tons dung, 3 cwt. superphosphate, $\frac{1}{2}$ cwt. muriate of potash.	—	—	80 lb.	175 lb.	—
10	Potatoes	1907	3 cwt. superphosphate, 24 cwt. potash manure salts.	24 cwt.	—	—	—	—
		1908	3 cwt. superphosphate, 24 cwt. potash manure salts.	24 cwt.	—	—	—	—
		1909	3 cwt. superphosphate, 24 cwt. potash manure salts.	24 cwt.	—	—	—	—
		1910	3 cwt. superphosphate, 24 cwt. potash manure salts.	24 cwt.	—	—	—	—
11	Wheat	1913	241 lb. superphosphate, 241 lb. phosphate powder, 60 lb. sulphate of potash.	198 lb.	241 lb.	—	172 lb.	153 lb.

TABLE VIII.

Comparison of the increase in crops on sand and loam produced by farmyard and artificial manures (Hansen and Hansen, Askor).

		Averages 6 years, 1894—1910.				
		Rye.	Oats.	Grass and clover.	Mangolds.	Potatoes.
Loam	Unmanured	54	60	69	42	64
	Farmyard manure	89	89	90	93	131
	Artificial manure	100	100	100	100	100
Sand	Unmanured	47	43	30	38	52
	Farmyard manure	70	74	92	77	102
	Artificial manure	100	100	100	100	100

Each plot receives 36.5 lb. of nitrogen, 26.3 lb. of phosphorus, and 31.1 lb. of potash per acre in the form of nitrate of soda superphosphate and kainit or of 3.6 tons farmyard manure. The dressings are given yearly.

at Moscow, however, obtained definitely beneficial results with three out of a number of minerals tested, viz., nephelin, mica schist, and biotite.

Attempts have been made to obtain a soluble potassium compound as a by-product in the manufacture of Portland cement, but so far as I know they have not been altogether successful. A sample sent in to us contained only 0.4% of K_2O soluble in water, a further 0.2% only being extracted by 2% citric acid. Wood ashes may supply some potash, but not a great deal. Seaweed is an almost inexhaustible source which we have hardly yet begun to exploit systematically; it is greatly to be hoped that some steps will be taken to establish a proper seaweed industry.

Relation of crop yield to amounts of nitrogen supplied.

In general the yield increases as the dressings of fertiliser increase, though the law of diminishing returns operates and prevents indefinite increase in crop. The best known instance is found on the Broadbalk wheat field, Rothamsted:—

	Series I.	Series II.	Series III.
Number of varieties used ...	27	11	19
Yield of canes per acre:—			
No nitrogen	17.8	13.4	19.1
Low nitrogen (40 per acre) .	23.5	—	—
Normal nitrogen (60 per acre)	—	19.8	27.4
High nitrogen (80 per acre)	28.1	—	—
High nitrogen (90 per acre)	—	23.8	—

The nitrogen was applied as sulphate of ammonia.

Except with very small dressings the efficiency of the utilisation process is not very great, in some cases only some 50 or 60% of the nitrogen being used by the crop. Suitable investigation generally results in an improvement in the efficiency of the process, and sometimes in a reduction in the consumption of fertiliser. Thus in India before the manuring of the sugar cane was properly investigated, Mollison found that the cultivator frequently applied fertiliser containing 750 lb. of nitrogen per acre. He began by recommending 500 lb. instead, and later on showed that maxi-

TABLE IX. *Crop yields with increasing nitrogen supply. Broadbalk wheat field, Rothamsted.*

	Grain, bushels per acre.	Increase per 200 lb. ammonium salts, bushels per acre.	Straw, cwt. per acre.	Increase per 200 lb. ammonium salts, cwt. per acre.
Mineral manure alone per acre	14.5	—	12.1	—
Mineral manure + 200 lb. ammonium salts per acre	23.2	8.7	21.4	9.3
Mineral manure + 400 lb. ammonium salts per acre	32.1	8.9	32.9	11.5
Mineral manure + 600 lb. ammonium salts per acre	36.6	4.5	4.1	8.2

The rule is also demonstrated in the Irish experiments with potatoes:—

Manures applied.	Yield of potatoes per acre, 5 years 1908-12	
15 tons farmyard manure, 4 cwt. superphosphate, 1 cwt. muriate of potash.	Tons.	Cwt.
+ 1 cwt. sulphate of ammonia	11	2
+ 2 cwt. sulphate of ammonia	11	6
+ 3 cwt. sulphate of ammonia	11	11

In like manner Harrison has shown in British Guiana that the yields of sugar cane are closely dependent on the amount of readily available nitrogen either naturally present in the soil or added as manure. The following is a summary of his results*:—

imum crops could be obtained by the use of 350 lb. More recently it has been shown that if the water supply is carefully regulated so as to avoid excessive irrigation no more than 250 lb. is needed, and there are indications that even less can be applied if better implements are used for distributing and working the manure into the soil. Thus the scientific investigator has been able to reduce the consumption of nitrogen by 66% without any loss of crop.*

All these strivings after economical usage tend to increase the consumption of artificial manures by widening the circle of cultivators who use them.

How much artificial manure can be employed per acre?

This question is of vital importance to the manufacturer because it gives him information

* West Indian Bulletin, 1913, 13, 128.

* Dept. of Agric. Bombay, Bull. 61, 1914. J. B. Knight: Sugar Cane, its Cultivation, etc.

as to the extent of the demand that might be worked up. It is impossible to form any precise estimate because, as has already been stated, the organic fertilisers and imported and home grown feeding stuffs constitute a serious competing and complicating factor the effect of which cannot be completely gauged.

Table X. gives a comparison showing the amounts consumed in different countries; the details of the more important are given in Table XI.

production, and it is reasonable to anticipate a great expansion in the demand if the supply is forthcoming. This is an after-the-war problem, but chemists will have no difficulty in seeing its close connection with the present problems of the supply of explosives.

DISCUSSION (INCOMPLETE).

Mr. W. E. OAKDEN remarked that there was one point in Dr. Russell's paper which he had a little

TABLE X.

Total amounts of artificial fertilisers used in the different agricultural countries of the world.

Group I.			Group II.			Group III.			Group IV.		
	Metric Quintals per hectare.	Cwt. per acre.		Metric Quintals per hectare.	Cwt. per acre.		Metric Quintals per hectare.	Cwt. per acre.		Metric Quintals per hectare.	Cwt. per acre.
Belgium ...	2.71	2.18	Netherlands	1.96	1.56	United Kingdom	0.7—0.9	0.6-0.7	Sweden	0.53	0.42
St. Maurice	2.19	1.75	Germany	1.68	1.34	U.S. (S.)	0.87	0.70	Ireland ..	0.44-0.50	0.35-0.40
Luxembourg	2.02	1.61				Switzerland	0.60	0.48	Japan ...	0.48	0.38
						France	0.57	0.46	Portugal	0.36	0.29
						Italy	0.57	0.46	S. Africa	0.29	0.23
						Denmark	0.57	0.46	Norway	0.29	0.23
						Australia	0.55	0.44	Austria ..	0.29	0.23
									Spain ...	0.14	0.11
									N. Zealand	0.13	0.10
									Hungary	0.10	0.08

TABLE XI.

Detailed comparison showing amounts of fertilisers used in the chief consuming countries.

	Belgium.		Luxembourg.		Germany.		Great Britain (estimated).		Italy.		France.		Denmark.	
	Metric Quintals per hectare.	Cwt. per acre.	Metric Quintals per hectare.	Cwt. per acre.	Metric Quintals per hectare.	Cwt. per acre.	Metric Quintals per hectare.	Cwt. per acre.	Metric Quintals per hectare.	Cwt. per acre.	Metric Quintals per hectare.	Cwt. per acre.	Metric Quintals per hectare.	Cwt. per acre.
Phosphatic	1.38	1.10	1.71	1.36	0.82	0.66	0.6	0.48	0.53	0.42	0.52	0.42	0.41	0.33
Potassic	0.20	0.16	0.26	0.21	0.60	0.48	0.1	0.08	0.006	0.005	0.032	0.026	0.06	0.05
Nitrogen	0.60	0.48	0.085	0.068	0.23	0.18	0.2	0.16	0.038	0.030	0.024	0.019	0.10	0.08
Total chemical fertilisers	2.74	2.18	2.055	1.638	1.68	1.34	0.9	0.72	0.60	0.48	0.576	0.459	0.57	0.46
Lime and chalk	1.29	0.96	0.014	0.011	0.17-0.23	0.14-0.18	—	—	—	—	—	—	0.11	0.09

Note.—1 Metric Quintal per hectare = 0.797 cwt. per acre.

From these it appears that we have considerable leeway to make up in this country before we reach the consumption of Germany, and that Germany is (or was) far behind Belgium, but we are not as bad as we have sometimes supposed. The position of Great Britain arises not so much from ignorance or prejudice on the part of the farmer as from the circumstance that the fiscal and economic conditions in this country have tended to favour the production of grass rather than of corn and roots, while in Germany and Belgium the conditions have favoured the production of corn and roots rather than of grass. Now grass land only requires a fraction of the manure given to corn and roots, and therefore our system of husbandry calls for less fertiliser than that of Belgium or Germany. Our system also produces less food: in peace time that was not supposed to matter, but in war time its weakness is exposed. If a change in our system comes, and if it leads to less grass and more corn, we shall automatically consume larger quantities of artificial manures.

But it is in our Empire that we may look for the greatest increase in consumption. The experiments show that phosphates and nitrogenous fertilisers bring about large increases in crop

difficulty in fully reconciling with his previous impressions. A few years ago Sir William Crookes had advanced the opinion that the world's supplies of natural nitrates would be practically exhausted at the end of 20 years from that particular time, or anyhow the supplies would be totally inadequate to meet the necessary requirements for the world's wheat production, and yet Dr. Russell had stated that the Government of Chili estimated that their nitrate resources would last over another hundred years. He would like to know which calculation was the correct one. He believed it was owing to that prognostication of Sir William Crookes that chemists had been so strongly stimulated in working out successfully special synthetic processes for the production of nitrates from the nitrogen of the atmosphere by means of the electric furnace.

Dr. J. A. VOELCKER said that Dr. Russell had made little reference to the difficulties of the moment or the prospects of the future. Under "nitrogenous fertilisers" he had mentioned nitrate of soda, nitrate of ammonia, nitrate of lime, nitrolim, and sulphate of ammonia. But it was well known that only one of these, viz., sulphate of ammonia, was at all procurable at the present

time. The influence of potassic fertilisers was also dealt with at length, but it was of no use speaking about these, for none of them could be obtained. And in treating of phosphatic fertilisers there were only two of them, viz., superphosphate and basic slag, that entered now into practical consideration, and there were great difficulties attaching to obtaining even these, for a farmer ordering them now might have to wait any time between one month and three months before he could get them supplied to him. What he (the speaker) had hoped to hear was how these difficulties could be got over, what substitutes for them might be found, and also to get some information as to the extent to which the land might be deteriorating from the absence of these various supplies of fertilisers to it.

As regards particular points mentioned by Dr. Russell, he considered that the general preference shown by farmers for nitrate of soda over sulphate of ammonia was based more on custom than on anything else, and that it would be found generally that sulphate of ammonia would answer the purposes quite as well. It was true that nitrate of soda was used, as Dr. Russell had said, more as an "emergency" dressing, but, after all, there was not above 10 days' difference in the actual "working" of the two fertilisers. Moreover, though Dr. Russell had been inclined to attribute the superiority of sulphate of ammonia for sugar production—as instanced in the West Indies—solely to differences of rainfall, he (Dr. Voelcker) thought that apart from this—as shown in the case of sugar-beet on the Continent—there was, where sugar production was concerned, an advantage attaching to sulphate of ammonia. Like Dr. Russell, he had been experimenting with nitrolim, and chiefly with reference to the alleged harm caused by the presence of dicyanodiamide. His experiments were with wheat and his results were quite different from those set out by Dr. Russell. In the examination of a number of commercial samples of nitrolim he had found them to contain dicyanodiamide in amounts much greater than the 0.3% which the Rothamsted sample contained, but there was no evidence of injurious action from it so far as the wheat crop was concerned, nor even when a practically pure dicyanodiamide was used was there deterioration to a greater extent than 10 or 20%.

Mr. KAPIBRAM VAKIL, referring to the fertilisers used in sugar cane cultivation, pointed out that in the Neera Valley Canal area in the Bombay Presidency the cultivators had found that castor cake containing from 4.5 to 5% nitrogen was the most economical fertiliser, and was preferred to other oil cakes, *e.g.*, safflower. Similar results had also been noted in Southern India, especially for soils which showed tendencies to efflorescence and contained sodium salts like chloride and carbonate in large proportions.

BASIC SLAG AS AFFECTING AGRICULTURAL DEVELOPMENT.

By PROFESSOR D. A. GILCHRIST, M.Sc., Armstrong College, Newcastle-upon-Tyne;

and

PROFESSOR HENRY LOUIS, M.A., D.Sc., Armstrong College, Newcastle-upon-Tyne.

Phosphatic manures have enormously developed the production of farm and garden crops. Soils can obtain nitrogen by the growth of leguminous plants, and to a certain extent, by other means without the direct addition of nitrogen to the soil; but the phosphates removed by crops must be returned by direct manuring, and farmyard manure does not return these phosphates in a sufficient manner because so much of these are retained by

the animal. Bones and bone ash were used to some extent to replace phosphates early in the nineteenth century. When Liebig and Lawes, about 1840, found that bones and mineral phosphates could be rendered more effective by treatment with sulphuric acid so as to make part of the phosphates soluble, an enormous impetus was given to the growth of swedes and turnips, the crops of which were greatly increased by the judicious application of soluble phosphates (superphosphate) upon soils where phosphate exhaustion had been long in progress. Worn-out pastures, also suffering from phosphate exhaustion, gave a remarkable response to these phosphatic manures. When superphosphate had been used for a considerable time it came to be realised that this manure did not give as good results on peaty soils or on soils poor in lime as on soils in which a fair amount of lime was present. The conclusion was therefore reached that the soluble phosphates in superphosphate gave the best results when they were precipitated into insoluble phosphate in the soil, and were thus well distributed in the soil in a fine state of division. Until about 1880 the supply of phosphatic manures was met to some extent by bone meal, but chiefly by mineral phosphates, the bulk of the latter being converted into superphosphate, while a small quantity was used as ground phosphates. The discovery by Messrs. Gilchrist and Thomas that it was possible to remove phosphorus from iron and to transfer it to the slag in making steel, gave rise to the so-called Gilchrist-Thomas or basic Bessemer process of steel making, and it was soon found that the slag produced in this operation possessed valuable manurial properties.

The late Dr. Andrew Aitken, Chemist of the Highland and Agricultural Society of Scotland, conducted trials for that Society at the Pumpherton Agricultural Station, near Edinburgh, some years before 1889, which proved that rock phosphates or mineral phosphates, when finely ground, gave quite good results. About this time, however, basic slag came into general use and phosphate of lime could be purchased in this manure at about 9d. a unit, whereas the same in finely-ground rock phosphate cost over 1s. 2d. a unit. As Dr. Aitken found that basic slag phosphates gave better results than mineral phosphates, the use of the latter, which had begun among farmers in Scotland, was stopped, and basic slag came into general use, as it was somewhat more effective and cost less per unit of phosphate of lime.

Not all iron ores produce pig-iron suitable for the basic Bessemer process; it so happens that certain of the ores occurring in vast quantities in Germany are particularly adapted to it, and owing to this circumstance, Germany came rapidly to the front as a large producer of basic steel and of basic slag as a by-product. Basic slag thus came into competition with rock phosphate: the German chemists, whose object it was to push the sale of the former, discovered that whereas the calcic phosphate in rock phosphate was practically insoluble in citric acid, that in basic slag was readily soluble in that acid, and they succeeded to a large extent in persuading agriculturists that the fertilising value of all phosphates depended not upon the percentage of total phosphoric acid, but upon the percentage of citric soluble phosphoric acid present. It does not appear that this dictum was supported by any definite field experiments; it sounded quite plausible, and was apparently adopted by agricultural chemists in this country without proper investigation, and without any perception of the commercial object that underlay this apparently scientific hypothesis. Rock phosphates were thus discredited, basic slag was pushed as a fertilising agent, and in this way the German steel makers were able to make a profit out of their by-products. This gave them an advantage that enabled them to develop their steel industry with immense rapidity,

and it is not too much to say that it has been one of the factors that has made the present war possible.

When the manufacture of basic openhearth steel commenced in this country, a process for which many British ores are quite well adapted, the slag produced by it was forthwith discredited as a manurial agent, simply because it happens that slag produced by this process contains but little of its phosphoric acid in the citric soluble form. The reason assigned for this difference by Dr. J. E. Stead and others, is that whereas calcium phosphate is but slowly attacked by citric acid, the silico-phosphate is attacked readily.* Pig iron suitable for the basic Bessemer process must be relatively high in silicon and its treatment in the converter produces silico-phosphates, whereas for the basic openhearth process, pig iron is required to be as low as possible in silicon, so that practically the whole of the phosphorus is converted into calcium phosphate (tetracalcic phosphate, according to Dr. Stead). It should be noted that even this compound is slowly attacked by citric acid, hence the test introduced by Dr. Wagner—and, as above stated, generally accepted—consists of allowing a solution of citric acid of definite strength to act for an arbitrarily limited time upon the material under examination. It need hardly be pointed out that no such time factor exists when the slag is applied to the soil, and that the empirical test does not correspond to natural conditions.

This aspect of the subject is adequately discussed in a paper by Mr. G. S. Robertson, M.Sc., of the East Anglian Institute of Agriculture, which demonstrates how wholly fallacious is the citric solubility test, even from the purely chemical standpoint.

The matter is one of grave importance; thus in Great Britain the production for 1915 was as follows:—

Basic Bessemer Steel	479,816 tons.
Basic Openhearth Steel	2,958,968 tons.

The figures for Germany for 1911 are:—

Basic Bessemer Steel	8,169,183 tons.
Basic Openhearth Steel	5,946,215 tons.

so that whilst in Germany the production of basic Bessemer steel exceeds that of basic openhearth steel by more than one third, the make of the former in Britain is only one-sixth of that of the latter, and the great importance to this country of the proper recognition of the manurial value of openhearth basic slag becomes obvious. Roughly speaking, about 5 cwt. of slag are produced for every ton of basic openhearth steel made, so that the production of such slag in this country is about 750,000 tons annually, or say 100,000 tons of phosphoric acid, a large proportion of which is wasted every year, instead of being employed to fertilise our fields, mainly on account of insistence upon the empirical citric solubility test.

It is only within recent years that experiments have been conducted with the object of determining whether the citric soluble phosphoric acid has such greater manurial value than the insoluble phosphoric acid as has been ascribed to it by the Germans.

Trials conducted at Cockle Park, the Northumberland County Agricultural Experiment Station, from 1907 till 1915, on meadow hay and on temporary seeds mixtures for three years by one of the writers, show that in only one case out of five have slags with high citric solubility given the best results. The medium citric soluble slags gave the best results in one case out of two. The balance of results does not indicate that a high citric solubility gives either quicker or better results. The popular

belief that a high citric soluble slag means a quicker acting slag was not confirmed by these results. The results also indicated that a high content of lime in slags is advantageous, although the results as to this were somewhat contradictory. It was also shown that both Tunisian mineral phosphate and Belgian mineral phosphate, containing practically no citric soluble phosphates, gave quite satisfactory results, and the latter especially so when it had been calcined. In West Well Close pasture field, when equal amounts of phosphoric acid are applied in basic slag and in superphosphate, the results over many years are considerably better from basic slag. When cross dressings of lime were applied over the basic slag and superphosphate plots, the use of lime in addition to superphosphate made the results comparable with those from basic slag, whereas when lime was applied in addition to basic slag the pasture has only been slightly improved thereby.

Mr. James Knott, Close House, Wylam-on-Tyne, placed his park of about 31 acres at the disposal of Armstrong College in 1914 for trials of the effects of basic slag and of ground mineral phosphates on the improvement of pasture. The Park was then in poor condition and provided an excellent experimental area. The soil varies from a clay loam to a sandy loam. The plots were carefully inspected in July, 1916, about 2½ years after the application of the dressings. Basic slag (39% phosphate of lime), Belgian phosphate (38% phosphate of lime), and Algerian phosphate (67% phosphate of lime), were each applied at the rate of 200 lb. phosphoric acid per acre. In the basic slag 80% of the phosphates were citric soluble, but practically none of these were so in the other dressings. The fineness of grinding of the basic slag was 80% of the Belgian phosphate, 85% of the Algerian phosphate, 75% these being the amounts which passed through a mesh containing 10,000 holes to the square inch. All the treated areas showed a marked improvement over that untreated. Clovers, especially wild white clover, have been well developed by all three phosphatic manures, and the pasture is far more closely grazed and of a more nutritious character than on the untreated land. A close examination at the boundaries of the dressed plots failed to show any difference between the results of the three manures. Basic slag has effected the same characteristic improvement on poor pasture as at Cockle Park, and the two mineral phosphatic manures have given equally good results to the slag. The pasture on the untreated area was valued at 25s. an acre, and on the remaining areas at 45s. an acre. These striking results from mineral phosphatic manures, containing practically no citric soluble phosphates, show that the citric solubility test does not indicate the availability of phosphates for plant life, and that when mineral phosphates are as finely ground as basic slag the phosphates they contain can be equally effective.

In an address to the Illinois Farmers' Institute in 1916, Mr. C. G. Hopkins stated that at moderate prices, bone meal, superphosphate, basic slag, or finely-ground rock phosphate, may be used with profit, and that liberal applications of raw phosphate may well be used when high prices are charged for other phosphates.

Mr. G. S. Robertson, of Chelmsford, in a paper read to the Newcastle Section of this Society in February, 1916, after describing elaborate tests, came to the following conclusions:—

"1. The results clearly show that the citric acid test gives no true idea of the solubility of the phosphate in 'fluorspar slags' and affords no guide to its value to the plant.

"2. The use of fluorspar in the manufacture of steel by the openhearth process results in the production of a phosphatic slag with low citric solubility. Nevertheless the slag is completely soluble

* See paper by Dr. J. E. Stead on the "Relative Fertilising Value of Different Varieties of Basic Slag" in the Proceedings of the Cleveland Institution of Engineers, January, 1895.

in citric acid if sufficient time is spent on the extraction.

"3. The phosphate or phosphates which the slag contains do not appear to be in combination with silica and they seem to bear a very close resemblance to those contained in mineral phosphates."

In a second paper read at the same time Mr. Robertson stated that "With one exception calcining produced a marked decrease in the citric solubility of mineral phosphates. The longer the calcining continues the more insoluble does the phosphate become," and yet at Cockle Park the calcining of Belgian phosphate made this manure more effective! He also stated in the same paper: "The results judged as a whole confirm the conclusion arrived at as the result of a previous investigation, namely, the worthlessness of the citric acid test as a means of judging the relative value of phosphatic manures to the plant. Rock phosphates are quite as soluble in a $\frac{1}{4}$ % hydrochloric acid solution as the phosphates in basic slag, and there is just as much reason in favour of using a weak solution of a mineral acid for a solvent as there is for using a 2% citric acid solution."

In a paper on the "Availability of Mineral Phosphates for Plant Nutrition" in the Journal of Agricultural Research of the United States Department of Agriculture for 1916, Mr. W. L. Burlison, after experimenting with rock phosphates for cereals, clover, and lucerne, found that the crops tended to increase as the application of rock phosphate increased up to a certain point, and that the plants obtained their calcium from rock phosphate. Better results were not given when calcium carbonate was added to rock phosphate. "There was no particular relation between the citric-acid-soluble phosphorus and the availability of these phosphates for plants." To some extent the fineness of the rock phosphate determined its availability.

All the foregoing points to the conclusion that citric solubility is certainly not the only criterion, and is apparently not even a reliable criterion, of the value of phosphatic material as a manurial agent. It is therefore submitted that total phosphoric acid content is a far more reliable test of manurial value, and possesses the further advantage that it depends on the definite analytical determination of a substance, instead of being an empirical test liable to be affected by the conditions and methods of its application, and that it should therefore be authoritatively substituted for the citric solubility test throughout the country. This change would not only render available for the use of British agriculturists an annual amount which may reach up to one hundred thousand tons of phosphoric acid, most of which is now merely a troublesome waste product, but would at the same time render valuable assistance to the steel trade of the country, and would thus on both counts help this country in the forthcoming economic conflict with Germany, which is generally acknowledged to be impending.

Professor Hendrick, Aberdeen University, estimated that in 1906 the total world production of basic slag was nearly $2\frac{1}{2}$ million tons, of which Germany produced about $1\frac{1}{2}$ million tons, and the United Kingdom about 300,000 tons. Germany used nearly as much as she produced on her own land, whereas only about 167,000 tons were so used in the United Kingdom. As the total amount of basic slag now produced in this country is from 800,000 to 900,000 tons, and will certainly be increased in the near future, it can readily be recognised how much manuring by basic slag can be developed in this country.

At Cockle Park, on heavy loam soils of a poor character, a dressing of 10 cwt. an acre of high-grade basic slag, applied once in six years, has easily increased the seeds hay crops by 10 cwt. an acre in each of the three following years after its

application; oats have easily been increased by 10 bushels an acre in the fourth year thereafter, swedes by over 4 tons an acre in the fifth year thereafter, and barley by 4 bushels an acre in the sixth year thereafter. At pre-war prices, valuing hay at £3 a ton, oats at 3s. a bushel, swedes at 7s. 6d. a ton, and barley at 4s. a bushel, this gives a total of £8 2s. 6d. as the increased value of the crops for six years after the application of 10 cwt. high-grade basic slag, which at pre-war prices would cost about 25s.

On the sandy loam soils at the same centre, a dressing of 5 cwt. an acre of high grade basic slag has probably increased the following seeds hay crop by 10 cwt. an acre, the oats in the second year by 10 bushels an acre, the swedes in the third year by 3 tons an acre, and the barley in the fourth year by 4 bushels an acre. This gives an estimated return of £1 18s. 6d., from the application of 5 cwt. basic slag at a cost of about 12s. 6d.

In the Hanging Leaves fields at Cockle Park, where a pasture of the poorest character has been treated with basic slag alone, the increased gains made by the cattle and sheep during the past eleven years show a gain of about 7s. 6d. for each shilling spent on basic slag.

The foregoing estimates of increased crops from the application of basic slag are based on crop results at Cockle Park. It should be noted that the basic slag owes much of its effects to the inclusion of wild white clover in the seeds mixtures. This plant is enormously developed by basic slag, and the nitrogen collected by its roots is of the greatest help to the phosphatic residues of the slag in increasing the various crops.

The amount of basic slag now used annually for manurial purposes in this country may be between 200,000 and 300,000 tons. It has already been estimated that the total amount of basic slag produced in this country is now about 850,000 tons, but as much of this is of low grade, the total amount produced may be equal to about 600,000 tons of high-grade basic slag.

The total area under crops and grass in the United Kingdom (not including mountain and heath land) is under 47 million acres. Assuming that 250,000 tons of basic slag are now used for agricultural purposes in the United Kingdom, this would provide a dressing of 5 cwt. of basic slag per acre every fourth year for four million acres. If the total basic slag produced in this country were used for agricultural purposes, (estimated to be equal to 600,000 tons high-grade basic slag) the total area of land so treated would be increased to 9,600,000 acres, and it can be realised from the foregoing Cockle Park figures how enormously the food production of this country would be increased.

In this country there were produced annually before the war, from 820,000 to 850,000 tons of superphosphate, of which about 76,000 tons were exported. These figures give some idea of the relative amounts of superphosphate and basic slag used before the war for manurial purposes. Superphosphate is produced mainly from rock phosphates, of which nearly 600,000 tons were imported to this country in 1913.

A low-grade basic slag from the openhearth steel process, contains on the average only about 10% phosphoric acid, whereas high-grade basic slag contains from 17% to 20%. Before the war, various costs in producing high-grade and low-grade basic slags were probably about the following per ton:—

Grinding	6/-
Bags	3/- to 5/-
Putting on rail and other labour, say	3/-
Railway carriage, about 100 miles, say	8/6
	20/6 to 22/6

These costs amount to the same for slags of low-

grade as of high grade. It is therefore readily seen that a high-grade basic slag can be delivered at a distant railway station at a much less cost per unit of phosphoric acid, than is the case with a low grade basic slag. Actually railway rates to stations about 50 miles from Middlesbrough, amount to about 6s. per ton; and 100 miles distant to about 8s. 6d. per ton. A most valuable concession to agriculturists and to the producers of basic slag would be made by railway companies if low-grade basic slags were carried at reduced rates somewhat in proportion to their actual values.

Investigations are now being made with the object of ascertaining whether high-grade mineral phosphates (containing about 30% P_2O_5) can be added to the basic slag immediately it leaves the openhearth, say in about equal amounts of mineral phosphate and slag. If by doing so the mineral phosphates can be given practically the same character as those of basic slag, a high-grade basic slag will be produced which should reach the farmers' nearest railway stations at considerably less cost per unit of phosphoric acid, owing to the saving made in costs per unit of grinding, bagging, and railway carriage.

This subject is of the greatest importance to British agriculture and demands the best attention that can be given to it. At the present moment a vigorous campaign is being conducted throughout the country for the reclamation of available waste land with the object of increasing the area under cultivation. Whilst this is most desirable, there are far greater possibilities by increasing the output from the land now under cultivation, or laid away to pasture. With practically no increase in labour this can be obtained very largely by the judicious use of basic slag, which is now thrown aside as a waste product, one of the main reasons for this being insistence upon a test which gives results bearing no real relation to the manurial value of the material.

DISCUSSION (INCOMPLETE).

Mr. JOHN HUGHES said that if the citric acid test gave a low percentage of soluble phosphate in respect of the open-hearth slag as against a high percentage in the Bessemer slag it was a real practical illustration of the more insoluble character of the former, especially when it was borne in mind that in the case of the Bessemer slag practically the whole of the soluble phosphate was dissolved with the first extraction, whereas it was admitted that it required some four or five extractions before the whole of the phosphate was dissolved in the case of the open-hearth slag.

Dr. BERNARD DYER said that no doubt fine grinding was a matter of great importance as affecting the availability of water-insoluble phosphates, but fine grinding was not everything. A good deal would depend upon the kind of material ground. One would scarcely expect to get much efficacy, for instance, from the grinding of crystalline Canadian apatite, while on the other hand soft phosphates like some of the North African phosphates, when ground to a sufficiently fine state, become effective fertilisers. Any standardised citric acid test must in some sense be empirical. The validity of some of the experimental work on the basis of which Wagner evolved his solubility test had been some time ago brought into question, and, as a result, a meeting of representatives of all the German agricultural experiment stations remitted the whole subject for re-investigation. The result had been to confirm the conclusions originally arrived at, and it was decided, on the basis of this re-investigation, to retain the use of the citric acid solubility test for basic slag. Apart from experimental evidence, if a complex molecule like that of the phosphate in Bessemer basic slag could be readily broken down and brought into solution by a dilute solution of citric

acid, it would surely seem that it would be more likely to yield to the even gentler natural solvent processes in the soil than the phosphatic molecule of another form of slag which under similar conditions showed itself more resistant. The question, however, was one of experiment. He (Dr. Dyer) thought that more field experimental work remained to be done before general conclusions could be arrived at. It might be that open-hearth slag, if sufficiently finely ground, could do all that was claimed for it by its defenders, and if so it would become a further asset to agriculture. But its action should be tried on various kinds of soil, and there ought to be little difficulty in getting further experiments carried out with it under varying conditions. If it had anything like the properties of the better known basic slag, there was plenty of poor grass land on which its efficacy could be easily demonstrated.

Mr. G. S. ROBERTSON said that what was really wanted was a series of experiments in many parts of the country to test the value of open-hearth basic slags or fluorspar basic slags, compared with high citric soluble Bessemer basic slags. During the past two years he had been engaged in carrying out such experiments in Essex on various types of soil, and although the results were not yet sufficiently complete for definite conclusions to be drawn, still they indicated that the fluorspar basic slag was just as valuable as the highest citric soluble slags. The citric acid test did certainly seem to be very unfair to open-hearth basic slags and rock phosphates. There appeared to be no particular reason why one should use 5 grms. of phosphate in performing the test, or why the shaking should last for half an hour, or the volume of the solution be 500 c.c., or the strength of the citric acid 2%. If one gm. were used instead of 5, and the other conditions kept as usual, the order of solubility of the various phosphates was often completely altered. For example a particular sample of fluorspar basic slag had a solubility of 45% and a rock phosphate 38% according to the usual citric acid test, that was to say using 5 grms. When, however, the test was repeated using 1 gm. the solubility of the slag was only 68% whereas the solubility of the rock phosphate was 80%. That was not an isolated case: such results were continually being recorded, and they completely shattered any faith which could be put on the value of the citric acid test. The question of fineness of grinding which had been raised by the authors was, in his opinion, also of much greater importance than citric solubility. The difficulty in sowing such finely ground materials was not nearly so great as had been suggested in the discussion. The low citric solubility of open-hearth basic slags was due, not to the absence of silica, but to the fact that it was not in combination with the phosphate. Apparently the fluorspar used displaced the silica in combination. It was quite easy to reduce the citric solubility of a basic Bessemer slag to that of an open-hearth slag by heating it with a small amount of fluorspar in an ordinary furnace. The paper had been of great interest to him and he found himself in complete agreement with the conclusions drawn by Prof. Gilchrist and Prof. Louis.

Manchester Section.

EXPERIMENTS RELATING TO THE ACTIVATED SLUDGE PROCESS OF SEWAGE PURIFICATION.

BY WILLIAM T. LOCKETT, M.S.C.

Previous communications to this Society relating to the activated sludge system of sewage purification have been a series of papers under the title

"The Oxidation of Sewage Without the Aid of Filters,"¹ by E. Arden and the author, descriptive of experiments pertaining to the development of the activated sludge process which had been carried out with Manchester sewage, and a paper by S. E. Melling.²

A number of papers dealing with the subject have also appeared from time to time in various English and American journals, notably those by Fowler,³ Duckworth,⁴ Chalkley Hatton, of Milwaukee,⁵ and Bartow and others, of the University of Illinois.⁶

In the present communication it is proposed to give the results of a series of investigations carried out with the sewage of a manufacturing town, attention having been given to—

- (1) The volume of air required for the efficient working of the process;
- (2) Possible means of effecting economy of air;
- (3) Experiments relating to the maintenance of the activity of the sludge;
- (4) Enquiries into the bacteriological nature of effluents.

The sewage dealt with in these investigations may be classed as one of "average" strength, and contained, in common with other sewages of manufacturing towns, a variety of trade wastes, including those, inimical in character, discharged from chemical works concerned largely at the present time with the production of material for war purposes. The apparatus employed, in general, was similar to that used in the previous experiments with Manchester sewage and consisted essentially of a series of aerating vessels (capacity 3—4 litres) fitted with porous tiles for aeration purposes; each vessel being connected to a separate and controlled air supply.⁷

i. Volume of air required for the efficient working of the process.

In a previous study of the economics of the activated sludge process as applied to Manchester sewage, it was demonstrated that, with improved methods of aeration—diffused air—the minimum air supply necessary to maintain the maximum rate of oxidation of the sewage did not exceed the amount of air required for the adequate mixture and circulation of the sludge.

The early experiments with the sewage dealt with in the present investigations, indicated that purification of the sewage could be readily brought about by means of activated sludge and "diffused" air, and investigations were then made to determine the quantity of air required for the purification process. For this purpose it was necessary to determine, in the first instance, whether the above conclusion was applicable in this case also to the activated sludge process. Accordingly, a series of comparative experiments was carried out to ascertain the oxidation effected when using (a) quantities of air sufficient to obtain adequate mixture and circulation of the sludge and sewage, (b) air in excess. The following are the average results of these experiments:—

Results in parts per 100,000.

Raw sewage.	Effluent obtained with 2 hours' aeration using quantities of air:—		
	(a) sufficient for adequate mixture.	(b) in excess.	
Four hours' oxygen absorption	10.50	1.46	1.74
Free and saline ammonia	2.30	0.83	0.64
Albuminoid ammonia	0.99	0.115	0.15
Nitrite as NH ₃	—	0.06	0.08
Nitrate as NH ₃	—	0.71	0.94

Although the foregoing experiments showed that more highly nitrified effluents could be obtained in a given time by the use of excessive quantities of air, demonstrating that the conclusion arrived at in the Manchester experiments was not strictly applicable in this particular case, the question remained whether, in general, when dealing with the sewage employed in these investigations, it would really be advantageous to use more air than that required for adequate mixture and circulation. As a guide to the solution of this problem, the conditions which would obtain in large-scale operations were first considered. The use of large volumes of air in practical operations would tend to reduce tank capacity, as the periods of aeration would be short, but this advantage would not compensate for the increased cost of air unless the extent of the oxidation were reasonably proportionate to the volume of air used.

To obtain a decision on this question and thus provide a satisfactory basis to work upon, a series of comparative experiments was carefully carried out with mixtures of sludge and sewage in the proportions of 1:4, using air at the rate of (1) 6 cubic feet per hour per square foot, i.e., with just sufficient air under experimental conditions to produce adequate mixture, (2) 12 cubic feet per hour per square foot, and samples were taken after 1½ and 3 hours' aeration. In these experiments samples of strong sewage were used so that every opportunity was given for the beneficial effect of the larger volume of air to be shown. The following are the average results obtained:—

Results in parts per 100,000.

	Raw sewage.	Effluents obtained when using air at the rate of:—			
		6 cub. ft., etc., for		12 cub. ft., etc., for	
		1½ hrs.	3 hrs.	1½ hrs.	3 hrs.
Four hours' oxygen absorption	10.34	—	1.26	—	1.30
Free and saline ammonia	2.84	1.40	0.37	1.10	0.25
Albuminoid ammonia	1.30	—	0.13	—	0.13
Nitrite as NH ₃	—	0.08	0.07	0.08	0.05
Nitrate as NH ₃	—	0.59	1.39	0.78	1.52

From the foregoing results it will be seen that by the use of air at the rate of 12 cubic feet per hour, etc., the oxidation effected with 1½ hours, aeration was by no means equal to that obtained by the use of 6 cubic feet per hour, etc., for three hours—the extent of the oxidation not being reasonably proportionate to the volume of air used. Consequently, it was concluded that in the treatment of this sewage, no material advantage was to be obtained by the use of quantities of air in excess of that required for adequate mixture and circulation.

Purification effected, using suitable quantities of air and varying proportions of sludge.—Having arrived at a conclusion as to the quantity of air which could be most economically employed, a study was made of the purification effected when the sewage was aerated with that quantity of air, using 20 and 40 % by volume of activated sludge. To obtain average samples of the sewage over the 24 hours was practically impossible, and so to avoid misleading results experiments were conducted with samples of strong sewage obtainable from the afternoon flow.

In the following table, the average results are given of the series of experiments carried out under suitable temperature conditions, using

mixtures of sludge and sewage strictly in the proportions of 1 to 4 and 2 to 3. The quantity of air employed, which was carefully determined both prior to and during each experiment, was as nearly as possible throughout the whole series equivalent to 6 cubic feet per hour per square foot of the sectional area of the aeration vessel. Under these conditions well-oxidised effluents were obtained with the different proportions of sludge in 3 and 1½ hours respectively.

In the table, the average results of similar experiments carried out previously with average Manchester sewage under almost precisely the same experimental conditions are also given, for a purpose which will be seen later.

higher proportion of sludge to sewage, *e.g.*, 2 : 3, the volume of air should not exceed 1,200,000 cubic feet.

These conclusions, in view of the character of the sewage, indicate strongly the eminent practicability of the activated sludge process.

ii. Possible means of effecting economy of air.

The absolute minimum quantity of air requisite for the purification of any particular volume of sewage by means of activated sludge, apart from that required for agitation, depends upon the strength and nature of the sewage to be dealt with and the oxygen needed to maintain the vital

Results in parts per 100,000.

Sewage of a manufacturing town.					Manchester sewage.			
Raw sewage.	20 vols. of sludge to 80 vols. of sewage.	10 vols. of sludge to 60 vols. of sewage.		Raw sewage.	20 vols. sludge to 80 vols. sewage.	40 vols. sludge to 60 vols. sewage.		
		Effluents obtained after aerating for:—				Effluents obtained after aerating for:—		
		2 hrs.	3 hrs.			1 hr.	1½ hrs.	4 hrs.	2 hrs.
Four hours' oxygen absorption	12.25	1.63	1.44	1.30	1.13	12.41	1.76	1.39
Free and saline ammonia.....	2.82	1.03	0.53	0.84	0.41	3.71	1.83	1.14
Albuminoid ammonia	1.14	0.17	0.13	0.125	0.095	1.16	0.19	0.11
Nitrite in terms of NH ₃	—	0.04	0.06	0.05	0.08	—	0.14	0.13
Nitrate in terms of NH ₃	—	0.96	1.46	0.65	1.01	—	1.39	1.59
Percentage purification of raw sewage calculated on:—								
(1) 4 hours' oxygen absorption	—	87	88	89	91	—	86	89
(2) Albuminoid ammonia	—	85	89	89	92	—	84	91
Percentage loss of ammonia	—	63	81	70	85	—	51	72
Percentage ammonia oxidised (NO ₂ , NO ₃)	—	36	53	25	39	—	41	46

An estimate of the volume of air required for large scale operations.—By a comparison of the results obtained in the preceding experiments with those obtained previously in similar experiments with Manchester sewage, it will be seen that strong samples of the sewage in question can be purified in approximately three-quarters of the time required to purify average Manchester sewage. Taking into consideration the superiority of the effluents produced by the treatment of the sewage dealt with, in 3 hours (20% sludge) and 1½ hours (10% sludge) over those obtained in 4 and 2 hours respectively with Manchester sewage, and the fact, known but not previously referred to, that frequently the weaker samples of the former sewage can be completely nitrified with 2 hours, (20% sludge) and 1 hour (10% sludge) aeration, it may be concluded that the quantity of air required for the purification of the average sewage would be one-half to three-quarters of that required for the satisfactory purification of average Manchester sewage.

Accordingly, on the basis of an approximate estimate of the volume of air required for the purification of a definite volume of average Manchester sewage given in a previous paper,⁸ it would appear that the volume of air necessary for the satisfactory purification of 1,000,000 gallons of the sewage dealt with in these investigations, in tanks 6 feet deep, would be considerably less than 1,500,000 cubic feet allowing for the application of air at the rate of 15 cubic feet per hour per square foot of tank area (a quantity of air more than sufficient under these conditions to produce adequate mixture and circulation), using sludge and sewage in the proportions of 1 : 4. With a

processes of the sludge. In actual practice, the quantity of air required for the satisfactory working of the activated sludge process greatly exceeds the absolute minimum requirements, and thus it would appear that the introduction of more suitable means to bring about the circulation of the sludge and sewage would lead to appreciable economy of air.

In the opinion of many engineers, agitation can be more economically produced by the use of air than by the application of mechanical devices. Accordingly, to reduce the disparity between the large volumes of air required for the satisfactory working of the process and the absolute minimum requirements, improvements must be looked for in the methods of applying the air to the sewage, and the experiments described in the following relate to the possibility of effecting economy by applying air "intermittently" instead of "continuously" as hitherto.

That appreciable economy of air might be obtained by the adoption of intermittent aeration has been known for some time to those concerned with the development of the activated sludge process, although, I believe, the original suggestion is to be attributed to Mr. Makepeace, the Borough Engineer of Stoke-on-Trent. Without desiring to depreciate the merit of others who may be working on similar lines, I record the results of certain experiments which I have carried out in this particular line of enquiry, with a view to their possible usefulness in the mutual endeavour of sewage chemists and engineers to render the activated sludge process an economic success.

Intermittent aeration experiments.—In the first

series of experiments, the oxidation of sewage obtained by two hours' "continuous" aeration was compared with that obtained by two hours' "intermittent" aeration, excessive quantities of air being used in both cases.

At the outset, to the mixture of sludge and sewage to which intermittent aeration was applied, air was admitted continuously for 10 to 15 minutes to ensure a complete mixture of sewage and sludge; afterwards, in this particular series of experiments, excessive quantities of air were admitted for two out of every four minutes. Thus, during the total aeration period of two hours air was admitted for 68 minutes only. The following average results show the purification effected by the two methods of aeration:—

Results in parts per 100,000.

	Raw sewage.	Effluents obtained after two hours' aeration.	
		Air applied:—	
		Continuously.	Intermittently.
Four hours' oxygen absorption	14.21	2.34	2.36
Free and saline ammonia	2.57	1.16	1.22
Albuminoid ammonia	1.34	0.135	0.14
Nitrite in terms of NH_3	—	0.13	0.10
Nitrate in terms of NH_3	—	1.06	1.04

As the results of the foregoing experiments showed that with excessive quantities of air, the stoppage of aeration for short periods had little effect upon the purification process, the experiments were carried further to observe the effect when reasonable quantities of air were employed.

In these later experiments, in which air was applied at the rates of 12, 10, 8, and 6 cubic feet per hour, etc., it was found that as the rates at which the air was applied were reduced from 12 to 10, etc., it was necessary to increase gradually the total aeration period for the mixtures aerated intermittently in order to produce effluents equal in quality to those obtained by two hours' continuous aeration, and thus with the extension of the total aeration period the percentage saving of air was gradually reduced, until eventually, it became questionable whether intermittent aeration possessed a direct economic advantage over continuous aeration when the latter was applied in the most economical manner.

To obtain some definite information with regard to this question, a series of carefully controlled experiments was carried out as follows:—Two similar aerating vessels were taken, the air supply to each regulated to the requirements of the experiment, and the vessels filled with similar mixtures of sludge and sewage in the proportions of 1:4. In the one case, the mixture was aerated continuously for two hours in the most economical manner, i.e., with a quantity of air equivalent to 6 cubic feet per square foot per hour, known to be the minimum quantity of air which can be used satisfactorily for continuous aeration under the conditions of experiment. In the second case, the mixture was aerated intermittently throughout, the volume of air used being 3 to 4 cubic feet per square foot per hour, and the aeration of the mixture was continued until a quantity of air had passed equal to that used in the control experiment in two hours, viz., 12 cubic feet per square foot. Thus, in these

experiments the only altered factor was the means of applying the air, as ultimately each mixture received approximately the same volume.

During the short periods of time when air was admitted to the intermittently aerated mixture, the air was applied at the rate of 8 cubic feet per square foot per hour, a quantity of air found by experience to be the minimum amount possible under conditions of working to produce adequate mixing and stirring of the sludge and sewage within a short period of time.

Particular care was exercised to determine as accurately as possible the quantities of air used and, if anything, the tendency has been slightly to over-estimate rather than under-estimate the quantity of air applied intermittently, so that any advantage shown by intermittent aeration over continuous aeration in the following results may be taken as the minimum to be obtained by the use of the former.

The following are the average results of a series of experiments carried out as described:—

Results in parts per 100,000.

	Raw sewage.	Effluent obtained when air was applied:—	
		Continuously.	Intermittently.
Four hours' oxygen absorption	10.03	1.26	1.12
Free and saline ammonia	2.36	0.79	0.65
Albuminoid ammonia	0.98	0.10	0.075
Nitrite in terms of NH_3	—	0.06	0.07
Nitrate in terms of NH_3	—	0.83	0.87
Length of aeration period	—	2 hours.	3-3½ hours.

From the above results it will be seen that with intermittent aeration, effluents can be obtained distinctly superior to those produced by continuous aeration (applied in the most economical manner) using approximately the same quantity of air in each case. The direct economic advantage to be obtained by applying air intermittently appeared, however, from these experiments to be small.

It was thought that the above results could be considerably improved upon if the best method of applying air intermittently could be found, and accordingly a large number of experiments were carried out applying air intermittently in many different ways, by varying the length of the short aeration periods, etc. These experiments were not productive of results which could be considered a striking improvement upon those previously obtained; it appeared, however, that in the application of air intermittently to a mixture of sludge and sewage the following were matters of importance:—(1) That the periods of time for aeration should be sufficiently long or the amounts of air passed should be sufficiently great to produce adequate mixture. (2) That the periods of rest should be reasonably short, so that use may be made of any remaining momenta of the particles of sludge.

The following are the results of a series of experiments carried out under careful control, in which ample provision was made to fulfil these apparently requisite conditions for the satisfactory application of air intermittently. Short aeration periods of a few seconds' duration were employed and approximately equal volumes of air passed in each case.

Results in parts per 100,000.

Raw sewage.	Effluent obtained when air was applied:—	
	Continuously.	Intermittently.
Four hours' oxygen absorption	11.09	1.15
Free and saline ammonia	2.36	0.61
Albuminoid ammonia	1.22	0.14
Nitrite in terms of NH_3	—	0.02
Nitrate in terms of NH_3	—	0.71
Length of aeration period	—	2 hours. 3.31 hours.

The results obtained in these later experiments show some slight improvement upon the earlier ones and definitely establish the fact that sewage can be purified with reduced expenditure of air by intermittent aeration. On the other hand, the time required for the purification of any particular volume of sewage is materially increased.

On the basis of the foregoing results it would appear that the economy of air to be obtained by intermittent aeration, whilst appreciable, is not great, and in view of the increased tank capacity which would be required, it becomes a debatable point whether on a practical scale its adoption for general purposes would be productive of a substantial reduction in the cost of the purification of sewage. It is to be remembered that besides the increased capital cost a certain annual expenditure would be needed for the upkeep of the additional tiles, so that much would appear to depend upon the "life" of a porous tile and the cost of replacing it.

Consequently, whilst it is realised that the possibility of purifying sewage with a reduced expenditure of air by applying the air intermittently instead of continuously, may lead eventually to important practical developments, and further experiments are in progress with this object in view, it is felt that the evidence accumulated up to the present is not of sufficient strength to warrant a general recommendation of intermittent aeration.

The facts elicited by the foregoing investigations are of such a character, however, as to suggest that intermittent aeration may be of considerable practical value if its application to the activated sludge process is limited to certain occasions. For instance, the author considers that it would be particularly useful and would effect appreciable economy of air, if utilised for dealing with the night flow of sewage. Moreover, its use would be of considerable help in providing for the treatment of storm water.

With regard to the former it may be said that on the "fill and draw" system, it would be advantageous to treat the weak sewage and reduced flow which obtains during the night time by air applied intermittently, with a view to lengthening the period of aeration to obviate the loss of activity of sludge by standing and incidentally establish a check upon the consumption of air during the time of relaxed supervision. On the "continuous flow" system, intermittent aeration should be exceptionally useful. Under continuous aeration conditions presumably an equal amount of air would be passed during the night as through the day in order to maintain the circulation and mixing of the sludge and sewage, notwithstanding the fact that considerably less sewage, and that very much diluted, would be dealt with. Intermittent aeration might be applied in this case for 12 out of the 24 hours and would effect an appreciable saving of air.

In connection with the treatment of storm

water it is suggested that certain tanks might under dry weather conditions be operated on an intermittent aeration basis. In the time of storm, by changing the method of applying the air, i.e., to continuous aeration, an appreciable increase in tank capacity would result, as sewage could then be more rapidly purified.

iii. *Experiments relating to the maintenance of the activity of the sludge.*

It has been known from the outset of the investigations with regard to the activated sludge process that when a quantity of activated sludge is quiescent for some length of time certain changes take place and the sludge loses much of its activity.

The present investigations were carried out to ascertain what effect known periods of standing without aeration have upon the activity of the sludge, with a view to a knowledge of the conditions requisite to maintain the activated sludge process at its highest efficiency.

The following experiment illustrates the method of investigation adopted, and the results obtained are typical of those yielded by a number of experiments carefully carried out on similar lines.

A large volume of a recently aerated mixture of activated sludge and completely oxidised sewage was taken and allowed to settle for 20—30 minutes. At the end of this period, the supernatant liquor of oxidised sewage was decanted and the whole of the sludge remaining was collected, thoroughly mixed, and divided into several equal portions. A large volume of sewage was similarly divided. A mixture of one portion of sludge and one portion of the sewage was then made and immediately put on for aeration for a definite period of time, excessive quantities of air being used for aeration purposes. Samples were taken as required. Later, according to the time allowed for standing, a second portion of sludge was mixed with a second portion of sewage and aerated under similar conditions. Similarly with the third, fourth, etc., portions of sludge and sewage.

The following results show the nitrification effected with one and two hours' aeration, using fresh sludge and quantities of the same sludge after standing without aeration for periods of 4, 6, 8, and 10 hours respectively.

Results in parts per 100,000.

Sludge employed.	Composition of effluents after aeration for:			
	One hour.		Two hours.	
	Free and saline ammonia.	Nitrite and nitrate as NH_3 .	Free and saline ammonia.	Nitrite and nitrate as NH_3 .
1. Fresh sludge	1.13	0.71	0.33	1.33
2. Sludge after 4 hours' standing	1.23	0.39	0.41	1.12
3. Sludge after 6 hours' standing	1.33	0.34	0.67	0.87
4. Sludge after 8 hours' standing	1.50	0.25	0.86	0.80
5. Sludge after 10 hours' standing	1.73	0.22	1.01	0.63

Free and saline ammonia content of original raw sewage = 2.86.
Temperature of experiments 17°C .

The quantities of free ammonia remaining unoxidised and the quantities of nitrate produced in the several cases, after one and two hours' aeration, demonstrate the desirability of reducing to a minimum the period of non-aeration for sludge both in the "fill and draw" and "continuous flow" systems.

Experiments which have been carried out in connection with the changes taking place in the sludge during the periods of standing, indicate a rapid removal of the dissolved oxygen and nitrate present in the containing water of the sludge itself, accompanied by the formation of increasing quantities of free ammonia. From the following results it will be seen that appreciable quantities of ammonia are produced within short periods of time by the fermentation of the sludge whilst standing.

One litre of activated sludge yields:—0.97 mgrm. NH_3 in 2 hours, 2.06 mgrms. in 4 hours, 3.13 mgrms. in 6 hours, 4.10 mgrms. in 8 hours, and 10.40 mgrms. in 24 hours.

From a consideration of the whole of the facts ascertained with regard to the harmful effect of non-aeration upon sludge, it would appear that the activity of the oxidising bacteria contained in the sludge is not so seriously impaired as one would at first be inclined to think. The fact that sewage is not so perfectly purified by sludge which has been standing as by fresh sludge, is due to a large extent to the additional bacterial energy required to oxidise the accumulated products of the secondary fermentations. In this connection it may be interesting to state that the activity of activated sludge can be recovered by prolonged aeration even after standing several days. In one particular case a sludge which, when fresh, completely oxidised a sewage in 2 hours, after 48 hours' standing, completely oxidised a sample of sewage of similar character in 6 hours and subsequently rapidly improved, so that by the following day complete activity was regained and the sludge produced clear and well nitrified effluents with reasonable periods of aeration.

iv. Enquiries into the bacteriological nature of effluents.

A number of determinations of the bacterial content of effluents have been made during the course of the foregoing investigations, and from the results obtained it is evident that the purification of sewage by air and activated sludge is accompanied by an effective removal of bacteria.

From estimations of the number of organisms per cubic centimetre, contained in raw sewage, and in effluents obtained after 3 hours' aeration (20% sludge) and 1½ hours' aeration (10% sludge), it has been found that rather more than 99% of the organisms contained in the raw sewage are removed during the periods of aeration mentioned.

The following are the average results of a large number of estimations:—

Number of bacteria per c.c.

	Gelatin at 20° C.	Agar at 37° C.
Raw sewage	8,500,000	4,200,000
Effluent	66,000	30,000
Percentage removal.....	99.2	99.3

Experiments have also been made to determine the nature of the bacteria contained in the effluents, principally to ascertain whether the purification of sewage by aeration and activated sludge is accompanied by an effective removal of intestinal organisms. From a large number of determinations made it would appear that in general there is a high percentage removal of such organisms, although effluents of exceptional clarity and eminently satisfactory from a chemical point of view have been found to contain more than 1000 *B. coli* and more than 10 spores of *B. enteritidis*

sporogenes per c.c. It is to be remarked, however, that usually these high results for effluents were obtained when the original raw sewage gave a correspondingly high return for these particular organisms.

In these investigations extensive use was made of Klein's *B. enteritidis sporogenes* and the MacConkey bile salts tests although a number of effluents have been examined in greater detail. Below, the results are given of a detailed bacteriological examination—carried out on the lines suggested by Dr. Houston in the 2nd Royal Commission Report on Sewage Disposal—of a raw sewage and two corresponding effluents, obtained by the aeration of the sewage with (1) 20%, (2) 40% sludge for 3 and 1½ hours respectively. The results of a chemical examination of the sewage and effluents are also given.

	Effluents obtained after aerating for:—		
	Raw sewage.	3 hours. (20% sludge)	1½ hours. (10% sludge)
Bacteriological results:			
Number of organisms per c.c.:—			
Gelatin at 20° C. ..	4,100,000	36,000	48,000
Agar at 37° C.	1,700,000	23,000	24,700
c.c.	c.c.	c.c.	c.c.
<i>B. coli</i>	+0.0001	+0.01	+0.00110
<i>B. enteritidis sporogenes</i> (spores)	+0.01	+1	+1
Gas test	+0.001	—1	+1
Indole test	+0.00001	+0.01	+0.001
Neutral Red broth test	+0.001	+0.01	+0.01
Bile salt broth test ..	+0.00001	+0.001	+0.001
Litmus-milk (modified test)	+0.00001	+0.001	+0.001
GAC	GAC	GA (C ?)	GAC
Chemical results.			
Parts per 100,000.			
Four hours' oxygen absorption	12.23	1.12	1.00
Free and saline ammonia	3.36	1.16	0.83
Albuminoid ammonia	1.11	0.115	0.10
Nitrite in terms of NH_3	—	1.02	0.02
Nitrate in terms of NH_3	—	1.05	0.92

In conclusion, the author begs to acknowledge his great indebtedness to the Worshipful Company of Grocers for their continued material help, and to the members of the staff of the Municipal and Sanitary Engineering Department, School of Technology, Manchester—Prof. Radcliffe and Mr. Herring-Shaw, M.Sc.—for their generous assistance and helpful interest in the research.

¹ This Journal, Part I., 1914, **33**, 523—539; Part II., 1914, **33**, 1122—1124; Part III., 1915, **34**, 937.

² This Journal, 1914, **33**, 1125.

³ Inst. San. Eng., Feb., 1916. Surveyor, Feb. 4, **49**, No. 1255.

⁴ Sewage Wks. Managers' Assoc., Dec., 1915. Surveyor, **48**, No. 1249. Inst. Mun. Eng., March, 1916. Surveyor, **49**, No. 1263.

⁵ Eng. News, N.Y., **74**, No. 3, July 15th, 1915, etc.

⁶ Eng. News, **73**, March 25th, 1915. Met. & Chem. Eng., **13**, No. 15, Dec. 1st, 1915, etc.

⁷ For detailed description and sketch see "Oxidation of Sewage without Filters," Part 3.

⁸ "Oxidation of sewage without filters," Part 3.

⁹ Sludge of usual density, similar to that produced by 2 hours settlement of mixtures of sludge and sewage equivalent to 25 to 50 grms. of dry matter.

¹⁰ +0.001 c.c.=positive result with 0.001 c.c., negative result with 0.0001 c.c., or at least 1000 organisms in the cub. centimetre but less than 10,000.

THE PREPARATION AND PROPERTIES OF 1,3,5-TRINITROBENZENE.

BY L. G. RADCLIFFE AND A. A. POLLITT.

The Publication Committee regrets that owing to a decision of the Department of Explosives Supply, the above paper cannot be published for the present.

Nottingham Section.

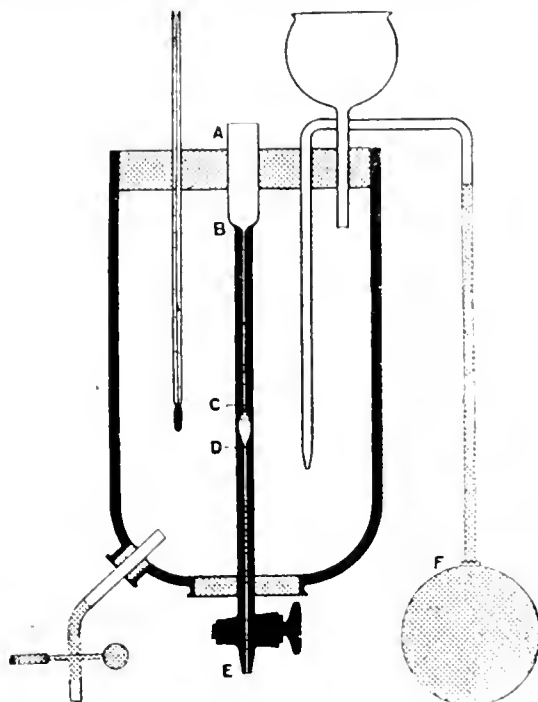
Meeting held at Nottingham on Wednesday,
31st January, 1917.

DR. R. M. CAVEN IN THE CHAIR.

A MERCURIAL VISCOMETER.

BY F. M. LIDSTONE.

This viscometer (see fig.) was designed to meet the need often felt by the chemist for an instrument capable of accurately measuring the viscosity of an oil when only a very small quantity is available, as, for example, the mineral oil extracted from a blended oil or from a grease.



(One-third scale).

The tube, B E, is a fine capillary with a small bulb blown in it. The stopcock is opened and clean mercury sucked up to just above B, and the stopcock closed. A small measured quantity of the oil (just more than sufficient to fill the bulb) is then run into the cup, A B, where it is allowed to rest on the surface of the mercury, surrounded by the water jacket, for ten minutes, or sufficient time for the oil to acquire the exact temperature of the water, which is kept in constant agitation by means of the bellows, F.

When ready to take the reading, the stopcock is opened and the time occupied by the mercury level in falling from C to D is observed. The time reading is then converted into seconds (Redwood, or whatever other viscometer has been used for the calibration), by the equation

$$\frac{t}{d} \cdot K = R$$

where t is the time of running in seconds.

d is the sp. gr. of the oil at temperature of the running.

R is the time taken through the (Redwood) viscometer.

K is a constant for the instrument.

No allowance is made here for the variations in the head of oil, for although the volume is always the same if a definite measure be always used and the differences in specific gravity of the various oils ought strictly speaking to be taken into account, this correction is so small as to be negligible. Neither is any correction made for the varying time taken by the mercury itself apart from the oil. Both corrections are extremely minute, and with a moderately long capillary below the bulb the first correction is so small as to be negligible. However, as regards the second, namely, the time taken by the mercury, in the case of very mobile oils, if great accuracy be required, this time can be corrected for by the amended equation:—

$$\frac{tK}{d} \left\{ 1 - \left(\frac{t'}{t} \right)^3 \right\} = R$$

where t' time taken by mercury in flowing freely from C to D with no resistance from above to overcome (which of course includes the air friction in the capillary, B C): the other letters being the same as before.

This correction is arrived at thus:—

Let V' = mean velocity of mercury flowing freely.

V = mean velocity of mercury retarded by oil.

t' = time taken by mercury flowing freely.

t = time of running together with the oil.

m = mass of mercury.

Then $\frac{1}{2}m(V'^2 - V^2)$ represents work spent on the oil and $t' \frac{V^2}{V'^2}$ is time taken during the running

by the mercury in doing work on itself.

$$\text{But } V = \frac{V' t'}{t}$$

Therefore by substitution

$$t' \frac{V^2}{V'^2} = \frac{t'^3 V'^2}{t^2 V'^2} = \frac{t'^3}{t^2}$$

and this time has to be deducted from t , hence

$$t \left\{ 1 - \left(\frac{t'}{t} \right)^3 \right\} \text{ is the corrected time.}$$

The following readings taken when calibrating the instrument against Redwood's viscometer will show the accuracy obtainable when using an ordinary thermometer divided into one degree divisions, the temperature in each case being 60° F.

Oil used.	t	d	R	$K = \frac{Rd}{t}$
Typewriter	31.8	0.8838	195	5.12
Machine	91.8	0.9022	551.5	5.42
Heavy machine	187.5	0.9127	1116	5.43
Gas engine	387.2	0.9150	2293	5.42
Heavy engine	438	0.9312	2383	5.44

The particular instrument made by the author has the following approximate dimensions which may serve as a guide, as they have been found generally suitable for most purposes:—Diameter of capillary, 0.5 mm.; capacity of bulb, 0.18 c.c. The relative lengths of the capillary tubes and the proportions of the rest of the apparatus can be seen from the diagram, which is to scale.

Now taking Poiseuille's formula for absolute viscosity,

$$\eta = \frac{\pi g d h r^4 t}{8 V a}$$

The variations in the density, d , have been seen to be practically negligible in this case, and, as all the other factors except t cannot vary, the equation becomes $\eta = Kt$, also the correction for the kinetic energy of the oil usually reduced to a minimum by having a very long capillary, is here made

equally negligible by having the equivalent of an enormous "h."* The only significant correction (and that is a small one) is that already noticed for the mercury itself so that

$$\eta = \kappa t \left\{ 1 - \left(\frac{t'}{t} \right)^3 \right\}$$

Of course if the mercury pull were increased very much the velocity would in the case of thin oils reach the critical speed, sinuous motion would be set up, and the instrument would cease to be of any use. But the velocities obtained with a viscometer of the dimensions given above come well within the limits required by the formula found by Osborne Reynolds in order that a steady flow shall be produced.†

A viscometer made as above, but with a bulb 20 or 50 times the capacity, should be capable of giving very accurate determinations of η , although of course it would cease to fulfil the requirements for which the instrument was originally designed, namely, that of being able to work on very small volumes. However, a very small viscometer is only occasionally required, and it might be suggested that an instrument of this type be used as a standard instrument and specific viscosities be given in terms of water at 15.5° C. or 20° C., preferably the latter. Viscometry would thus be much simplified and worked on a more scientific basis.

The distinctive advantages which this viscometer possess may be summed up as follows:—

(1) There are no meniscus troubles, owing to the fineness of the capillary and the consequent speed with which the mercury passes the lines; errors due to parallax in reading are similarly reduced to a minimum.

(2) The volume of the oil run is exactly the same in all cases, as at the start the bulb is dry and at the finish full of oil. In viscometers where the reverse is the case, there is always a certain amount of oil left clinging to the sides of the vessel, which is greater in the case of thick oils than with thin ones.

(3) The capacity of the bulb can be made very small (the capillary being similarly reduced or else lengthened) without the instrument losing much in point of accuracy. There is, however, a drawback to an extremely fine capillary because of the almost certain presence either in the oil or mercury of tiny specks of dirt, which of course cause an obstruction and render the readings worthless.

(4) The whole of the working parts of the apparatus are surrounded by the water jacket with the exception of the small emergent stem of mercury, and here the error is solely one of expansion of the mercury and consequent lessening of the pull on the oil. But as the coefficient of expansion is only 0.00003 per degree it will be seen that errors due to all likely laboratory temperatures will not affect seriously even the most exact readings.

This feature, namely, the complete enclosure of the instrument by the water jacket, is more important than is generally thought, if the readings are to be at all reliable. The Ostwald type of viscometer is the only other one at all adapted to commercial uses which enjoys this freedom from external temperature influences. As the result of a large number of runnings from viscometers, having the exposed jet in laboratory temperatures as much as 10° F. above or below the temperature of the oil, the author can definitely state that this error can amount to as much as 3% on the time of efflux. It is obvious that if at the start of the running the jet is, say, 10° warmer than the oil, the first part of the running

will certainly be too short, and even after the oil has cooled the jet down to approximately its own temperature there is bound to be a flow of heat between the oil and the jet, although this is small as compared with the initial warming or cooling. This has been proved by taking half-way readings. There is also another disturbing influence which augments the error in the case of thick oils, and this is the immediate effect of the atmospheric temperature on the surface tension of the hanging drop, and when the head is small this error becomes appreciable. To get concordant runnings viscometers having an exposed jet must be used in a room the temperature of which is the same as that of the oil or else where the difference in temperature is always the same.

(5) The cost of the whole apparatus is trifling compared with that of most of the other viscometers, whereas in point of accuracy it compares favourably with the best of them.

This viscometer is at present in use at the Chemical Laboratory of the Midland Railway Co. at Derby, and my thanks are due to Mr. L. Archbutt for affording every facility and encouragement towards perfecting the instrument and for his helpful criticisms of it. My thanks are also due to my colleague, Mr. R. W. Lunn, for verifying the calculations and preparing the sketch.

DISCUSSION.

Mr. ARCHBUTT said that those who had to deal with the analysis of lubricants had often felt the want of a handy viscometer capable of measuring accurately the viscosity of the small quantities of oil separated from mixtures in the process of analysis. Mr. Lidstone had done more than design an instrument of that kind; his viscometer was not only convenient to use but distinctly novel in design, and either in its present form or in a modified form he believed it might eventually replace for ordinary work some of the commercial instruments at present in use. It was very desirable that viscosity values should be expressed in absolute measure, and he had suggested to Mr. Lidstone that he should calibrate his viscometer with liquids of known viscosity with this object in view. Mr. Deeley and he (the speaker) in their book on "Lubricants" had shown how this could be done with mixtures of glycerol and water, and Professor Dunstan had more recently suggested calibration by the addition of phenol in which the temperatures had been accurately determined. In commercial work, however, one had to wait until the business man had learned to appreciate the advantages of the scientific method, and at the present time all countries were content to make use of so-called standard viscometers with exposed jets and use the times of efflux as measures of viscosity. All such instruments suffered from imperfections and serious faults in design. In those with tubes of wide diameter, such as the Redwood and Engler viscometers, there was a slope in temperature of the liquid from the outside to the centre of the tube which could not be corrected for, especially when working at high temperature, but, as Mr. Lidstone had pointed out, the temperature of the liquid in the exposed jet was dependent upon that of the room in which the experiment was being conducted. Mr. Lidstone's viscometer resembled the Ostwald type in being free from these defects, and it was superior to the Ostwald in simplicity and rapidity of action.

Mr. H. DROOP RICHMOND said that he was much impressed with the simplicity of the viscometer; the viscosity in absolute units could be obtained by this instrument with a very much nearer approach to accuracy than with most commercial viscometers. He quite agreed with what Mr. Archbutt had said about some of the commercial

* Archbutt and Deeley's "Lubrication and Lubricants," 3rd Edition, p. 28.

† Phil. Trans., 1895, page 149.

forms, but he thought it followed that such types did not measure the viscosity; they measured a sort of compromise between viscosity and surface tension, and were affected by errors due to varying temperature and varying quantities running out. Now in Mr. Liddstone's instrument the other things which were measured were to a very large extent eliminated, or if not quite eliminated, to a very great extent controlled. One thing of which he did not approve in Mr. Liddstone's viscometer was the variable head; as it was a head of mercury, not a head of oil, the oil hardly counted at all; it was the head of mercury that counted. He thought that could be eliminated. He suggested that the tube should be bent at the point marked D at a right angle and at the point marked C, or a little above those points respectively, so as to reduce the variation in the head. He thought that with such a slight modification the instrument would give the viscosity in absolute units with a much nearer approach to accuracy. Mr. Liddstone had said that the ratio between the efflux of his instrument and that of the Redwood only varied between 5.42 and 5.44, and he was surprised, seeing the errors of the Redwood, that there was not a greater variation in the constant. The simplest viscometer he had used, which unfortunately was not generally available, was one in which a long tube was filled with liquid and the viscosity determined by the rate of fall of a small sphere. After a very short interval of time the motion of the small sphere in the liquid would approach almost to constancy, and if the size of this small sphere were known, viscosity could be deduced from the rate of fall, which could be measured with a high degree of accuracy. In that form of viscometer there were no disturbing factors so long as the size of the sphere were such that it did not move too fast. But what prevented that form of viscometer being of general use was that it was very difficult to get a suitable sphere which would not move too fast except in liquids of very high viscosity. In theory he thought that the next best approach to accuracy was to have a revolving cylinder or disc, preferably a hollow cylinder, which could be rotated by means of a constant force. If that force were suitably chosen, and the shape of the rotating body were also suitably chosen, there was quite a simple relation between the time of rotation and the viscosity expressed in absolute units. But the two instruments he had mentioned, though giving very accurate results, lacked the very important advantages that Mr. Liddstone's apparatus possessed. The important advantage, to his mind, was that it could be used with a small quantity of material, that it was very simple, cheap, and very easy to use.

Mr. LIDSTONE, in reply, said, with regard to Mr. Archbutt's remark as to the exposed jet, that all viscometers, except his own, had fixed jets and could not be adjusted, but Mr. Archbutt's was the only one in which the jet was moved and could be pushed up into the liquid. He did not point that out in the paper. In reference to Mr. Droop Richmond's criticisms, as to the variable head of mercury, he did not see how putting the bulb horizontally would be any advantage at all, for only the head varied from the top line to the bottom. It was the main head which counted. It did not make any difference in the calibration. The Redwood and all other viscometers gave viscosities very nearly in proportion to the absolute viscosity. It was only with thin oils that there was any large degree of departure in ratio, and that was why the 5.42 to 5.44 was in very good agreement. He thought that the American rotating disc viscometer had not been found to give very good results, and he believed it was rather difficult to work.

SOLUBLE FILTERS AND FILTERING MEDIA.

BY JOHN M. WILKIE, B.Sc., F.I.C., AND H. S. ANDERSON.

A filter may be regarded as consisting of a medium, a support for the medium, and the containing vessel. When a filter paper is used in a funnel, the paper plays the double rôle of medium and medium support, and the same is true of paper or cloth used in frames or presses. When asbestos or similar material is used with a filter paper, the paper then more strictly functions as the "medium support." In the disc filters so largely used, the medium support may be attached to the containing vessel as in the Buchner type. In the Gooch crucible the rôle of the upper disc is largely protective, though it may be classed as a support. When the precipitate has to be removed quantitatively from the filter, it is sometimes useful to employ a filter in which both medium and medium support are soluble in some arbitrarily selected liquid. A filter satisfying these conditions we term a "soluble filter." So far as we are aware, such filters have not been previously described, although a soluble medium (anthracene) has been used in conjunction with a Gooch crucible. (We are indebted to Mr. Droop Richmond for drawing our attention to this use of anthracene, which had not come under our notice.)

It is, of course, essential that the medium or medium support should not be appreciably soluble in the liquid to be filtered, while it must be readily soluble in some other liquid. In some cases the insolubility of the medium does not require to be absolute provided solubility during filtration is so limited that mechanical destruction of the filter does not occur.

The most general case would be where the medium and support were insoluble in water and soluble in some other liquids. Such substances are numerous—calcium carbonate is of one type, and anthracene of another. Another important case would be where the medium and support are insoluble in alcohol but soluble in water. Probably all types are included in the following classification:—

- (1) Insoluble in neutral or alkaline liquids, but soluble in aqueous acids.
- (2) Insoluble in aqueous solutions; soluble in organic liquids.
- (3) Insoluble in organic liquids; soluble in inorganic liquids.
- (4) Insoluble in aqueous liquids and soluble in organic liquids, at the same time being volatile without decomposing at moderate temperatures.

In connection with some work on the separation of potash soaps from strong alcoholic mother liquors, the advantages of a soluble filter became apparent. Briefly, we wished to filter such solutions, decompose the soaps with aqueous acid, and shake out the fatty acids with ether. If filtration could be effected by means of a filter in which the medium and support were soluble in water and insoluble or practically insoluble in alcohol, we hoped to be able to carry out the whole process in a stoppered separator with a considerable saving of time and manipulations. The use of a separator solved any question that might have arisen as to the shape of the containing vessel. The medium support would occupy the tubular portion above the stopcock—a circumstance that made its selection comparatively simple.

Practically any crystalline inorganic salt of the alkalis or alkaline earths is available. Ammonium chloride was first used. The fibrous salt has considerable mechanical strength. The tubular neck of the separator was filled with fragments of such a size that they packed down easily but did not fall through the stopcock bore, but potassium nitrate was found to be as good. For filtering medium the selection in any particular

case is limited by density, and that indefinable property "texture." Powdered ammonium chloride and potassium nitrate possess the required features in a marked degree. Even in very fine powder they feel markedly granular when rubbed between the finger and thumb.

Filters made on the above lines were found to answer admirably when used with suction. They did not block and they retained the precipitated soap completely.

Our experience with filters of this type has been limited almost entirely to one in which crystalline and powdered potassium nitrate are used as support and medium respectively for alcoholic solutions. In use continuously during the last eight years, it has worked admirably. At a later date we hope to describe further work with the other types of soluble filters referred to above.

For the separation of precipitates from alcoholic solutions the filter is prepared as follows:—A separator is selected with well-marked tubular portion between bulb and stopcock, special potassium nitrate crystals are introduced so as to give a column nearly filling the tube and then 3–5 grms. of powdered potassium nitrate (rubbed down smooth between paper just previous to using, is added through a funnel. The separator is finally tapped on the bench to consolidate the filter. The filter is then ready for use, and with alcoholic soap solutions (of type used here) no precautions are required other than seeing that the added liquor does not unduly disturb the surface of the potassium nitrate powder. The above directions refer to an ordinary pear-shaped separator of 150–200 c.c. capacity. With larger separators the amount of powdered potassium nitrate needed require to be increased.

This investigation was carried out in the analytical laboratory of Messrs. Boots Pure Drug Co., Ltd., to whom our thanks are due.

NOTE.

Dr. W. R. E. HODGKINSON has suggested that the material known as "meal nitre," obtained by rapidly cooling and agitating a hot solution of potassium nitrate, is more suitable as a filtering medium than powdered crystals. Most substances can be obtained in this "meal" form by suitable rapid cooling and agitation of a hot, nearly saturated solution.

RAPID DETERMINATION OF OIL IN MALT AND COD LIVER OIL PREPARATIONS.

BY H. DROOP RICHMOND, F.I.C., AND F. G. HITCHMAN.

The method employed is based on the fact that while the density of cod liver oil is less than that of water, averaging 0.925, that of malt extract is considerably greater, and further that the density of a 50% solution of malt extract (a convenient strength for the determination of density) is, within small limits of error, proportional to the refractive index of the malt extract itself. It has also been observed that small solid particles or small globules of oil do not affect the refractive index; the solid particles either obstruct a portion of the light, or deflect it outside the pencil of emergent rays, while spherical globules either let the light pass through without deflection, deflect them right away, or allow rays to pass through in equal amounts in opposite directions; the result is that there is a slight diminution in the light and sharpness of reading, but the refractive index of malt extract is unaltered whether determined on the malt extract, or after emulsification with a considerable proportion of cod liver oil. On these observations the following rapid method for the estimation of oil in malt and cod liver oil preparations has been founded.

Equal weighed quantities of the sample to be examined and distilled water are mixed thoroughly and the density determined at 20° C. by means of a delicate hydrometer; if the temperature is not exactly 20°, the density may be corrected by adding 0.0006 for each 1° above. The refractive index is determined at 20°, preferably by the Abbe refractometer, correcting the reading, if necessary, for small differences of temperature by adding 0.00018 for each 1° above. The percentage of oil is calculated by the following formula:—

$$(n_D - 1.3332) \times 549.6 - \left(\frac{d-1}{d} \right) \times 584.8$$

The following figures give a few of the results obtained:—

	Oil found.	Oil calculated.
	%	%
1.....	9.8	9.6
2.....	14.5	14.5
3.....	18.1	18.4
4.....	29.4	29.8

This investigation was carried out in the Analytical Laboratory of Messrs. Boots Pure Drug Co., Ltd., to whom our thanks are due.

THE ESTIMATION OF SMALL QUANTITIES OF COBALT.

BY A. D. POWELL.

The solubility of cobalt ammonium thiocyanate in amyl alcohol, with formation of an intense blue coloration, was first made use of by Vogel as a means for the qualitative detection of cobalt in nickel salts, and has since been applied to quantitative separation of these metals (Rosenheim and Hildschinsky, this Journal, 1901, 810). The test, as described by Treadwell, consists of the addition of a concentrated solution of ammonium thiocyanate to the solution to be tested, followed by extraction with amyl alcohol. In the presence of cobalt, the amyl alcohol is coloured blue; if ferric iron be present, however, the blue colour is masked by the red colour of the ferric thiocyanate, and the solution is then shaken again after the addition of sodium hydroxide or carbonate to destroy the ferric salt, when the blue colour of the cobalt salt becomes apparent.

In using this test for the estimation of cobalt in samples of pyrolusite containing 2% or more of iron oxide, it was found that, unless a certain concentration of ammonium thiocyanate was maintained throughout, the cobalt either was not extracted by the amyl alcohol, or else, after extraction along with the iron, the addition of sodium carbonate, and consequent reduction in the concentration of the ammonium thiocyanate, caused part of the cobalt to be re-extracted into the aqueous solution.

On making further experiments it was found that the minimum concentration of ammonium thiocyanate necessary for complete extraction of the cobalt was 25%, and in all succeeding tests a concentration of 30% was maintained, two extractions from a solution of this strength removing practically all the cobalt. In making comparative tests, a known amount of cobalt was added to a solution containing about the same quantities of iron and manganese as were present in the solution under examination, and the extractions were made under the same conditions, the matching being carried out in Nessler cylinders, in a volume of 50 c.c. It was found impossible to filter the amyl alcohol extract through paper before matching, owing to absorption of the coloured salt by the paper, the first few c.c.s. coming through almost

colourless. As the separated extracts, even after long standing, always held in suspension sufficient ferric hydroxide to render the colour greenish and difficult to match correctly, sodium carbonate was discarded as a reagent for removing the iron, and sodium pyrophosphate, recommended by Romijn for suppressing ferric iron (see this J., 1911, 1471), was substituted. With this alteration the difficulty entirely disappeared, the ferric pyrophosphate formed dissolving in the excess of sodium pyrophosphate. In fact, except in cases where the amount of manganese present formed too much precipitate with pyrophosphate to make extraction possible, half a gram or so of sodium pyrophosphate added to the solution before extraction, entirely prevented the iron reacting with the thiocyanate, and the cobalt could be extracted directly, the test thus taking only a very short time to carry out.

Another advantage of sodium pyrophosphate is that it ensures a very uniform colour being obtained. In the earlier experiments very varying colours were obtained according to the acidity or the alkalinity of the solution from which the cobalt was extracted. The control tests also when kept for some time for the purpose of comparison with future tests, became slightly acid, and changed from light blue to violet blue. When kept over a little solid sodium pyrophosphate, however, the control solution retains its colour unchanged in tint and density for many months. The quantity of substance taken was usually arranged to give a coloration not exceeding that produced by 0.5 mgrm. of cobalt, as this quantity gives a sufficiently deep coloration for matching. A far smaller amount of cobalt may be matched, the colour being visible when only 0.02 mgrm. of cobalt is present.

This investigation was carried out in the Analytical Laboratory of Messrs. Boots Pure Drug Co., Ltd., to whom my thanks are due.

Communications.

PRELIMINARY NOTE ON THE NATURAL COAGULATION OF THE LATEX OF *HEVEA BRASILIENSIS*.

BY L. E. CAMPBELL, B.Sc., F.I.C.

(1) In 1913, Whitby* advanced the hypothesis that four agencies are responsible for the changes that take place in the latex of cultivated *Hevea brasiliensis*—namely, a coagulating enzyme, an oxidase, anaerobic putrefaction, and aerobic putrefaction.

In the present paper we are concerned only with the coagulating enzyme. Whitby's conclusion that spontaneous coagulation of latex is probably due to a coagulating enzyme was founded on observations which showed that heating prevents such coagulation. The present author has carried out a series of investigations on this subject, and is able to support Whitby's theory. He has, in addition, determined to some extent the nature of the enzyme in question.

The natural coagulation of latex bears a superficial resemblance to the clotting of blood. It is known that blood contains a coagulating enzyme—thrombin or fibrin ferment, and that lime salts, e.g., calcium chloride, exert a particularly favourable influence on the rapidity with which the clotting of blood takes place. On the other hand, if blood be collected in a solution of alkali oxalate it does not clot, owing to the precipitation of the calcium as oxalate. Again, the presence of calcium

salts plays some part in the coagulation of milk by rennin.

Coagulating enzymes (the photo-chymases) are known to occur in certain plants, and some of these are known to require the presence of calcium salts for their action.

In view of all these considerations it was apparent that a study of the influence of calcium salts on the natural coagulation of *Hevea* latex might throw some light on the nature of the enzyme present.

Two sets of experiments were carried out—

(1) On the influence of the addition of calcium chloride; and

(2) On the influence of the addition of precipitants of calcium.

Calcium chloride.—In the first experiment, various amounts of a 10% solution of calcium chloride were added to equal quantities (1 litre) of normal latex containing 30–35% dry rubber. Without calcium chloride solution and with 1 c.c. small clots formed in three hours. With 5, 10, or 25 c.c. clotting occurred within half an hour.

Further experiments were then carried out in order to compare the action of barium chloride and calcium chloride. These substances were added in the form of 1% solutions. When 1 c.c. or 5 c.c. of calcium chloride solution was added to one litre of latex, no effect was observed within 3 hours. With 10 c.c. small clots formed in 20 minutes, with 25 c.c. coagulation started in 10 minutes, and 50 c.c. caused coagulation to start immediately. Addition of 1, 5, 10, or 25 c.c. of 1% barium chloride solution to the latex produced no effect within 3 hours; when 50 c.c. was added, the latex started coagulating in 10 minutes.

In the next experiment, the effects of manganese sulphate, calcium chloride, and magnesium sulphate were compared. The addition of from 5 to 50 c.c. of 1% manganese sulphate solution to 1 litre of latex produced no effect; 100 c.c. produced coagulation within one hour.* Quantities of 1% magnesium sulphate from 5 to 100 c.c. had no effect on 1 litre of latex, neither was any effect produced by 2 or 5 c.c. of 1% calcium chloride solution, but 10 c.c. produced coagulation within one hour and 25 c.c. produced coagulation very rapidly.

Further experiments were then carried out with the object of ascertaining the smallest amount of calcium chloride which will produce a marked effect in hastening natural coagulation.

The various sets of experiments were carried out on different days with one litre of latex from the same trees. In the first experiment 5 c.c. of 1% solution produced a marked effect within 1 hour, and 10 c.c. within 1/4 hour; with 25 c.c. the latex was thickly clotted in 10 minutes, and with 50 c.c. the majority coagulated in 10 minutes, whilst with 100 c.c. a solid coagulum formed in 10 minutes. In the second experiment, 5, 10, and 15 c.c. produced no visible effects after 1 hour; with 20 c.c. the latex started coagulating in 1 hour, and with 30 c.c. in 1/4 hour. In the third experiment no effect was produced by 5 c.c. within 1 1/2 hours; with 10 c.c. the latex commenced to coagulate in 1 1/2 hours, and with 25 c.c. within 10 minutes. In the fourth experiment, no visible effect was produced by 5 or 10 c.c. in three hours; with 15 c.c. an effect was observable within 1 1/2 hours, and with 20 c.c. within 1 hour. In the fifth series, 5 and 7.5 c.c. had no effect; 10 c.c. produced a marked effect within 2 hours, and 15 c.c. within 1 hour.

The effect of adding neutral, or faintly acid, potassium oxalate was then ascertained, a 10% solution of this salt being added to one litre of normal latex over a series of days. In each case

* India Rubber Journal, 1913, 45, 941.

* The coagulating effect in the case of barium chloride and manganese sulphate is attributable to a purely electrolytic reaction.

the clots of rubber were weighed after 18 hours, the weights being given in grammes of dry rubber.

10 % Potassium oxalate solution. c.c.	Weight in grms. of rubber coagulated after 18 hours.					Next morn- ing.
	A.	B.	C.	D.	E.	
0	280	350	300	400	360	400
5	185	200	200	320	—	—
10	—	40	150	160	280	230
20	—	30	—	—	—	—
25	10	—	—	80	200	14
30	—	30	—	—	—	—
50	20	—	0	110	110	28
100	70	—	—	160	170	0

In all these cases it is apparent that neutral potassium oxalate has a considerable inhibiting effect on the natural coagulation of *Hevea* latex. In order to confirm this conclusion, experiments were made with another precipitant of calcium, namely, sodium fluoride. This substance was added in the form of an approximately 5% solution, the reaction of which was rendered neutral or faintly acid with hydrofluoric acid. The results obtained are given in the following table, one litre of latex being used in each case:—

5% sodium fluoride solution added. c.c.	Weight in grms. of rubber coagulated after 18 hours.			
	A.	B.	C.	D.
0	400	310	400	310
5	370	—	—	—
10	110	170	200	230
25	0	130	—	14
50	0	15	0	28
100	—	—	0	0
200	—	—	0	—

These experiments show that an amount of sodium fluoride equivalent to from 0.125 to 0.250 % of the latex is capable of almost totally inhibiting spontaneous coagulation for 18 hours after tapping. Sodium sulphate was found to have a slight inhibiting effect.

It is to be noted that latex when rendered alkaline with the hydroxides of sodium, potassium, or barium did not coagulate at all. It is therefore probable that the coagulating enzyme of *Hevea* latex requires an acid medium for its action. It was for this reason that particular care was taken to ensure that the solutions of sodium fluoride and potassium oxalate were not alkaline in reaction. Had this not been the case, the retarding action of the salts in question on the natural coagulation of the latex might fairly be assumed to be due to their alkalinity rather than to their calcium-precipitating properties.

Conclusions.

The natural clotting of *Hevea* latex is aided by the addition of calcium chloride.

So far, salts of other metals have not been found to produce an equal effect. This natural clotting is, on the other hand, retarded or inhibited by:— (1) Heating; (2) addition of neutral or faintly acid solutions of precipitants of calcium, namely, potassium oxalate and sodium fluoride; (3) rendering the latex alkaline in reaction; (4) formalin.

In the case of (4) it may be noted that the phenomena are somewhat complicated by the fact that by the prolonged action of formalin on latex, a peculiar condition of the latex is produced. It retains its superficial appearance but is in reality a suspension of flakes of coagulated rubber in a clear serum, the Brownian movement of the particles having ceased. The factors concerned in the "natural" coagulation of latex are, like those concerned in the coagulation of blood, somewhat complex. In the latter case it is not yet clear how the coagulation is effected.

Nolf has stated that it consists in the interaction of three colloidal proteins, thrombogen, thrombozyme, and fibrinogen, in the presence of calcium salts.

According to Morawitz, the thrombogen in the circulating blood is converted by a thrombokinase, which is present in the tissues, into prothrombase which is changed by the action of calcium ions into the active form of the coagulating enzyme thrombase.

According to Pekelharing, thrombin is the calcium compound of prothrombin, the nucleo-protein which occurs in blood-plasma.

In view of the uncertainty as to the mechanism of the coagulation of blood it is not proposed here to offer explanations as to the mechanism of the coagulation of latex. From the evidence obtained, however, it is fair to assume that:—

(1) The natural coagulation of latex depends upon the action of an enzyme.

(2) The action of this enzyme is encouraged by the presence of calcium ions.

(3) The enzyme does not act in an alkaline medium, and

(4) according to Whitby the coagulation can take place in the absence of air.

Speculations as to the reason why latex does not coagulate in the latex vessels of the tree under normal conditions would no doubt prove as interesting as similar speculations as to the non-coagulation of blood in the blood vessels of the body.

It has frequently been stated by various investigators that latex as it emerges from the latex-vessels is alkaline in reaction, afterwards becoming acid on exposure to air. It is possible that the coagulating enzyme is enabled to act only on the development of this acidity.

In the experiments quoted above, the addition of a given amount of calcium chloride to a given amount of latex on one day did not produce the same effect as an equal amount of calcium chloride on the same amount of latex on another day. The same remark applies to the action of potassium oxalate and of sodium fluoride.

This difference is probably due not to the fact that the latices on the 2 days contained different amounts of enzyme, but rather to the fact that the latices had been examined at different times after collection. The action of the enzyme had already proceeded to a greater extent in one case than in the other.

It is to be noted that latex contains a carbohydrate, *l*-methylinosite.

Many enzymes appear to be combinations of protein and carbohydrate, and it is possible that *l*-methylinosite may prove to be part of the enzyme of *Hevea* latex.

Serum from pure latex contains up to 4% of solid matter.

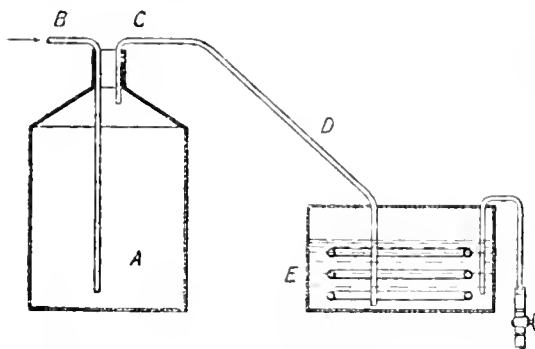
This work is being continued, but it is thought that the results already obtained are of sufficient interest to justify the publication of this preliminary note.

The thanks of the author are due to Messrs. K. C. Browning and C. T. Symons of the Government Analysts' Department, Ceylon, for suggestions and assistance.

STEAM DISTILLATION.

BY F. J. TROMP.

In a series of experiments in which the author had to distil large amounts of aniline in the laboratory he was led to devise a condensing apparatus which considerably shortened the time usually taken for such distillations.



The liquor which is to be distilled is contained in the vessel, A. Steam enters at B, passes out at C, and is led by means of D below the surface of some water in E. The water in E is cooled by means of a cooling coil. As the liquor collects in E, it may be siphoned off. Once the air has escaped from A, there appears to be practically no limit to the rate at which the steam can be passed. Condensation is complete so long as the liquor in E is below the boiling point. It is possible to heat the liquid in the cooling coil to above 80° C. and still have efficient condensation.

If a number of vessels similar to E were connected in series by means of siphons and cooling coils, the apparatus would serve as a rapid and efficient condenser, and would be very suitable on the large scale for utilising the heat from the condensed vapours.

Faraday Society.

THE TRAINING AND WORK OF THE CHEMICAL ENGINEER.

A general discussion on the above subject was held at the Faraday Society on March 6th.

The President of the Society, Sir ROBERT HADFIELD, in opening the discussion, said that each important branch of industry demanded its own special type of chemist, and no course of training could cover all the requisite ground; thus a chemist suitable for the chemical industry would probably not shine as a chemist in the industry of ferrous metallurgy, for the ferrous metallurgist had to deal with a large range of high temperatures, up to and exceeding 3000° C., in addition to the much lower "treatment temperatures" and those used in tempering work. It would be advisable if somewhat early in his training the student could more or less branch to a special study of the line of work with which he expects later to be associated. He felt that, in some respects, a chemist of the first rank was born and not made. It was most desirable that increased facilities should be given to training chemists to meet those conditions which would arise after the war.

Sir Robert then alluded to the benefits which the world had derived from the discoveries of

British chemists, and also referred to the State organisation of scientific research, expressing the hope that the efforts of the Advisory Council would bear good fruit. He mentioned that in 1914 there were 69 agricultural colleges in America, with an annual income of £7,000,000, and instructing 60,000 students, and also that the Bureau of Standards expended annually about £125,000 on research work.

Sir Robert concluded with an appeal for support for the Ramsay Memorial Fund, one of the objects of which was to establish a laboratory for dealing with engineering chemistry.

In the course of his introductory address, Sir GEORGE BELLBY pointed out the danger that the present war conditions might encourage the development of unbalanced proposals for the training of the future leaders and workers in industry, and that it was desirable to make the general relation of chemical engineering to industrial chemistry as a whole more clear. He had always considered chemical engineering to have as its function the design and construction of apparatus required for carrying out chemical processes on a manufacturing scale. In the future the control of processes in the factory must pass more and more into the hands of trained chemists, but no amount of purely scientific training would produce the right type of man for this purpose. A man might easily be over-trained if left too long amidst purely academical surroundings. Laboratory training tended to produce a narrow individualism which might be a serious disqualification for the work of the factory. He strongly recommended a certain amount of engineering training in the education of the industrial chemist in the majority of cases; the heads of the engineering department could select from the chemical students those who showed special mechanical aptitude, and these could then be given further training in engineering. The training of the industrial chemist should consist of a sound and practical three years' course in chemistry and chemical physics, at the end of which the student should be advised in what direction to specialise; average students with no special bent should complete their four years' course by general advanced studies, but those fitted to become chemical engineers, research chemists, and specialists in other branches should devote one or two years to higher post-graduate study.

To fulfil his proper functions the chemical engineer must have a great deal of knowledge and experience quite outside the range of the ordinary engineer, and must know from within the chemist's as well as the engineer's point of view. Since the chemist's views of matter and energy were much further removed from every-day notions and conceptions than are those of the engineer, it was wiser first to imbue the mind of the future chemical engineer thoroughly with the chemical point of view.

Prof. F. G. DONNAN, in the course of a paper on "The Training of the Chemical Student for work in the Factory," said that there were three broad lines upon which to train a man for future work in connection with chemical processes in the factory, viz., (1) thorough and extensive chemical training, with a certain amount of training in engineering; (2) a pretty extensive training in both chemistry and engineering; (3) a further study of chemistry for those who have received or are receiving a thorough training in engineering. Method (1) produces the chemist (research chemist), method (2) the engineer-chemist, and method (3) the chemical engineer. The research chemist should possess a good knowledge of physics and physical chemistry with some idea of engineering science. Engineer-chemists, who are required in

very large numbers, must receive a very considerable amount of engineering training, and should possess sound "horse" sense, cool quick judgment, power to control workmen, and courage in the face of danger. The training of both these types must include research, which, in the case of the engineer-chemist, should take the form of an investigation of the conditions which determine how a given chemical process can best be carried out on a technical scale. The essential for men of class (3) is that they are thoroughly trained engineers. In chemical engineering there lies the greatest and most lucrative field of development for engineering science, and schools of chemical engineering should be founded without delay.

Mr. W. R. COOPER, in "A Plea for the Forgotten Factor in Chemical Training," urged that the financial side of chemistry should not be neglected during the training of the chemical student. He should appreciate the fact that manufacturing cost is only a part of the total, and that the cost of selling, depreciation of plant, etc., must be considered. Further, costs must be divided into "overhead" and running costs. The commercial efficiency of plant is also of importance; for instance, it may be worth while to have a lower technical efficiency if this increases the utility factor, *e.g.*, the ratio of the quantity of material actually produced in a given time in a discontinuous process to the quantity produced if the plant were working continuously under the best conditions. The speed of reaction is another point to be considered. He suggested that three months might be devoted to this part of the subject at the conclusion of the technical course.

Mr. CHARLES R. DARLING read a paper on "The Training of the Works Chemist in Physics," in which he described the course of instruction in physics at the City and Guilds Technical College, Finsbury, in which students receive a training to fit them to enter works as chemists. He said that physico-chemical subjects, such as electro-chemistry, osmotic pressure, etc., are dealt with in the Chemical Department, either following or parallel with instruction in sound, light, heat, and electricity in the Applied Physics Department. During the three years' course the student received about 120 lectures in purely physical subjects, and spent about 200 hours in the Laboratories. Instruction in light includes a description of, and practical work with, the optical instruments used in industries, whilst the course on heat includes fuels, electrical heat production, fusion, pyrometry, heat insulation, etc.

Mr. J. W. HINCILEY, describing "The Work of the Imperial College in the Training of Chemical Engineers," said that the Department of Chemical Technology was inaugurated in 1912. The students here obtain practical acquaintance with experimental units of filter-presses, reaction towers, stills, grinding mills, etc., they make original designs of simple plant for a given output of product, and finally study the process on a suitable scale. They design the plant, prepare specifications and estimates, and determine the cost of production, and also devise a system of factory records for controlling the plant and plan a factory for the manufacture.

Sir ARTHUR DUCKHAM thought that the engineer-chemist should not try to go too deeply into engineering, but should simply be able to think as an engineer and appreciate engineering problems. He agreed that the chemical engineer, the engineer who could think as a chemist, was essential. He emphasised the value of practical training, and said that it was necessary to introduce the practical work of the factory into the college, where it should be taught by practical men. The questions

of fuel economy and fuel utilisation were of the highest importance, and must always be kept in view by the engineer-chemist and the chemical engineer.

Prof. A. K. HUNTINGTON agreed with Mr. Cooper as to the necessity of teaching the student to think of a problem from a financial point of view. It must be borne in mind that because a process cannot be economically worked to-day, it did not follow that it would not pay a year or two hence, since knowledge was increasing at such a vast rate. He mentioned that the Haber ammonia process could be worked at a pressure of 200 atmospheres, which would have been impossible a few years ago. Referring to the deficient nature of the technical education in this country, he attributed it to the fact that the student came to college altogether inadequately equipped in mathematics. He thought the scientific man was rather to blame for the antagonism which had existed between scientific and practical men in the past. The theories of the scientific man did not always work out in practice, owing to the fact that he did not get into touch with practical work, and was therefore apt to overlook certain important factors in a problem.

Mr. A. P. M. FLEMING expressed it as his opinion that engineering experience, which was necessary to every chemist, should partly be obtained in the works. In that way the chemist would get to understand men, and that might do away with the inherent antipathy to the chemist which existed in many English works. It was essential for every chemist to get into early touch with the works, so as to get some grip of manufacturing processes. He was trying a scheme in which his chemists were put for a year into the shops before they came into the laboratory. He was of the opinion that post-graduate courses might with great advantage be spent in the works. Finally, he urged the necessity of employers using every means to attract to engineering and chemistry the best brains in the country.

Dr. W. ROSENTHAL said that in training students it was necessary to encourage breadth of view. A man trained solely as a chemist or solely as an engineer tended to lack that breadth of view, and probably much better results would be obtained by a course of training as outlined by Prof. Donnan. The antagonism between theory and practice, alluded to by Prof. Huntington, arose from the complexity of industrial problems. In the laboratory the conditions of a problem could be simplified to a large extent by isolating the factors, but in a works the problems had to be dealt with by methods of approximation and frequently by insight, which could only be acquired by those possessing the necessary breadth of view and reasoning power. His own experience was that the most useful man for elucidating practical problems was one who had changed his opinions half way, or better, one who had been trained in one direction, and had been later impelled to take up another line of study. A man expert in one subject and in nothing else was always liable to be in trouble when he got out of his own groove.

Dr. R. ROBERTSON said that the necessity for engineer-chemists had been brought home to them by recent events. A course of engineering should be introduced into the training of every chemist, because, apart from the fact that it would be of direct benefit to the student, it might enable the professor to differentiate between students fitted for purely research work and those adapted to applied science. He agreed with what had been said as to the value of contact with the reality of works practice, and mentioned that in the nitro-glycerin works at which he had been engaged, chemists who were to take charge of a process had

to go into the works and perform the duty of each of the men attached to that process. Post-graduate students might be set a practical problem not necessarily a novel one—but a specific problem to solve with certain facilities and in his own way. A man who had shown himself capable of tackling such a problem would be very useful in a chemical works.

Mr. W. MACNAB thought that the teaching institutions were to some extent to blame for the lack of engineering chemists in this country. It was true that some chemists received very small salaries, but they were often not worth more. The chemist now had ample opportunity of showing his value, and engineering training must take a part in his education. The exchange of views which was now taking place between manufacturers would be of the greatest benefit to the nation at large.

Prof. E. G. COKER thought that the scheme of putting students to solve problems in the works would to a large extent overcome the difficulty in placing young engineers in suitable positions. He agreed that chemists should receive some training in engineering, but considered that it should be a training of a special kind, so as not to deal with subjects which would be of no ultimate value to the student.

The PRESIDENT, speaking of competition, said that it was the life-blood of trade, and we did not fear fair competition of the type we looked for from America; the type which was difficult to meet was the so-called peaceful penetration system of Germany.

Lieut. GREENWOOD said that it was lamentable that in many chemical works the design and erection of the factory was entrusted entirely to the engineer, with the result that the chemist often took little interest in the matter afterwards. The remedy was to be sought in our educational system, and students who intended to go into industrial work should receive a training in applied physics and engineering. Great prominence should also be given to physico-chemical subjects, since the modern process tended more to involve physical methods for its control and less to depend on analysis.

Mr. C. S. GARLAND agreed as to the value for chemists of some training in engineering. The chemist must be induced to take up the most important chemical work in this country, viz., manufacture.

Dr. E. F. ARMSTRONG said that his experience had been that there had been no difficulty in getting men of the type described by Prof. Donnan as engineer-chemists. He agreed that research chemists were of great value, and the aim of teaching institutions must be to produce well-trained chemists first of all; at a later stage of training the professor could select those with mechanical aptitude and those suitable for research work, with a view to suggesting specialisation. It would also be a great advantage if the Universities were to get into closer touch with industry by inducing manufacturers to become members of their academic councils. The management of a works, with its commercial and other problems, soon lost touch with science, and must depend very largely on chemists. Industries had been revolutionised by men who had specialised in certain branches of science, such as the phase rule and colloid chemistry. He believed that if a hundred leading chemists engaged in industry were asked what was their deficiency as the result of their training, they would agree that it was a lack of greater knowledge of chemistry. He mentioned that of the three really great achievements of industrial chemistry in recent years, viz., synthetic ammonia, artificial silk, and fat hardening, the two last had been worked out entirely in this country, although fat

hardening had actually been discovered by a German. Synthetic ammonia was a German process, but it had not appealed to us because we had plentiful supplies of cheap ammonia.

Mr. W. GATHORNE YOUNG agreed with Prof. Donnan as to the training of the engineer-chemist, and considered that it should consist of a three years' scientific course at a University, including elementary instruction in engineering, followed by a two years' post-graduate course in general chemical engineering; during this latter course systematic visits to chemical works should be arranged, and the student should work at these factories during his vacations. He was sure that manufacturers would be willing to co-operate with Universities in the matter, as it would give them opportunities of securing useful additions to their staff. He thought British chemical industry had done remarkably well during the last 30 years, considering the poor inducement that chemists had been offered.

Mr. T. G. ELLIOTT agreed as to the necessity of better secondary education, particularly in regard to a course of physics. He thought that the system followed by our northern Universities of specialising in the industries of the district, was an admirable one.

Written communications were received from Mr. F. H. Carr, Dr. P. E. Spielmann, Mr. H. L. Heathcote, Dr. E. B. R. Pridaux, and Mr. G. S. Albright.

Industrial Notes.

CHEMISTS IN WAR.

Under the above title the Registrar of the Institute of Chemistry has written an interesting account of the part chemists have played in the present war, from which the following passages are taken:—

Owing to the conditions of modern warfare chemists have been more than ever in request. The Government has secured the guidance of chemists and other men of science to assist in the investigation of suggestions and inventions and to bring their knowledge and experience to bear on measures and devices of offence and defence, while apart from those acting in an advisory capacity, chemists have been called for service in the field as well as in the factory. In such times there is a demand for the solution of problems of an unusual character which can only be entrusted to men of the highest scientific training, with initiative and foresight.

So much had we come to rely on foreign sources of supply for many of our needs, that means had to be found for dealing promptly and efficiently with difficulties some of which, unless overcome, threatened serious disaster. The chemists of the country have not been found wanting.

The laboratories of our universities and colleges have become small factories for the preparation of drugs and medicaments, and many institutions have been entrusted with the examination of materials used in the manufacture of explosives. The measures taken in this emergency secured uniformity in method and the standardisation of processes which would otherwise have been difficult to attain. Under the supervision of their professors, students unfit for service with the colours have been helping the country and at the same time gaining useful experience.

Several hundred chemists have been engaged for assistance in the laboratories and in the works of Government and controlled establishments supplying armaments, munitions, and other materials of war. In cases where the number of

men having technical experience in some branches was limited, the authorities have made arrangements for probationary training, so that their services should be available when required in new factories.

The staffs of the chemical departments of Woolwich Arsenal and other Government factories have been considerably augmented, as also that of the Government Laboratory, which, as the recently published report shows, has been largely responsible for the examination of foodstuffs and many other requirements of the Expeditionary Forces.

In previous wars the authorities have considered officers of the R.A.M.C. sufficiently trained for all necessary military duties involving chemical knowledge, but in the present conflict, with an unprecedented demand for medical men, qualified chemists have volunteered in such numbers as to give practical force to the suggestion that they should be engaged for the purification and examination of water supplies and for dealing with matters of hygiene requiring chemical knowledge. As a result many have been appointed to commissions and engaged for scientific work, not only with the R.A.M.C., but also with the A.S.C., A.O.D., and other units. Attached to various forces at home, with the armies on the Continent and in Africa, chemists have thus rendered valuable service.

In consequence of methods of offence initiated by the enemy, such as the employment of poisonous gases, there arose a further demand for men with training in chemistry for service in the field. For the duties involved the authorities deemed it expedient to enlist men with such training, rather than entrust them to men without any scientific knowledge, and the unit thus formed is a fighting force. With the assistance of the universities and technical colleges and the various bodies interested in chemistry, an entirely new force was brought into existence. At that time there was no question of compulsion, yet it was raised with little difficulty, being subsequently augmented by the addition of other troops. The men went voluntarily, and were sent abroad at very short notice, and after short training went into action. The officers were mainly selected from chemists who already held commissions, while sergeants and corporals with knowledge of chemistry were transferred from other units. That they did their work well is shown by the dispatches of Lord French and Sir Douglas Haig, dated October 15th, 1915, and May 19th and December 23rd, 1916.

High qualifications were unnecessary for the work of the rank and file, but many very competent men joined, and it may be mentioned incidentally that it was remarked on an early occasion that generally speaking the best qualified chemists proved the best soldiers. The majority of the university graduates and men possessing recognised diplomas, who originally enlisted as corporals, subsequently received commissions, and when the force was more completely organised a considerable number were withdrawn and transferred to the Ministry of Munitions in order that their services might be available in work of a more scientific character.

Mention should also be made of the fact that during the campaign against the rebels in South Africa and the Germans in South-West Africa chemists were attached, on the personal order of General Botha, to the different brigades and rendered valuable service.

From the experience gained in the campaign it is clearly advisable that the State should have control of such an organization of professional chemists as to ensure at any time their efficient service in the many requirements of the naval, military and air forces. In addition to competent chemical advisers of undoubted standing, the following appear to be essential:—

Chemists to control the manufacture of munitions explosives, metals, leather, rubber, oils, gases, food, drugs.

Chemists for the analysis of all such materials and for research.

Chemists, on active service, to assist in the control of water supplies, in the detection of poison in streams, in the analysis of water and food, in the disposal of sewage, and in other hygienic matters.

Chemists, both at home and on active service, to assist in devising safeguards against enemy contrivances of a scientific nature, and methods of offence to meet the same, as well as for the instruction of troops in such matters.

To sum the matter up, chemists have met the situation with a spirit of true patriotism and have been promptly organised for the service required of them. It is not too much to hope that, as the discoveries of science have been applied to the destruction of humanity, they may be devoted more and more to the furtherance of the arts of peace, to the uplifting of civilisation and the pacification of the world.

During the war, in spite of the shortage of labour, considerable additions have been made to the large manufacturing concerns throughout the country in the extension of factories, both for the production of things hitherto obtained from abroad and for the requirements of the war.

One important lesson which on no account must be lost sight of is that the country must be self-supporting in all such requirements.

The chemists engaged in connection with the production of materials of war include a large number who were previously occupied in works which have passed under Government control. Most of these were members of the Institute or graduates in science and many were teachers, who thus obtained an insight into operations on a manufacturing scale. If they return to teaching, this experience will have broadened their views, but many will no doubt prefer to remain in industry. Of those with the forces, probably the majority will return to their former work. In any case, many good British chemists should be available for the furtherance of British industry.

THE FOOD SUPPLY OF THE UNITED KINGDOM.

At the request of the President of the Board of Trade, a Committee was appointed by the Royal Society in 1916 to report upon the food supply of the United Kingdom. The Committee comprised Prof. A. D. Waller, F.R.S. (Chairman), Prof. W. J. Ashley, Mr. A. W. Flux, Mr. A. D. Hall, F.R.S., Prof. F. G. Hopkins, F.R.S., Mr. T. H. Middleton, Prof. D. Noel Paton, Prof. W. H. Thompson, and Prof. T. B. Wood.

The first part of the report of this Committee [Cd. 8421] deals with the food supply of this country in the period before the war. The quantities of the various food materials available for human consumption in the five years before the war (1909-1913) are given in tabular form; the statistics of home-grown foods are admittedly liable to error, but as considerably more than half of our food supply is imported and the import statistics are on the whole sufficiently accurate, the ultimate error in the figures given is much reduced.

The subjoined table shows the average quantities of food materials (imported and home produced) available for the United Kingdom during the five years, 1909-1913, inclusive, together with the amounts of protein, fat, and carbohydrate present and the energy value. The average population is taken as having been 45·2 millions.

	Amounts.	Protein.	Fat.	Carbo- hydrate.	Energy value. Millions of Calories.
	Metric tons.	Metric tons.	Metric tons.	Metric tons.	
Cereals	4,865,000	549,000	63,000	3,628,000	17,712,000
Meat	2,685,000	356,000	799,000	—	8,890,000
Poultry and eggs, game and rabbits	331,000	42,000	31,000	—	461,000
Fish	848,400	91,000	17,000	—	531,000
Dairy produce (including lard and margarine)	5,231,800	199,000	686,000	258,000	8,253,000
Fruit	1,271,000	9,000	14,000	222,000	1,077,000
Vegetables	5,482,000	120,000	10,000	1,031,000	4,812,000
Sugar, including cocoa and chocolate	1,657,000	5,000	18,000	1,572,000	6,633,000
Cottage and farm produce not included above	—	67,000	13,000	551,000	2,655,000
Total	—	1,438,000	1,651,000	7,262,000	51,024,000
Per head per day	—	grms. 87	grms. 100	grms. 440	3,091 Calories
Per "man"† per day	—	113	130	571	4,009 ..

* Negligible quantity.

† A "man" is an average workman doing an average day's work. One hundred of the total population (men, women and children) are reckoned as equal to 77 "men."

As a result of a full consideration of the dietary requirements of a nation for the most part engaged in active work, the Committee is convinced that these requirements cannot be satisfactorily met on a less supply of food, as purchased, than 100 grms. of protein, 100 grms. of fat, and 500 grms. of carbohydrate, representing approximately 3400 calories, per "man" per day. This has been adopted as the minimum standard. From the figures for available food supply and the minimum standard it is calculated that there has been either wasted or consumed in excess of requirements 11—14% of protein, 25—30% of fat, and 10—14% of carbohydrates.

In Part II. of the Report, the food supply during 1916 is considered, on the assumption that the pre-war supply is maintained. The total population is estimated at 46·5 million, of which four million were our fighting forces at home and abroad; this leaves a civil population of 42·5 million, equal to 31·8 million men. The food requirements for the fighting forces is calculated from the Army Rations, and the calculations show that, on the pre-war basis of supply, the food available for the civil population would be more than sufficient, both as regards the supply of protein and of energy. From the information available to the Committee it is believed that the available amount of protein, fat, and carbohydrate per "man" has been maintained at about the normal level, but the needs of our armies, the decreased yield of the harvest at home in 1916, and the possible interference with imported foods, may reduce the supply in the future below this level.

Up to the present the supply of food has provided a general margin of about 5% above the minimum necessary for proper nutrition, and rather more as regards the supply of energy, so that a reduction could be borne without serious consequences provided the available food were equitably distributed. It is pointed out that if the rising prices curtail for any class of the community its accustomed supply of food, its output of work will be reduced, and that a slight reduction of food below the necessary amount causes a large diminution in working efficiency.

Part III. of the Report deals with certain suggestions as to possible means for increasing or economising our available food supply. (1) *Better recovery of flour in milling.* Under present conditions millers obtain on the average about 70% of flour from cleaned wheat, but many mills could readily be adjusted to recover 80%

of the wheat as flour, and this 80% flour makes wholesome and palatable bread. It is calculated that the gain for human consumption which might result from raising the milling standard from 70% to 80% (after making allowance for the reduced digestibility of the 80% flour and for the decrease in production of pig meat due to removal of 10% of offals from the market) would be 31,000 metric tons of protein and 866,000 million calories. (2) *More economical meat production* is possible in several directions, e.g., slaughtering cattle when 17 months old instead of at 2½ years, discontinuing fattening when no increase in weight is shown, and feeding animals which are good "converters" of fodder into energy. (3) By adopting *cheese-making* as a general practice in place of butter-making it is calculated that an annual saving of 55,000 tons of protein would be effected. (4) The economy which might be effected by the *prohibition of brewing* was dealt with in the last issue of this Journal (p. 198).

Note.—It will be observed on reference to page 301 of this issue that it is now compulsory on all millers to extract from wheat not less than 81% of flour.

MINERAL PRODUCTION OF THE UNITED KINGDOM IN 1915.

THE subjoined table, showing the mineral produce of the United Kingdom, is taken from the Report on Mines and Quarries, Part III. [Cd. 8441].

The average price of coal in 1915 was 12s. 5·60d. per ton in 1915 as compared with 9s. 11·79d. in 1914. The quantity of coal exported, exclusive of coke and manufactured fuel and of coal shipped for the use of steamers engaged in foreign trade, was 13,534,560 tons. France received over 17½ million tons, Italy over 5½ million tons, Denmark over 3 million tons, Sweden over 2½ million tons, Norway over 2½ million tons, the Netherlands over 1½ million tons, the Argentine over 1½ million tons, Spain over 1½ million tons, and Egypt over 1½ million tons. Adding the 2,786,401 tons exported in the form of coke and manufactured fuel, and the 13,630,961 tons shipped for the use of British and foreign steamers engaged in foreign trade, the total quantity of coal which left the country was 59,951,925 tons, as against 80,993,890 tons in 1914. The amount of coal remaining for home consumption was 193,254,156 tons, or 4·193 tons per head of the population. 37,284,600 tons was used in the manufacture of coke and briquettes,

Description of mineral.	1914.		1915.	
	Quantity.	Value at the mines and quarries.	Quantity.	Value at the mines and quarries.
	Tons.	£	Tons.	£
Alum shale	6,078	607	7,911	791
Antimony ore	—	—	21	59
Arsenical pyrites	—	—	421	233
Arsenic	1,988	19,052	2,496	32,779
Barium (compounds)	48,930	43,506	62,477	79,829
Bauxite	8,286	2,159	11,723	3,163
Bog ore	2,342	585	1,986	496
Chalk	4,291,170	197,154	3,233,897	155,560
Chert, flint, etc.	76,213	13,304	102,698	15,539
Chromite	100	50	—	—
Clay and shale	13,124,361	1,731,779	8,871,821	1,172,877
Coal	265,664,393	132,596,853	253,266,081	157,830,670
Copper ore	2,373	13,985	579	3,084
Copper precipitate	185	5,529	243	9,938
Fluorspar	33,816	11,005	33,123	11,484
Gold ore	47	318	5,086	3,389
Gravel and sand	2,498,872	215,351	2,350,267	213,373
Gypsum	265,365	83,868	247,229	78,747
Igneous rocks	7,135,243	1,369,242	6,085,415	1,200,212
Iron ore	14,867,582*	3,921,683	14,235,012†	4,587,651
Iron pyrites	11,654	4,759	10,535	4,873
Lead ore	26,013	309,813	29,744	295,071
Lignite	300	159	1,783	536
Limestone (other than chalk)	12,158,441	1,295,512	11,115,909	1,306,268
Manganese ore	3,437	2,931	4,640	4,640
Natural gas	87,000 cubic feet	Not stated	87,000 cubic feet	Not stated
Ochre, umber, etc.	11,069	10,635	8,989	9,641
Oil shale	3,268,666	837,249	2,998,652	836,593
Salt	2,069,989	560,893	2,005,605	607,251
Sandstone	3,464,528	1,037,096	2,520,856	758,325
Slate	318,912	806,196	226,037	452,819
Soapstone	180	90	850	575
Sulphate of strontia	13,157	10,439	640	688
Tin ore (dressed)	8,085	681,865	8,144	668,609
Tungsten ores	205	19,722	331	44,803
Uranium ore	344	Not stated	82	Not stated
Zinc ore	15,419	56,652	12,057	70,383
Total values	—	145,863,032	—	170,460,949

* Exclusive of 400 tons of micaceous iron ore, used for paint, and placed under the heading "Ochre, Umber, &c."

† " 312 " " " "

and 2,509,456 tons of coal with 9,746,743 tons of coke (equal to 16,244,572 tons of coal) in the blast furnaces for the manufacture of pig iron, as against 36,289,010 tons and 18,381,106* tons respectively in the previous year. 20,059,140 tons of coke

was obtained in 1915, valued at £18,270,018. 16,574 coking ovens were in use during the year. 1,697,541 tons of briquettes was produced, valued at £1,755,406.

During 1915 the output of iron ores was 11,235,012 tons, yielding 4,567,351 tons of iron, or more than half of the total quantity of pig iron made in this country.

* Previous to 1915 the actual quantity of coke used was not furnished. This figure therefore represents the coal used and the equivalent in coal, or coke used.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each, to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.

United States.—1s. each, to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—Patent number, date, name of patentee, and title of invention.

French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Behn et Cie., 56 Rue Ferou 8 Paris (3e) Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

PATENTS.

Regenerator. L. Bergfeld, Durlach. Ger. Pat. 295,436. July 1, 1913.

A SERIES of glass balls passes first through the hot, escaping gases or liquid, and then through the gas or liquid which it is desired to heat. The balls travel in the opposite direction to the gas or liquid.—A. B. S.

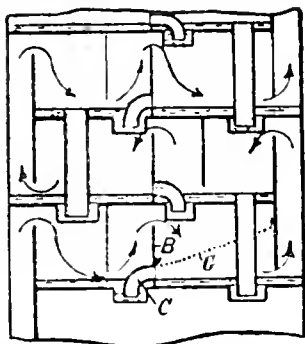
Catalytic reactions; Method of carrying out. J. Walter. Geneva, Switzerland. Ger. Pat. 295,507, Apr. 20, 1913.

MECHANICAL agitation of the catalyst is effected by the application of a magnetic field. If the catalyst itself is not magnetic it is supported on a magnetic body. By rapidly making and breaking the circuit forming the magnetic field, fresh parts of the catalyst can continually be brought into contact with the reacting substances and the catalyst can be moved to different parts of the

apparatus. For reactions with gases the catalyst is supported preferably on nets or perforated plates, and a magnetic field is maintained permanently near the outlet to cause the settling of any material carried along by the gas.—J. N. P.

Distilling and rectifying columns. Metallwerke Neheim A.-G. Ger. Pat. 291,781, July 11, 1911.

The spaces between the perforated plates of a vertical column are each divided into two compartments by a



partition, *B*, provided with an overflow pipe, *C*. The vapour ascending the column takes the path shown by arrows and the is brought repeatedly in contact with the condensed liquid, but does not bubble through the latter. Pieces of wire gauze, *G*, may be provided to effect better

distribution of the vapour. Radial or concentric partitions may be used in place of the transverse partitions, *B*, and the spaces may be so connected that the vapour is forced to bubble through a layer of the condensed liquid.

Lead linings of vessels; Increasing the resisting power against mechanical shocks of —. F. Schüller, Frankfurt. Ger. Pats. (A) 295,556, Oct. 7, 1915, and (B) 295,557, Nov. 9, 1915. (A) Addition to Ger. Pat. 288,571 (this J., 1916, 365).

(A) After applying the small pieces of metal harder than lead, as described previously (*loc. cit.*), the lead is heated to its melting point; or the pieces of hard metal may be embedded in the lead after heating the latter to the melting point, or may be added to molten lead and the latter then cast in position. (B) Effective hardening of the lead is brought about by heating and at the same time subjecting to mechanical working such as kneading, pressing, and rolling.—J. N. P.

Centrifugal dryer. K. and A. Ward, Stockholm, Sweden. U.S. Pat. 1,213,983, Jan. 30, 1917. Date of appl. Apr. 30, 1914.

See Eng. Pat. 10,783 of 1914; this J., 1911, 1192.

Separation of colloids from mixtures by electro-osmotic action. Ger. Pat. 295,666. See XI.

IIA.—FUEL; GAS; MINERAL OILS AND WAXES.

Coke production in the United Kingdom in 1915.

PART III. of the General Report on Mines and Quarries for 1915 [Cd. 8114] contains full particulars as to the quantity of coke produced. The figures show that 35,690,342 tons of coal was carbonised producing 20,059,140 tons of coke, valued at £18,270,018. Gas works produced 8,150,200 tons and coke ovens 11,908,919 tons. All these figures are higher than those for 1911. The total number of coke ovens in operation during 1915 showed a decrease as compared with the preceding year, the figures being 16,571 and 17,025 respectively. It is

satisfactory to note, however, a considerable reduction in the number of beehive ovens used, viz., from 9210 to 7521, whilst the by-product ovens increased from 7815 to 9053. Increased numbers of Simon-Carvès, Otto-Hilgenstock, Semet-Solvay, Koppers, Simplex, Huessener, and Collins ovens are noted, whilst fewer Coppée ovens were in use.

Scottish shale industry: Appointment of Committees on the —.

THE Minister of Munitions, after consultation with the Admiralty and the Home Office, has appointed the following Committees to deal with certain problems connected with the Scottish shale industry:—

Owners' Committee.—Mr. John Wishart (Chairman); Mr. J. C. Clarke, Admiralty; Mr. A. H. Thrichton; Mr. H. Fraser; Mr. A. Kerr; and Mr. William Love.

Workmen's Committee.—Mr. John Byrne; Mr. Robert Hood, President, Shale Miners' Association; Mr. John Kilday; Mr. Michael O'Hagan, General Secretary, Oil Works Association; Mr. Robert Simpson, General Secretary, Shale Miners' Association; and Mr. H. Walker, H.M. Divisional Inspector of Mines.

The Minister has appointed Professor John Cadman to represent the Ministry of Munitions in connection with this subject, and to act as Chairman of the two Committees on any occasion on which they meet in joint session. Sir George Beilby will act as technical adviser on the questions within the purview of the Committees, and Mr. Hugh Johnstone has been appointed to be a member of, and to act as Secretary to, the Committees.

Wood charcoal; Heat of combustion of —. N. I. Nikitin, J. Russ. Phys.-Chem. Soc., 1916, 48, 51–75.

VARIOUS methods of drying charcoal to constant weight have been investigated. Satisfactory results are obtained by drying in a desiccator over sulphuric acid, and with charcoal which has been stored in the air for a year or more the dry weight obtained in this way is almost exactly the same as that given by five hours' heating in an oven at 103° C., whilst a further heating for three hours at this temperature is without appreciable influence. On the other hand, charcoal which has been recently prepared exhibits progressive increase in weight when heated at 103° C., probably owing to oxidation, which also occurs, although slowly, at the ordinary temperature. Eighteen samples of charcoal prepared from different kinds of wood by carbonising, some in heaps and others in retorts, have been analysed and investigated as to calorific value. The percentage of carbon varied from 73.01 to 92.11 and was always higher in heap charcoal than in retort charcoal; the proportion of hydrogen varied from 0.64 to 1.71%. The values for the heats of combustion, calculated by means of either Dulong's or Mendeléev's formula, were always less than the experimental values, and in general the divergence increased with the proportion of oxygen and nitrogen taken together, although the introduction into these expressions of a correcting term was not found possible. Calculation from the author's experimental results shows that the number of calories generated by the combustion of 1 gram of charcoal is given very closely by the expression, $80.51 C + 273.4 H$, *C* and *H* representing the percentages of carbon and hydrogen in the dry charcoal. The errors of the values calculated from this formula lie between the limits, $\pm 0.63\%$ and $\pm 0.17\%$, and, for a sample of brown charcoal

and dividing each by the number n of oxygen atoms necessary for complete combustion, values of H/n are obtained which are remarkably constant. This is shown in a graph in which the measured heats of combustion of 121 compounds (hydrocarbons, halogen compounds, ethers and acetals, alcohols, aldehydes and ketones, acids and anhydrides, esters, mercaptans and other sulphur compounds, cyanogen compounds, nitro-compounds, and amines) are plotted against the oxygen atoms per molecule required for complete combustion in each case. Many of the points practically coincide, and a straight line drawn from the farthest to zero touches 55 of them. The heat of combustion is therefore, as a first approximation, proportional to the number of oxygen atoms which combine with a molecule of combustible gas, irrespective of molecular complexity and of whether carbon or hydrogen is burnt, and is equal to $53n$ kilo-calories per gram-molecule. This suggests, as the essential feature of combustion, that oxygen is first sensitised by contact with the source of ignition and becomes an immensely active agent, atoms of which are able to seize upon and tear apart the almost unresisting hydrocarbon molecule. The heat of the reaction, being all translational energy, is the result of the speed with which the oxygen atoms rush into combination, and is therefore proportional only to their number. This is capable of interpretation, in many instances, in terms of the regular occurrence of the CH_2 radicle; but it also suggests that the heat of combustion of carbon being twice that of hydrogen may not be altogether accidental, but may be an example of this general relation from which the value for CH_2 is itself derived. If the combined oxygen in nitro-compounds be regarded as used in their combustion, a much higher value for H/n is obtained; thus the value for nitromethane, which requires only 1½ atoms of oxygen per molecule, is 120.5. But if the combined oxygen be regarded as not used in the combustion, nitromethane would require 3½ atoms of oxygen per molecule, in which case the value of H/n would be 51.7 and in line with that of other organic compounds. This opens a question as to the part played by combined oxygen in explosives. From the relation, $H=53n$, the quantity of air required for the complete combustion of any hydrocarbon of unknown composition, such as

million galls. The tendency has also been in the direction of the production of pure compounds, probably 80% of the present production being worked up into pure benzene and toluene. The future field for benzol products includes industrial blasting explosives, paints, varnishes, grease and fat extraction, solvents for rubber, cleaning processes, manufacture of artificial leather and insulating material, gas enrichment, and motor spirit. The use of benzol for gas enrichment is dying out, but the field for benzol as a motor spirit is very extensive. The present output of benzol in the United States only represents 25 galls. per car per annum, whilst if all the coke were made in by-product ovens recovering benzol, this figure would reach 55 galls. The majority of benzol recovery plants in the United States are of the Koppers type, the wash oil used being a petroleum product, "straw oil," of which at least 90% distils between 250° and 350° C. A good absorbing oil should have a specific gravity of less than 0.88 at 15° C. and be readily fluid at 4° C. In practice the amount of benzol absorbed by the oil should be kept between 2 and 3%. Heavy tar oils, as used in Europe, may find increasing application in the United States. These should contain less than 7% naphthalene, and 90% should distil between 200° and 300° C. Cost of manufacture should not include items involved in the manufacture of gas, but only the extraction of the benzol, and subsequent purification, the total figure for these being between 3 and 4 cents (1½—2d.) per gallon. The author anticipates under normal conditions a substantial profit in the production and sale of 90% purified benzol at prices competing with those of gasoline. From figures given by Shaeffer (this J., 1916, 1209) the author estimates a reduction in heating value of the gas corresponding to 8% of the normal value of the benzol recovered, based on gasoline prices, or about 3.83 cents (1-9d.) per ton of coal. —J. E. C.

Mineral oil exports from the United States. Oil, Paint, and Drug Reps., Feb. 5, 1917.

Exports of mineral oils from the United States during 1916 showed a gain of about 275,000,000 gallons over the exports of 1915, the figures being as follows:

	1915.	1916.		
	Gallons.	Dollars.	Gallons.	Dollars.
Crude oil	154,704,318	4,175,011	168,358,167	6,832,001
Illuminating	835,219,438	43,787,216	852,765,091	55,861,298
Lubricating and paraffins	247,660,120	32,001,289	258,993,634	42,601,575
Naphthalene, gasoline, etc.	273,906,978	33,081,274	349,721,727	67,562,520
Residuum, gas oil, fuel oil, etc.	808,343,638	21,956,813	953,199,204	26,772,057
Total	2,900,766,792	131,001,603	2,581,047,822	199,630,471

a petrol substitute, can be found when the heat of combustion and the vapour density are known; and in the same way the calorific value of any liquid or gaseous fuel can be determined by finding by explosion the volume of air required to burn completely a measured volume of the vapour of known density.—W. E. F. P.

Benzol recovery after the war. F. W. Sperry, jun., Amer. Inst. Chem. Eng., Jan., 1917. Gas J., 1917, 137, 295—296.

The total production of benzol products in the United States in 1915 was over 22 million galls., being more than twice the amount recovered in 1911. Allowing for enlargements and new plants, it is estimated that the amount will rise to 50

Petroleum: Irreversible adsorption of the "carbonaceous substances" of —. M. A. Rakuzin, J. Russ. Phys.-Chem. Soc., 1916, 48, 720—724. (See this J., 1915, 859.)

The adsorption of a 1% solution of petroleum in benzene by animal charcoal and by calcined kaolin has been investigated. The "carbonaceous substances," that is, those which cause polarimetric opacity, are adsorbed less rapidly by kaolin than by animal charcoal, but their adsorption is complete if the carbonisation constant (coefficient of polarimetric opacity) is not less than 18%. The adsorption is irreversible, neither boiling light petroleum nor boiling water extracting anything from the adsorbent after use. Other conclusions drawn from the results obtained

are: (1) The qualitative and quantitative results of adsorption depend on the character and proportion of the adsorbent, but not on the mode of its application. (2) The velocity of adsorption is very high, since with a suitable concentration of the solution, filtration of the latter through a layer of adsorbent 2.5 cm. in thickness is accompanied by adsorption. (3) The adsorbent used as filtering layer for petroleum may be regenerated by ignition. The bearing of these results on the natural filtration-distillation processes of petroleum is discussed.—T. H. P.

Gasoline; Construction and operation of a single tube cracking furnace for making —. C. P. Bowie. U.S. Bureau of Mines, Tech. Paper 161, 1916. 16 pages.

IN operating the Rittman vapour-phase cracking process (this J., 1916, 1003), with furnaces containing several tubes, *e.g.*, ten, an even temperature is difficult to maintain and the single tube furnace is now preferred. The tube is of steel and lap welded, 13—13½ feet long over all, 13—14 inches outside diameter, and with walls about 1 inch thick. It is connected to a tar pot from which carbon and tar can be easily removed when necessary. In the inside of the tube, at the top, is a cast steel basket which serves as a bearing for the stirring rod (which occupies the centre of the tube and prevents its choking by deposited carbon) and as a receptacle for steel balls or other pieces of metal over which the oil passes before entering the tube. Vaporisation is, however, more suitably effected by means of a spray nozzle. The stirring rod is made from 3-inch extra strong pipe, to which are fastened four vertical rows of chains 3 inches apart. The rod enters a stuffing-box and gland which are placed in the tar pot. On the lower part of the stirring rod is a cast-iron paddle, to prevent carbon from accumulating on the stuffing-box and choking the neck of the tar pot. Before entering the tube the oil is strained and heated to about 100° C. From the preheater the oil passes through another strainer, a meter, and a needle valve for regulating flow, into the cracking tube. By means of a pressure reducing valve condensation of the cracked products takes place at practically atmospheric pressure in the ordinary box type of condenser. The cost of the plant, exclusive of a building or other protective covering, and condenser box, is about \$3000. After the best working conditions have been determined, temperature and pressure control should be based on the specific gravity of the crude oil produced. After removal of gasoline from the cracked oil by distillation, the residuum may again be cracked but should not be mixed with the original oil, as "once cracked oil" may require somewhat different temperatures and pressures for re-cracking, and may yield a distillate of a different specific gravity from that of the cracked oil originally obtained. The paper is illustrated by 10 plates.—F. C.

Ichthyol oils; Chemical constituents of sulphur-containing, bituminous tar oils. —. H. Scheibler. Ber., 1916, 49, 2595—2600.

SULPHUR plays an essential part in the formation of asphaltic oils from petroleum, and some light is thrown on the method of their formation by the production of asphaltic substances when a solution of sulphur in petroleum is subjected to distillation. The sulphur-containing non-volatile product appears to contain thiophene derivatives, and its formation involves both polymerisation and dehydrogenation, which is accompanied by liberation of hydrogen sulphide. The presence of this gas is a well-known feature of many asphalt-producing districts.—G. F. M.

PATENTS.

Washing or sorting coal and other minerals; Apparatus for —. P. Habets, Montegnée, and A. France, Liège, Belgium. Eng. Pat. 100,967, June 30, 1914. Under Int. Conv., July 26, 1913. (Appl. No. 10,417 of 1916.) (See also Eng. Pats. 22,655 of 1912, 17,011 of 1913, and 15,689 of 1914; this J., 1913, 471; 1916, 957.)

IN apparatus for washing coal and other minerals, in which the material is passed along a trough having transverse slots in the bottom, longitudinal slots are also provided, the bars separating the slots being of a form adapted to tilt flat pieces of mineral to facilitate separation.—J. E. C.

Briquetting porous materials, as small coke, peat, sawdust, &c. R. Behr, Kolberg. Ger. Pat. 295,491, Aug. 20, 1915.

THE binder, such as pitch, resin, starch, tale, gums, animal or vegetable albumin, casein, glue, &c., is used in the form of vapour, dust, or atomised liquid, which is blown into an exhausted chamber containing the fuel to be briquetted. Under these conditions, very little binder is needed. Moist fuels are dried automatically on the introduction of the binder.—A. B. S.

Coke ovens or the like; Regenerators for —. A. Roberts, Chicago, U.S.A. Eng. Pat. 103,321, Jan. 18, 1916. (Appl. No. 816 of 1916.)

IN connection with coke ovens or the like a pair of regenerators is located away from the oven heating walls, spent gases passing through one regenerator and air through the other. On reversing by means of valves, dampers, or the like, air is conducted through the first regenerator in a direction at right angles to that of the gases previously passing through, spent gases being conducted into the second regenerator also in a changed direction. The heated air passes through a recuperator between adjacent heating walls of the oven prior to reaching the burners.—J. E. C.

Retort-setting for gas and coke manufacture. H. Koppers, Essen. Ger. Pat. 295,321, June 7, 1914.

THE retorts are arranged in groups of four, one above another, with heating flues between them and regenerators below, so as to secure a uniform heating of their contents, to enable any groups to be set in and out of action without difficulty, and to recover as much as possible of the heat produced by the gas used in heating the retorts. The arrangement of the retorts is more compact than usual and there is no limit to the number in a bench.—A. B. S.

Gas retorts; Charging mechanism for —. Riter-Conley Manufacturing Co., H. A. Carpenter, and A. W. Warner, Leedsdale, Pa., U.S.A. Eng. Pat. 103,494, Jan. 19, 1916. (Appl. No. 856 of 1916.) Addition to Eng. Pat. 17,855, Aug. 1, 1912.

Treating materials; Process of —. [Production of water-gas.] J. W. Hornsey, Summit, N.J., Assignor to General Reduction Gas and By-Products Co. U.S. Pat. 1,211,161, Jan. 30, 1917. Date of appl. July 15, 1910. Renewed June 24, 1916.

SEE Eng. Pat. 19,101 of 1912; this J., 1913, 1000.

Petroleum; Process of treating crude —. C. B. Forward, Urbana, Ohio, U.S.A. Eng. Pat. 103,572, Apr. 7, 1916. (Appl. No. 5126 of 1916.)

SEE U.S. Pat. 1,189,083 of 1916; this J., 1916, 883.

Process for improving the fertilising value of the ammoniacal liquor produced in the manufacture of gas or coke. Ger. Pat. 292,145. See XVI.

Preparation of fertiliser from lignite ash. Ger. Pat. 294,858. See XVI.

IIb.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

Heat of combustion of wood charcoal. Nikitin. See IIa.

PATENTS.

Separation of volatile products from solid carbonaceous material. W. W. White, London. Eng. Pat. 14,800, Oct. 19, 1915.

SOLID carbonaceous material is carried by a conveyor through a heated chamber the temperature of which increases progressively from the inlet to the outlet, the vapours being conducted from various portions of this retort into a substantially parallel condensing tube. The vapours in the condensing tube flow in the opposite direction to the solid material, so that vapours given off at higher temperatures are condensed by contact with successively cooler vapours.—J. E. C.

Charcoal kilns. W. J. Mellersh-Jackson, London. From G. H. Dale, Cape of Good Hope. Eng. Pat. 103,321, Jan. 19, 1916. (Appl. No. 875 of 1916.)

The kiln consists of detachable sections capable of being readily assembled to form a structure of circular or polygonal cross-section. The sections are secured to each other by stops and latches so as to form inner and outer walls kept apart by distance pieces. The space between these walls is filled with sand or similar material. A double-walled roof constructed of radial sections also filled with sand and supporting a feed drum with movable cap, is provided.—J. E. C.

Flotation process of concentrating ores. U.S. Pat. 1,124,130. See X.

III.—TAR AND TAR PRODUCTS.

Benzene; Action of ammonia and calcium on —. A. V. Dumanski and A. V. Zvereva. J. Russ. Phys.-Chem. Soc., 1916, 48, 994–996.

WHEN dry ammonia is passed through benzene containing shavings of calcium, the following reactions take place: $\text{Ca} + 4\text{NH}_3 \rightarrow \text{Ca}(\text{NH}_2)_2 + 2\text{H}_2$; $\text{Ca} + 2\text{NH}_3 \rightarrow \text{Ca}(\text{NH})_2 + \text{H}_2$; and $\text{C}_6\text{H}_6 + \text{H}_2 \rightarrow \text{C}_6\text{H}_8$. —T. H. P.

Benzophenone; Basic derivatives of —. Tertiary aminobenzyl alcohols and their derivatives. V. J. von Braum. Ber., 1916, 49, 2605–2608.

BASIC diphenylmethane derivatives containing methyl- or dimethyl-amino groups in the ortho position to the methylene group cannot be oxidised directly to the benzophenone derivative with chloranil, but the oxidation is effected by chromic acid if the $-\text{N}(\text{CH}_3)_2$ groups are first converted into $-\text{N}(\text{CN})\text{CH}_3$ groups. The cyanogen group may then be removed by saponification with formation of a monomethylamino group, and from the latter on methylation the dimethylamino group is regenerated.—G. F. M.

Dihydroindole bases; Substituted —. Fission of the reduced indole and quinoline rings by reduction. III. J. von Braum, K. Heider, and L. Neumann. Ber., 1916, 49, 2613–2624.

THE dihydroindole ring is reduced in three different directions when the indole base in the form of the quaternary methyl chloride compound is treated with sodium amalgam, viz., with the formation of an N-methyldihydroindole, an o-alkyldimethylaniline, and a 3-phenylalkyldimethylamine. The relative proportions of these products vary greatly according to the substituents present in the pyrrole ring. Thus whilst dihydroindole itself gave 75% of tertiary cyclic base, 8% of aromatic base, and 17% of aliphatic base, α-methyldihydroindole gave 40%, 40%, and 20% respectively, and β-methyldihydroindole (dihydroskatole) gave but traces of the aniline base, and as much as 21% of 3-phenylpropyldimethylamine. Substitution in both α and β positions gave results intermediate between the above extremes.—G. F. M.

Benzol recovery after the war. Sperr. See IIa.

PATENTS.

o-Chlorotoluene; Process of preparing —. Badische Anilin u. Soda Fabr. Ger. Pat. 291,638, July 5, 1914.

TOLUENE-p-SULPHONIC acid, or its chloride or amide, is dissolved in sulphuric acid, the solution treated with chlorine, and the sulpho group removed from the resulting o-chlorotoluenesulphonic acid, e.g., by heating it in a current of steam. —C. A. M.

Arylamides of 2-hydroxynaphthalene-3-carboxylic acid; Process of preparing —. Farb. vorm. Meister, Lucius, u. Brünning. Ger. Pat. 294,799, Apr. 30, 1914.

A MIXTURE of 2-hydroxynaphthalene-3-carboxylic acid with a large excess of an aromatic amine is treated with phosphorus chloride, whereby the hydroxynaphthoic acid chloride first formed, reacts with the amine to form the arylamide. The yield is approximately quantitative.—C. A. M.

2,3-Hydroxynaphthoic acid and its derivatives; Process of preparing —. Farb. vorm. Meister, Lucius, u. Brünning. Ger. Pat. 295,183, Oct. 23, 1913.

AN acyl-2,3-hydroxynaphthoic acid is heated until an intermediate product of the nature of an anhydride is formed, and this is treated with ammonia or with bases capable of yielding acyl-derivatives.—C. A. M.

Tar; Continuous distillation of —. J. Artmann, Essen, Germany. U.S. Pat. 1,214,259, Jan. 30, 1917. Date of appl., Oct. 14, 1909.

SEE Fr. Pat. 407,906 of 1909; this J., 1910, 552.

IV.—COLOURING MATTERS AND DYES.

Hydroxyquercetin; Synthesis of —. M. Nierenstein. Chem. Soc. Trans., 1917, 111, 4–10.

THE synthesis of hydroxyquercetin from 1,2,3,5-tetrahydroxybenzene was undertaken to establish the correctness of the formula of this substance, which had previously (Ber., 1911, 44, 3187) been obtained from quercetin by oxidation and subsequent reduction. Tetrahydroxybenzene was con-

verted into 2,3,4,6-tetrahydroxyacetophenone by the action of acetic acid and zinc chloride; this on methylation under suitable conditions gave a trimethyl ether, m.pt. 125°—126° C., which condensed with veratraldehyde to give 2-hydroxy-3,4,6-trimethoxyphenyl-3,4-dimethoxystyryl ketone, m.pt. 143° C. The latter in presence of hydrochloric acid was converted, with ring formation, into 5,7,8,3',4'-pentamethoxyflavanone, which through its 3-isonitroso-derivative gave the corresponding flavonol, m.pt. 147°—149° C. The demethylation of this compound gave a substance identical with the hydroxyquercetin previously obtained.—G. F. M.

PATENTS.

Triarylmethane dyestuffs fast to light: Manufacture of—. Farbw. vorm. Meister, Lucius, und Brünig. Ger. Pat. 295,495, Mar. 5, 1915. Addition to Ger. Pat. 290,065 (this J., 1916, 531).

IN addition to the diarylindyl dyestuffs which contain a halogen atom in the *para* position to the methane carbon atom as claimed in the original patent, similarly constituted bodies having an amino, sulphonic, or oxy group, either in the form of an ether or ester, in the place of the halogen, may be treated with aromatic amines.—J. F. B.

Copper-containing pigments. Ger. Pat. 295,794. See XIII.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Vegetable fibres: Purification of—. G. L. Stadnikov. J. Russ. Phys.-Chem. Soc., 1916, 48, 301—302.

THE purification of vegetable fibres (cotton, flax) to be used in the study of adsorption in general and that of colouring matters in particular, may be effected as follows. The fibre is boiled with water, which is changed each day after boiling for eight hours, this procedure being followed until 250 c.c. of the filtered water after use leaves no residue on evaporation. The extracted fibre is left for three days covered with alcohol, which is then replaced by a fresh quantity. After another period of three days, the fibre is removed from the alcohol and washed with ether, alcohol, and water successively. The complete displacement of the alcohol by water is effected only very slowly at the ordinary temperature, since even after eight months a fresh quantity of water was found to contain alcohol after being in contact with the fibre for a few days. The process takes place far more rapidly when the fibre is boiled with successive quantities of water.—T. H. P.

Paper-yarn textiles, and dyeing and impregnating them. A. Kertesz. Ver. deut. Textilveredlungsbund., Düsseldorf, Dec. 9, 1916. Chem.-Zeit., 1917, 41, 43—44.

THE manufacture of paper-yarn textiles in Germany has been stimulated in an extraordinary degree by the war. The industry may be considered under two branches: the manufacture of substitutes for jute sacking and the manufacture of textiles for ordinary use. Very great progress has been made in a technical sense in the manufacture of jute substitutes; the satisfaction of the requirements as regards high tensile strength presented considerable difficulty, on account of the shortness of the paper fibre, but improved results have been attained by certain after-treat-

ments, notably by suitable impregnation. This branch of the trade is essentially a war industry, the material being employed mainly for sand bags, and the question of its continuation after the war remains more or less open. Nevertheless, it is hoped that the substitution of the entirely home-manufactured product for the imported material may be permanently established after the war, more especially since it is shown that the price of jute increased 120% during the twenty years from 1893 to 1913. Other materials have advanced in much lower ratio, e.g., cotton 47%, wool 43%, raw silk 2%, flax 30%. The quantity of raw jute imported into Germany in 1913 was 162,063 tons, and even as compared with 1910, the price showed an advance of 76%. The manufacture of the finer grades of paper textiles for general purposes shows even better prospects for the future; the technical progress made during the period of the war is most striking when products of the present day are compared with those of three years ago. Yarns of different character are required for this branch of the trade; the cotton manufacturer requires yarns and fabrics of greater softness. It has been found that a textile finished by calendering from a weakly alkaline soda or soap bath becomes much softer and more pliable. It is expected that public taste will be trained by the present scarcity of the standard textile fibres to take these new materials into favour for decorative printed goods and wearing apparel and that the demand will go on increasing after the war. As regards the impregnation of paper yarns to increase their strength and resistance to moisture, it has been found that the treatment with aluminium soaps as practised with cotton goods does not give such satisfactory results in this case. The best treatment is by impregnation in two baths: (1) passage through a glue, tannin, and silicate bath at 50° C. without drying, and (2) passage through a cold basic aluminium formate bath of 6° B. (sp. gr. 1.01), and drying. The first bath is made by steeping 80 grms. of glue in cold water for several hours and then melting. In a separate vessel 1.5 grms. of tannin is dissolved in hot water and 1.5 grms. of water-glass of 36° B. (sp. gr. 1.31) is added. The glue solution, heated to 50° C., is then treated with the tannin-silicate solution, while stirring, and the whole made up to 1 litre. The impregnated yarn shows an increase of over 10% in dry tensile strength and about 30% in wet strength. The dyeing of paper yarns and fabrics is done exactly on the same principles as that of cotton. Substantive, sulphur, and vat dyestuffs are employed, but greater care is required in turning and handling the goods. Dyeing machines are preferable to hand dipping on this account, and for the same reason the baths must not be too strongly alkaline and the temperature must be kept below the boiling point, preferably at 50° to 60° C.—J. F. B.

Economic sources of polish and wool fat in S. Australia. Winterbottom. See VII.

PATENTS.

Yarn: Conditioning or moistening of—, and apparatus therefor. The Fine Cotton Spinners' and Doublers' Assoc., Ltd., H. Brooks, Manchester, and A. Stafford, Bolton. Eng. Pat. 103,923, Feb. 23, 1916. (Appl. No. 2683 of 1916.)

IN the process of singeing, doubling, and winding or spinning yarn, the latter, as it leaves the bowls of the singeing machine, is humidified by passing in front of a nozzle through which a blast of air and spray of water is caused to issue and impinge upon the yarn. A wind shield or receiver is placed so as to stop the blast or spray, collect the surplus water, and convey it to a tank.—J. F. B.

Cotton yarns and fabrics: Manufacture or treatment of — [to produce woolly effects]. Tootal Broadhurst Lee Co., Ltd., and H. Lester, Manchester. Eng. Pat. 103,057, May 4, 1916. (Appl. No. 6373 of 1916.)

TEXTILES having the appearance and "feel" of wool are produced from yarns spun from mixtures of dyed and undyed cotton or of different shades or colours of dyed or undyed cotton, the yarns or the fabrics made from them being subsequently shrunk by treatment with caustic soda or sulphuric acid.—J. F. B.

Celluloid: Process of treating —. E. Josephson, Assignor to Pantasote Leather Co., Passaic, N.J. U.S. Pat. 1,211,588, Jan. 9, 1917. Date of appl., Feb. 2, 1914. Renewed Aug. 19, 1916.

FINELY powdered celluloid is treated with water and the camphor is distilled off with steam.—J. F. B.

Cellulose: Manufacture of —. C. N. Waite (C. B. Magonn, administratrix) and J. E. Hedin, Wilmington, Del., Assignors to W. H. Sharp, Philadelphia, Pa. U.S. Pat. 1,212,158, Jan. 9, 1917. Date of appl., Oct. 1, 1915.

A RAW material containing cellulose is digested with caustic soda which has been treated with a small quantity of sulphur so that the amount of sodium sulphide present is less than 0.5%. This small quantity of sulphide is sufficient to neutralise the effect of the free oxygen present and thus prevent the formation of oxycellulose, but is insufficient to exert an appreciable digesting action.—J. F. B.

Pulp or paper stock: Method and apparatus for indicating and regulating the consistency of —. E. J. Trimbley, Glens Falls, N.Y., U.S.A. Eng. Pat. 17,811, Dec. 20, 1915.

THE apparatus comprises a constant-level chamber having a discharge orifice maintained under a constant head of pulp, and a variable-level chamber arranged to receive the pulp discharged from the constant-level chamber and provided with an outlet pipe of suitable size and shape to cause a frictional resistance in the flow of pulp, thus maintaining a head of pulp varying with its consistency and frictional resistance. The variable-level chamber may be supported by an arm and counter-weights so that variations in the level are indicated on a scale. The variations in the level are caused to operate a rod controlling a supply of diluting water through a ratchet wheel operated by a double reciprocating pawl, with means for throwing the pawl into and out of engagement, the movement of the ratchet wheel in one or the other direction causing an increase or decrease in the supply of diluting water as required.—J. F. B.

Paper stock: Apparatus for the treatment [steeping] of —. W. G. Fiske, Purfleet, Essex, Eng. Pat. 103,376, Mar. 2, 1916. (Appl. No. 3160 of 1916.)

MATERIAL, such as wood pulp, waste paper, or the like, is fed continuously along with liquid into one end of a revolving drum, the internal periphery of which is divided up by a helical partition into an open channel winding from one end of the drum to the other, so that the material with the liquid travels with a rolling motion through all the convolutions, being discharged at the further end in a thoroughly steeped and partially disintegrated condition, without the use of positive mechanical tearing devices. At inter-

vals in the channel are placed variously shaped obstructions, such as gates, serrated plates, strainer bars, etc., which impede the passage of the more resistant portions of material and cause them to remain for a longer period under treatment. The material caught on these obstructions is carried round to the top of the drum and then drops off, and the edge or lip is so constructed that the humps fall into the preceding and not into the succeeding convolutions of the channel.

—J. F. B.

Preparation of a gutta-percha substitute from paper impregnated with waterproof substances. Ger. Pat. 295,121. See XIV.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Cotton yarns: Action of two different processes of bleaching on American —. F. P. Jecusco. J. Soc. Dyers and Col., 1917, 33, 34—38.

FOR the control of the cotton yarn bleaching process, three skeins of yarn are taken from the batch and tested in the grey state for tensile strength, elasticity, and weight; they are marked, returned to the batch, and one skein is withdrawn after the boiling, one after the "chemic" and sour, and one after finishing. The results are recorded and any departure from normal conditions can be located and investigated. The standard process through which the yarn is passed consists of the following operations:—Boiling under a pressure of 15 lb. in an injector kier with 2% of "sulphated oil" and 3% of caustic soda for 8 hours; washing in kier, upwards for 1 hour and downwards for 1 hour; chemicking with calcium hypochlorite of 1°—2° Tw. (sp. gr. 1.005—1.010) for $\frac{1}{2}$ —2 hours according to the count of yarn; washing for half an hour; souring with sulphuric acid of 1—2 Tw. (sp. gr. 1.005—1.010) for half an hour; washing for half an hour; soaping and neutralising (soap 1—2%, borax 0.25%) for half an hour; blueing and softening. In order to test the quality of the bleach, two skeins are taken after the neutralising, one of them is steamed in a small laboratory kier for one hour and compared as to colour with the other one; if there is any yellowing the bleaching should be repeated. The softening agent is an ammoniacal emulsion of stearic acid and coconut oil. In a normal bleach, the effect on the mechanical properties of the yarn is represented by the following figures which are the average of twelve different records:—Boiling out, gain in strength 22.8 and in elasticity 6.95, loss in weight 6.15%; bleaching, gain in strength 25.9 and in elasticity 0.79, loss in weight 7.3%; finishing, gain in strength 19.2 and in elasticity 0.61, loss in weight 6.2%, all calculated on the grey. These numbers are liable to variations according to the relative work performed by the boil-out and by chemicking respectively; if the boil-out be thorough, the chemicking would reduce the strength of the yarn slightly as compared with the boiled yarn, but in all cases the sum total of the bleaching operations is a substantial gain in strength and elasticity over the grey, owing to the more intimate contact of the fibres produced by the removal of the impurities. On the other hand, when the boiling process is so restricted as to necessitate a very much more severe hypochlorite treatment, the total effect of the bleach may result in a loss of strength. For instance, a batch of yarn boiled for 8 hours with 1% of soap and 5% of soda ash, required 2 hours in hypochlorite of 2° Tw. (sp. gr. 1.01), and showed a total loss in weight of 7.1% and loss in strength of 4.7%.

J. F. B.

Paper-yarn textiles, and dyeing and impregnating them. Kertesz. See V.

PATENTS.

Cotton fabrics; Manufacture of—. [*Production of transparent and wool-like effects.*] Akt.-Ges. Cilander, Herisau, Switzerland. Eng. Pat. 103,432, July 6, 1916. Under Int. Conv., Feb. 9, 1916. (Appl. No. 9516 of 1916.)

Transparent effects on cotton fabrics, whether mercerised or not, are produced by treatment with sulphuric acid of less than 50% B. (sp. gr. 1.497), cooled to at least -4° C., and subsequently mercerising with caustic soda. Wool-like effects are produced on non-mercerised cotton fabrics by immersing for 5–10 mins. in sulphuric acid of similar concentration and temperature. Patterns may be produced by local action.

—J. F. B.

Size [for yarns]; Heating of—. J. Brandwood, Bury. Eng. Pat. 103,431, July 6, 1916. (Appl. No. 9514 of 1916.)

SIZE in the size-beck or size-box is heated, and its temperature maintained by blowing a current of hot compressed air directly through the size, thus avoiding the dilution arising from the use of live steam and evaporating off any moisture introduced by the passage of damp yarns.—J. F. B.

Dyeing; Impts. in—. Surpass Chemical Co., Assignees of H. B. and I. J. Smith, Albany, N.Y., U.S.A. Eng. Pat. 103,445, July 31, 1916. Under Int. Conv., Mar. 21, 1916. (Appl. No. 10,788 of 1916.)

SEE U.S. Pat. 1,199,745 of 1916; this J., 1916, 1153.

Preparation of artificial ochre from iron mordant liquors and clay. Ger. Pat. 295,209. See XIII.

Manufacture of concentrated solutions of complex organic chromium salts for tanning and dyeing. Ger. Pat. 295,518. See XV.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Potash and wool fat in South Australia; An investigation into the economic sources of—. D. C. Winterbottom. S. A. Dept. Chem., Bull. No 2, 1916. 1–34.

The imports of potash salts into Australia for the year 1913 are returned as follows: Potash alum, alum, and aluminium sulphate, 3285 cwt.; potash and pearlash, caustic potash, 2499 cwt.; potassium chloride and sulphate, 88,113 cwt.; potassium and sodium cyanides and bromides, 40,400 cwt. Of these, very small amounts were imported direct to South Australia. The possible sources of potash salts in the State are discussed under eight heads. The production of potash from the ashes of land plants does not appear to offer any considerable prospect for industrial enterprise. An investigation of four species of local seaweeds indicated that the kelps from these varieties were too poor in potassium and too rich in sodium to have any commercial value; two of them, however, contained appreciable quantities of iodine. As regards the wool-scouring industry, about 3500 tons of wool is scoured annually in S. Australia, equivalent to about 157.5 tons of potassium carbonate and 700 tons of wool fat. It would

not be possible to recover the whole of these by-products, but a simple method for collecting some of the potash is suggested which would be commercially advantageous. The wool should receive a preliminary steep or wash in water before the application of chemicals, for which purpose an ordinary wash-bowl or Malard steeping machine would be suitable. The steep-water should be allowed to attain a conveniently high concentration, then evaporated in open vats, and the residue incinerated in pans. It is estimated that a plant for treating 3000 tons of wool, including 3 steeping bowls and a small Porion evaporator, would cost £1700 and would yield £863 profit on a working expenditure of £1501, at normal prices. The recovery of potassium salts from sea water has not been closely investigated under Australian conditions. Another possible commercial source of potash is from the mineral alunite, two distinct deposits of which occur in S. Australia, with potash contents of 10.5 and 9.0% (as K₂O) respectively. By various known methods of treatment it would be possible to carry out the manufacture either of potash alum or potassium sulphate for the Australian market, but for export it would be more profitable to ship the crude alunite. The fume condensed from cement kilns is capable of yielding commercial quantities of potassium salts. The recovery of potash from beet sugar manufacture is of no interest in the present discussion. Felspar rocks may serve as a source of potash when they contain not less than 12% K₂O. A very rich variety containing 14.04% is found at the yelta mine but not in commercial quantities; a large deposit of felspar occurs at Kangaroo Island but it contains only 7% K₂O. The recovery of the unsaponifiable portions of wool fat from the wool-scouring industry is capable of profitable development, especially when combined with the recovery of potash. In Australian wool washing, no soap is employed, only sodium carbonate, and the unsaponified grease may be skimmed off the surface of the liquor in the wash-bowls and submitted to some simple refining treatment. It is melted, strained, and kept melted for half an hour in presence of wood-charcoal as a deodoriser. The melted fat is washed by boiling with water for about one hour four times in succession, then cooled and kneaded with cold water until no further colouring matter is removed. The hydrated fat is then melted and separated from the enclosed water, at the same time it is treated again with wood charcoal and a little bone charcoal, and subsequently filtered. The yield can only be roughly estimated, but the 3500 tons of wool scoured in S. Australia might be expected to yield 50 tons of lanolin at a cost for treatment of not more than £15 per ton. The treatment of the scour-liquors by the acid process would hardly be profitable unless chamber-acid could be obtained at not more than £2 per ton.—J. F. B.

Metabisulphites of potassium and of sodium. P. Carles. Rep. Pharm., 1917, 28, 33. Pharm. J., 1917, 98, 161.

SINCE the war, and the consequent scarcity of potassium metabisulphite, considerable attention has been directed to the corresponding sodium salt. This is richer in sulphurous anhydride, containing, when pure, 67.2%, and it should, for many reasons, be preferable to the potassium salt. Sodium metabisulphite does not readily crystallise, and it is placed on the market in powder, or in compressed tablets. Hence it does not keep so well as the crystals of potassium metabisulphite. A more serious defect is the frequent presence of notable quantities of iron as an impurity. Frequently samples are met with containing sufficient

iron to impart a distinct yellow colour to the powder. This defect is specially harmful when the product is used as a preservative for wines and dietetic preparations. When these contain tannin, they ultimately develop a dark or even black shade when treated with the iron-contaminated preservative. This undesirable result is not at once evident, since the sulphurous acid at first present keeps the iron in the ferrous condition. As, however, the reducing acid is volatilised or oxidised, so the dark tint develops. It is, therefore, necessary that all sodium metabisulphite used as a preservative should be reasonably free from iron.

Magnesium [in limestone]; Rapid method for the determination of —. N. Busvold. *Chem.-Zeit.*, 1917, 41, 42.

As a rapid method for the determination of magnesium, suitable for industrial laboratories, the following procedure is recommended:—5–10 grms. of the limestone containing magnesium is calcined in an electric crucible furnace and dissolved in the smallest possible quantity of dilute hydrochloric acid (1:1). The solution is boiled for a few minutes with an excess of pure calcium carbonate, which precipitates the metals of the third group, then poured on a folded filter, and the residue washed. The filtrate is treated with 20 c.c. of a 6% suspension of pure lime, boiled for just sufficient time to produce a granular precipitate, easy to filter, cooled, filtered, and the precipitate washed with water containing a little milk of lime. The precipitate with the filter is placed in an Erlenmeyer flask of 1 litre capacity and treated with about 300 c.c. of water and 40 c.c. of *N/1* oxalic acid solution. The liquid is boiled for 5 mins. or sufficiently long to convert all the calcium into oxalate, filtered hot, and the precipitate washed with boiling water. The filtrate contains the excess of free oxalic acid and the magnesium oxalate in solution. It is cooled and titrated with *N/5* sodium hydroxide in presence of methyl red as indicator; 25 c.c. of sulphuric acid (1:5) is added, the solution heated to 70° C. and the total oxalic acid titrated with *N/5* permanganate. The difference between the total and the free oxalic acid is calculated as magnesium oxalate; 1 c.c. of *N/5* oxalic acid = 0.001306 gm. MgO. The whole operation takes about two hours.—J. F. B.

Dialysis of the chlorides of ferric iron, chromium, and aluminium; Hot — and rapid preparation of their colloidal hydrous oxides. M. Neidle and J. Barab. *J. Amer. Chem. Soc.*, 1917, 39, 71–81.

THE membranes used were of parchment paper and were prepared by moistening discs of 38 cm. diam., folding into a bag, and tying to the flanged end of a glass tube, 15 cm. long and 2 cm. in diameter. Commercial C.P. chlorides were employed in all except a few experiments, in which specially prepared green chromic chloride was used. It was found that the yield of colloidal hydrous oxide obtained by dialysis of solutions of aluminium and ferric chlorides is far greater in hot solutions than in cold ones, and that for a given volume of chloride solution, the percentage yield of colloid decreases with increasing concentration. Colloidal aluminium and chromium hydrous oxides can be prepared by dissolving the freshly precipitated hydrous oxide in the chloride and dialysing at 70° to 80° C. To prepare the clear brownish-red colloidal hydrous ferric oxide, it is necessary to dialyse first in the cold, until no more iron passes through the membrane. For example, 25 grms. of ferric chloride was dissolved in 250 c.c. of water, and 127 c.c. of 1.365 *N* ammonia solution, sufficient to react with 92.5% of the ferric chloride, was added. After shaking vigorously, the mixture was

allowed to stand several hours or over night. The perfectly clear brownish-red solution obtained, was diluted to 400 c.c. and dialysed in the cold for 23½ hours, and then for 23½ hours at 75°–80°. The yield of colloid was 89.9%. To prepare the purest hydrosol in the shortest time, the lightest (30 lb.) paper must be employed, and the dialysis should be carried out at the boiling temperature. Operating in this manner, colloidal sols can be obtained in 10 hours of a purity equal to that obtainable only after dialysis for several months by the older methods.—J. B. C. K.

Platinum sulphide; New method of precipitating — and analysis of platinised asbestos. V. N. Ivanov. *J. Russ. Phys.-Chem. Soc.*, 1916, 48, 527–529.

THE addition of mercuric chloride to a platinum solution prior to precipitation of the metal as sulphide facilitates the estimation of platinum and allows of accurate results being obtained (see Gaze, this J., 1913, 48), but the bulk of the precipitate is greatly increased and injurious mercury vapour is liberated when the precipitate is ignited. The incomplete precipitation of platinum sulphide under ordinary conditions depends on the formation of a stable colloidal solution of the sulphide, and the author finds that the hydrosol is converted into the insoluble hydrogel if magnesium chloride is present in the solution. The method employed is as follows: A weighed quantity of about 5 grms. of platinum chloride is dissolved in water in a 250 c.c. flask, the solution being made up to volume and mixed. Twenty-five c.c. of this liquid is diluted to about 200 c.c. in a 250–300 c.c. beaker and then treated with a few drops of hydrochloric acid and about 5 grms. of magnesium chloride, either in solution or as crystals, per 100 c.c. of liquid. A rapid current of hydrogen sulphide is then passed through the solution until the latter is saturated, the precipitate adhering to the gas-delivery tube being removed by a piece of filter paper and the latter dropped into the liquid, which is then boiled until all odour of hydrogen sulphide has disappeared. The platinum sulphide is washed twice by decantation and several times on the filter with water acidified with one or two drops of hydrochloric acid, the wet filter being then charred in a covered platinum crucible and finally ignited in a blowpipe flame. This method gives results in very close agreement with those obtained electrolytically.

In the case of platinised asbestos, this is treated with *aqua regia*, which dissolves the platinum and also sufficient magnesium salts from the asbestos to render subsequent addition of magnesium chloride superfluous. Ten grms. of the asbestos is heated in a large beaker with excess of *aqua regia* (2 parts of hydrochloric and 1 part of nitric acid) on a water-bath until all the black particles disappear from the asbestos and the liquid assumes an orange-yellow colour. The contents of the beaker are carefully poured into a porcelain funnel, the asbestos, which serves as a filtering medium, being washed free from platinum. The filtrate is made up to a litre in a measuring flask and 100 c.c. of the solution evaporated three times to dryness with hydrochloric acid on a water-bath. The residue is dissolved in 50 c.c. of hot water containing 5 c.c. of hydrochloric acid, and the silica and any fibres of asbestos filtered off. The filtrate is diluted with water to about 250 c.c., and the platinum precipitated as sulphide, the subsequent procedure being as described above. With a particular sample of platinised asbestos, five estimations of the percentage of platinum present gave results varying from 7.72 to 7.75 by the electrolytic method and from 7.75 to 7.77 by the above hydrogen sulphide method.

—T. H. P.

Carbonyl chloride; Preparation of—V. A. Plotnikov, J. Russ. Phys.-Chem. Soc., 1916, 48, 457—458.

THE catalytic effect of salts is often attributable to the formation of complexes containing the catalyst and the substances reacting under its influence. Such complexes then undergo decomposition, which is induced either by temperature conditions or by the presence of compounds causing a diminution in the stability of the complexes. In this connection, interest attaches to the compounds of aluminium chloride and carbonyl chloride obtained by Baud (Comptes rend., 1905, 140, 1688). Experiments by the author and Salatkó-Petrishitsche show that carbonyl chloride is formed when carbon monoxide and chlorine are passed through a tube containing pieces of aluminium chloride at 36°–35° C., or, still better, if the gaseous mixture is passed through a saturated solution of aluminium chloride in chloroform; subsequent treatment of the chloroform solution with water yields a considerable quantity of carbon dioxide.—T. H. P.

Heterogeneous catalysis. [Decomposition of carbon bisulphide.] Gurvitsch. See XX.

PATENTS.

Tin oxides; Method and means [electric furnace] for producing—C. H. Thompson, Stourbridge, and E. K. Scott, Edgbaston, Eng. Pat. 103,415, May 22, 1916. (Appl. No. 7254 of 1916.)

TIN is admitted to a fuel-heated furnace by means of a hopper. A short channel at the base of the hearth leads to the bath of an adjacent electric furnace and enables the molten tin in this bath to be kept at a constant level. The electric furnace is covered with a domed roof through which three equidistant electrodes are admitted and adjusted to meet in the centre of the furnace. The electrodes, which are of carbon or of iron with an arrangement for water cooling, allow of the formation of an arc above the surface of the molten tin. A short pipe is fitted vertically in the centre of the roof, and a stream of air or oxygen blown through this impinges on the centre of the arc and causes it to strike on the surface of the tin. The volatilised metal is immediately oxidised, and the tin oxide passes into a third chamber which is fitted with baffles and serves to collect the product.—J. N. P.

Apparatus for the electrolytic decomposition of water. U.S. Pat. 1,211,687. See XI.

VIII.—GLASS; CERAMICS.

PATENTS.

Graduations on glass ware; Method of producing burned-in—C. Fiege, Cassel, Ger. Pat. 295,552, May 5, 1916.

THE graduations are marked on the glass by means of a fusible stain which is afterwards burnt in. The surface of the glass is then covered with oil by means of a roller and dusted over with a transparent and readily fusible glass. The articles are heated first to volatilise the oil and then to fuse the vitreous coating. The graduations are thus covered with a vitreous coating which prevents the colour in them from being removed when cleaning them.—A. B. S.

Clays; Reducing the plasticity of—Dr. North, Kommanditges., Hanover, Ger. Pat. 295,719, May 30, 1915.

HIGHLY plastic clays contain notable proportions of fatty substances which can be removed by the

customary methods of fat extraction. On removing these, a dry, friable material is produced which is excellent as a diluent for other clays or a substitute for grog. The fat-free clay resembles Scotch fireclays, and it may be used for the manufacture of articles without the addition of any non-plastic material.—A. B. S.

Enamels; Manufacture of—H. Wade, London, From R. Koepf und Co., Oestrich, Germany. Eng. Pat. 101,221, Aug. 16, 1916. (Appl. No. 11,586 of 1916.)

ENAMELS are clouded or rendered opaque by the addition of zirconium borate supersaturated with zirconia, e.g., by a product of the composition $ZrO_2 \cdot 2B_2O_3 - 1ZrO_2$. Cryolite or other suitable alkali fluoride and an oxidising agent may advantageously be added. For example, 70 parts of raw zirconia, 30 parts of boric acid, 20 parts of cryolite, and 50 parts of sodium nitrate are mixed together, fused, and the product ground to a very fine powder. This material has a much greater covering power than ordinary zirconium borate and does not cause the enamels to become spotty and dull. The nitrate converts the brown zirconia into a bright borate which produces a white clouding.—A. B. S.

Coatings with a metallic appearance and the durability of enamels; Production of—on metallic articles. Gebr. Jacob, Zwickau, Ger. Pat. 295,627, Feb. 13, 1911.

IN order to produce the appearance of brass, copper, tin, and other metals on enamelled ware, the appropriate metallic mixture is painted or sprayed on to the enamelled surface of the article to be decorated, and afterwards fused. For copper and brass effects, the enamel should be grey and for steel it should be blue, so that the colour of the ground coat adds to the intensity of the effect desired, thereby enabling a minimum thickness of metallic mixture to be used. The metallic mixture is made by suspending or dissolving the desired metal, with or without the addition of bismuth and borax as fluxes, soot and kaolin as clouding agents, and suitable oils. By the use of a mixture of metal and bismuth oxide, mercurous or mercuric oxide, patina and other antique metallic effects are produced.—A. B. S.

IX.—BUILDING MATERIALS.

Cement; Behaviour of—in water containing sulphuric acid. H. Nitzsche, Armierter Beton. 1916, 9, 167—172. Z. angew. Chem., 1917, 30, Ref., 16.

SHORT cones were made from two Portland cements, an iron Portland cement, a mixed cement, and five blast-furnace slag cements respectively, both from the neat cements and from mixtures with sand in the proportion of 1:2.5. After 36 days storage under water, in air, and again under water, the test pieces were kept for 14 days in water containing 1% free sulphuric acid, then, for the same time, in a solution of 1.2%, and finally for three months in a 1.5% solution of sulphuric acid. The Portland cement test-pieces blistered, owing to the formation of gypsum; the cement-sand mixtures swelled badly, and some of them were badly cracked. The presence of trass or blast-furnace slag cements only delayed the destructive action of the acid. Test-pieces made with blast-furnace slag cements were more resistant to the acid. After 1 month, the pieces of pure cement were covered with a smooth, white, hard coating of gypsum, which protected the interior, and the cement-sand test-pieces retained

their form and structure fairly well. The iron Portland cements were more strongly attacked than the others. The author admits that the acid solutions used were stronger than those likely to come into contact with concrete under ordinary conditions, but considers that these tests show that blast-furnace slag cements have a greater resistance to acids than Portland and iron Portland cements.—A. B. S.

Rapid method for the determination of magnesium [in limestone]. Busvold. See VII.

PATENTS.

Preservation of wood; Process for waterproofing and —, D. P. Schröder, Hamburg, Ger. Pat. 295,053, June 16, 1911.

Wood is treated with an alkaline extract of lignite, with or without the addition of water-glass, and afterwards with acids or oxidising materials, such as chromic acid or peroxides, and is finally subjected to the action of hot air.—F. C. T.

Dust; Removal of — from the waste gases from cement-kilns. G. Polysius, Dessau, Ger. Pat. 295,490, Jan. 25, 1916.

The gases are washed by passing them through the slurry tanks, wherein they are cleaned much more effectively than in ordinary wet scrubbers. — A. B. S.

Stones; Covering natural and artificial — with a metallic coating. E. Abeles, Vienna, Ger. Pat. 295,607, June 19, 1915.

COPPER or other metal, in powder, is mixed with water-glass or other solution of a silicate and applied to the surface to be coated. After each application, the articles are dried rapidly at 200–300° C. and then immersed in a bath of dilute acid. The process is particularly applicable to the production of roofing tiles of asbestos and cement which have the appearance of being made wholly of metal. The coating is insensitive to changes in temperature, weather-resisting, and more durable than coatings produced by the customary methods of bronzing.—A. B. S.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Ironsand; Titanium, phosphorus, and vanadium in Taranaki —, W. Donovan, N. L. Wright, and R. P. Wilson. 49th Annual Report, Dominion Laboratory, New Zealand. 5 pages.

SIX representative samples of Taranaki ironsand were analysed. Samples 1–3 were obtained from the coast at Patea, samples 4–6 from New Plymouth.

Sample.	Fe.	TiO ₂ .	P.	V.
1.....	21.03	3.8	0.16	0.08
2.....	57.12	10.6	0.16	0.16
3.....	35.42	6.0	0.25	0.14
4.....	49.56	9.2	0.28	0.34
5.....	50.92	10.6	0.29	0.26
6.....	36.62	6.2	0.27	0.16

Concentration by means of a horse-shoe magnet showed that vanadium and titanium remained with the iron, the titanium content being slightly

increased relatively in the concentrate; the relative phosphorus content was not decreased appreciably by concentration. The concentrates assayed 50–60% of iron.—W. R. S.

Manganese in high speed steels; Determination of —, C. T. Nesbitt. Chem. News, 1917, 115, 61–62.

ON account of the difficulty in obtaining bromine at the present time, an investigation was made of methods which do not involve the use of this element in estimating manganese in high-speed steels. These steels contain tungsten and chromium, together in some cases with vanadium and molybdenum. The method which was found to be the most advantageous is based on the oxidation of manganese to permanganate by means of sodium bismuthate and titrating with ferrous sulphate. The steel (1.1 grms.) is dissolved in 12 c.c. of hydrochloric acid, 5 c.c. of nitric acid is added so as thoroughly to oxidise the tungsten, and the liquid evaporated to a syrupy consistency. Sulphuric acid (7 c.c.) is then added and the mixture heated to fuming to decompose all chlorides, cooled, treated with dilute nitric acid (30 c.c. of acid of sp.gr. 1.2 and 20 c.c. of water), boiled, and the tungsten oxide filtered off. The filtrate is treated with 15 c.c. of concentrated nitric acid, and a very small quantity of bismuthate, and chromium is then reduced by sulphurous acid (10 c.c.), the excess of which is removed by boiling. More sodium bismuthate (0.2 grm.) is added and the liquid after filtering is titrated with N/10 ferrous sulphate until all the permanganate colour is discharged, and then with N/10 permanganate until a permanent pink tint is obtained; 1 c.c. N/10 ferrous sulphate = 0.1% Mn. — J. N. P.

Gold; New method of precipitating — from cyanide solutions by zinc. H. R. Conklin. Eng. and Min. J., 1917, 103, 195–196.

A REVOLVING cylinder, 10½ in. × 16 ft., inclined at 30°, with an inner cast-zinc lining and a central spiral rib acting on the principle of an Archimedean screw, is used. The inner space is filled with zinc balls and small zinc fragments. As the cylinder revolves, the zinc balls travel upwards, and at the end of the spiral they drop into a small central pipe and travel again to the bottom of the machine. The cyanide solution, flowing through the tube, and the rolling of the zinc, remove the precipitate from the surface of the metal. The separation of the precipitate from the exhausted solution takes place in a steep conical zinc-lined tank. Iron cannot be used, as zinc in contact with iron does not precipitate silver from cyanide solutions. The advantages of the device are that zinc is used in its cheapest form; no excess of zinc is used; clean precipitate is produced which can be melted with fluxes without intermediate acid-treatment or roasting.—W. R. S.

Zinc; Velocity of solution of — in acids. M. Centnerschwer. J. Russ. Phys.-Chem. Soc., 1916, 48, 170–521. (See this J., 1915, 965.)

ETCHED zinc dissolves in hydrochloric acid more rapidly than zinc with a polished surface. The metal, which reaches its maximum velocity of dissolution in 2N-hydrochloric acid, dissolves in fresh acid with a continually diminishing velocity, and the process of solution follows Boguski's law. Sulphuric acid dissolves zinc appreciably more slowly than hydrochloric acid with an equal concentration of hydrogen ions. Zinc sheets from one and the same melt dissolve with different velocities, owing to variations in the crystalline structure of the metal, but with rolled zinc sheets concordant

results are obtained. Zinc which has been treated with emery dissolves more rapidly than polished zinc, and zinc plates subjected to the action of iodine solution more rapidly than fresh plates. The velocity of dissolution of the metal increases more rapidly than the concentration of the acid, and the black precipitate which forms at the surface of the metal during the action accelerates dissolution, removal of this precipitate resulting in the loss of the former activity of the metal. In distilled water zinc retains its activity for a long time, but in the air the metal partially loses its activity. When rapidly cooled, zinc exhibits a more pronounced induction period than when slowly cooled, but if its surface is subsequently etched, its velocity of dissolution is the same as in the latter case. Prolonged heating at 400° C. of zinc which has been rapidly cooled increases its period of induction. The potential of active zinc is somewhat higher than that of passive zinc. In order to explain the phenomena observed, the supposition is made that ordinary (chemically pure) zinc is in a passive condition, increase of the velocity of dissolution during the period of induction being explained by transformation of the metal from the passive to the active state.

An attempt is made to explain the passivity of iron and other metals in accordance with Helmholtz's theory of the electric double layer and it is shown that such a representation is capable of furnishing explanations of: the influence of foreign metals on the solution of zinc (De la Rive's theory), the influence of mechanical and chemical treatment of the surface of the zinc, the period of induction, periodic phenomena in the dissolution of metals, the passivification of metals by means of oxidising agents and polarisation, rusting of iron and other metals (compare Walker, Cederholm, and Bent, this J., 1907, 1051; Cushman, this J., 1907, 1201), the activation of metals by hydrogen (compare Grave, this J., 1911, 1120), the specific influence of different electrolytes on the condition of metals, etc.—T. H. P.

Tin concentrate; Hcl assay of —. H. W. Hutchin. Bull. 149. Inst. Min. and Met. [Advance proof.] 27 pages.

VERY serious errors may be introduced in crushing the sample, agate being the only material unaffected by cassiterite. A sample crushed in different mortars was assayed for tin with the following results: unpowdered, 75.1; in agate, 75.1; in steel, 74.0; in Wedgwood mortars (3 different types) 73.35, 73.65, and 72.95%. The colour of the powdered material from the steel mortar was much darker than that crushed in agate. For reducing the solution prior to iodine titration, it is recommended to add 5 grms. of pure powdered zinc after nearly neutralising the excess of acid; 50 c.c. of hydrochloric acid is then added, a nickel coil is inserted, and the solution boiled for 10 minutes. The solution is cooled in an atmosphere of carbon dioxide and titrated. Ores containing tungsten, arsenic, or copper should be treated with acid before fusion. Titanium was not found to interfere when the ore was decomposed with lime (this J., 1914, 262) and zinc-nickel used for reduction.—W. R. S.

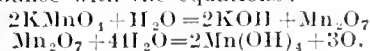
Stibnite ores; Flotation of —. J. Daniels and C. R. Corey. Eng. and Min. J., 1917, 103, 185—187. (See also this J., 1916, 1222.)

EXPERIMENTS were made on material from tailing dumps resulting from the hand-sorting of stibnite ore in the Fairbanks district, Alaska. The material contained Sb 35.8%, and Au 0.14 oz., and Ag 2.0 oz. per ton; it was tested in a Case experimental machine with a view to recovering

antimony, disregarding gold and silver. The best conditions were found to be: Size of ore, —100-mesh (aperture 0.0058 in.); pulp ratio, 1:5; peripheral speed of agitator, 1200 ft. per min.; temperature, 26° C.; time of agitation, 15 min.; concentrated sulphuric acid and creosote oil, 0.44 and 0.60% respectively of the weight of ore. The recovery for all tests was 54—92%, the tailings carrying 8—20% of antimony. Re-treatment of combined tailing samples gave a 70% recovery.—W. R. S.

Potassium permanganate; Action of — with metals. W. Foster. Chem. News, 1917, 115, 75.

It was found that dilute solutions of potassium permanganate, when either acid or neutral, are reduced by finely divided metals, including platinum and gold. The reduction appears to be accompanied by the formation of oxygen, potassium hydroxide, and hydrated manganese dioxide, in accordance with the equations:—



In the case of certain metals, e.g., mercury, the oxygen converts the metal into an oxide, but such inactive metals as gold and platinum serve merely as catalytic agents in decomposing the permanganate. In some cases, green potassium manganate is formed as an intermediate product of decomposition.—J. N. P.

Metals; Thermo-electric properties of certain polymorphous —. P. A. Laschitschenko, S. F. Bukov, and S. V. Eremov. J. Russ. Phys.-Chem. Soc., 1916, 48, 279—296.

MEASUREMENTS have been made at different temperatures of the thermo-potentials of a number of pairs of metals, one metal in each case being capable of existing in polymorphous modifications; the numerical results are given and also the curves showing the connection between electromotive force and temperature. The Ni-Pt curve shows a characteristic bend in its early part but no break, and the temperature coefficient of the thermo-electric force (dE/dt) exhibits a minimum at about 400° C. With Fe-Pt, dE/dt has minima at 475° and 1025° and a maximum at 850° C., the last temperature corresponding nearly with the transformation of β into γ -iron (compare Broniewski, this J., 1913, 290). With Zn-Pt, Zn-Pd, Zn-Au, and Zn-Fe, the results obtained bear little relation to allotropic change of the zinc. With Zn-Cu, however, this change is sharply shown, the neutral point at which the thermo-electric force is a maximum, being at about 240° C.; at 310° C., the curve again assumes its regular parabolic form, this temperature being regarded as that of the transformation of zinc. The Sn-Pt curve shows no peculiarity, but the Sn-Ni curve consists of two branches meeting at a very slight angle at 160°—165° C. (compare Degens, this J., 1909, 1041; Werner, this J., 1913, 1113). The influence of the allotropy of thallium on the thermo-electric properties of the metal appears, from a study of Tl-Pt, Tl-Cu, and Tl-Ni, to be only slight (Werner, *loc. cit.*). Investigation has been made of aluminium paired with platinum, palladium, silver, and constantan, the aluminium employed containing 1.30% Si, 0.85% Fe, and traces of copper. In all these cases the curves exhibit changes in direction at temperatures lying within the limits 570°—590° C., which are in agreement with those observed by other investigators in other ways.—T. H. P.

Physico-chemical force of attraction. III. [Formation of colloidal solutions of metals.] L. G. Gurvitch. J. Russ. Phys.-Chem. Soc., 1916, 48, 856—861.

THE phenomenon of the auto-disintegration of

floridin which occurs in various liquids necessitates the assumption that the force of physico-chemical attraction which tears off small particles from the surfaces of the floridin granules is capable of similar behaviour at the surfaces of other substances, such as metals. Experiment shows, indeed, that metals do undergo pulverisation when shaken in the form of granules or small pieces with various liquids at the ordinary temperature. Between the degree of disintegration of the metal and the residual chemical energy of the liquid as measured by the heat of adsorption, perfect parallelism exists, and the conclusion is drawn that the pulverisation is caused by the physico-chemical attractive force between the metal and the liquid. This force alone is insufficient to dislodge particles from the compact surface of the metal, but becomes able to do so when the impacts of the metallic fragments loosen the surface layers. The agitation of certain liquids of especially great residual energy, such as water, methyl alcohol, acetone, etc., with metals may even lead to the formation of colloidal solutions of the metals of very considerable concentration and marked stability. The maximum percentage concentrations of the colloidal solutions obtainable on shaking 100 grms. of granulated lead with 120—130 c.c. of various liquids are: water, 0.098; methyl alcohol, 0.132; ethyl alcohol, 0.0131; amyl alcohol, traces; acetone, 0.0115; pinene, 0.0088; and aniline, 0.0071. In methyl alcohol, colloidal solutions of the following percentage concentrations are obtainable: cadmium, 0.052; zinc, 0.0028; bismuth, 0.059; mercury, 0.032; and tin, 0.0031. This procedure furnishes a very simple method for obtaining colloidal metal solutions, but it is attended with some uncertainty, which appears to be due to insufficient cleanness of the surface of the vessel in which the shaking takes place. The best results are obtained if the vessel is washed successively with chromic-sulphuric acid mixture, water, alcohol, and several times with the liquid to be employed; it should then be charged at once and closed. Excessive shaking may result in the complete deposition of the metal from the colloidal solution.

—T. H. P.

Preparation of collargol [colloidal silver]. Gerashimov. See XX.

PATENTS.

Iron alloy. F. C. T. Daniels, Natick, Mass. U.S. Pat. 1,211,826, Jan. 9, 1917. Date of appl., Apr. 3, 1916.

A WHITE iron alloy for casting contains silicon 1.0—5.0, manganese 1.0—2.75, carbon 1.25—3.5, nickel 1.0—3.5%, and sulphur and phosphorus. The relative proportions of the ingredients are maintained so as to produce white iron.—W. R. S.

Steel and tin plates: Process for heating —. V. C. Smith, Whentland, Pa. U.S. Pat. 1,211,635, Jan. 9, 1917. Date of appl., Oct. 1, 1915.

To prevent scaling, welding, and sticking, the articles are heated in a furnace in which an oxygen-free atmosphere is obtained by boiling a soft metal such as lead in the hotter part of the furnace (e.g., near the fire-bridge).—W. R. S.

Coatings of fusible substances [metals]: Process for making —. G. Stolle, Berlin-Schöneberg, Germany. Eng. Pat. 23,289, Oct. 15, 1913. Under Int. Conv., Oct. 21, 1912.

THE fusible material, such as metal, is wholly or mainly volatilised, and then caused to impinge on the work by means of a blast of compressed

inert gas, without using a closed chamber. The blast may be passed through a highly-heated superheater, preferably of quartz, so arranged that the superheated blast impinges on the surface of the object, the latter being placed close to the outlet of the superheater.—B. N.

[Lead] smelting furnaces. A. S. Moses, New York. Eng. Pat. 103,205, Mar. 4, 1916. (Appl. No. 3271 of 1916.)

A FURNACE of the Scotch hearth type has an annular hearth supported so that it can be rotated. All the operations (supply of ore, fuel, blast, and cooling-water, tapping for metal, catching fume) can be carried out while the hearth is in motion. Automatic compound-movement poking and levelling devices operate along the hearth, the levelling devices moving in an inclined path with respect to it. A slag seal between the basin and the receiving trough prevents discharge of slag along with the metal.—W. R. S.

Welding a protective covering of copper to an iron or steel body: Method of —. J. Kirby, Pittsburgh, Pa. U.S. Pat. 1,211,715, Jan. 9, 1917. Date of appl., Dec. 8, 1915.

A SOLID copper body, e.g., a copper plate, is placed in position within the moulding cavity of the mould, and the iron or steel, at 2400° to 2600° F. (1300—1400° C.), is then supplied to the moulding cavity so as gradually to make contact with the inner face of the copper and soften it. The metal is allowed to cool, and the copper is thus welded to the solid iron or steel.—B. N.

Amalgamator. R. F. Lounsberry, Assignor to Mid-Continent Machinery Co., Sheridan, Wyo. U.S. Pat. 1,211,729, Jan. 9, 1917. Date of appl., July 11, 1913.

THE receptacle of the amalgamator, designed to contain mercury, is provided with means for agitating the metal and drawing off the amalgam formed, and with an inclined platform at the delivery end for the supply of ore and water. The top of the platform is provided with a series of riffles, each of which is composed of a vertical front portion and a rear portion inclined in a downward direction towards the delivery end. A water receptacle below the inclined platform is divided into compartments, each of which is supplied with water under pressure, and each compartment is provided with water openings discharging in an upward direction parallel to the inclined side of each riffle. Openings also discharge water, in a horizontal direction, from the lowest compartment over the top of the mercury in the mercury chamber.—B. N.

Smelting ores: Process and apparatus for —. G. W. Wright, Deming, N. Mex. U.S. Pat. 1,211,805, Jan. 9, 1917. Date of appl., July 25, 1916.

THE apparatus comprises a retort from which air can be excluded and provided with an agitator extending through one of its walls in an air-tight manner. The retort has an inlet, a reciprocating and revolving feeder to which a closure for the inlet is attached, and a housing closely fitted to the feeder. The feeder is supplied outside the retort with material from a hopper.—W. R. S.

Flotation process of concentrating [ores]. G. H. Clevenger, Palo Alto, Cal. U.S. Pat. 1,212,130, Jan. 9, 1917. Date of appl., June 13, 1916.

THE distillate from the destructive distillation of sage is utilised as a floatative agent. (See also this J., 1916, 1020.)—W. R. S.

Lead alloys; Manufacture of—F. C. Frary, Niagara Falls, N.Y., and S. N. Temple, St. Paul, Minn., U.S.A. Eng. Pat. 101,025, July 19, 1916. Under Int. Conv., July 26, 1915. (Appl. No. 10,151 of 1916.)

SEE U.S. Pat. 1,158,671 of 1915; this J., 1915, 1256.

Production of coatings with a metallic appearance and the durability of enamels on metallic articles. Ger. Pat. 295,627. See VIII.

Covering natural and artificial stones with a metallic coating. Ger. Pat. 295,607. See IX.

Electrical resistance material. U.S. Pat. 1,211,913. See XI.

XI.—ELECTRO-CHEMISTRY.

PATENTS.

[Electric storage] battery cells. W. L. Walker, Boston, Mass., U.S.A. Eng. Pat. 100,176, Mar. 2, 1916. Under Int. Conv., Mar. 17, 1915. (Appl. No. 3161 of 1916.)

THE battery cell is composed of an outer jar of an acid-resisting alloy of lead and antimony, and an inner jar of an acid-resisting non-conducting material, such as vulcanised rubber, fitting snugly in the outer jar. A removable cover is supported within the cell on an enlarged portion at the top of the inner jar, and is held in place by bolts, bearing against the cover, carried by locking strips engaging in lugs on opposite sides of the outer jar.—B. N.

Batteries; Electric—R. S. Baxter, Tayport, Fife, Eng. Pat. 103,020, Feb. 15, 1916. (Appl. No. 2256 of 1916.)

THE negative element of the battery, cell, or voltaic couple, is formed from a plate of tin, with a layer of sulphur on one side of it, so that a sulphide of the positive metal, such as zinc, is formed during the electrochemical action. The electrolyte is composed of a solution of one or more alkali or alkaline-earth chlorides; the precipitated zinc sulphide may be recovered subsequently by filtration, or barium chloride may be used as the electrolyte and a precipitant stirred in with it, so as to form barium sulphate which is collected jointly with the zinc sulphide.—B. N.

Electrode; Protected—and process of making the same. E. H. Becker, Washington, D.C., Assignor to Kinetic Electric Co., Norfolk, Va. U.S. Pat. 1,211,388, Jan. 9, 1917. Date of appl., Oct. 18, 1916.

A NEGATIVE electrode, for galvanic cells, is composed of an intimate and uniform mixture of cuprous and cupric oxides, having its surface coated with copper, and the coating then amalgamated with mercury.—B. N.

Electrolytic decomposition of water; Apparatus for the—A. Dohmen, Cologne, Germany. U.S. Pat. 1,211,687, Jan. 9, 1917. Date of appl., Oct. 20, 1913.

AN electrolytic apparatus, of the filter-press type, is composed of a series of cells, each comprising a thin quadrilateral wrought iron frame having a single central opening, and with two passages through the top of the frame. A detachable sheet metal electrode is secured in the opening of the frame, and the top of the latter is also provided

with two gas-separating chambers, one at each end. The chambers extend laterally in a downward direction to the active faces of the electrode, for conducting the gases from opposite sides to the two passages.—B. N.

Resistance material; Electrical—M. A. Hunter, Troy, N.Y. U.S. Pat. 1,211,913, Jan. 9, 1917. Date of appl., Aug. 9, 1916.

THE resistance material is formed from an iron alloy portion containing 75 to 25% of iron and 25 to 75% of a metal having the properties of nickel or cobalt, 100 parts of this alloy being combined with 10 to 30 parts of a metal of the chromium group.—B. N.

Colloids; Separation of—from mixtures by electro-osmotic action. Elektro-Osmose A.-G. (Graf Schwerin Ges.), Berlin. Ger. Pat. 295,666, Jan. 26, 1915. Addition to Ger. Pat. 291,672 (see Eng. Pat. 11,823 of 1914; this J., 1915, 877).

IN carrying out the process described in the original patent (*loc. cit.*), the mixture is stirred so that feebly charged particles may be brought into the sphere of action of the strongly charged diaphragm. Stirring also prevents the formation on or near the diaphragm of layers which impede the migration of certain colloids.—J. N. P.

Bipolar-electrode electrolyser. G. G. Hepburn, Manchester. U.S. Pat. 1,213,871, Jan. 30, 1917. Date of appl., Aug. 26, 1916.

SEE Eng. Pat. 12,730 of 1915; this J., 1916, 1120.

Method and means [electric furnace] for producing tin oxides. Eng. Pat. 103,415. See VII.

XII.—FATS; OILS; WAXES.

Vegetable oils; Influence of climatic conditions on the composition of—G. V. Pigulevski. J. Russ. Phys.-Chem. Soc., 1916, 48, 324–341.

EVIDENCE is adduced showing that among plants belonging to one and the same sub-family, the iodine value of the essential oil increases as the geographical distribution of the plant extends further towards the north. Plants of the families *Rosaceæ*, *Ericaceæ* and *Pinaceæ* yield fatty oils containing the same acids. In the case of oleic acid, for which a number of isomerides are possible with different positions of the double linking, the natural acid is practically always the Δ^6 acid and the existence of this acid is doubtless related to its activity, since the activity varies considerably with the position of the double linking in the carbon chain. The iodine value of an oil, characterising the degree of unsaturation, depends on the percentage of the triglycerides of unsaturated acids, and may be expressed by the formula, $A_m = a_1x/100 + a_2y/100 + a_3z/100$, where A_m is the iodine value, x , y , and z are the percentages of the triglycerides of oleic, linolic, and linolenic acids respectively, and a_1 , a_2 , and a_3 the corresponding iodine values of the triglycerides, have the respective values, 86.2, 173.58, and 262.15. By means of this formula a table has been constructed which shows how, for one and the same iodine value, the proportions of the three glycerides may vary.

—T. H. P.

Soap; Determination of free alkali hydroxide in—V. A. Izmailski. J. Russ. Phys.-Chem. Soc., 1916, 48, 411–432.

FOR the determination of the free alkali hydroxide

in soap neither the alcohol method nor the barium chloride method yields results which are accurate or reproducible by different workers. The errors of the alcohol method are due principally to the capability of colloidal soap in an alcoholic medium of adsorbing free alkali, and the difficult solubility in alcohol of the "alkali soap" thus formed and its marked retention of the filtrate. When barium chloride is used, special precautions are necessary to prevent hydrolysis of the soap itself. From the results of experiments made by the author the following method has been devised. A portion of the soap is freshly cut from the interior and *a* (about 10) grms. is weighed into a flask of about 400 c.c. capacity fitted with a rubber stopper, and dissolved in 20*a* c.c. of boiling distilled water. To the hot solution is gradually added 2 *a* c.c. of neutralised (towards phenolphthalein) barium chloride solution containing 30 grms. of the salt to 100 grms. of water, the liquid being rotated and boiled for a short time as long as the precipitate does not settle. During the dissolution and boiling, the flask is loosely closed with the stopper. When the precipitate settles the flask is cooled under the tap and tightly stoppered, the cold liquid being immediately filtered through a rapid filter into a conical flask and the filter washed with cold boiled water. Any precipitate remaining in the original flask is washed with three portions of boiled and cooled water, amounting to 19 *a* c.c., in the closed flask. The liquid is titrated with *N* 10 acid in presence of phenolphthalein. The values thus obtained, which the author terms the "alkali numbers," are characteristic for different types of soap. —T. H. P.

Economic sources of polish and wool fat in S. Australia. Winterbottom. See VII.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

PATENTS.

Artificial ochre: Preparation of— from iron mordant liquors and clay. C. E. Sachse, Elberfeld. Ger. Pat. 295,209, Mar. 11, 1914.

AN ochre of even grain and colour is obtained by evaporating to dryness a mixture of iron mordanting liquor and clay and roasting the resulting mass with access of air.—B. V. S.

Lampblack: Production of—. Gebr. Siemens und Co., Berlin-Lichtenberg. Ger. Pat. 295,517, Aug. 25, 1914.

IN a continuous process for the production of lampblack, the soot-containing gases are strongly cooled and led into settling chambers of sheet lead. The cooling may be done by passing the gases through a system of tubes extending upwards from the burning oven and then downwards to the lead chamber, the tubes being slightly or not at all cooled at the inlet and strongly cooled, e.g., by cold water, at the outlet.—B. V. S.

Copper-containing pigments. Siegwirk Chem. Lab. Ges. m. b. H., Siegburg. Ger. Pat. 295,794, Mar. 3, 1914. Addition to Ger. Pat. 287,149 (this J., 1916, 368).

COPPER is introduced into suitable pigment colours and organic lakes (e.g., the barium, calcium, and other lakes of Diamine Pure Blue) by the action of a neutral solution of a copper salt and a substance which will neutralise the acid formed in the reaction.—B. V. S.

Substitute for drying oils as a medium for paints, varnishes, and impregnating agents for fabrics, wood, etc. O. Rohm, Ger. Pat. 295,340, June 5, 1915.

A SOLUTION of a polymerised acrylic acid ester, in acetone, lower fatty esters, or other solvents, is claimed for the purposes mentioned in the title. The acrylic esters may be prepared from allyl alcohol, glycerin, lactic acid, etc. When exposed to sunlight or artificial ultra-violet light, they are transformed into a colourless, transparent, very elastic (not gelatinous) tough mass, which is soluble in the solvents for oils. Alternatively the ester may be mixed with a solvent, and the mixture polymerised. The polymerised ester dries rapidly, resists many chemical agents, and is not readily affected by exposure to weather.—C. A. M.

Printing inks. V. Friedrich, Berlin-Schöneberg. Ger. Pat. 295,489, Nov. 28, 1915.

PRINTING inks with about half the normal content of linseed oil, turpentine, drying oils, and the like are obtained by dilution of the usual printing inks with water mixed with wool-fat, and the addition of more colouring matter to compensate for the dilution.—B. V. S.

Lead oxide: Apparatus for carbonating—. F. H. Sharpe, Liverpool. U.S. Pat. 1,214,222, Jan. 30, 1917. Date of appl. May 31, 1916.

SEE Eng. Pat. 9486 of 1915; this J., 1916, 933.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Vulcanisation: Studies on—. A. Dubosc, Caout. et Gutta-Percha, 1917, 14, 9109—9115.

THE author puts forward the view that in order to bring about vulcanisation sulphur must be present in the colloidal form. In ordinary practice colloidal sulphur is formed *in situ* by the interaction of hydrogen sulphide and sulphur dioxide, the former produced by the action of ordinary sulphur (S_8) upon the rubber resins, or upon the protein, or upon the caoutchouc itself, the latter by the interaction of ordinary sulphur with the oxygen-containing insoluble constituents, or with some added substance such as a metallic oxide:— $e.g., 16PbO + 3S_8 = 16PbS + 8SO_2$. The results obtained by Stevens (this J., 1914, 268) are readily explained on this hypothesis. Rubber freed both from insoluble constituents and from resins shows little tendency to vulcanise, and this is also true of rubber from which only the insoluble constituents have been removed. The removal of the resins only, however, has not the same effect. Rubber containing an excess of insoluble constituents is readily vulcanised to a high coefficient. Owing to the fact that the ease with which they are decomposed by heat varies, all resins are not equally active. Thus Jelutong resins have not as great an effect as colophony, or as the original resin, when added to de-resinified rubber.—E. W. L.

Vulcanisation: Coefficient of— as a check on the state of cure. O. de Vries. India Rubber J., 1917, 53, 101—103.

ALTHOUGH he has not met with so wide a range of values for vulcanisation coefficient at "correct cure" as that quoted by Schidrowitz and Goldsbrough, viz., 2.03—1.86% (compare this J., 1915, 842; 1916, 550), the author agrees with the view that the chemical process of combination of rubber and sulphur is in itself independent of the physical process determining the position of the stress-strain curve. In support of this view it is shown

that it is possible to bring the rubber to the "correct" or other standard cure (as judged by the curve) with other and quite arbitrary coefficients of vulcanisation. Below 80° C. the percentage of combined sulphur does not increase with time (cf. Spence, *Koll. Zeits.*, 10, 299; Hinrichsen, *ibid.*, 8, 245; Rubber Industry, 1911, 306; this J., 1911, 699; 1912, 651), although the curve shifts its position. Thus in the case of a crêpe mixing (rubber, 92.5; sulphur, 7.5%), vulcanised for 105 minutes at 148° C., and tested at various intervals after vulcanisation, the breaking strain increased from 1.285 kilos. per sq. mm. at 2 hours to 1.39 kilos. at 20 hrs., the length at break fell from 1058 to 1033, and the length at 1.30 kilos. load from 1060 to 1018; whereas the combined sulphur varied only between 1.59 and 4.69%, variations which may be ascribed to experimental error. Similar results were obtained in a shorter time when the vulcanised samples were kept at 70°–75° C., instead of at the ordinary temperature. In the case of one particular sample, at 148° C., vulcanisation for 115 minutes was necessary to reach the standard curve (elongation of 990% at 1.30 kilo.) and a coefficient of 5.50% was obtained; nearly the same position of the curve was reached, with a vulcanisation coefficient of only 4.45%, by vulcanising at 148° C. for 95 minutes and heating at 70° C. for 36 hours. In another case the same position of the curve was reached by vulcanising at 148° C. for 60 minutes, and afterwards heating at 70° C. for 66 hours, as by vulcanising at 148° C. for 100 minutes; but in the former case the coefficient of vulcanisation was only 2.85%, whereas in the latter it was 4.40%. It is pointed out, however, that a parallelism—really accidental—exists between the state of cure and the coefficient of vulcanisation, within the limits of 0.5% of combined sulphur, under ordinary fixed conditions of vulcanisation.—E. W. L.

Polymerisation of α -phenyl- Δ^2 -butadiene, Lebedev and Ivanov. See XX.

PATENTS.

Drying materials [pulverised reclaimed rubber]; Method of—, R. B. Price, New York, Assignor to Rubber Regenerating Co. U.S. Pat. 1,209,643, Dec. 19, 1916. Date of appl. Feb. 3, 1913.

IN order to prevent its oxidation and spontaneous combustion during the process of drying, pulverised reclaimed rubber is agitated in a heated, non-oxidising vapour atmosphere maintained for a part of the treatment below the saturation point, and for another part of the treatment above the saturation point.—E. W. L.

Rubber articles: Manufacture of hollow—, R. B. Price, New York, Assignor to Rubber Regenerating Co. U.S. Pat. 1,209,644, Dec. 19, 1916. Date of appl., Apr. 19, 1915.

THE wall of the hollow article is formed of sections of vulcanisable plastic material (rubber) with a skin of rubber containing no, or very little, sulphur, attached to the edges which are ultimately to be united. The sections are vulcanised, the skins moistened with sulphur chloride, the sections assembled and united by pressing the moistened skins together. The sections may also be only partially vulcanised in the first instance, vulcanisation being completed after the complete article has been built up.—E. W. L.

Vulcanisable plastics: Manufacture of articles embodying fibrous filaments and—, Process of manufacturing rubber articles. R. B. Price, New York, Assignor to Rubber Regenerating Co. U.S. Pats. (A) 1,211,228, and (B) 1,211,351, Jan. 2, 1917. Dates of appl., Dec. 1 and Feb. 9, 1915. (B) Renewed June 6, 1916.

IN the manufacture of articles composed of fibrous

filaments and vulcanisable plastic (rubber), the material is partially vulcanised, in the absence of materially distorting conditions. The article (*e.g.*, a tyre) is then built up of this partially vulcanised material, and vulcanisation is completed under pressure. In (A) the process is applied to materials in which each filament of fibrous material is enclosed in vulcanisable plastic material.—E. W. L.

Gutta-percha substitute from paper impregnated with waterproof substances; Preparation of a—, G. Münzel, Leipzig, Ger. Pat. 275,121, Nov. 2, 1915.

PAPER is impregnated with potassium acetate and then waterproofed by treatment in a half-dried condition with a solution of an aluminium salt of a fatty acid, being finished with a coat of suitable lacquer. The potassium acetate has the effect of making the paper pliable.—J. F. B.

XV.—LEATHER; BONE; HORN; GLUE.

Tannins: Biological detection and valuation of—, R. Kobert, Collegium, 1916, 164—174, 213—225. *Chem.-Zeit.*, 1917, 41, Rep., 12. (See also this J., 1915, 672.)

THE author describes three methods of finding the maximum dilution at which a tannin solution exerts astringent action, as shown by the coagulation of fresh blood corpuscles. The first is the determination of the visible limit, *i.e.*, that dilution beyond which there is no coagulation visible to the naked eye. The second is the determination of the filtration limit, *i.e.*, that point when the coagulated corpuscles are retained by a filter paper, which allows unaltered corpuscles to pass through. The third method is to find the reaction limit, *i.e.*, when the liquor, after separation of the blood coagulum, no longer gives a coloration with ferric chloride. Of these, the filtration limit is the most useful, lying between the other two. Analysis of tannins by the use of hide powder gives only the tannin content, and does not distinguish between weakly and strongly astringent tannins as does the biological method.—F. C. T.

Gelatin; Osmotic pressure of—, W. Biltz, G. Bugge, and L. Mehler. *Z. physik. Chem.*, 1916, 91, 705—712. *Z. angew. Chem.*, 1916, 29, Ref., 540.

THE molecular size of gelatin was determined by measuring the height to which a gelatin solution rose in the osmometer. A dry-plate gelatin gave a value of 10,900; purified gelatin preparations values of 5500 to 15,500; and four technical gelatins, 5650 to 18,500. From these results, on the basis of the molecular weight of gelatin (900) found by Paal and by Procter, it was calculated that the molecular aggregates of good gelatin are composed of about 10 individual molecules. The absolute value of the molecular size of technical gelatins decreases with their technical value. The viscosity of gelatin increases with the increase in the size of the particles, whilst the "gold value" decreases under the same conditions. The amounts of ash in the samples examined were:—Dry-plate gelatin, 1.4; purified gelatins, 0.063 to 0.62; and technical gelatins 1.55 to 2.4%. The ash consisted mainly of calcium and phosphoric acid, with small quantities of iron, magnesium, chlorine, sulphuric acid, carbonic acid, and alkali.—C. A. M.

Study of the nitrification of different leathers and of "sulphurated" rape-cake. Guillin. See XVI.

Immunity studies on anthrax serum. Eichhorn and others. See XIXB.

PATENTS.

Mocha leather: Manufacture of ——. S. T. Thring, R. J. Luffman, and L. Forse, Yeovil, Eng. Pat. 192,986, Jan. 6, 1916. (Appl. No. 228 of 1916.)

THE grain is removed by the use of a composition such as 12½% caustic soda, 12½% caustic potash, and 75% water, applied to one side of the skin only.—F. C. T.

Chromium salts: Process for manufacture of concentrated solutions of complex organic ——. for *tanning and dyeing*. P. Kauschke, Dresden, Ger. Pat. 295,518, June 17, 1914.

CHROMIC acid in concentrated hydrochloric acid is reduced by waste materials containing proteins, such as leather cuttings, horn chips, hair, etc., and especially chrome leather waste. Several methods of starting the reaction are given, e.g., warming the mixture, adding dehydrating or easily oxidisable substances or substances capable of producing nascent hydrogen. The resulting solution of complex organic chromium salts may be used advantageously for the one-bath tanning process or as a mordant for textiles.—F. C. T.

XVI.—SOILS; FERTILISERS.

Soils: Calcium compounds in ——. E. C. Shorey, W. H. Fry, and W. Hazen. J. Agric. Res., 1917, 8, 57–77.

IN an attempt to establish the identity of calcium compounds occurring in soils by petrographic and chemical methods, 63 samples were investigated which represented 23 soil types taken from 24 localities in 19 States. Eleven different minerals were sought for in the petrographic examination, and their relative abundance is summarised in tabular form. Of these, hornblende was the most common, followed in order by plagioclases and epidote. Gypsum, dolomite, and apatite were found but once each. In the chemical investigation, determinations were made of total calcium, of the calcium extracted by 2% and by 1% hydrochloric acid, of carbonic acid, of water-soluble calcium, and of water-soluble sulphates; and from the analytical data the quantities of calcium carbonate, sulphate, silicates, and the calcium combined with humus matter were calculated, subject to certain assumptions which introduced only small errors. It was found that there were wide variations in the contents of total calcium, calcium carbonate and silicates, and no relation between the total calcium content and that of any particular calcium compound could be deduced. Further, it was possible to have two soils of the same calcium content, but containing a very different assortment of calcium compounds. In twenty-nine of the soil samples, no calcium was found in combination with "humus." Five of the soils, representing two types, were acid to litmus; these contained relatively little total calcium and calcium carbonate, and were derived from badly drained areas. A clay loam (Mecklenburg), recognised as a good alfalfa (lucerne) soil, was found to have a high calcium content but to contain practically no calcium carbonate.—E. H. T.

Phosphoric acid: Forms of occurrence of — in the soil. M. A. Jegorov, Agric. Gaz. of S. Russia, 1916, No. 13–14, 4–5, and No. 15, 1–5. Bull. Agric. Intell., 1916, 7, 1248–1249.

THE organically combined phosphorus of the soil

was separated and estimated by leaching with 3% hydrochloric acid and treating with 3% ammonia solution, the resulting solution being then filtered and precipitated with lead acetate. The washed precipitate, freed from lead with hydrogen sulphide, was re-dissolved in dilute ammonia, the liquid filtered, concentrated, and finally extracted with ether, the organic phosphorus going into solution. The soils used were, "Podzol" from Moscow, containing 0.0532% of phosphoric acid, "Tchernoziom" from Ufa (0.115%), and Tchernoziom from Kursk (0.110%). Of the total phosphoric acid in these soils, the ammonia solution removed about one-half in the first and third, and one-third in the second. The organic phosphoric acid extracted varied from 10 to 17.67% of the total phosphoric acid; its nature varied with the source, but it is apparently related to the nucleic acids. The 3% hydrochloric acid extract contained the element in both inorganic and organic forms, and during its evaporation a considerable amount of the latter was converted into the former.—E. H. T.

Soil: Method of sterilising and chloroforming — used in studying "Tchernoziom." S. Skalskij, Agric. Gaz. of S. Russia, 1916, 18, Nos. 1, 2, 5, 7, and 9. Bull. Agric. Intell., 1916, 7, 1249–1253.

THE "Tchernoziom" soils selected for the investigation were a fallow soil ploughed in April [A], a soil cleared several years previously [B], and a 3-year-old lucerne soil [C]. From each of these a surface layer (0–17.7 cm.) and a layer immediately below it (17.7–35.5 cm.) were taken, treated with various fertilisers, potted, and sown with sterilised oat seeds. The first series (a) served as controls, the second (b) was manured with potassium nitrate and magnesium sulphate, and used to determine the assimilable phosphoric acid content, the third (c) received potassium dihydrogen phosphate and magnesium sulphate, and was used to determine the assimilable nitrogen, the fourth (d) received a complete mineral dressing of potassium nitrate, potassium dihydrogen phosphate and magnesium sulphate, the fifth (e) contained soil sterilised by heating in an autoclave in steam for 1 hour under 2.5 atmos., and in the sixth (f) chloroformed soil was employed. Four plants were grown in each pot, and they were watered from below with rain water, so that the moisture content remained at the optimum throughout. The plants died in some of the sterilised samples of soil, probably owing to physico-chemical changes incurred during sterilisation. The fertility of (d) and (e) was about the same and much superior to the rest, (f) came next, followed by (c), (b), and (a). To investigate the causes of the increase in fertility, the bacterial flora in [A] was examined. The bacterial numbers in (e) and (f) were incomparably greater than in (a), greater in the shallow than in the deep soil, and greater on agar than on gelatin. In (f), the bacterial increase and the higher fertility were accompanied by an enrichment in nitrogen and phosphorus. The gain of assimilable nitrogen is ascribed to bacterial fixation of atmospheric nitrogen and to the decomposition of organic matter, that of the phosphorus to the action of soil organisms in liberating acids which attacked the phosphates, and in converting unavailable organic phosphorus into an assimilable state. The bacteria in the sterilised samples (e) were derived from the air, and the enhanced fertility was chiefly due to the increase in available phosphoric acid, which amounted to 47–76.5% in the lower layer and 88–121% in the arable strata, and which is ascribed to the decomposition of nucleins containing 5.7% of phosphorus which liberate free phosphoric acid when heated to 150° C. The nitrogen contents of the sterilised and un-

sterilised soils were the same; and as the good effects of sterilisation could not be entirely due to the increase in soluble phosphoric acid, they must also be accounted for by assuming that assimilable nitrogen is liberated from organic matter during sterilisation. The increase of available nitrogen in series (e) was clearly indicated by the rich green colour of the leaves of the young plants.—E. H. T.

Nitrification of different leathers and of "sulphurated" rape cakes; Study of the— Guillin. Compt. rend. de l'Acad. d'Agric. de France, 1916, 2, 760—769. Bull. Agric. Intell., 1917, 7, 1253—1256.

NITRIFICATION experiments were carried out with a clayey-lime soil (Gournay, Seine-et-Oise), which was treated in 1 kilo. lots with the following materials, in amounts containing 1 gm. of nitrogen: dried blood (N 14.72%), tanned leather (N 8.15%), chrome leather (8.87%), roasted leather (6.77%), leather waste treated with sulphuric acid and converted into a pasty mass (6.63%), the same treated with more acid and liquefied (7.36%), and "sulphurated" rape cake (5.62%). Nitric acid determinations were made at intervals of 1, 2, and 5 months by the Schloesing method, which was tested and found to be applicable and reliable. The following were the weights of nitric acid found after one and after three months: blood 1.080, 2.433 grms.; tanned leather, 0.166, 0.404 gm.; chrome leather, 0.003, 0.227 gm.; roasted leather, 0.220, 0.523 gm.; dissolved leather (pasty), 0.742, 1.547 grms.; dissolved leather (liquid), 0.990, 2.015 grms.; rape cake, 0.888, 2.291 grms.; untreated soil, 0.145, 0.326 gm. The effects of chrome leather and of dissolved leather upon the growth of young wheat plants was investigated in pot experiments. Ten weeks after germination, the crops were weighed, and taking the weight of the control plants as 100, that treated with chrome leather was 30, and that with dissolved leather 115. Chrome leather is therefore injurious to vegetation. Neither tanned leather nor roasted leather are suitable soil amendments. Under very favourable conditions of nitrification, the former gave 0.021 and 0.078 gm. of nitric acid after 1 and 5 months respectively, and the latter, 0.075 and 0.197 gm., per gm. of fertiliser nitrogen applied. Leather which has been thoroughly decomposed with sulphuric acid is a useful fertiliser.—E. H. T.

Manganese; Use of— as a catalyst in atmospheric nitrogen fixation by plants through bacterial agency. R. A. De Gregorio. Rev. Real. Acad. Ciencias exact., de Madrid, 1916, 14, 681—693. Bull. Agric. Intell., 1917, 7, 1256—1257.

QUANTITIES of 100 c.c. of culture bouillon of known nitrogen content, and containing mannitol and varying amounts of manganese chloride, were inoculated with pure cultures of *B. radicola*, *Clostridium pasteurianum*, and *Azotobacter chroococcum*, incubated at 22°—23° C. for 25 days, and after sterilisation analysed for total nitrogen by Kjeldahl's method. With the exception of *B. radicola*, the organisms did not function in the total absence of manganese, but in all cases its presence accelerated nitrogen fixation, the optimum quantity being 0.006 gm. of manganese ion per 100 c.c. of bouillon. With this amount three times more nitrogen was fixed than in the control vessel. Acceleration was retarded when the manganese exceeded the optimum, and with 0.02 gm. the fixation itself was retarded. Under field conditions, crops could be stimulated by fertilisers containing manganese in amount not exceeding 0.006 gm. per 100 grms. of soil. Most soils already contain more than this amount of manganese, but it is

mostly in an unavailable form. In estimating the quantity of this catalyst to be applied, the amount already present in a soluble form must be taken into consideration.—E. H. T.

PATENTS.

Manure from refuse; Manufacture of— A. D. Furse, Beckenham, Kent. Eng. Pat. 103,118, Sept. 7, 1916. (Appl. No. 12,651 of 1916.)

HOUSE or town refuse is disintegrated and a small quantity of fertile mould, butchers' offal, fish offal, beetroot waste, etc., may be added. The mass is then treated with a culture of bacteria capable of producing ammonia and fixing nitrogen, and kept at 80°—90° F. (27°—32° C.) for several days. Afterwards, the mass is dried and powdered, or it may be pressed and the liquid portion used as a manure. A modification of the process consists in sterilising the refuse by treatment with steam before the culture of bacteria is added.

—W. P. S.

Ammoniacal liquor; Process for improving the fertilising value of the— produced in the manufacture of gas or coke. A. Schubert, Parsberg. Ger. Pat. 292,145, Mar. 20, 1911.

THE ammoniacal liquor, together with the crude tar, obtained by the destructive distillation of coal is subjected to redistillation in such a manner that a final temperature of 200° C. is reached, and the distillate up to this temperature is collected and diluted with water before use as a fertiliser. The secondary changes which take place on heating the crude tar with the gas-liquor, assisted by the use of superheated steam and agitating devices, produce substances which have a stimulating influence on vegetable growth and a poisonous effect on parasites. Some of these substances have a direct fertilising value, others are made available by the action of atmospheric organisms or carbon dioxide.—J. F. B.

Fertiliser from lignite ash; Preparation of— H. Fehn. Ger. Pat. 291,858, Sep. 4, 1914.

LIGNITE ash is mixed with quicklime and the mass slightly moistened and mechanically agitated in a current of air, heat being applied if required. The process may be carried out in a drum through the horizontal axis of which air is admitted, whilst a series of paddles are attached to the inner walls of the drum. By this treatment the sulphides in the lignite ash are oxidised.—C. A. M.

Nitrolim [crude calcium cyanamide]; Apparatus for treating— G. Zarniko, Hildesheim. Ger. Pat. 291,993, Apr. 1, 1915.

NITROLIM is treated with water to decompose carbide, and mixed with moist or liquid materials to prevent dusting, in a long horizontal rotating drum, which is provided with cooling means and separate inlets for nitrolim, liquids, and inert gas, and an outlet for the finished product which can be closed by means of a cap or valve, or may be connected with a spiral conveyor which can be made to rotate in the same or an opposite direction to that of the drum so as to keep back the material. Baffle plates may be fitted inside the drum to promote the movement of the mass in either direction. The drum is surrounded by a cooling jacket. —C. A. M.

Fertiliser; Preparation of a non-dusty— of uniform composition. F. Winterfeld, Cöln-Mülheim. Ger. Pat. 295,112, Dec. 31, 1915.

NITROLIM is mixed with dolomite sand, with or without subsequent moistening of the mass with a dilute solution of syrup. —C. A. M.

Superphosphate chambers: Method and apparatus for emptying—W. Mellwig, Lehrte, Ger. Pat. 295,418, July 29, 1911.

The material is loosened by a rake-like arrangement, and a powerful current of air is directed over its surface for transporting, aerating, and drying it. The compressed air duct, which at the same time forms the shaft of the rake arrangement, terminates between the prongs of the rake in an orifice directed towards the discharge orifice of the chamber and is moved to and fro over the surface of the material by a slide and an automatic reversing gear attached to the spindle of the slide-guide, and is lowered gradually and automatically as the material is discharged, by means of a rack and pinion which operates the upright shaft.

—J. F. B.

Phosphatic manure, and process for producing the same. E. Stoppani, Bologna, and V. Volpato, Milan, Italy. Eng. Pat. 100,034, Jan. 21, 1916. Under Int. Conv., Aug. 4, 1915. (Appl. No. 1004 of 1916.)

SEE FR. Pat. 480,697 of 1916; this J., 1917, 152.

Calcium phosphate: Treatment of natural—E. Ciselet and C. Deguide, Brussels, C.S. Pat. 1,214,008, Jan. 30, 1917. Date of appl., Feb. 19, 1914.

SEE FR. Pat. 468,042 of 1914; this J., 1914, 976.

XVII.—SUGARS; STARCHES; GUMS.

Synthesis of the phenylglucosides. Fischer and von Meehel. See XX.

XVIII.—FERMENTATION INDUSTRIES.

Yeast: Further methods for the preparation of permanent—T. Bokorny, Allg. Brauer u. Hopf. Zeit., 1916, 56, 1547–1550. Z. angew. Chem., 1917, 30, Ref., 49.

Yeast cells may be killed, without destroying the fermentative activity of the contained zymase, by treatment with 0.1–0.5% solutions of sulphuric acid, ammonium and sodium fluorides, formaldehyde, ferrous sulphate, ammonium oxalate, potassium chlorate, chloroform, ether, etc. Continued action of the toxic solution, however, ultimately affects the zymase also. By drying the yeast treated with these toxic solutions, after washing out the reagent used with water, permanent yeast preparations may be made similar to the so-called "acetone yeast." The process is much cheaper than the acetone and the ether-alcohol processes for making permanent yeast. Only with the fluorides were the results unsatisfactory. Rapid treatment is not necessary; for instance, in using sulphuric acid, it is advisable to leave the yeast for several hours in contact with a 0.1% solution, in order to make sure of killing all the cells.—J. F. B.

Diastase: Optical properties of—and its adsorption by kaolin and by aluminium hydroxide. M. A. Rakuzin and G. D. Flier, J. Russ. Phys.-Chem. Soc., 1916, 48, 321–324.

At 60°C., only 84–12% of Merck's diastase is soluble in water; the solution is optically inactive and gives the biuret, xanthoprotein, Molisch's, and Ostromyslenski's reactions (this J., 1916, 433), the limits of sensitiveness being 1 in 1690, 810, 6660, and 750 respectively. In two solutions of diastase, 7.19% and 7.10% of the total diastase

present was adsorbed by aluminium hydroxide, and a second treatment with the latter effected no further diminution in the specific gravity of the solution. Further, if the aluminium hydroxide is subsequently washed carefully and pressed, and then treated with hot water, the liquid shows none of the colour reactions of the original diastase solution; the adsorption is, therefore, irreversible. The adsorbed portion of the diastase fails to give Ostromyslenski's colour reaction with picramic acid. Since diastase consists of two enzymes, of which one converts starch into dextrins, the other starch to maltose it may well be that the adsorbed and non-adsorbed parts correspond with these two constituents. Diastase is not adsorbed by the electro-negative kaolin (compare W. Ostwald, Grundriss der Kolloidchemie, 1909, 421).—T. H. P.

Beers: Low alcoholic—O. Overbeck, J. Inst. Brew., 1917, 23, 3–12.

The author gives some practical details of a method of brewing beers of low alcohol-content which has furnished satisfactory results. The water employed, which is calcareous in character, is treated with 12 grains of calcium chloride per gallon. No malt substitutes are used, but admixture of a considerable proportion of foreign malt is found to have a steadying effect on the yeast, besides reducing danger of infection by wild yeasts and giving the beer a firm, permanent head. Owing to the sensitive character of the beers, as regards flavour, old hops are avoided as far as possible. One quarter of the total amount of hops used is reserved for addition to the wort about 15 mins. before turning out of the copper; this improves the real hop-flavour of the beers to a marked extent. The Yorkshire stone square system of fermentation is employed. Cleanliness is essential, since the wort remains for a long time without a protective yeast head. To avoid infection the fermenting vessels are covered with sheets of cotton twill moistened with very dilute sulphurous acid, and these sheets are sterilised after every brew. A wort of original gravity 1015°–1020°, pitched on Monday evening, is ready to rack at half-gravity on Thursday morning; racking may, however, be delayed to Saturday (but not later) if the wort is pitched with 3–4 oz. of yeast per barrel and very careful attention is given, the wort being kept within 1° of 60°F. The beer is racked into well-cleaned barrels, which, after introduction of about a wineglassful of sulphurous acid solution (sp. gr. 1.025), have stood overnight loosely shived. One-third of the usual amount of finings is added to each barrel, and after the full barrels have been shived tightly and well rolled, the beer becomes "star bright" in about 2 hours and is ready to send out. The amount of preservative used is about half that for an ordinary beer. In full barrels the beer remains in good condition for months. If brewed at an original gravity of 1016° and racked at 1008°, its alcohol-content falls within the limit for temperance beverages (1% of alcohol, or about 2% of proof spirit), but this limit is exceeded on storage. The author gives some particulars relating to Belgian and Danish beers of low alcohol-content.

—J. H. L.

Malic acid: Fermentation of—A. Lebedev, J. Russ. Phys.-Chem. Soc., 1916, 48, 725–748.

The separation and estimation of lactic acid in presence of malic acid by Kunz's method (Z. Unters. Nahr. Genussm., 1901, 4, 673) gives good results if 3 volumes of 96% alcohol instead of 2 volumes of 95% alcohol are added per 1 volume of solution; further, this addition must be made in small portions and with constant

stirring, otherwise the barium lactate is partly precipitated.

Attention is directed to the presence in commercial ether of acetaldehyde, alcohol, acetic acid, etc.; this is regarded as the source of the acetaldehyde detected by Buchner and Langheld in sugar solution fermented by means of yeast juice in presence of a phosphate.

Experiment shows that, in a concentration of 2%, malic acid is readily fermented by yeast, the decomposition it undergoes being, however, more complicated than that represented by the equation.

$\text{CO}_2\text{H}.\text{CH}_2.\text{CH}(\text{OH}).\text{CO}_2\text{H} = \text{CO}_2 + \text{OH}.\text{CH}(\text{CH}_2).\text{CO}_2\text{H}$. When its concentration is 4%, malic acid is only feebly fermented, evidently owing to the high acidity of the solution. All the results obtained show that the initial stage in the fermentation of malic acid consists in the scission of carboxyl from the group, $\text{CO}_2\text{H}.\text{CH}_2$, this change being perfectly analogous to the rupture of the aldol linking. On this account the author regards the carboxylase concerned, which is possibly not identical with the carboxylase of Neubauer and Neuberg, as belonging to the group of the aldolases. Such enzymes have not yet been isolated but undoubtedly exist, as is shown by the lactic and alcoholic fermentations of the hexoses, in which a chain of six carbon atoms is broken into two chains of three carbon atoms. It might be expected that many, if not all, dibasic acids containing the group $\text{CO}_2\text{H}.\text{CH}_2$ would be decomposed by carboxylase, and the same might be expected of polybasic acids, since citric acid is also readily fermented by yeast. In the fermentation of succinic acid, the latter appears to decompose firstly into carbon dioxide and propionic acid, but with malonic acid no decomposition is effected by yeast. The action of carboxylase is, therefore, specific. In presence of Methylene Blue, the fermentation of malic acid gives rise to acetaldehyde. It is found also that, in presence of acetaldehyde, a comparatively small proportion of lactic acid undergoes oxidation to pyrotartaric acid. The results show that, if lactic acid is fermented to alcohol and carbon dioxide, such reaction is extremely slow and must be regarded as a secondary one. From the fact that malic acid is dehydrated more slowly and feebly than lactic acid, it is supposed that in the decomposition of malic acid carbon dioxide is first split off, the lactic acid being liberated in an anhydrous condition.—T. H. P.

Tyrosol [p-hydroxyphenylethyl alcohol]; Biological synthesis of —. P. S. Pischtschimuka. J. Russ. Phys.-Chem. Soc., 1916, 48, 1—54.

THE greater part of this paper has been previously published (see Ehrlich and Pischtschimuka, this J., 1912, 506 and 1050). The formation of esters during the normal alcoholic fermentation of amino-acids appears to be a biological process of wide extent, its effect being to render harmless the excess of acids and alcohols, which would otherwise be injurious to the micro-organisms. A number of the esters of tyrosol have been prepared by ordinary chemical synthetical methods and are found to exhibit faint odours. The mixture of esters formed naturally during alcoholic fermentation has a pleasant odour, but this is probably due to the presence of admixed indole derivatives.—T. H. P.

Metabisulphites of potassium and of sodium. Carles. See VII.

Protein "bodies" and "anti-bodies" as products of adsorption. Rakuzin. See XIXA.

Calculation of specific heats of aqueous-alcoholic solutions. Kolosovski. See XXIV.

PATENT.

Distilling and rectifying columns. Ger. Pat. 291,781. See I.

XIXA.—FOODS.

Manufacture of Flour and Bread Order.

UNDER the "Manufacture of Flour and Bread Order (No. 2), 1917," it is compulsory on all millers to extract from the wheat not less than 81% of flour. Admixture of some other substance is compulsory to the extent of an additional 5%. Materials allowed to be mixed are rice, barley, maize, semolina, oats, rye, or beans, and the Food Controller reserves power to add any other cereal. Further admixture to the extent of an additional 10% is permitted. Mixtures must be made by the millers before selling their flour. The Order comes into effect as regards millers on March 12th and as regards vendors of bread on March 26th.

Egg albumin; Behaviour of ferric oxide and hydroxide towards —. M. A. Rakuzin. J. Russ. Phys.-Chem. Soc., 1916, 48, 95.

WHEREAS aluminium hydroxide is an excellent adsorbent and the adsorptive capacity of dry alumina is only 3—4 times less than that of the hydroxide, neither ferric hydroxide nor oxide exerts any adsorptive action when immersed for 24 hours in an aqueous solution of egg albumin. Since albumins are adsorbed more readily than other substances, it may be concluded that the latter will not be adsorbed by ferric hydroxide or oxide.—T. H. P.

Egg albumin; Adsorption of — by aluminium oxide and hydroxide. M. A. Rakuzin and E. M. Brando. J. Russ. Phys.-Chem. Soc., 1916, 48, 95—97.

ONLY when chemically pure does aluminium hydroxide exert its full adsorptive power on aqueous solutions of egg albumin. Commercial precipitated alumina is applicable as an adsorbent after having been dried to constant weight in a steam oven, such aluminium hydroxide then giving identical results in the hands of different experimenters. The adsorptive power is diminished by the presence of moisture. Aluminium oxide exerts but a feeble adsorptive action on albumin solutions. The above conclusions appear to hold also for solutions of substances other than albumin.—T. H. P.

Egg albumin; Specific gravity of aqueous solutions of —. M. A. Rakuzin and G. D. Flier. J. Russ. Phys.-Chem. Soc., 1916, 48, 458—461.

THE albumin of hens' eggs is in the state of a saturated solution containing about 15% of the albumin, together with small proportions of fats and salts. At 17° C. the saturated solution contains 15.35% and the specific gravities at this temperature of solutions of different concentrations are: 1%, 1.00283; 5%, 1.01341; 10%, 1.02666; 15%, 1.03942. The limiting solubility of albumin being 15.35%, the specific gravities for solutions of higher concentrations (up to 60%) given in Witz's table (*Chemiker-Kalendar*) are without experimental foundation. For 5% solutions, the following results were obtained: (1) untreated egg-albumin, sp. gr. at 15° C., 1.01341; $[\alpha]_D = -36.6^\circ$; (2) fat-free albumin, prepared by extraction with light petroleum, sp. gr. at 15° C., 1.01344; $[\alpha]_D = -36.6^\circ$; (3) fat- and salt-free albumin, obtained by treating a solution of the fat-free albumin with lead acetate and decomposing the lead albuminate with hydrogen sulphide, sp. gr. at 15° C., 1.01288; $[\alpha]_D = -36.6^\circ$ —T. H. P.

Protein "bodies" and "anti-bodies" as products of adsorption. M. A. Rakuzin. J. Russ. Phys.-Chem. Soc., 1916, 48, 465—468.

From analogy with the separation into toxin and anti-toxin occurring when anti-diphtheritic and other serums are treated with adsorbents, the author regards the selective adsorption of proteins, enzymes, etc., by aluminium hydroxide as separation into an adsorbed portion and a non-adsorbed "anti-body." Thus egg albumin $[\alpha]_D^{20} = -37.1$, yields 19.22% of adsorbed albumin, $[\alpha]_D^{20} = -56.0$, and 80.78% of "anti-albumin," $[\alpha]_D^{20} = -32.6$; egg albumin peptone, $[\alpha]_D^{20} = -95.24$, gives 24.49% of adsorbed peptone, $[\alpha]_D^{20} = -156.68$, and 75.51% of "anti-peptone," $[\alpha]_D^{20} = -75.0$; and diastase (optically inactive) yields 7.10% of adsorbed diastase I, and 92.90% of "anti-diastase," the latter but not the former giving Ostromyslenski's reaction with picramic acid. In the case of the solid paraffins of Grosny petroleum, adsorption effects removal of the lower homologues present, and it may be assumed that the adsorbed fractions of proteins, enzymes, and serums are also of lower molecular weight than the non-adsorbed fractions remaining in solution.—T. H. P.

Legumin as the analogue of casein. M. A. Rakuzin and G. F. Pekarskaja. J. Russ. Phys.-Chem. Soc., 1916, 48, 469—470.

LEGUMIN (Merck's) resembles casein in its physical and chemical characters. Contrary to the statement of Osborne and Harris concerning the legumin of horse-beans, it does not dissolve in 10% sodium chloride solution, but it dissolves in water containing 0.5% of hydrochloric acid (1:2) and 0.2% of pepsin, its specific rotation in this solution being $[\alpha]_D^{20} = -12.88$. It contains 0.16% of phosphorus and it gives the following colour reactions, the sensitiveness being indicated in brackets: biuret (1:3030), Millon's (1:1510), Adamkiewicz's (1:14920), Molisch's (1:14920), Pettenkofer's (1:3030), and Ostromyslenski's (1:1510).—T. H. P.

Metabisulphites of potassium and of sodium. Carles. See VII.

PATENTS.

Bread or the like: Manufacture and composition of —. E. S. and G. Roworth, Matlock Bath, and F. C. Lynn, Matlock. Eng. Pat. 100,295, Jan. 21, 1916. (Appl. No. 1024 of 1916.)

A PRODUCT for use in bread-making is prepared by mixing 5 lb. of cornflour, $4\frac{1}{2}$ lb. of starch, $\frac{1}{2}$ lb. of arrowroot, and $\frac{1}{2}$ lb. of sugar in 12 pints of water, pouring into 36 pints of boiling water, and boiling until gelatinised. A small quantity of alum may be used with the ingredients. In making bread, about 60 lb. of the product is divided into small pieces, added to the mixing water at 90—94° F. (32—34° C.), with yeast and salt, and worked into dough with 20 stones of flour in the ordinary way.—J. H. J.

Margarine: Manufacture of —. K. Esley, Nijmegen, Holland. Eng. Pat. 103,343, Jan. 26, 1916. (Appl. No. 1252 of 1916.)

FROM 0.5 to 1% of an alkali or alkaline-earth salt of formic, acetic, or propionic acid, or a mixture of the same, is added to the fat or ingredients in order to preserve the buttery aroma of the margarine. An alkali lactate may also be added if desired (see Eng. Pat. 2013 of 1915; this J., 1916, 324).—W. P. S.

Margarine: Preparation of an emulsion with fruity aroma from eggs to be used, especially in place of milk or cream, in the manufacture of —. L. Bernegau, Berlin-Halensee. Ger. Pat. 295,351, Mar. 21, 1914.

FRESH white-of-egg is treated at about 40° C. with freshly expressed pineapple juice (containing yeast cells), and the resulting liquid mixed with sugar, emulsified with fresh egg yolk, and sterilised by heating. The emulsion is suitable for blending with coconut oil or hydrogenated oils to produce an edible fat.—C. A. M.

Food suitable for cattle and poultry. Midland Cattle Products, Ltd., and J. Austin, Birmingham. Eng. Pat. 103,333, July 6, 1916. (Appl. No. 9519 of 1916.)

A MIXTURE of cereal meal, 2 parts, and fresh blood, 1 part by weight, is spread in layers not more than 0.5 inch thick, and dried. During the drying the temperature is raised gradually from 100° F. (38° C.) to 500° F. (260° C.). If necessary, the above mentioned quantities are varied so that the product shall contain approximately 20% of proteins and 70% of carbohydrates.—W. P. S.

XIXB.—WATER PURIFICATION; SANITATION.

Anthrax serum: Immunity studies on —. A. Eichhorn, W. N. Berg, and R. A. Kelsner. J. Agric. Res., 1917, 8, 37—56.

SIMILAR methods to those used in the preparation of diphtheria antitoxin were used in an examination of anthrax serum. When the serum was treated with 30% of saturated ammonium sulphate solution, the euglobulin was precipitated, and when the saturation of the filtrate was raised to 50%, the pseudoglobulin was precipitated and carried down the anthrax-immune bodies with it. This precipitate was pressed and dialysed in running tap-water, and the concentrate obtained in the dialyser was preserved with chloroform. When this globulin concentrate was injected into animals inoculated with anthrax, death was prevented in many cases. In analysing the serum and the globulin, the total coagulable protein was determined by adding acetic acid, filtering, and weighing the precipitate. The total globulin was determined by adding half-saturated ammonium sulphate solution and centrifuging at 3000 revolutions per min. for 40 mins. The liquid was poured off, the precipitate dissolved in distilled water, and the total coagulable protein determined. The therapeutic treatment of anthrax in animals and man with the serum and the globulin gave favourable results. Experiments were made on the standardisation of anthrax serum by means of the complement-fixation method, and the results pointed to this method proving an accurate one.—J. H. J.

PATENTS.

Water-softening. F. Blumenthal, Cologne-Braunsfeld, Germany. U.S. Pat. 1,212,007, Jan. 9, 1917. Date of appl. Apr. 26, 1915.

A SUBSTANCE for softening water is prepared by precipitating a solution of sodium silicate with a solution of ferrous chloride, and washing, pressing, and drying the precipitate, which forms into hard lumps. On being moistened, the lumps break up into particles of 1—2 mm. size, which are dried at a low temperature.—J. H. J.

Water, sewage, and liquid manufacturing-waste: Means for treating—F. Noble, Brooklyn, N.Y., U.S. Pat. 1,211,481, Jan. 9, 1917. Date of appl., Sept. 17, 1913.

THE polluted liquid is passed through a broad, shallow tank, containing submerged perforated receptacles holding calcium carbonate and hypochlorite. When these chemicals are saturated with the liquid, hypochlorous acid is evolved and is diffused through the liquid, producing oxidising effects. The suspended matter is deposited within the tank.—J. H. J.

Odours from gases, fumes, etc.: Device for eliminating—S. D. Eisendrath, Chicago, Ill., U.S. Pat. 1,211,691, Jan. 9, 1917. Date of appl., Apr. 7, 1913.

THE gas to be purified is collected in a receptacle and passes out from it at the top by a pipe with an inverted U-bend in which is a water spray. The pipe is connected with a discharge flue and has another upright U-bend in it, which has a spray directed into the bend, with a shield in front of the spray.—J. H. J.

Inse. ticides, sheep dip, and the like. G. J. Lemmens, Waterbury, and P. J. Fryer, Tonbridge, Kent, Eng. Pat. 103,458, Oct. 7, 1916. (Appl. No. 14,278 of 1916.)

THE fruit, berry, seed, or other portions of plants of the *Menispermaceæ* order (particularly *Cocculus indicus*, fish-berry) are ground and, if desired, mixed with soap, sulphur, or other ingredients.—W. P. S.

Liquid and solid materials [sewage]: Purification of—E. J. M. Janvier, Paris, U.S. Pat. 1,214,166, Jan. 30, 1917. Date of appl., Jan. 29, 1913. SEE Eng. Pat. 27,775 of 1913; this J., 1914, 1169.

Manufacture of manure from refuse. Eng. Pat. 103,148. See XVI.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Thebaine: Conversion of—into hydroxycodeinone and its derivatives. M. Freund and E. Speyer, J. prakt. Chem., 1916, 94, 134—178.

THEBAINE on treatment with 30% hydrogen peroxide in acid solution, or with potassium bichromate and sulphuric acid, is converted into hydroxycodeinone, $C_{15}H_{19}NO_4$, decomposing at 275° C., and containing one methoxy group less than thebaine. It gives a well-crystallised oxime, $C_{15}H_{19}N_2O_4$, identical with the oxime prepared by boiling bromocodeinone with hydroxylamine, and gives a mono-acetyl derivative, m.pt. 185—186° C., and mono-benzoyl derivative, m.pt. 245—247° C. On treating hydroxycodeinone with methyl iodide, a compound, $C_{15}H_{19}NO_4 \cdot CH_3I$, is obtained which with sodium ethoxide solution gives N-methylhydroxycodeinone. The latter gives a well-crystallised compound with methyl iodide, which splits off trimethylamine on treatment with alkali but gives no crystalline nitrogen-free derivative. Thebaine oxidised with 30% hydrogen peroxide in absence of acid does not give hydroxycodeinone but a very small amount of a deep yellow base, dehydrothebaine, $C_{15}H_{19}NO_3$, m.pt. 178°—180° C., containing two methoxy groups, which forms deep-red salts. Hydroxycodeinone when reduced with zinc dust in glacial acetic acid solution gives hydroxycodeine, $C_{15}H_{21}NO_4$, m.pt. 293° C., insoluble in alkali and containing no keto group, but giving

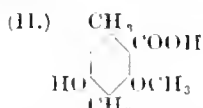
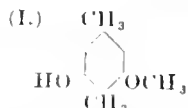
a monoacetyl derivative; whilst when reduced with stannous chloride and hydrochloric acid it yields an isomeric hydroxycodeine, hydroxythebainone, containing a keto group, and soluble in alkali, and probably constituted analogously to the thebainone obtained by reducing thebaine with stannous chloride and hydrochloric acid. Hydroxycodeinone on treatment with hydrogen in presence of platinum black or palladous chloride solution gives a tertiary base, dihydrohydroxycodeinone, m.pt. 220—222° C., isomeric with hydroxycodeine and hydroxythebainone, which forms well-crystallised salts and gives an oxime and an acetyl and benzoyl derivative. Dihydrohydroxycodeinone on warming with sodium amalgam is converted into a compound, m.pt. 219—220° C., of different solubility and crystalline form but which yields the same derivatives and hence is probably a tautomeric form of dihydrohydroxycodeinone. By progressive methylation with methyl iodide, dihydrohydroxycodeinone gives a series of compounds, and eventually, on heating with alkali, a nitrogen-free substance, $C_{17}H_{16}O_4$, m.pt. 214°—215° C., is obtained containing one methoxy and one keto group. Dihydrohydroxycodeinone on reduction with sodium amalgam in alcoholic solution is converted into dihydrohydroxythebainone, $C_{15}H_{23}NO_4$, m.pt. 145° C., giving well-crystallised salts and particularly a well-crystallised perchlorate, m.pt. 270° C. The constitutional formulae of hydroxycodeinone and these derivatives and the relationships between the constitutional formulae proposed and the constitutional formulae proposed for codeine and thebaine by Knorr and Helein and also by the present authors (this J., 1907, 213; 1916, 1032) are fully discussed.—T. C.

Phenylglucosides: Synthesis of the—E. Fischer and L. von Mehel, Ber., 1916, 49, 2813—2820.

WHEN a mixture of acetobromoglucose, 50 grms., dry phenol, 160, and quinoline, 19 grms., is heated on the water-bath for 1½ hours, treated with dilute acid, and shaken out with ether, there is obtained, after distilling off the excess of phenol *in vacuo*, a crystallisable residue (yield 32 grms.) consisting of a mixture of two isomeric tetra-acetylphenylglucosides in the proportion of 6 parts of the β -isomeride to 1 of the α -compound. These are easily separated by crystallisation from carbon tetrachloride and yield on saponification with barium hydroxide the already known β -phenylglucoside, hydrolysable by emulsin, and α -phenylglucoside, which is hydrolysed by yeast enzymes. The use of quinoline in the above manner affords a general method for the preparation of glucosides of aromatic, hydro-aromatic (e.g., menthol), and aliphatic alcohols. α -Phenylglucoside crystallises with 11H₂O, melts at 173°—174° C. (corr.), and has $[\alpha]_D^{20} = +180$; the corresponding tetra-acetyl compound melts at 115° C. and has $[\alpha]_D^{20}$ in benzene solution = +165. β -Phenylglucoside crystallises with 21H₂O, melts at 175°—176° C., and has $[\alpha]_D^{20} = -71.7$; its tetra-acetyl derivative melts at 127—128° C. and has $[\alpha]_D^{20} = -28.9$.—J. F. B.

Lichens: Constituents of—II. *Synthesis of rhizonic acid* A. Sonn, Ber., 1916, 49, 4589—4593.

m-DINITRO-*p*-XYLENE, which is readily obtained from *p*-xylidine, was converted by Kostanecki's method (this J., 1886, 599) into 2-nitro-*p*-xylen-6-ol and the latter methylated by treatment with dimethyl sulphate. The ether thus obtained was reduced and the amino group replaced by hydroxyl, with the formation of β -orcinol monomethyl ether (I). An aldehyde group was then introduced in



the *para* position to the hydroxyl by the action of hydrogen cyanide and chloride in presence of aluminium chloride, and the aldehyde after acetylation was oxidised with permanganate, the resulting acid after the removal of the acetyl group being identical with rhizonic acid (II), produced by the hydrolysis of naturally occurring barbatinic acid.—G. F. M.

Storax in perfumery. Chem. and Drug., Oct. 21, 1917.

MUCH of the storax of commerce is impoverished by the removal of cinnamic acid, to the compounds of which the peculiar odour of storax is due. The cinnamic acid content of storax may fall below 3%, although 30% is about the normal figure. The British Pharmacopoeia requires only 20% of the acid in the prepared storax, which represents at least 16 or 18% in the imported article, but more is really shown by the best gum-resins. Under these circumstances, it may be that, if attention were directed to other sources of cinnamic acid, it might pay better to utilise them for perfumery purposes, and to leave the storax for medicinal use. The liquid balsam of *Liquidambar styraciflua*, known in the United States as sweet gum, and used in the preparation of chewing-gums, was shown in the Nicaragua and Guatemala departments of the 1878 International Exhibition in Paris. It was in the form of a clear brownish-yellow liquid of the consistence of virgin honey, without the admixture of water usual in Asiatic storax. According to Gildemeister and Hoffmann, this storax closely resembles in almost all its properties the storax of the Levant, the oil distilled from it differing chiefly in not containing ethyl and benzyl alcohols, and in being dextro-rotatory. Another source of cinnamic acid which has not been exploited in this country is the balsam obtained in Brazil from *Myroxylon Peruvianum*. The odour of the balsam resembles that of balsam of Peru, from which it differs in readily mixing with castor oil in all proportions, thus possessing a considerable advantage for perfumery purposes. The oily portion of this balsam, containing the cinnamic acid, can be separated from it by benzene and petroleum ether. Another source of cinnamic acid is the resins of various species of *Xanthorrhoea*, called "grass-tree gums" in Australia, the best known of which in English commerce are *acaroides* (*Xanthorrhoea arborea*) and black-boy "gum" (*X. hastilis*). Although the percentage of cinnamic acid in them is small, the quantity of resin available is enormous. The volatile oil distilled from *acaroides* contains a considerable quantity of cinnamic acid, the proportion being 20% when crystallised from water. The oil itself has a storax-like odour, and, like storax, contains styrene. The liquid balsam obtained by incision from *Liquidambar Allingiana*, Blum., to which the name of "Rasamalas" is applied by the Malays, in common with that of *L. orientalis*, is deserving of examination as a source of cinnamic acid. This balsam is obtainable in Tenasserim and Borneo. It may be noted, however, that these trees only produce the balsam when the climate is warm, i.e., in latitude 20°–30°. *L. styraciflua* stands the winter in this country, but produces no balsam; and although the tree occurs as far north as Connecticut and Illinois in North America, the product is commercially produced only in the sub-tropical countries, such as Mexico, Guatemala, and Nicaragua.

Camphor: Comparative physiological action of natural and synthetic—G. Joachimowicz. Ber. deut. Pharm. Ges., 1916, 26, 427–455.

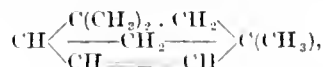
Owing to the cessation of imports of Japanese natural camphor, the German medical authorities at the beginning of the war recommended that synthetic camphor should be substituted for natural camphor in preparations intended for external use only. An extended series of comparative physiological and germicidal experiments using natural *d*-camphor, *l*-camphor, $[\alpha]_D = -10^\circ$, m.pt. 176–177°C., and synthetic camphor, $[\alpha]_D = +3.025$ (Schering) and $[\alpha]_D = -0.225^\circ$ (Boehringer), carried out on cats, using an intra-peritoneal injection in olive oil solution, on the isolated frog's heart, and with *B. coli* and *Vibrio Metchnikoff*, gave results showing that there is no qualitative or quantitative difference in the physiological or germicidal action of the three modifications of camphor, and hence synthetic camphor can effectively replace natural camphor also for internal use.—T. C.

Santene: Complete synthesis of—G. Komppa and S. V. Hintikka. Bull. Soc. Chim., 1917, 21, 13–19.

CAMPHENONE was converted by reduction into the corresponding alcohol, campheninol, and the latter either on dehydration with sodium bisulphate or by the removal of the elements of hydrogen chloride from its chloride, camphenyl chloride, gave a hydrocarbon mixture consisting essentially of a smaller fraction, b.pt. 136–140°C., to which the name camphenylene is given, and a larger fraction, b.pt. 110–112°C., which was shown to consist mainly of a hydrocarbon identical with santene. By the action of sulphuric and acetic acids identical acetates were obtained from both the synthetic and natural hydrocarbons, and the alcohol previously termed isocampheninol, m.pt. 60–65°C., obtained by their saponification, is therefore identical with santenol. This identity was further proved by the oxidation of both isocampheninol and santenol to santenone and santenic acid.—G. F. M.

Fenchylene, a new synthetic terpene. S. S. Nametkin and A. K. Rushneeva. J. Russ. Phys.-Chem. Soc., 1916, 48, 450–452.

WHEN heated at 230°C., methyl isofenchylxanthate undergoes partial decomposition, yielding the new hydrocarbon, fenchylene.



which is a volatile liquid with a faint but characteristic odour recalling that of fenchene; it boils at 139–140°C. under 760 mm. pressure, has sp. gr. 0.8381 at 20°/4°C., $n_D = 1.4491$ at 20°C., and $[\alpha]_D = -68.76^\circ$ (in alcohol). The hydrocarbon unites energetically with bromine, yields a crystalline nitroschloride, and gives *cis*-fenchocamphoric acid when oxidised with alkaline permanganate.—T. H. P.

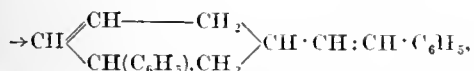
Catalysis: Heterogeneous—[Polymerisation of pinene: decomposition of carbon bisulphide.] L. G. Gurvitch. J. Russ. Phys.-Chem. Soc., 1916, 68, 837–856.

DETAILED investigation of the reaction of pinene with floridin (see this J., 1915, 1231) leads to the conclusion that the initial products of this reaction are polyterpenes which, under the influence of the heat developed, subsequently undergo partial decomposition into simple terpenes. The formation of the polyterpenes is caused by the adsorption of the pinene on the surface of the floridin, propinquity of the pinene molecules being thus

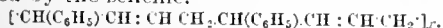
effected; factors which impede this adsorption also retard the transformation of the pinene. A catalytic reaction of another type has been discovered in the action on carbon bisulphide of the partly dehydrated aluminium hydroxide obtained from metallic aluminium in presence of traces of mercury: this reaction, which proceeds at the ordinary temperature, is expressed by the equation, $\text{CS}_2 + 2\text{H}_2\text{O} = 2\text{H}_2\text{S} + \text{CO}_2$. The yield of hydrogen sulphide attains a maximum for a certain percentage of water in the alumina, and it is assumed that the transformation of the carbon bisulphide is a result of its adsorption, that is, of the approach of the carbon bisulphide molecules to the water molecules within the sphere of action of the molecules of alumina. In a similar manner, alumina prepared as described above causes the conversion of ethyl chloride into ethyl alcohol in the cold. The hypothesis that adsorption always forms the basis of heterogeneous catalysis also furnishes a very simple explanation of those reactions in which the formation of intermediate chemical compounds is usually assumed, for instance, the reactions of Ipatiev, Sabatier, Bredig, etc.—T. H. P.

α -Phenyl- Δ^7 -butadiene: Polymerisation of —. S. V. Lebedev and A. A. Ivanov. J. Russ. Phys.-Chem. Soc., 1916, 48, 997—1008.

α -PHENYL- Δ^7 -BUTADIENE is able to polymerise into two different products, one of them soluble, obtained on heating, and the other, insoluble, obtained at the ordinary temperature in the light. The authors find that the dimeride is a monocyclic hydrocarbon containing two double linkings; it combines with 2 mols. of hydrogen or with 2 mols. of ozone, and on oxidation with permanganate yields benzoic acid and an acid, $\text{C}_{13}\text{H}_{14}\text{O}_6$. The character of the polymerisation and the properties of the dimeride and of the polymeride indicate that in spite of individual divergences, the type of the polymerisation is the same as with derivatives of diphenyl containing aliphatic substituents. According to the scheme previously given by Lebedev (this J., 1914, 1223, 1224), the formation of the dimeride is expressed thus:—



the resulting product being 2-phenyl-4-styryl-cyclohexene and its oxidation product, α -phenyl-butane- α,γ -tricarboxylic acid, $\text{CO}_2\text{H}\cdot\text{CH}(\text{C}_6\text{H}_5)\cdot\text{CH}_2\cdot\text{CH}(\text{CO}_2\text{H})\cdot\text{CH}_2\cdot\text{CO}_2\text{H}$. The crude polymeride obtained by heating α -phenyl- Δ^7 -butadiene at 150°C . is a colourless, viscous liquid and the dimeride separated by distillation in an atmosphere of hydrogen consists almost entirely of the modification with the higher boiling point. The pure dimeride boils at $197^\circ\text{—}196.5^\circ\text{C}$. under 5 mm. pressure and has the sp. gr. at $20^\circ/1^\circ\text{C}$. 1.0332, and the refractive index, $n_D^{20} = 1.60570$ at 20°C . The polymeride, $(\text{C}_{10}\text{H}_{10})_x$, is formed to the extent of 5% at 150°C . and is a powdery mass coagulating at about 90°C .; its behaviour towards ozone is that of polymerides of divinyl hydrocarbons, the resultant compound, $(\text{C}_{10}\text{H}_{10}\text{O}_4)_x$, being a white solid. It is concluded that the structure of the polymeride is represented by the scheme,



—T. H. P.

Toxins and antitoxins: Adsorption of — by aluminium hydroxide: Koch's tuberculin. M. A. Rakuzin and G. D. Flier. J. Russ. Phys.-Chem. Soc., 1916, 48, 711—716.

Of the eight ordinary colour reactions of the

proteins, the only one not given by tuberculin is the violet coloration with fuming hydrochloric acid (Liebmann's reaction); since, further, tuberculin contains phosphorus, it must be regarded as an analogue of casein. In aqueous solution its specific rotation is $[\alpha]_D = -11.62$. By adsorption with aluminium hydroxide, it is separated into: (1) 4.11% of an adsorbed antitoxin which gives only Molisch's and Ostromyslenski's reactions (this J., 1916, 133), and in composition and properties resembles pepsin, the latter giving only Molisch's reaction; (2) 95.56% of a non-adsorbed toxin which, like casein, gives the biuret, Millon's, xanthoprotein, Adamkiewicz's, Molisch's, Pettenkofer's, and Ostromyslenski's reactions. The adsorption is irreversible.—T. H. P.

Nucleic acids and alkali nucleates: Rotatory powers of —. M. A. Rakuzin and E. M. Braudo. J. Russ. Phys.-Chem. Soc., 1916, 48, 97—99.

MEASUREMENT of the rotation of commercial 5% nucleic acid solution (Parke, Davis and Co.) gives the value $[\alpha]_D = +68.51$ for the nucleic acids. As with the caseinogenates, the rotatory powers of the alkali nucleates increase with the atomic weight of the metal.—T. H. P.

Cholesterol and isocholesterol: Separation of —. A. Madinaveitia and A. Gonzalez. Ann. Soc. Esp. Ph. Ch., 1916, 14, 398—401. Bull. Soc. Chim., 1917, 22, 41.

CHOLESTEROL and isocholesterol, obtained together by energetic saponification of lanolin (cp. Moreschi, this J., 1910, 1168), may be separated after conversion into benzoates. Cholesteryl benzoate crystallises in plates and the iso-compound in needles, and the former may be separated from the latter by elutriation with water (Schulze). A better method of separation is to dissolve the mixed alcohols in ether and add an ethereal solution of anhydrous oxalic acid. A crystalline precipitate containing the two oxalates is formed. Cholesteryl oxalate, m.p. 175°C . $[\alpha]_D^{20} = -29$, separates first. The residue from the evaporation of the mother liquors has $[\alpha]_D^{20} = +27$. The former is readily converted into pure cholesterol, m.p. 147°C . The mother liquors, on treatment with benzoyl chloride, yield isocholesteryl benzoate, m.p. 190°C .—J. H. L.

Nitriles: Transformation of — into amides by hydrogen peroxide. L. McMaster and F. B. Langreck. J. Amer. Chem. Soc., 1917, 39, 103—109.

By using hydrogen peroxide of higher concentration it is possible to prepare amides from nitriles which cannot be transformed by weaker solutions of the peroxide. The transformation of benzonitrile, *m*-nitrobenzonitrile, *o*-tolunitrile, *p*-tolunitrile, *n*-naphthonitrile, terephthalnitrile, trichloroacetoneitrile, and isobutyrlacetoneitrile into the corresponding amides is described. *Benzonitrile*.—5 grms. of benzonitrile was added to 50 c.c. of a 6% solution of hydrogen peroxide and the mixture made slightly alkaline with sodium hydroxide, stirred by means of a motor-driven apparatus, and the temperature kept at 65°C . for 1.5 hours, during which time the amide separated out as white flakes. The stirring was then interrupted and the mixture cooled with ice and salt, whereupon more of the amide separated. It was filtered off, washed with cold water, dried over sulphuric acid for 18 hrs., and crystallised from absolute alcohol. Yield 92%. *m*-Nitrobenzonitrile.—1 gm. of the nitrile was added to 15 c.c. of a 20% solution of hydrogen peroxide, the mixture made slightly alkaline and heated to 65°C . The mixture was shaken vigorously, and allowed to

dark, with occasional shaking, for 24 hours. The pale yellow crystals which had separated were filtered off, washed with cold water and dried on a suction filter. The crystals were dissolved in a minimum amount of hot absolute ethyl alcohol, and the amide freed from any unchanged nitrile by suddenly cooling the hot solution in a freezing mixture. The nitrile, being less soluble than the amide, crystallised out first and was filtered off. On allowing the alcohol to evaporate, the amide crystallised out. Yield 80%. *o*-Tolunitrile, — 10 c.c. of a 15% solution of hydrogen peroxide was added to 1.1 gm. of the nitrile in a large test-tube, the mixture was made slightly alkaline, heated to 65° C., and shaken vigorously. After standing 24 hours a white crystalline mass had formed at the surface of the liquid. On warming the mixture again, the unchanged nitrile separated from the enclosing crystalline mass. The contents of the tube were again heated to 65° C., shaken, and allowed to stand for another 24 hours. The crystals were filtered off on a suction filter, dried, and re-dissolved in absolute ethyl alcohol. From the third recrystallisation the amide separated as white, semi-transparent needles, readily soluble in alcohol, moderately in ether, and quite insoluble in cold water. Yield 90%. J. B. C. K.

Collargol [colloidal silver]: Preparation of —, A. F. Gerasimov, J. Russ. Phys.-Chem. Soc., 1916, 48, 251–253.

INVESTIGATIONS on the preparation of collargol by Paal's method (this J., 1902, 916, 991) show that the reduction to metallic silver takes place mainly, if not entirely, at the expense of the silver oxide, preparations with approximately the same proportion of silver being obtained with widely varying concentrations of silver nitrate. The percentage of silver in the preparations is increased but slightly by precipitation with acids. On the basis of these results the following method of obtaining collargol is recommended. The reducing mixture is prepared by shaking 100 grms. of albumin with a solution of 15 grms. of sodium hydroxide in 500 c.c. of water until it is uniformly distributed throughout the liquid, which is then heated for about an hour in a water-bath and freed from a little flocculent precipitate by filtration. To 27–30 grms. of this solution is added the silver oxide obtained by precipitating a solution of 10 grms. of silver nitrate with potassium hydroxide and washed five times by decantation. The mixture is diluted to about 200 c.c. and heated in a water-bath, with constant shaking, for 40–60 minutes. When cold, the liquid is precipitated with a few drops of concentrated acetic acid and the precipitate washed 5 or 6 times and then dissolved in water in presence of a very small quantity of sodium hydroxide. The liquid is allowed to settle and dried, either in a desiccator over sulphuric acid or in a vacuum at about 10° C., or in a current of air free from dust; over-drying should, however, be avoided. By this method, a blue powder containing about 75% of silver is obtained. — T. H. P.

Glycerin for medicinal purposes: Substitute for —, J. Leemox, Pharm. J., 1917, 98, 186.

IRISH moss ($\frac{1}{2}$ oz.) is boiled with water for 15 mins., the extract is made up to 19 fl. oz., and 1 oz. of glucose is added.

Chemical constituents of sulphur-containing bituminous tur oils, ichthol oils, Scheibler, See IX.

Influence of the climatic conditions on the composition of vegetable oils, Pigulevski, See XII.

Immunity studies on anthrax serum, Eichhorn and others, See XIXb.

PATENTS.

Glycocoll: Process for separating — from inorganic compounds, G. Weinberg, Berlin, Ger. Pat. 291,821, Sep. 22, 1915.

THE solution of glycocoll and sodium chloride obtained in the usual way from monochloroacetic acid, ammonia, and a quantity of sodium hydroxide approximately equivalent to the monochloroacetic acid, is concentrated by heat, after evaporation of the ammonia, whereby the bulk of the sodium chloride separates from the hot solution, whilst on cooling the mother liquor the glycocoll crystallises. — C. A. M.

Picolaldehyde: Process of preparing —, L. Schmidt, Munich, Ger. Pat. 295,337, Sep. 30, 1915. Addition to Ger. Pat. 278,778 (see Fr. Pat. 471,986; this J., 1915, 249).

THE piperonal diacetate, obtained from piperonal as described in the original patent (*loc. cit.*), is treated with chlorine, and the resulting dichloro-piperonal diacetate is decomposed with water. No chloroacetic acid derivatives are formed during the chlorination. — C. A. M.

Barbituric acid: Preparation of ether-like derivatives of —, Farbenfabr. vorm. F. Bayer und Co., Ger. Pat. 295,192, Jan. 31, 1915.

ALKYL- or aralkylaryloxyalkylmalonic acids or diaryloxyalkylmalonic acids or their derivatives, e.g., the corresponding esters, acid chlorides, cyanacetates, or malononitriles, are converted into barbituric acid derivatives by the usual methods. Alternatively, monosubstituted malonic acid derivatives containing one of the above specified substituent groups are converted into barbituric acids and the second substituent group is introduced by alkylation of the resulting monosubstituted barbituric acids or of the product at an intermediate stage of the conversion. Such ether-like derivatives, containing at least one aryl residue attached to an oxygen atom, possess strong hypnotic action combined with low toxic effects. Ethylphenoxyethylbarbituric acid, diphenoxyethylbarbituric acid, C.C-propyl-*p*-cresoxyethylbarbituric acid, and C.C-benzylphenoxyethylbarbituric acid are described. — J. F. B.

Hexamethylenetetraminemethylhydroxide: Preparation of salts of —, K. H. Schmitz, Breslau, Ger. Pat. 295,736, Sept. 20, 1913.

AMMONIA, formaldehyde or one of its polymerides, and an acid or acid ion are heated for several hours and the product treated with a soluble bichromate; the resulting sparingly soluble chromate, of composition corresponding to the formula $[C_6H_{12}N_4CH_3]_2Cr_2O_7$, is decomposed with barium hydroxide, and the precipitated barium chromate filtered off. Alternatively, hexamethylenetetraminemethylhydroxide chloride, bromide, iodide, or thiocyanate is digested with silver oxide, the resulting solution of the free base is concentrated *in vacuo*, neutralised by any desired inorganic or organic acid to form the corresponding salt, and the solution evaporated *in vacuo*. The salts of this base possess the property of liberating formaldehyde in alkaline solutions, which is not the case with hexamethylenetetramine salts, and have a therapeutic value. — J. F. B.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

Hydrogen peroxide reaction: Catalysts in the —, [Prevention of fogging of photographic plates, etc.] Lüpcke-Cramer, Phot. Ind., 1916, Heft 43. Z. angew. Chem., 1917, 30, Ref., 23

THE fogging action of terpenes, resins, wood,

packing-papers, etc., on photographic sensitive materials, generally recognised to be due to the formation of hydrogen peroxide, can be prevented by the interposition of paper containing finely divided manganese dioxide which catalytically destroys the peroxide. Such protective paper is most easily prepared by soaking filter paper or black packing paper in 1% solution of potassium permanganate. (See also Russell, this J., 1899, 516.)—B. V. S.

Osmotic pressure of gelatin. Biltz and others. See XV.

PATENT.

Development films free from damp spots; Preparation of—on various baryta-coated bases. Chem. Fabr. auf Actien vorm. E. Schering. Ger. Pat. 295,502, Nov. 27, 1913.

BARYTA-COATED paper, mica, or celluloid is coated with a solution of albumin before applying the sensitive emulsion.—B. V. S.

XXII.—EXPLOSIVES; MATCHES.

Relation of oxygen to heat of combustion of organic compounds. Thornton. See IIA.

PATENT.

Explosives. Stockholms Superfosfat Fabriks Aktiebolag, Stockholm. Eng. Pat. 17,583, Dec. 16, 1915. Under Int. Conv., Dec. 23, 1914.

EXPLOSIVES possessing the favourable qualities of dynamite, but cheaper and having a much lower freezing point, are made up of the following constituents:—(A) Ammonium perchlorate, 74—80; ferrosilicon or other silicide, 6—18; wood meal, 2—6; nitrated or unnitrated naphthenes (residues from distillation of mineral oils), 4—10 parts by weight. (B) Ammonium perchlorate, 74—80; ferrosilicon, 6—18; wood meal, 2—6; nitrated or unnitrated naphthenes, 4—10; and liquid nitrotoluenes gelatinised with nitrocellulose, 10—12 parts by weight. The ferrosilicon serves to raise the temperature of explosion, and the wood meal increases the speed of detonation.

—J. N. P.

XXIII.—ANALYSIS.

Rapid method for the determination of magnesium [in limestone]. Busvold. See VII.

New method of precipitating platinum sulphide, and analysis of platinised asbestos. Ivanov. See VII.

Determination of manganese in high-speed steels. Nesbitt. See X.

Wet assay of tin concentrate. Hutchin. See X.

Determination of free alkali hydroxide in soap. Igmailski. See XII.

Biological detection and valuation of tannins. Kobert. See XV.

XXIV.—MISCELLANEOUS ABSTRACTS.

Specific heats of aqueous-alcoholic solutions; Calculation of—. N. A. Kolosovskii. J. Russ. Phys.-Chem. Soc., 1916, 48, 84.

THE specific heats of aqueous-alcoholic solutions may be calculated by means of the empirical formula, $C = 1 + n(C_0 - 1) + 0.004x - 0.00012x^2 +$

$0.00000069x^3$, where C is the required specific heat of the aqueous-alcoholic solution of substance, A , n the number of gram.-equivalents of this substance per 200 mols. of water in the given aqueous-alcoholic solution, x the number of molecules of alcohol per 200 mols. of water and C_0 the specific heat of an aqueous solution of 1 gram.-equivalent of substance A in 200 gram.-mols. of water. The value of C_0 is obtained from tables of physical constants. In 34 cases in which direct measurements were made of the specific heats of aqueous-alcoholic solutions, the difference between the experimental and calculated values was less than 0.005 in 27 cases and between 0.006 and 0.010 in the remaining 7 instances.—T. H. P.

Trade Report.

Prohibited exports.

AN Order-of-Council, dated 23rd February, makes the following alterations in the list of exports prohibited:—

The following headings are deleted:—(1) Copper wire and cables containing copper; (3) cordite presses; (2) gauze manufactured of copper or its alloys; (3) incorporators; (3) copper ore; (2) copper, unwrought and part wrought, all kinds, including alloys of copper (such as brass, gun metal, naval brass and delta metal, phosphor copper, phosphor bronze, and solder containing copper), copper and brass circles, slabs, bars, ingots, scrap, rods and plates and also wrought copper of the following descriptions:—Copper and brass pipes, sheets, condenser plates, brass wire, bronze wire, perforated brass sheets, perforated brass linings, and copper foil; (3) all articles wholly or partly manufactured of copper or its alloys not otherwise specifically prohibited; (2) yellow metal.

The following headings are added:—(1) Cordite presses; (1) incorporators; (1) copper ore, regulus, matte, concentrate and precipitate; (1) copper, whether refined or unrefined, unwrought, wrought or partly wrought, of all kinds and descriptions including brass, bronze, yellow metal, and all other alloys of copper; (1) all articles wholly or partly manufactured of copper or its alloys, except: (a) Articles partly manufactured of copper or its alloys exported before the 9th day of March, 1917, to all destinations not in foreign countries in Europe or on the Mediterranean or Black Sea, other than France and French Possessions, Russia, Italy and Italian Possessions, Spain and Portugal, and to all ports not in any such foreign countries, except Russian Baltic ports; and (b) articles partly manufactured of copper or its alloys in which the total weight of copper and copper alloy does not exceed 5% of the total weight of the article, and does not exceed 56 lb.

Prohibited imports. Prohibition of Import (No. 14) Proclamation, 1917.

A PROCLAMATION, dated 23rd February, prohibits as from that date the importation into the United Kingdom of the following goods, exception being made in respect of such goods as are imported under licence given by or on behalf of the Board

* The prohibition of exports is as follows:—

Goods marked (1) to all destinations;

Goods marked (2) to all ports and destinations abroad other than ports and destinations in British Possessions and Protectorates;

Goods marked (3), to all destinations in foreign countries in Europe and on the Mediterranean and Black seas, other than France and French Possessions, Russia, Italy and Italian Possessions, Spain and Portugal, and to all ports in any such foreign countries, and all Russian Baltic ports.

of Trade, and subject to the provisions and conditions of such licence:—Aerated, mineral and table waters. Antimony ware. Brandy. Cocoa, preparations of. Cocoa, raw. Diatomite and infusorial earth. Fruit, raw, of all descriptions (except lemons and bitter oranges), and almonds and nuts used as fruit. Glass manufactures not already prohibited. Hides, wet and dry. Incandescent gas mantles. Leather, dressed and undressed. Painters' colours and pigments. Perfumery. Photographic apparatus. Plated and gilt wares. Quebracho, hemlock, oak and mangrove extract. Rum. Soya beans. Sugar, articles and preparations containing, used for food (except condensed milk). Wine. Wood and timber of all kinds, hewn, sawn or split, planed or dressed.

List of trades and occupations of primary importance.

THE Reserved Occupations Committee has issued a list of trades and occupations which have been declared by the Government to be of primary importance. The following occur in this list:—*Mining and quarrying.* Coal mining. Patent fuel works. Oil shale mining, including shale oil works. Iron mining and quarrying. Copper mining. Tin and wolfram mining. Lead mining. Fireclay and silica stone mining and quarrying. Gaiister mining and quarrying. Limestone quarries (mainly supplying iron, steel, or chemical works). *Metals, machines, implements and conveyances.* All classes of workers engaged in the manufacture of the following metals or their constituent parts from the treatment of the ore to the production of the metal in standard forms, such as ingot, billet, bloom, bar, rod, sheet or section:—Aluminium, copper, iron, steel, lead, nickel, tin (smelting only), spelter, zinc and other metals (e.g., tungsten, vanadium, wolfram) needed for war purposes, and their alloys (e.g., brass, phosphor bronze). Iron foundries and steel smelting works and rolling mills. Electrical accumulator manufacture and repairing. Scientific instrument making. Slag wool making. *Pottery and glass trades.* Chemical ware (stoneware and fireclay) manufacture. Furnace firebrick (including gaiister and silica brick) manufacture. Optical and chemical glass manufacture. Optical lens and prism making. Other glass manufacture (except table and decorative ware and bottles for beer, wine, spirits and aerated waters). *Chemical, oil, etc., trades.* Coal tar products, manufacture of. Dyestuffs, manufacture of. Explosives and propellants, manufacture of. Other chemical products, manufacture of. Lubricating oils and other lubricants, manufacture of. Oil-seed crushing. Soap and candles, manufacture of. Fertilisers, manufacture of. *Leather trades.* Hide and skin markets and fat and bone factories. Fellmongery. Tanning and currying of heavy leather. Leather transmission belting manufacture. *Food trades.* Flour, oatmeal and rice milling. Machine creameries and condensed milk and milk powder factories. Margarine manufacture. Edible oils and fats, preparation of. Sugar refineries working under Government. *Miscellaneous.* Coke, manufacture of. Rubber trades. Waterproofing of fabrics for war purposes, and of paper. *Public utility services.* Gas works. Water works.

Books Received.

THE FOOD SUPPLY OF THE UNITED KINGDOM. A REPORT drawn up by a Committee of the Royal Society at the request of the President of the Board of Trade. [Cd. 8121.] H.M. Stationery Office, London. Price 4d. (See page 279.)

INDUSTRIAL AND MANUFACTURING CHEMISTRY. INORGANIC. Vol. I. By GEOFFREY MARTIN and others. 496 pages. Crosby Lockwood and Son, 7, Stationers' Hall Court, London, E.C. Price 25s.

THE present volume, which is similar in style and arrangement to the work dealing with organic chemical industries by the same author, is divided into fifty-one sections, in each of which an industry is dealt with very briefly, with copious references to the literature. The wide range of subjects covered is indicated by the following list of sectional headings and authors:—I. Solid fuels, by A. B. Searle. II. Manufacture of briquettes, by J. L. Foucar. III. Liquid fuels, by A. B. Searle. IV. Furnaces, by A. B. Searle. V. Coke ovens, by G. Martin. VI. Surface combustion, by E. Jobling. VII. Pyrometry and pyroscopy, by A. B. Searle. VIII. Refrigerating and ice-making machinery, by G. Martin. IX. Liquefaction of gases, by J. M. Dickson. X. Industrial oxygen, by G. Martin. XI. Industrial nitrogen, by G. Martin. XII. Industrial hydrogen, by H. S. Redgrove. XIII. Producer-gas, by H. S. Redgrove. XIV. The carbon dioxide industry, by H. S. Redgrove. XV. Industrial ozone, by E. Jobling. XVI. The technology of water, by H. H. Hodgson. XVII. Artificial mineral waters, by C. A. Mitchell. XVIII. The sulphur industry, by G. Martin and J. L. Foucar. XIX. Sulphuric acid, by G. Martin and J. L. Foucar. XX. Manufacture of sulphur dioxide and sulphites, by G. Martin and J. L. Foucar. XXI. Manufacture of other sulphur compounds, by G. Martin. XXII. The salt industry, by G. Martin. XXIII. Manufacture of hydrochloric acid, by G. Martin. XXIV. Manufacture of sodium sulphate (salt cake), by G. Martin. XXV. to XXVII. Sodium carbonate, by G. Martin and S. Smith. XXVIII. The Stassfurt industry, by F. Milsom. XXIX. Potassium salts, by F. Milsom. XXX. Calcium and magnesium salts, by G. Martin. XXXI. The gypsum industry, by J. Shelton. XXXII. Barium salts, by F. E. Milsom. XXXIII. Strontium salts, by F. E. Milsom. XXXIV. Compounds of boron, by F. E. Milsom. XXXV. Manufacture of chlorine by the Weldon and Deacon processes, by G. Martin. XXXVI. Electrolytic chlorine and alkali, by G. Martin. XXXVII. Liquid chlorine, by G. Martin. XXXVIII. Manufacture of chlorates and perchlorates, by G. Martin. XXXIX. Bleaching powder and hypochlorites, by G. Martin. XL. The bromine industry, by G. Martin. XLI. The iodine industry, by G. Martin. XLII. The hydrofluoric acid industry, by G. Martin. XLIII. Peroxides and peracids, by G. W. Clough. XLIV. The circulation of nitrogen in nature. XLV. The nitrate industry, by G. Martin. XLVI. The nitric acid industry, by G. Martin. XLVII. The ammonia and ammonium salts industry, by G. Martin. XLVIII. Synthetic ammonia, by G. Martin. XLIX. The cyanamide industry, by G. Martin. L. The cyanide and prussiate industry, by G. Martin. LI. Manufacture of nitrous oxide, by G. Martin.

TECHNICAL CHEMISTS' HANDBOOK. Tables and methods of analysis for manufacturers of inorganic chemical products. By G. LUNGE. Ph.D. Second Edition. Revised. Gurney and Jackson, 33, Paternoster Row, London. 1916. 264 pages, with 21 illustrations. Price 10s. 6d. net.

IN this new edition of Dr. Lunge's well-known handbook, all the analytical factors have been recalculated on the basis of the atomic weights published by the International Committee for 1916, and the tables of specific gravity and other tables have been altered in accordance with the most recent and reliable determinations.

Journal of the Society of Chemical Industry.

No. 6, Vol. XXXVI.

MARCH 31, 1917.

No. 6, Vol. XXXVI.

Official Notices.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY.

The first volume of these reports will be issued during April. The manuscript of some of the sections not having come to hand, the volume will not be as comprehensive as was at first proposed, but it was decided to present an incomplete volume rather than delay publication any further.

CROSS AND BEVAN ESSAY PRIZE OF £20 AND LATHAM RESEARCH GRANT OF £300.

The Council have pleasure in announcing that a gift of £20 has been made by Messrs. Cross and Bevan as a prize for an essay on "The Interconnection of Economic Botany and Chemical Industry."

A further sum of £300 has also been presented by their friend, Mr. T. P. Latham, of Weybridge, to be paid in three annual instalments to such one of the competing essayists as may be judged to be of conspicuous ability, as a grant towards his expenses, on the condition that he apply himself, during three years, to research of approved character on a subject cognate with that discussed in his essay.

The immediate object of the donors is to promote the study of economic botany with special reference to its bearing on chemical industry, giving the widest possible interpretation of the relationship.

They desire, under the auspices of the Society, to assist in forming public opinion in this direction and to discover and further the career of a student of promise who may wish to devote himself to work in such a field.

The Essay Prize will be open to all members of the Society who are British subjects. The Research Grant will be limited to competitors under 25 years of age at the time of sending in the essay.

Essays are to be submitted to the Council of the Society not later than the close of the year 1917. The awards will be made promptly. Neither the prize nor the first grant will be given unless the essayist or essayists shall be deemed to have real merit. The Latham Research Student will be required to submit a report at the close of each year, to satisfy the Council that he has made and is likely to make proper use of the grant.

London Section.

Meeting held at Burlington House on Monday, March 5th, 1917.

MR. A. R. LING IN THE CHAIR.

COMPOSITION OF POWER GASES.

BY W. A. TOOKEY, M.I.MECH.E.

In the history of the development of the gas engine, working mixtures of very different compositions have been used from time to time and it must be generally admitted that, notwithstanding all preconceived ideas based upon more or less intelligent anticipation, progress has been achieved quite irrespective of the composition

of the gas forming the combustible ingredient. Thus in the earliest days Street (1791) used spirits of turpentine, the liquid being introduced into the bottom of a cylinder filled with air and to which heat was applied, while, in later years, successful operation has been obtained equally well with any and all of those power gases having greatly varying compositions, which are to be found recorded in standard works upon gas engines and gas producers.

The proper method of utilising power gases, so greatly varying in density, in calorific value, in chemical composition, and in the amount of air required for theoretically complete combustion, has been a matter which only painstaking and persevering experiment by the practical system of trial and error has discovered. Scientific research, valuable though it has been, has not aided the experimental staff in gas and oil engine manufacturing establishments to any great extent.

In making this statement it must not be thought that the author has overlooked much excellent work done by scientific men whose names will always stand well in the forefront of British technical history in connection with power gases. The early experiments of Grover of Leeds and of Dr. Dugald Clerk were undoubtedly helpful, but in a negative sort of way, as were the later researches of Bairstow and Alexander and of Prof. Bertram Hopkinson. All were conducted—almost of necessity—under circumstances greatly differing from those that actually obtain in the cylinder of a gas engine working under load and at speed. Dr. Dugald Clerk and other members of the British Association Gaseous Explosions Committee have during recent years elucidated many matters in connection with the phenomena of combustion in gas engine cylinders which before were only imperfectly realised and their researches have been described and results recorded more or less fully in the reports published from time to time. Yet so far as the author is aware there has been no definite lead given by any man of science to indicate what might be deemed the goal to aim at if it were required to manufacture a gas for power purposes without reference to prevailing circumstances in the gas making industry or any commercial interest.

The object of this paper is to discuss the subject of gas composition from the gas engine side, and the following remarks are offered by the author as an engineer, not as a chemist. That he can claim to speak from the gas engine side is due to the fact that since the year 1905 he has been called upon to carry out over 1500 tests upon gas and oil engines throughout the country, served with the various grades of town and producer gas that this number implies, as well as with the varying brands of kerosene and fuel oils that have been marketed in the country during the period. A particularly valuable and interesting series of tests by indicator—involving nearly 1000 in the London district alone—was carried out at the instance and expense of the Gas Light and Coke Co. and the South Metropolitan Gas Co. in order to ensure to their power consumers that the best results were being obtained in respect of output of power and of economy, which particular—and oft-times peculiar—circumstances permitted.

It was soon evident to the author that a mere collection of test results of a great number of engines would be of no value if the ordinary accepted methods of standardising outputs in terms of Indicated Horse Power and consumptions in terms of cubic feet of gas per I.H.P. per hour had been adopted, and in a paper read before the

Institution of Mechanical Engineers in January, 1914, he explained at length a method he had evolved for comparing engines of varying sizes, different systems of construction, and in all stages of repair and disrepair, by means of which he was able properly to estimate their relative performances. The basis of comparison took into account the ratio of total cylinder volumes to the respective clearance volumes or, what amounts to the same thing, to the pressure to which the charges of gas and air were compressed within the gas engine cylinders before ignition, that is to say coincident with the inmost position of the piston.

Briefly it may be said that the power output, in addition to being specified as "Indicated Horse Power," was also stated in terms of "mean pressure" produced by the combustion of the charge and acting upon each square inch of piston area, while the consumption of gas, as well as being referred to in terms of so many cubic feet per horse power hour, was also noted as a working fluid containing so many British Thermal Units per cubic foot—at normal temperature and pressure—on the basis of total cylinder volume before compression. In this way the author was enabled to establish with approximate truth how many lb. of mean pressure was obtained from each B.Th.U. in the mixture, allowance of course being made for the more or less completely filled cylinders such as were encountered during the whole series of indicator tests referred to.

Soon after this method of classifying test results was evolved and put into daily use it became apparent that there was a definite relation between output and consumption upon the basis above mentioned. The factor—power output in lb. of piston pressure divided by consumption in B.Th.U. per cubic ft. (or mean pressure divided by mixture strength)—being wonderfully consistent for engines dissimilar as regards construction but working at similar compression pressures, as long as the working charges were ignited properly and timely so as to secure the highest combustion pressures just after the engine piston has begun to move outwards on the power stroke. The discussion following the reading of the paper before referred to elicited from Capt. H. Riall Sankey a mathematical substantiation which demonstrated that the "factor" was also a means whereby the temperature of the charge would be computed. The author has since evaluated this "Tookey factor" for various compression pressures and in a recent contribution to the "Engineer" its relation to thermal efficiency on the Indicated Horse Power basis is referred to in graph form.

The above remarks have been made in order to explain that the author's work of recent years has been in the direction of basing test results upon mixture strengths and, as he has had peculiar facilities, he has naturally been interested in noting whether equivalent results with regard to ratio of output to consumption can be obtained with say town gas as with producer gas so long as the mixture strength in terms of so many B.Th.U. per cubic ft. is the same in each case, despite the fact that town gas has from four to five times the calorific value of producer gas and varies greatly in composition and also in the percentage of combustible to incombustible gases per unit volume. Similarly he has been interested in observing whether mixtures of kerosene vapour and air, or of liquid fuel "mists" injected in Diesel and in surface-ignition engines (generally misnamed "Semi Diesels") give similar or dissimilar "Tookey factors" either as between these various kinds of liquid fuel or between "oil" and "gas" mixtures.

The result of his observations can perhaps be best presented by a reference to the graph reproduced below from the article in the "Engineer"

which has just been referred to. It will be observed that this is a variation of the Tookey factor method of comparison inasmuch as instead of the mean piston pressures being plotted in terms of Indicated H.P., equivalent piston pressures on Brake H.P. basis are used; while as regards mixture strength, instead of this being stated in terms of B.Th.U. per cu. ft. of total cylinder volume, it is given in terms of piston displacement volume (total cylinder volume minus clearance volume).

The test results of eight engines of greatly varying characteristics as regards construction, compression pressures, etc., are plotted and it

Variation of piston pressures with mixture strength in gas and oil engines.

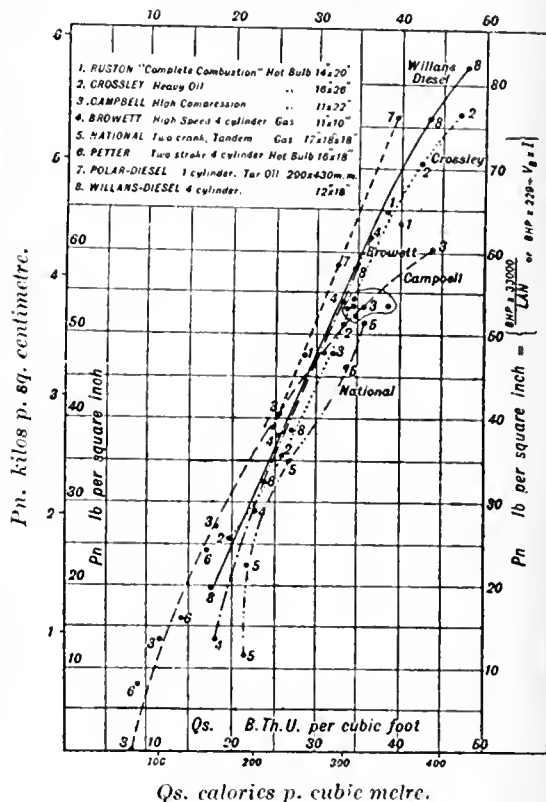


FIG. 1.

will be seen that speaking generally the output-consumption curves there drawn show no divergencies due to the nature of the working mixture. Town gas mixtures, as in the case of the Browett-Lindley engine—curve 4—or liquid fuel mixtures as in the case of the Willans-Diesel engine—curve 8, are practically identical when thus plotted. Such divergencies as are to be discerned throughout the eight sets of curves are explicable by the variation in the clearance volume ratio and consequent variation of maximum attainable thermal efficiency.

The chart (Fig. 1) shows the "output-consumption" curves when the former is based upon B.H.P. or the actual power derivable from the engine crankshaft for purposes of transmission. This is the basis which practical considerations would prefer as presenting a true comparison from an engine user's point of view, as distinct from that of the scientist who would prefer to compare "output-consumption" curves on the basis of I.H.P. or the pressures obtained within the

cylinder to deal with not only the load but also resistances of the engine mechanism.

To meet this scientific objection for the purposes of the present paper, the curves in Fig. 1 have been redrawn in Fig. 2 keeping the B.H.P. piston pressures as before but plotting the mixture strengths on the basis of units of total cylinder volume—that is to say piston displacement plus clearance, instead of piston displacement only. It will be seen that the position of all the curves moves to the left as compared with those in Fig. 1, and this for the reason that the number of B.Th.U. present has now been taken as being contained

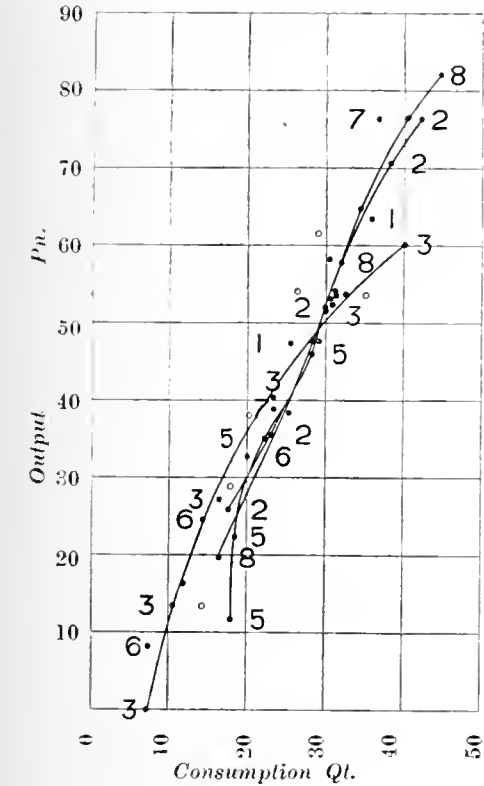


FIG. 2.

in a larger volume and therefore the mixture strengths are specifically weaker.

From an examination of the curves in Fig. 2 it is obvious that the varying composition of the gas used in the various engines, whether oil "vapour" or oil "mist"; town gas of 500 B.Th.U. p. c. ft.; or producer gas of 130 B.Th.U. per cb. ft., has no apparent influence on the performance of the engines. Furthermore it is evident that, whatever the composition of the gaseous mixture, of combustible and incombustible constituents, or whether diluted by excess air or residual gases from previous explosions, the output is of the same order in all types of internal combustion engines for a given strength of mixture when calculated upon the basis first adopted by the author.

A comparison of the test results recorded in standard works on the internal combustion engine (such as that most useful and valuable treatise "The Gas, Oil and Petrol Engine" by Dr. Dugald Clerk) when recalculated upon the author's mixture strength basis proves that the richness of the full load mixtures used has been strikingly uniform and of the order of 45 B.Th.U. p. cb. ft. based upon the total cylinder volume.

Further, such comparisons prove that the

increase in thermal efficiencies (I.H.P. basis) recorded during the last thirty years or so have been such as to coincide with the change in practice due entirely to increase in clearance volume ratio. That is to say as the dead spaces behind the piston and into which the charge is compressed, have been reduced in ratio, so the relative amount of gas drawn in by the piston to bring the working mixture up to unit strength has been proportionately decreased.

It is a striking fact that on this basis, the actual thermal efficiencies attained have been in strict agreement with calculations based upon uniform mixture strength, as will be seen from the curves herewith given and reproduced from the author's remarks in the discussion upon his paper "Commercial Tests of Internal Combustion Engines" (Proc. Inst. Mech. Eng., 1914).

It will be obvious that during the period in which the tests there tabulated were made the quality of the gas must have varied very considerably, as indeed was the case as recorded in the published results. It will also be noticed that the figures relating to liquid fuel engines fall upon the

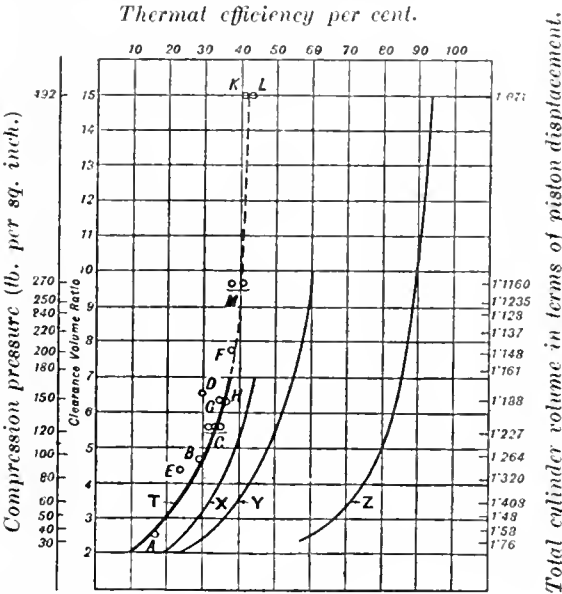


FIG. 3.

- Z.—Increasing efficiency with increasing compression pressure, due, by reason of reduction in clearance volume, to lesser total quantity of heat required to maintain equivalent mixture-strength.
 - Y.—Air standard efficiencies on basis of constant specific heat. (Inst. C.E. Committee, 1905.)
 - X.—Clerk's corrected efficiencies on basis of varying specific heat. (Junior Inst. E., Canet Lecture, 1913.)
 - T.—Tookey's curve of practical efficiencies ($Z \times X = T$.)
- The circles, and dotted continuation of curve T, show the actual efficiencies obtained by various experimenters during their years (1881 to 1911) as accompanying table and their close agreement with Tookey's curve.

Reference letter.	Test by.	Maker of engine.	Date.	Size of engine.
A	Slaby ...	Otto ...	1881	4.5 h.p.
B	Humphrey	Crossley	1900	360 h.p.
C	Inst. C.E.	National	1905	L., R., and X engines.
D	Stead ...	"	1911	750 h.p.
E	Clerk ...	Crossley	1894	12 h.p.
F	Burstable	"	1904	50 h.p.
G	Atkinson	"	1905	40 h.p.
H	Hopkinson	"	1908	40 h.p.
K	Longridge	Diesel	1905	500 h.p.
L	"	"	1905	80 h.p.
M	Robinson	Ruston	1910	50 h.p.

same curve and thus substantiate in no unhesitating manner the curves shown in Fig. 1. From such authoritative tests it surely can be deduced that the actual composition of power gases plays very little part in the thermal efficiency of internal combustion engines, other things being equal.

The main object in view when the writer was first called upon by the Gas Light and Coke Co. in 1911 to commence the series of tests upon engines working throughout their district was, as before stated, to adjust the mechanical details and to set the gas and air regulating devices so that the maximum benefit could be obtained from the consumers' point of view as regards maximum power output from low rates of gas consumption. As long as the engine was in good trim mechanically it was found to be a relatively simple matter to obtain the desired effect once the mixture strength of gas was determined as has been already explained and if the instant of ignition was properly timed. The method of procedure in all tests was first to get a mixture as nearly as possible 45 B.Th.U. p. cu. ft. of total cylinder volume into the cylinder—either by increasing the amount of gas passing through the gas regulating cock or by diminishing the volume of air drawn in through the inlet valve. This being secured, the ignition timing was then properly set by means of an indicator. No actual calorimetric measurements were taken during these work-a-day tests on consumers' premises for obvious reasons, but the periodically published reports of tests made in the official testing places prescribed by the Metro-

sulphed for obtaining the necessary bases for output-consumption ratios.

Since the outbreak of war the writer has had an opportunity afforded him of testing one and the same engine with "stripped" and "unstripped" gas alternately. He found that under the same

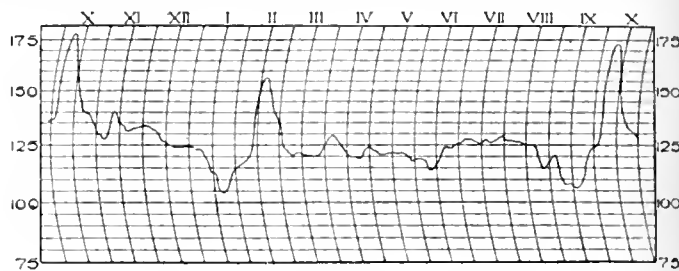


FIG. 5.

load and conditions there was a falling off in power developed per impulse on the "stripped" gas and therefore an increase of gas consumption of the order of 10 to 13%. The diagrams taken by an indicator showed that while the "unstripped" gas gave a series of regular impulses as regards power, the consecutive explosions of "stripped" gas mixtures were most irregular under similar conditions, but regularity of ignition was at once restored when the mixture strength was increased by proper adjustment to that obtained with the "unstripped" gas—and this by merely turning the gas regulator open a little more. This experience again confirms the statement already made that the composition of gas matters little but the strength or richness of working mixtures matters much.

One thing in connection with gas composition that is of the utmost importance however is its constancy as regards calorific value, for if this should vary but slightly the working of the engine will be greatly affected. This is a disadvantage in connection with the use of suction producer gas, for if by inattention or lack of skill in management of the plant, the quality of the gas be inconstant then trouble is bound to arise for, at present at any rate, it is not possible so to adjust the rate of air admission as to compensate for irregularities in calorific value per unit volume of the gas entering the engine. The consequence is that charges may remain wholly or partially unignited resulting in bumping or violent ignitions (caused by combustion of a new with a previously missed charge) at irregular intervals if due to lack of richness, or to similar bumping or early firing at each cycle if due to excess of richness. The deciding factor is the limit of mixture inflammability which the amount of air entering with the gas permits. An example of what may happen in normal work as regards variation in calorific value of gas from a suction gas producer is suggested by the accompanying chart taken from a recording calorimeter in one of the tests made by the author. An engine pulling its gas from a suction producer is fed with gas of varying calorific value per unit volume as the load may range between nil and maximum. A chart is also given based upon Dowson's figures to show these variations in respect of composition.

As an internal combustion engineer, therefore, the author would say that to a certain extent it is immaterial what kind of gas is made for this purpose of serving gas engines, but whatever its composition every effort should be made to obtain uniformity, remembering particularly that the less rich the gas in calorific value the more important is it that constancy of product should be striven for. An expert with an indicator always available

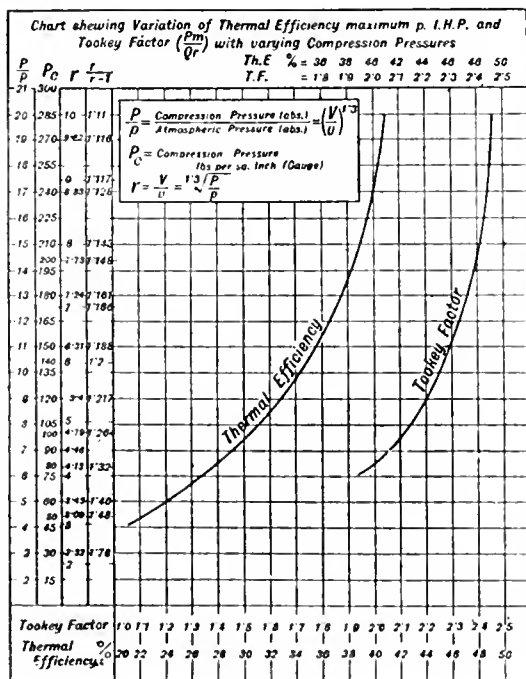


FIG. 1.

politan Gas Referees showed that, without great inaccuracy, the value of a cubic foot of town gas could at that time be taken as 500 B.Th.U. for such purposes. The reading of the gas meter and determination of mean piston pressure then

could undertake to run an engine with any and every kind of gas that could be piped to him so long as he had means of properly adjusting the proportions of gas and air and of varying the instant of ignition. But the ordinary gas engine user wants his engine to run every day and all day and day after day, with the same settings and with inexpert attendance, and this he will not be able to do unless the gas is of regularly uniform quality within close limits and is supplied at a uniform pressure through the service mains.

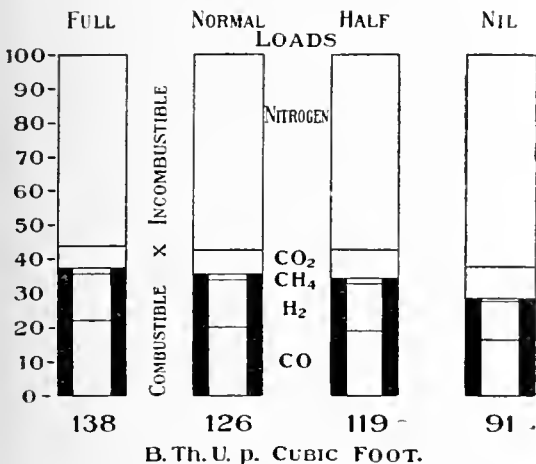


Chart showing variation in composition and calorific value of anthracite suction producer gas under varying loads.

FIG. 6.

The higher the proportion of incombustibles in the poorer power gases the more the encroachment upon the air capacity of an engine cylinder and consequently the limit is sooner reached in respect of mixture strength. It is a well known fact that gas producer engines are rated for output from 12½ to 25% less than the town gas figures. This can be taken as meaning that while with good coal, clean furnace, high fuel-bed temperatures, and well humidified hot air blast the smaller reduction may be expected, yet to compensate for the temporary absence of any one of these essential conditions and to cover the incidences of everyday work it is frequently found that a margin of 25% on basis of town gas powers is a much more practicable figure.

It was stated in a previous paragraph that uniformity of pressure of supply was important and it may be advisable to say a few more words upon the subject. Whatever the pressure of supply may be matters very little as long as it remains uniform. Indeed this is obvious seeing that gas engines are daily started up on a rich gas under pressure and switched over to a poorer gas under suction. All the same one hears even gas managers asking whether there should be a limiting minimum supply pressure to engines and if so what. The minimum pressure on a town gas service pipe must always be sufficient to keep the gas bag diaphragm well inflated between charges taken by the engine when working under full load. Those gas companies who have now, or are about to inaugurate a gas engine maintenance scheme would be well advised to include as a part of their instructions to employees to renew indiarubber gas bag diaphragms when flabby and irresponsive and to cleanse periodically the anti-pulsating valve attached to the diaphragm to ensure its smooth and reliable operation. Quite a large proportion

of complaints of "bad gas" or "lack of pressure" would in this way be obviated.

As to uniformity of calorific value, this is probably somewhat difficult to control having regard to practical gas making and problems and variation in fuels. But that very considerable success is obtained is borne out by the figures reported of the readings taken at the testing places prescribed by the Metropolitan Gas Referees. No doubt it is the same in other larger cities, but in many provincial towns it is the author's experience that no analysis or statement as to calorific value can be obtained because the proprietors will not sanction the expense of purchasing the necessary and simple apparatus required, even if amongst the staff a man could be found able to take daily records.

It will surely be admitted henceforward that at least a calorimeter should be considered an indispensable adjunct to the works meter even in the smallest provincial town. In one district of Suffolk the author when making a test obtained some figures for cb. ft. I.H.P. hour which seemed to require explanation. Upon application to the Manager at the Gas Works he was informed that no idea of calorific value or volumetric analysis could be obtained owing to lack of appliances but there was the coal store, there the coke stack, and

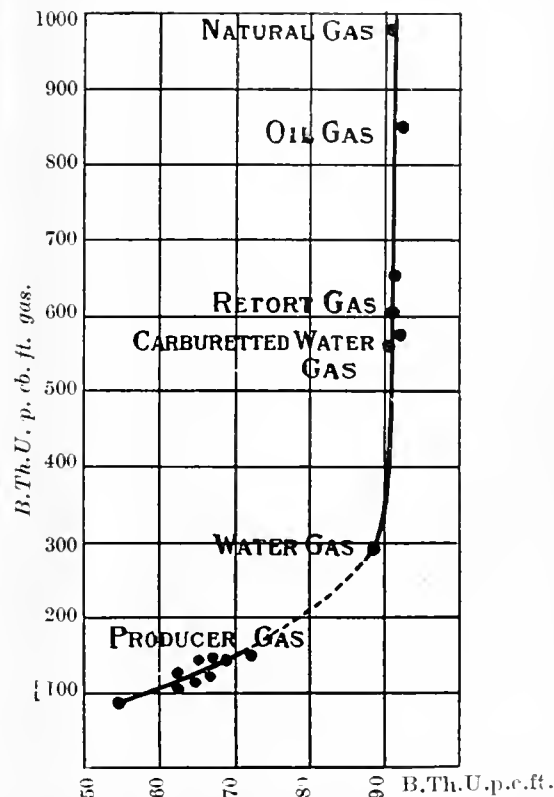


Chart showing similarity of mixture strength (theoretical) over wide range of power gases say 300 to 1000 B.Th.U. per cb. ft.

FIG. 7.

there a lighted burner. Certainly the lighted burner—flat flame—told the story of a rich gas but no more definite information was forthcoming. How successful progress of gas power business could be expected in competition with electricity in that borough was not discoverable.

It has very frequently been stated that an excess of hydrogen or of methane in power gas gives trouble in the engine cylinder, and the author has been at many tests when after an outbreak of pre-ignition the cause has been attributed by those in charge to too much hydrogen. Certainly it has frequently been reported in connection with coke oven gas that pre-ignitions occur due to a similar cause. On the other hand Prof. Bursfall, in the experiments he made at the Birmingham University, in order to study the influence of high compression, reported that with proper attention and adjustment of ignition and by taking particular care to cool the ignition plug, no trouble of pre-ignition occurred with mixtures even at compression pressures in the neighbourhood of 160 lb. per square inch.

There are a number of engines working to-day throughout the country on town gas with compression pressures exceeding 140 lb. per square inch and yet pre-ignitions are unknown in such engines. The writer's opinion is that it is a matter of mixture and when the trouble of pre-ignition exists, it can be greatly minimised or entirely obviated by reducing the amount of gas to the working charge, that is to say, by weakening the mixture. If this were not so, one could not believe that natural gas with its 92% of methane could be used at all, but yet it is in service at many places in the U.S.A. and additional support is given to the opinion by the fact that coke oven gas with its 50% of hydrogen and 36% of methane or thereabouts can be used in gas engines satisfactorily, if "to avoid pre-ignitions" a certain proportion of the charge consists of exhaust gas. The function of the latter after all is to weaken the mixture and while the same effect would logically be obtained by admission of pure air in proportionate excess, yet the very fact that such additional pure air was present, would enable still richer charges to be fired and thus increase the danger, consequently exhaust gas being inert is the better medium to use on this account.

Many people seem to forget that the working mixture of an engine is not the gas alone, nor gas and air mixture alone, but a mixture of gas, air, and residuals from previous charges. That residual gases from previous charges have an important effect will be clear from what has already been said, and it is well known amongst practical men that no engine can work to best advantage with a bottled up exhaust, that is to say, an engine which has its exhaust connection partially choked and permitting the retention of such a volume of an exploded charge as will interfere with the induction of an adequate volume of air to complete the combustion of a following charge. A producer gas engine is much more sensitive in this respect than is a town gas engine, for the percentage of combustibles in the gas constituent of the former is only of the order of 40%, whereas in town gas 90% of its volume is combustible. Thus one can say that a working mixture really consists of 40 to 90% combustible and 10 to 60% incombustible gas coming through from the producer or the service mains, oxygen 21% and nitrogen 79% in the air constituent, and residuals also of varying quantity according to site and conditions.

Some 10 or 12 years ago considerable interest, was aroused particularly in U.S.A., by experiments that were reported in the technical press at the time, of gas producers of the suction type, working without water vapour but, in place thereof, with a portion of the exhaust gases permitted to pass through the fuel bed, in regulated volumes, according to the load on the engine. It was reported at the time that very considerable success had been reached and that high compression pressures could be attained without risk of pre-ignition such as gas made with ordinary

water vapour would give under much lower compression pressures. Very little has been heard of this during recent years, probably on account of the fact that attempts to regulate the exhaust in accordance with the load mean that a great deal of circumspection is demanded by the engine attendant and it is realised that anything to do with engine operation should make as few demands as possible upon the intelligence of the attendant, otherwise gas engines get the reputation of being unreliable. It is in the author's opinion exceedingly doubtful whether hydrogen is to be blamed for pre-ignition in gas engine cylinders. Personally he has never been able to satisfy himself that pre-ignitions are directly due to hydrogen. When an engine has been working for some time quite well and suddenly begins to develop pre-ignition, it is a sure sign that something has happened at the producer end and that in consequence the calorific value of the gas has increased, but if one notices analyses of rich and poor qualities of producer gas one finds that as calorific values increase hydrogen rises practically in the same proportion as does carbon monoxide, and the latter being the slower in burning, one would have thought that the fault could not be properly placed to excessive hydrogen. It seems to the author that the increase of both has resulted in (relatively) greatly increased mixture strength, and the air supply being constant it may have changed the composition of a working mixture from one that is slow to burn into one that is fierce to burn. Thus with some ignition settings, pre-ignitions could quite well be accounted for.

An experience of the writer in this connection might be detailed. Two engines in the North of England were giving trouble. Both were fed from the same suction producer, both were running coupled, through dynamos, to the same load; and the engines would work sometimes quite comfortably throughout the working day and at other times an alarming amount of pre-ignition would occur, on one or other of the engines, which naturally produced irregular running and gave the attendant considerable trouble.

It was thought that there was too much hydrogen in the producer gas and steps were taken to reduce the amount of water flowing through. This had no effect as far as could be discerned. An experiment was also tried to drench the air going into the producer with water vapour so as to reduce the temperature of the saturated air as it entered the fuel bed and in this way to reduce the temperature of the combustion zone within the generator. This again had no good effect. Experiments were then made with the exhaust pipe and the exhaust valve settings, but showed that nothing that could be done in this direction would put an end to the casual pre-ignition. Eventually it was found that the setting of the magneto was incorrect in that it could not be sufficiently advanced. This having been put right the pre-ignition ceased and no further trouble has been experienced since as far as the author is aware.

Certainly whatever else this experience proved it could be said that the experiments had proved conclusively that the trouble was not due to the quality of the gas nor the amount of hydrogen in it.

Another experience that the author has had is an interesting one and may be of service. He was consulted in connection with an engine which had been giving serious trouble through pre-ignition, which first was put down, as usual, to too much hydrogen. The engine was still in the hands of the maker, that is to say, it had not been handed over owing to the troubles that were being encountered, but the engineer who had the matter in hand, had very carefully gone into all matters connected with it and described to the author what his tests had been and the conclusions to which these had led him. It appears that with

this particular engine pre-ignitions could be and were met with even when the engine was running under the lightest of loads and not only, as is usually the case, under heavy loads. All sorts of adjustments had been tried in connection with the water supply to the producer gas plant, but whether little, normal, or much, no benefit resulted, and pre-ignition still persisted. Eventually it was found that the gas contained a very high percentage of sulphur in the form of solid particles which were carried over from the generator through the scrubber, through a centrifugal fan and through a sawdust purifier, giving heavy deposits in each of these pieces of apparatus and forming a slimy deposit on the walls of the service main to the engine. Passing through the governor valve it quickly reduced the area through which the gas passed and even found its way into the manifold pipe supplying the four cylinders of a vertical gas engine. The peculiar feature about the whole affair was that pre-ignition did not occur in all cylinders, but only in one or other of the two centre ones. It did not occur persistently but casually. Pre-ignition in the usual way is recognised as being a sign that it will steadily get worse as time goes on and will necessitate eventually stoppage of the engine, but in this case nothing seemed to happen. Pre-ignition would take place, perhaps in one charge in a series of 100, but at other times one in 50, proving that the source of ignition, whatever it was, was momentary and not permanent in either one of the two inside cylinders. It was evident, therefore, that the working of the engine, or perhaps one should preferably say the pulsation of the gas in the manifold pipe, had the effect of causing a grain or two of sulphur to become detached and enter with the gas, which falling on to the hot piston top, and becoming ignited in the presence of air and under the influence of the added heat of compression which followed the suction stroke, set the mixture alight prematurely.

The difficulty was to find a remedy, having found the cause. The fuel was changed, different classes of anthracite coal tried, new coke was put in the scrubber, new wood-wool and sawdust in the dryer, the whole plant was stopped and thoroughly cleaned out, but all to no purpose. Even now the author believes that the trouble persists and it is clearly some local circumstance that is causing this most peculiar and unusual state of things. As a final endeavour to get rid of the bugbear the author has advised that instead of the ordinary water, rain water should be used for generating water vapour and for washing the gas. What effect this has had he does not yet know.

The upshot of the whole of this paper is that while as far as the author's experience goes, he can give no preference to any of the power gases for engine work from the point of view of their relative composition, he would like to insist upon the importance of the points alluded to earlier in the paper. That is to say, whatever composition of the power gas may be, its purity, its pressure, and its uniformity—both in composition and pressure of supply—are of far more importance from an engineer's point of view than is its calorific value.

DISCUSSION.

Mr. G. N. HUNTLY said that using brake horse power as a co-ordinate and thus introducing a variable friction factor appeared at first sight to reduce the chance of discovering a regular relation, but from the diagram shown it was clear that the author was justified. As regards the statement that over a wide range the efficiency of the gas engine was independent of the calorific value of the

fuel, since gas was bought in cubic feet and not in B.Th.U. there was a possibility of misconception.

Mr. W. J. A. BUTTERFIELD was of opinion that engineers had not given sufficient attention to the minor constituents of the gas, such as for instance carbon bisulphide, the temperature of ignition of which was very low. Pre-ignition might possibly be due to its presence. Acetylene was a gas of high calorific power and low temperature of ignition, and insufficient attention, he thought, had been given to its behaviour in the gas engine in comparison with other gases and oils.

Mr. P. H. JOSELYN said that having had considerable experience in stripping gas and never having seen the calorific power reduced by more than 7%, although 5% was about the average, he could not understand why the consumption in a gas engine should increase 10 to 15%, as quoted by Mr. Tookey, when running on stripped gas.

Prof. J. S. S. BRAME agreed with the author that hydrogen probably had no determining effect on pre-ignition; figures he had published a few years back showing the hydrogen content of the actual cylinder charge bore this out, and the cause must be sought, as far as the charge was concerned, in the minor gaseous constituents, probably acetylene. Mr. Butterfield's suggestion of carbon bisulphide being a possible cause of pre-ignition was worth following up. Referring to the author's remarks on the variability in composition of suction gas, he said that the author's curve really showed that with the engine running at a steady output the calorific value of the gas was uniform; it was only when change of load occurred that great variation in the gas was noted, the composition of the gas adapting itself to the load conditions.

Mr. J. W. HINCHLEY asked whether there was any conclusion to be drawn from the fact that a Norwegian engine, No. 7, appeared to be the most efficient engine examined, that is, if he understood diagrams 1 and 2 correctly. He also suggested to Mr. Tookey that his remarks, without further interpretation, might lead one to suppose that no real improvement had been made in gas engines for thirty years; he suggested that some further explanation was desirable.

Dr. R. LESSING asked whether the remarkable uniformity of curves obtained from a variety of fuels was not due to the fact that the amount of combustible matter in the mixtures was comparatively small, and the calorific value of the mixtures per cubic foot of cylinder space was made uniform by the different air requirements of each fuel. Thereby a rich fuel such as town gas had to be diluted down to practically the same calorific strength as a mixture made with poor producer gas. As the actual amount of combustible matter in these mixtures was comparatively small, it was obvious that their chemical characteristics could not be very evident, and did not show up in the author's results. However, he could not help feeling that the composition of the fuel gases and the chemical constitution of their components must influence the working of the engine. Although the output of horse-power might be the same with different mixtures, there must be differences in other respects, such as ignition temperature or propagation of explosion, with bodies of such varying constitution as benzene, methane, carbon monoxide, and hydrogen. He would, therefore, urge strongly not to disregard the composition of the combustible matter supplied to the engine, although he recognised the importance and convenience of studying the working of the engine from the point of view of B.Th.U.'s per total cylinder charge. How necessary it was to consider the quantitatively less important constituents of complex gas mixtures was shown by Mr. Tookey's

reference to the adjustment required after changing over from unstripped coal gas to a gas from which part of the benzene had been extracted, although the difference between these two gases probably amounted to less than 1% by vol. There was a danger that the author's statement, that well-made working mixtures with any kind of fuel gave approximately equal results, might be erroneously applied to the fuel gases themselves, and it would be as well to make it clear that such a misconception was not permissible. The choice between various types of gaseous or vaporous fuels must, in the first instance, depend on the cost per thermal unit, but was also largely influenced by questions of convenience, continuity of supply, capital outlay for the plant, and geographical position.

Dr. R. SELIGMAN asked if gas of low calorific power could be used in the gas engine as well as Mond gas.

Mr. W. A. TOOKEY, in reply, dealt first with the remarks of Mr. Butterfield and others with regard to the presence of small quantities of carbon bisulphide in power gases. He stated that the point raised was new to him and would no doubt prove to be well worth following up, but, speaking without full consideration of the matter, his first impression was that the presence of such minute quantities of these sulphur compounds was immaterial and had no influence upon the phenomenon of pre-ignition. The small amount of carbon bisulphide present in power gases and the very much lesser proportion present in working mixtures of gas and air could, he thought, have little or no effect.

Mr. BUTTERFIELD explained that he realised that the amount of carbon bisulphide present in working mixtures would be very small, but his idea was that, however small, it was just possible that it would act as a detonating cap and ignite the working mixture during the compression stroke under certain conditions.

Mr. TOOKEY said that the suggestion might possibly be valuable in explaining the cause of pre-ignition in rare instances, but his experience had been so far that pre-ignitions could be entirely cured by proper regulation of gas and air mixtures and by correctly timing the ignition. So far he had never met a case of pre-ignition which did not yield to treatment of this description.

He would hardly care to say what was the lowest calorific value of gas that could be piped to power consumers. He was inclined to think that gas of about 400 B.Th.U.'s would be a desirable minimum, but much depended upon other factors. Mr. Huntly had pointed out that calorific value itself was one standard and did not take into account the purchase price or whether the consumer was getting value for his money. Mr. Tookey said that he thought this was rather beside the point under discussion, as chemists and engineers could approach the subject entirely from a physical rather than a commercial standpoint. In the matter of £ s. d. the gas undertakings and their consumers could well be left to look after their own interests.

It would be realised that very little depended upon the density of the gases in respect to output of gas engines when it was a daily occurrence for engines to be started up on comparatively rich town gas and then switched over to relatively poor producer gas, the former having a density of perhaps 0.4 and the latter one of 0.8 in relation to air. There was no practical difficulty in getting the heavier gas into the engine for it merely meant a slight lowering of the suction line as depicted in an indicator diagram taken with a weak spring.

Replying to Mr. Joselin's remarks, the author said that in the case mentioned in the paper the "stripped" gas was about 5% lower in calorific value than the "unstripped" and this accorded

with Mr. Joselin's figures. The 13% mentioned in the paper was the increased consumption of gas to generate the same power without any alterations having been made to the mixture strength, as indeed was explained, but this increase was entirely due to the irregularity of ignition, i.e., while one charge would be fired less promptly than with the "stripped" gas, succeeding charges would be fired later and still later, involving wasteful consumption of gas. It was to correct this late and irregular firing that adjustment of the gas and air mixtures was made, and as soon as the mixture strength had been brought up to the requisite value, consecutive charges were fired regularly, so bringing the 13% increased consumption down to 5%—equivalent to the difference in calorific values of the "stripped" and "unstripped" gas.

Professor Brame had pointed out that the chart exhibited by the author showed that, speaking generally, suction producer gas was of fairly regular composition. The author stated that this was so as long as the load upon the engine was unchanged; if it were changed the calorific value of the gas was at once affected, rising for higher powers and falling for lower powers, as indeed was depicted by the diagram separately shown. This involved slight adjustments being made to the air regulation in order to obtain most economical results, but the author did not wish it to be thought that suction gas producer plants were unreliable or required an undue amount of attention. The fact was that practical considerations and the cheapness of gas production made it unnecessary for the average attendant to keep the working mixture tuned up to the most economical point, and the many thousands of engines working in all parts of the world and with all kinds of fuel, such as anthracite, charcoal, coke, cotton seed, and waste combustible materials of almost any kind sufficiently demonstrated that suction gas plants were reliable to a very great extent.

Mr. Hinchley must not draw the conclusion he suggested, for the Norwegian engine shown in one of the charts as being most efficient implied no lack of skill on the part of British inventors. This was an engine made with a very greatly restricted clearance volume in order that high compression pressures should be attained and that tar oils could be burnt. The diminished clearance space, other things being equal, was quite sufficient to account for the apparently more efficient working of this particular engine. Mr. Hinchley had also suggested that from the author's remarks it might be considered that no improvement in gas engine practice had been made during the last 30 years. That was quite contrary to what the author wished to emphasise, for had it not been for the improvements in gas engine construction during that period, we should still have been working with low compression engines, which, as would be seen from the diagrams, showed the lowest efficiency. It was first of all the hot ignition tube and afterwards magneto-electric ignition which had made high compression pressures practicable, to deal only with ignition improvements. For the rest it remained only to compare the engine of to-day with that of 30 years ago to see that the modern production was superior in every way.

Dr. Lessing had correctly stated the point which the author wished to make, namely, that whatever type of gas was used, its mixture with air and residuals practically eliminated all differences of calorific value within the engine cylinder. The author had at one time been of the opinion that the actual composition of the gas and the constitution of its components must influence the working of an engine, but he was bound to say that the differences that theory would expect were not discoverable in practical working.

Nottingham Section.

Meeting held at Nottingham on Wednesday,
31st January, 1917.

DR. R. M. CAVEN IN THE CHAIR.

A SIMPLE AND EFFICIENT GAS ABSORPTION APPARATUS.

BY H. DROOP RICHMOND, F.I.C., AND
E. HEMBROUGH.

An apparatus which can be made without difficulty by the average glass-blower and which has proved efficient for absorption of gases such as carbon dioxide, can be made by fitting a tube



13–15 cm. long about 4 mm. internal diameter, on which 6–8 bulbs about 12 mm. diameter have been blown, and the ends of which are expanded into small funnels of about 12 mm. diameter, inside a tube of about 17 mm. internal diameter, 20 cm. long, the bottom of which is drawn out and sealed to an inlet tube of about 3 mm. diameter bent in form of a U. In this tube is placed 10–15 c.c. of absorbing liquid; the gas enters by the inlet tube and bubbles up through the bulb tube, passing from bulb to bulb, and taking up some of the liquid which overflows from the upper funnel, while fresh liquid continually runs in to replace that carried up; under the circumstances the contact between the gas and liquid is efficient. The apparatus is simple, easily made, easily cleaned, and not at all fragile. The efficiency is shown by the following:—

Two comparative experiments were made in which carbon dioxide was generated from 15 c.c. of *N*/10 sodium carbonate; in the first two of the new apparatus and one ordinary wash bottle were arranged in series; in the second two wash bottles and one of the new apparatus were used; the carbon dioxide was absorbed in baryta solution, which was afterwards titrated with *N*/2 acid, in presence of phenolphthalein. The results obtained were:—

c.c. *N*/10 baryta used for absorption.

New	10.63	Old	8.03
New	2.89	Old	1.99
Old	1.24	New	2.76
	14.76		12.78

It is seen that in each case the new apparatus was more efficient than the wash bottle, and two of these and a guard tube would absorb the carbon dioxide from such a diluted gas as employed.

This investigation was carried out in the Analytical Laboratory of Messrs. Boots Pure Drug Co., Ltd., to whom our thanks are due.

A MERCURIAL VISCOMETER.

BY F. M. LIDSTONE.

ERRATA.

In the discussion on the above paper (this Journal, March 15th, 1917, pages 271–2) the following corrections should be made:—

Page 271, col. 2, lines 28 and 27 from bottom, for “by the addition of phenol in which the . . .” read “by means of phenol of which the viscosity at different . . .”

Page 272, col. 1, line 18 from bottom, for “jet was moved” read “pipette was movable.” Delete line 12 from bottom. Line 11 from bottom, delete word “bottom,” and for “main” read “mean.” Line 7 from bottom, after “viscosity” add “within the limited range chosen here.”

Yorkshire Section.

Meeting held at the Queen's Hotel, Leeds, on Monday,
February 5th, 1917.

PROF. J. W. COBB IN THE CHAIR.

OXIDATION OF OILS IN PRESENCE OF SOLUBLE METALLIC CATALYSTS.

BY W. MCD. MACKEY, F.I.C., AND HARRY INGLE,
D.S.C., PH.D., F.I.C.

In a paper read before this Section last session (this Journal, 1916, 454) we made a statement as to the relative drying power, or oxygen-carrying power, of certain metallic soaps when dissolved in oil. It was as follows:—“*That in its oil-soluble form, a metal which exists in more than one state of oxidation acts as a ‘drier’ or oxygen carrier, provided that the (salts of the) lower oxides are more stable than the higher,*” and in the present paper we are trying to show, and we think with considerable success, the truth of this dictum.

We felt compelled to justify this general statement by the examination of the action of metallic soaps on a drying as well as on a non-drying oil (i.e., olive, on which the experiments were made as recorded in the paper referred to).

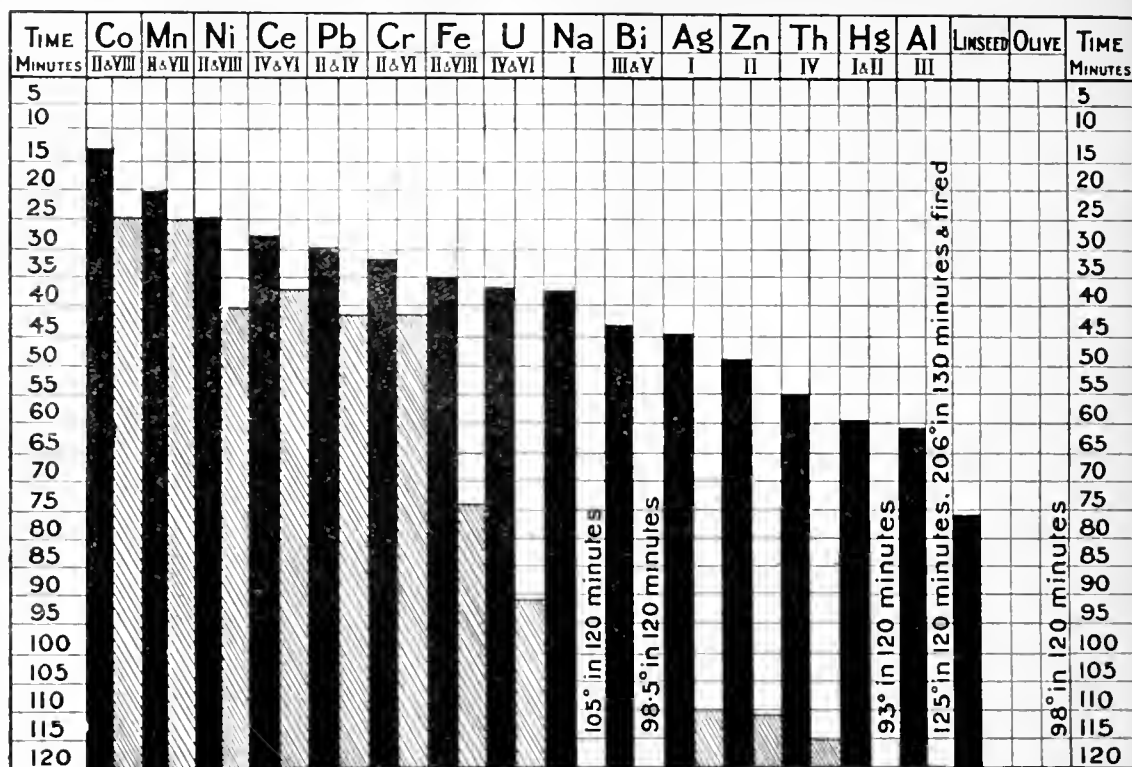
The following results show how far the general theory is justified. Of course it was well known that the rate of oxidation with drying oils in the tester (for description of the Cloth Oil Tester, etc., see this J., 1896, 90) must be greater than with non-drying oils, and this is clearly shown in the table.

The results, though the tests were made on oils, seem to be of importance as regards catalytic action generally; but our work has been confined to measuring or comparing the catalytic activity of the element experimented with as regards oxygen-carrying only.*

It was hoped to be able to draw up a table showing a definite relationship between the catalytic action of the elements and the periodic law, but so far we have not been able to prove this definitely. We have, however, considered the relationships of the valencies and the oxidation states of the elements, and as a result we may make a further generalisation, thus:—

That the more oxides a metal can form the greater the catalytic power.

* Most of the results on olive oil were published in the paper already referred to.



Iodine value of linseed oil used, 178; of the olive oil, 85. Roman numbers denote valencies. Black, linseed oil experiments. Shaded, olive oil experiments.

In the table the results are given from left to right in order of activity. The position of the head of each black or shaded column represents the number of minutes in which the oiled cotton wool—7 grms. cotton wool, 14 grms. oil containing 2% metallic soap—attained a temperature of 200° C. in the Cloth Oil Tester. (Thus cobalt, 12.5 minutes with linseed oil, 24.5 with olive.) In all experiments represented by black and shaded columns the oiled cotton wool fired on standing in the open.

Copper. In the case of the copper soap in linseed oil the maximum temperature attained was 138° C. in 53 minutes, and the temperature then fell. In the olive oil experiment the maximum was 120° C. in 55 minutes, and the temperature then fell.

Tin. With linseed oil the temperature was 98° C. in 120 minutes—the usual period given for an experiment—but in 150 minutes the temperature of 200° C. was attained and the oiled cotton wool fired on standing in the open. With olive oil the temperature was 92° C. in 120 minutes. The experiment was then stopped.

It will be seen from the table how far both the theories put forward are in agreement with results. Taking the table from left to right (in order of activity):—

Cobalt forms at least two well-defined oxides; the salts of the lower are the more stable.

Manganese. A large number of oxides are known, but in the salt forms the lower are the more stable.

Nickel, like cobalt, forms at least two classes of oxides, the salts of the lower being the more stable.

Cerium forms several oxides, but the cerous compounds are the more stable. It may be added that Ulzer and Deisenhammer (Verwendung der

seltenen Erden, R. Böhm, Veit and Co., 1913) have shown that cerium salts readily act as catalysts, in their experience being little less active than those of lead. They add that with a pure cerium salt they believe that cerium would be found to be more than the equal of lead as a siccative or "drier" (catalyst), and it will be noted that our work confirms this.

Lead readily forms two series of oxidised salts; the lower is the more stable, hence its drying power.

Chromium forms a considerable number of oxides. This metal was of much interest owing to its wide use in the dyeing industry: as previously pointed out (this J., 1916, 451) it is a constant constituent of khaki dyed goods. The salts of the lower oxide, CrO , are readily oxidised but the salts of the intermediate oxide, Cr_2O_3 , are stable, the higher oxides formed, e.g., CrO_3 , readily reverting to this.

Iron forms a number of oxides. The salts of the intermediate oxide are the most stable.

Uranium forms several oxides, of which the intermediate, like those of iron and chromium, are the most stable.

Sodium. The results obtained in the Tester with this element are rather anomalous, for they show that though forming only one well-defined oxide, it acts as a catalyst, and a more active catalyst than we should have expected.

Bismuth, silver, zinc, thorium, mercury, and aluminium, it will be noted, are all towards the right of the table, i.e., they are less active than the elements on the left of the table. They only form one class of oxide, or where they form more, as in the case of mercury, the salts of the higher oxide are the more stable, thus falling in with the general theory. But it will be observed that (leaving for the moment copper and tin out of account) in all cases the introduction of a metal in oil-soluble form accelerates the increase of temperature. The explanation of this is not at present evident. We think that it is probable that the soaps are ionised

in oil solution and that the ions exerting their partial valency accelerate the oxidation of the oil; but as a generalisation it may be taken that *the solution of a metal in an oil tends to accelerate the oxidation of the oil.*

Copper shows a very remarkable behaviour under the conditions of the experiment. At first it accelerates and then retards the oxidation of the oil—this occurs both with linseed and olive oils. We have observed that with linseed oil, at a low temperature, the copper soap dissolved, giving a green solution; but on further heating, at about 200° C., a reduction took place with the separation of a reddish deposit, presumably Cu_2O . Tested by the Weger plate method both solutions exhibited equal drying power; and the drying power was considerable—nearly equal to the drying power of a lead soap in linseed oil.

The following notes with reference to the preparation of the soaps may be of interest. A sodium soap was used as the basis, and the soaps of copper, aluminium, nickel, lead, manganese, iron, and mercury were easily prepared. The silver soap had to be dried *in vacuo* over sulphuric acid in the dark.

The following soaps presented difficulties:—

Tin soap. As a neutral solution of tin is difficult to obtain the precipitation had to be effected in a slightly acid solution, and therefore a certain amount of fatty acid was present in the soap, which had to be removed by alcohol.

Bismuth soap. This was prepared in the same way as tin soap.

Uranium soap. Probably this is the first time uranium soap has been prepared. It was made by the addition of the standard soap solution to an aqueous solution of uranium acetate. Little separation took place until the soap was salted out, when a granular yellow soap was obtained.

Cerium soap. This also presented some difficulties. It could only be obtained in slightly alkaline solution and required salting out.

Thorium soap. Thorium nitrate is fairly soluble, and with soap a well-defined granular precipitate was obtained. The soap was white in colour.

In conclusion we have to thank Mr. James Miller and Mr. F. A. Horsfall; the former in particular for his assistance in the preparation of some of the more difficult soaps. Mr. Horsfall took charge of the bulk of the experimental work and has prepared the table.

THEORY OF THE ACTION OF "DRIERS."

BY HARRY INGLE, D.SC., PH.D., F.I.C.

In previous papers (this J., 1913, 639; 1916, 454), a certain amount of work on the oxidation of unsaturated compounds (drying oils) was recorded, and the theory of the chemical reactions during this process was adumbrated.

It is well known that the solution of certain metals in oils, especially drying oils such as linseed, greatly accelerates the absorption of oxygen, and hence these metals are known as driers.

The method of solution varies. "Fire boiled oils" are usually oils treated with certain salts or oxides of the drying elements at a temperature of 400 to 500° F. "Cold boiled oils" are obtained by dissolving in the oils, soaps of the drying elements at a temperature of steam heat.

Many papers have been published on their action and many compounds have been proposed for this purpose.

I wish to set forth in this short note a more explicit view of the mechanism of the action of driers on unsaturated compounds. I use this somewhat vague term purposely because there is no doubt that driers (catalysts) act upon other

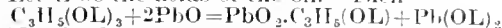
unsaturated compounds besides acting on the drying oils. The action of a catalyst, a drier, on other substances than drying oils, has a most important bearing on many industries.

Now lead, one of the oldest, may be taken as a type of a drier on a drying oil. When linseed oil or other oil is heated with lead oxide or lead salts containing a volatile acid, the oil is more or less saponified and converted into a lead soap. This reaction usually requires a fairly high temperature. The other method of utilising lead has been indicated.

The products from the action of litharge may be taken as the example of the catalytic action of the lead.

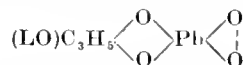
Saponification (partial) results.

Let L_2 be the acids of the oil. Then

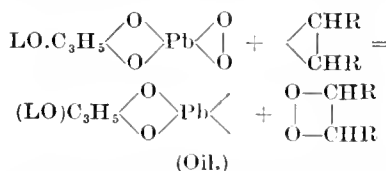


Now lead can act as a diad or a tetrad. Glycerol is but a weak acid, but it can form salts with lead; lead glyceride itself is not readily soluble in oil.

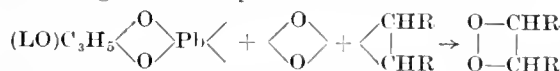
Glyceryl plumbolinoleate represents lead attached to a weak acid substance, amphoteric glycerol, which has at the same time part of its acidity reduced by the presence of linolic acid, attached to one of its hydroxyl groups. The absorption of the valencies of lead is thus little reduced, and the lead is able to exert its tetravalency and thus absorb oxygen from the air to form a peroxidised product. The following schemes will illustrate this. First of all the lead compound absorbs oxygen to become,



This compound transfers its peroxide oxygen to the unsaturated double linkages, *e.g.*, of an oil, thus:—

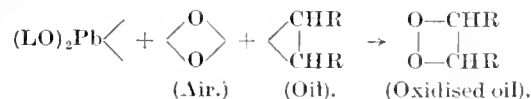


Or if it is desirable to summarise the reaction the following scheme may serve:—



The lead compound is alternately peroxidised and reduced and peroxidised again, the supply of oxygen from the air being practically inexhaustible. It is therefore obvious that provided that the metal still remains in solution as a soap, a very small quantity will suffice for the oxidation of an oil.

Taking lead linoleate, the action would be as follows:—



for it is found that the lead soap of linseed oil (glycerol-free) exerts a drying action.

The above theory would apply to all metals that act as "driers."

The results in the previous papers of Mr. W. McD. Mackey and myself confirm the theory, and show by actual experiment its truth as applied to the metals examined. They are not in absolute agreement in all cases with the theory, but the reasons for this are set forth in the papers.

DISCUSSION.

The CHAIRMAN said that the subjects for discussion resolved themselves into three divisions. Firstly, a number of experimental facts with both a technical and scientific value regarding the action of the metallic soaps in the oxidation of oils. Secondly, a theory put forward connecting the action of these soaps with the position of the various metals in the periodic classification, and their existence in more than one stage of oxidation, and thirdly a more complicated theory on the changes in the oil due to the action of the "driers," or accelerated thereby. He asked if the metals used in each case were pure and how the preliminary estimate mentioned in the paper of the probable similarity of cerium and lead in drying power had been arrived at.

Mr. F. W. RICHARDSON asked what was the reason for using cotton wool; he preferred asbestos wool or slag-wool. He also asked if the action of the metallic soaps on the composition of the cotton-wool had been investigated, more especially with regard to the sodium soap. He thought there was a liability to form oxycellulose. He was rather surprised at the widely different action of the cobalt and iron soaps (these metals occurring in the same group). In Mr. Ingle's theory he noted that a small amount of lead would act as carrier for an indefinite amount of oxygen under suitable conditions.

Mr. DAVIES asked if it was possible to form two soaps from one metal, *e.g.*, cobaltous and cobaltic. He noted that the more active elements here, *viz.*, nickel and cobalt, also acted as carriers of hydrogen in the hardening of oils. He also asked if a mixture of the metallic oxides had been tried.

Prof. A. G. PERKIN said his chief interest was the effect of oils in the dyeing operation. In preparing oiled cotton for these purposes it was considered that oxidation occurred and was followed by the production of insoluble lactones. He understood that Dr. Ingle held other views, and would be glad to hear these explained.

Mr. RICHARDSON asked if asbestos fibre had been tried. He said that the results were not comparable in the case of the sodium, no number having been obtained with sodium soap and olive oil. He certainly thought that this was due to the formation of oxycellulose.

Mr. W. HARRISON asked if the cotton had been dried before use, because he thought that 5% of water would make a difference in the readings. With regard to the possible influence of the cellulose in promoting oxidation, as suggested by Mr. Richardson, Dorée (*J. Chem. Soc.*, 1912, 101, 499) had stated that cellulose formed a peroxide on treatment with ozone. It was not to be expected, however, that such a compound would be formed in this case since the oils themselves were more likely to take up oxygen. The fact that oxycellulose was formed when drying oils were allowed to oxidise on cotton had been observed by the author some years ago, but its formation indicated a retarding action of the cellulose since it used up oxygen; moreover, oxycellulose, and in fact most of the oxidation products of cellulose, were reducing agents and should therefore retard the oxidation of oils.

Mr. B. A. BURRELL agreed with Mr. Richardson notwithstanding the curious results obtained with slag-wool. He had found that with fish oils cotton-wool heated more quickly than ordinary wool and actually fired. He thought that more information with regard to the preparation of the metallic soaps was desirable; were they pure or did they contain the by-products produced in their formation?

Mr. W. HARRISON asked if Dr. Ingle was acquainted with the fact that metallic soaps when dissolved in benzene caused it to conduct electricity to some

extent? It was therefore by no means impossible that ionisation might take place in benzene and in oils. The reason he asked the question about the moisture in cotton was because he thought that the water might get emulsified in the oil and thereby increase the surface exposed. This might be the explanation of the effect of sodium soap in increasing the rate of heating.

Mr. A. WOODMANSEY thought the inorganic wool would be the better of the two. He also thought that the specific heat of the fibre might cause the variation in time required for the same oil to heat up with different wools. The amount of oil per unit area, if determined, would be useful.

Mr. J. MILLER said that cotton wool was the easiest to manipulate. Slag wool might be either basic or acid and this might be a serious factor. When glass wool was squeezed in the hand in order to make an even distribution of the oil, the fibres broke into short pieces.

Mr. W. McD. MACKEY said, in answer to Mr. Davies, that 2% of the metallic soap in the oil was used in each case. A mixture of metallic oxides had not been tried. With regard to Mr. Richardson's and Mr. Harrison's remarks, Mr. Mackey said he quite appreciated the point concerning the action of the sodium soap on the cotton wool. He (Mr. Mackey) was responsible for the use of cotton wool in the experiments, his reason for using it being that he had come to the opinion that the cotton wool had no part in the reaction, unless towards the end, when the temperature rose and firing occurred. He had tried experiments under similar conditions with both cotton wool and such substances as glass wool, and had found that in experiments in which he had compared the behaviour of slag wool and glass wool with that of cotton wool in the Cloth Oil Tester, the temperature had gone up more quickly with the two former than with cotton wool (see this *J.*, 1915, p. 595). Further, with slag and glass wool it was impossible to keep an evenly exposed surface unless comparatively little oil was used, the oil tending to run to the bottom of the wool in the cylindrical cage.

The cotton wool had not been dried and no estimation of the moisture had been made. It was of course well known that moisture accelerated the reaction; thus, if the Tester leaked slightly, a little water getting inside accelerated the rise in temperature and vitiated the experiment. But in these experiments he had assumed that the little moisture present naturally in the cotton wool was driven off by the time the temperature rose above 100°C.

With reference to Mr. Burrell's remarks, it had been found that the rise of temperature was slower with ordinary wool than with cotton wool. Cotton wool was used ordinarily in the Tester because it could always be obtained of the same composition and texture. "Absorbent" cotton wool was used, *i.e.*, cotton wool which had been thoroughly extracted to remove any trace of grease.

The criticism as a whole had been very suggestive and it had been so in the case of the paper that Dr. Ingle and he gave last session, and it was to some extent owing to such questions as those raised by Mr. Harrison in the discussion that they had been encouraged to follow the matter up to the extent they had in the present paper.

Dr. INGLE said, in reply to Mr. Richardson's question with regard to sodium soap solution in oil, unless there was water present no hydrolysis of the soap could result and therefore he did not think that any oxycellulose could be formed. He was very interested to hear of experiments on the fact that metallic soaps dissolved in benzol conducted electricity. This had a very important bearing on his theory and the idea with regard to the ionisation of sodium salts dissolved in oil had been set forth in the paper.

He also drew attention to the action of cerium and thorium as applied to the gas mantle industry. All the metallic salts were bought as "pure."

The stability of the oxides and salts of iron, nickel, and cobalt was not the same. The lower oxides of the two latter were the more stable while the intermediate oxides of iron were more stable than the lowest. This would explain the results.

Asbestos had not been tried, but the authors had it in mind. The results obtained with cotton wool were comparable.

With regard to the preparation of the soaps he had little to add. They generally separated out well, but sometimes required "salting" out. They were washed with hot water on the filter, dried, and finally melted. Soaps of ferrous and ferric salts were prepared, but by the Weger plate method no difference could be detected.

In all the experiments the soaps used were dissolved in the oil at a gentle heat.

Communications.

ORGANIC VULCANISATION ACCELERATORS.

BY S. J. PEACHEY.

In reference to the above subject a communication from Dr. Spence has recently appeared in this Journal (1917, p. 118). The statements made therein appear to me to be of such an intemperate character that I feel constrained to challenge them.

In a curious preamble the writer protests that all those who have preceded him in contributing to the literature of the subject have "assumed that that which is not proclaimed from the housetop is not known, and from these faulty premises have drawn certain equally erroneous yet sweeping conclusions which it has been" his "intention sooner or later to nullify and correct."

After reviewing the discoveries made by different investigators in the new field of research he proceeds to elaborate a claim to priority which certainly cannot be said to err on the side of modesty. In effect he says that the use of the organic vulcanisation catalysts discovered and patented by Bayer and Co. in 1912 was known to him in America six months previously, and he claims further to have prediscovered the use of the nitroso-compounds which I patented in 1914 as accelerators of vulcanisation. In his own words "the proof of this assertion and the complete vindication of my position with reference to the subject I am content to leave over to a later date. At that time I will also bring evidence to show that even the reagents claimed by Peachey (English Patent 4263 of 1911) were known to me and had been used by me both scientifically and industrially several years before his application was applied for."

In so far as the above statements concern my own discovery I must point out that Spence's claim to priority is put forward unsupported by even the slenderest thread of evidence; as a matter of fairness therefore it should have been held back until such time as he chose to disclose his promised proofs. I may add that the nitroso-compounds, the use of which was patented by me, constitute a class of accelerators quite distinct from those discovered by Bayer and Co. in that the mechanism of the acceleration differs in the two cases; it would therefore be a remarkable coincidence if both types of catalyst should have been anticipated, and one is tempted to ask why Dr. Spence refrained from either publishing or patenting his discoveries.

I suggest that having put forward his claim in a scientific journal he should without delay submit the evidence which he has promised to reveal at a future date.

THE REMOVAL OF PITCH FROM SULPHITE PULP.

BY K. H. KNUDSEN.

(Abstract.)

The precise cause of the trouble experienced from the presence of resin in sulphite pulp has not yet been determined, but the evidence points to the fact that it is not necessary to remove the whole of the resin from the pulp, provided that it can be evenly distributed. A pulp with a low resin content may cause trouble whereas one with a higher content may be satisfactory.

The deleterious effects of resin are especially noticeable in the manufacture of thin paper, and occasionally the resin gives rise to considerable trouble in the bleaching of the pulp; the bleaching process seems to favour the agglomeration of the resin particles.

The author has examined a number of bleached pulp sheets containing resin spots, and has always found sulphur and lime to be present in these spots. Further examination showed that the mineral matter in these spots consisted of calcium monosulphite and silica. This points to the fact that the calcium monosulphite must have been embedded in the resin, since it could hardly have resisted oxidation during 12 to 15 hours in the bleaching beater. It would thus appear to be established that the clotting is produced mechanically by cumulative cohesion due to the slow rotation of the warm pulp. Hence more pronounced clotting will occur in the beater with pulps containing a greater number of resin-coated particles. It is probable therefore that the trouble can best be remedied during the digestion of the chips.

At the mill in which this investigation was made, the resin content of the pulp was fairly constant between 0.8 and 0.9%, and gave little trouble. On one occasion, however, trouble was found to occur in the bleaching beaters and no remedy could be found for it until the pulp was removed from the digesters when the liquor was lighter in colour than usual; this completely overcame the difficulty.

Although the advantages of the various devices and methods for removing resin from pulp during the later stages of manufacture must not be ignored, the author believes it to be of the greatest importance to prevent as far as possible the separation of crystalline deposits in the digester, since the calcium monosulphite crystals appear to facilitate the separation of the resin particles, particularly if the wood has not been properly seasoned.

Institute of Metals.

At the Annual General Meeting of the Institute of Metals, held on March 21st and 22nd, the most noteworthy feature was a general discussion on the melting of non-ferrous metals.

This discussion was opened by the PRESIDENT, Sir G. T. Beilby, who said that the object in view was to make known the best and latest developments in the melting of non-ferrous metals. The desiderata for successful results appeared to be speed of melting, purity of molten metal, i.e., freedom from contamination by gaseous and other impurities, accurate control of temperature, and economy in regard to fuel, labour, and repairs.

Furnaces designed on the principle of the laboratory gas blowpipe could not be regarded as the best type. He had had considerable experience in the use of water-gas as fuel, and he would recommend gas and air under low pressure, both measured; plenty of room for combustion, and no tall chimneys exposed to wind and weather. There should be a positive pressure in the furnace and the furnace gases should be led through a simple regenerator, which might be constructed of steel tubes so mounted in an oven that there was no "cutting" action by the gases. He drew attention to the recent formation of the Board of Fuel Research (this J., 1917, 203) and to the fact that users of fuel might afford considerable help by placing their experience at the disposal of the Board.

Mr. W. J. HOCKING read a paper on "Metal melting as practised at the Royal Mint." He pointed out that in the production of cast bars of coinage alloys, the strict requirements as to uniformity of composition tended to restrict the size of the charges. The usual charges were 2800 oz. (87 kilos.) for standard gold (Au 91½, Cu 8½%), 6000 oz. (187 kilos.) for Imperial silver (Ag 92.5, Cu 7.5%), and 400 lb. (182 kilos.) for bronze (Cu 95, Sn 4, Zn 1%) and cupronickel (Cu 75, Ni 25%). Since 1910 low-pressure coal gas had been used as fuel in place of the coke previously employed. The present installation comprised 16 furnaces for melting silver, bronze, and cupronickel, and 10 similar but smaller furnaces for gold. The large furnaces were built of Stourbridge firebrick lined with bricks, 3 in. thick, the joints

Records of costs were given for the five years, 1905-9, using coke, and for the five years, 1911-16, using gas as fuel. These showed that with gaseous fuel as compared with coke, the rate of output was more than doubled, the greatest increase being with the high-melting metals; and the cost of fuel per ton melted was reduced by about 3½%, the cost of crucibles, etc., by 32.6%, and the cost of labour by 19%, the mean total economy under the three last-mentioned heads being about 25% (see also Rigg, this J., 1914, 1157). In the period 1911-16, 9900 tons of coinage metal was melted with a total gas consumption of 121 million cubic feet, at an average cost for gas of 20.58s. per ton melted.

In a paper entitled "Coal gas as a fuel for melting non-ferrous alloys," Mr. G. B. BROOK gave the results of a test under works conditions, extending over 10 days of 10 hours each, of the melting of cupronickel (Cu 80, Ni 20%) in a gas-fired pit furnace taking a 60-lb. crucible and using Sheffield town gas (532 B.Th.U. gross), and air at a pressure of 3-6 in. of mercury. It was found that there was no difficulty in obtaining a temperature of 1400 °C., and the results of the test indicated the following advantages in favour of gas as fuel as compared with coke, *viz.*, absence of ashes, elimination of wasteful process of "slagging," economy of fuel as a result of ease of control, higher rate of melting, and reduction of impurities introduced during melting. Based on the results of the tests, the following comparison of the costs of melting, in different districts, with coke and gas respectively as fuel, was given:—

Town.	Special high-grade coke: "metallurgical," "steel," etc.	Gas (minimum rate per 1000 cub. feet).	Cost of melting cupronickel per ton (based on ruling prices for fuel).	
			Gas.	Coke.
Sheffield	40s. 3d. per ton	1s. 4d.*	24s. 2d. (found)	36s. 4d. (found)
		1s. 9d.	31s. 9d.	
Glasgow	about 40s. per ton	1s. 5d.	25s. 8d. (calc.)	36s. (calc.)
Birmingham	45s. 6d. per ton	1s. 5d.	25s. 8d. "	41s. 3d. "
London	50s. per ton	2s. 8d.	48s. 4d. "	45s. 5d.
		(Wandsworth, 2s.)	(34s. 3d.)	

* For use in gas-engines only.

being made with a mixture of carborundum, fire-sand, and sodium silicate. The central well was 19 in. diam. and 32 in. deep, and was closed, during melting, by a circular firebrick weighing 1½ cwt., for which a wheeled carriage was provided. The burner was of the Brayshaw type, and gas was supplied at 3 in. water pressure through a 6-in. service pipe, and air at 2½ lb. pressure by means of three rotary Reichhelm blowers, each with a capacity of 36,000 cb. ft. The gas consumption by the 16 large furnaces was about 15,000 cb. ft. per hour. From the burner mixing chamber the gas and air passed through a right-angled elbow pipe and a screwed nozzle with diminishing bore into the ignition hole of the furnace formed in a block of firebrick. The nozzle fitted closely in a recess in this block and was surrounded by asbestos packing, and the passage for the gas and air opened out from a bottle-neck portion of 1½ in. diam., at an angle of 30°, into the well of the furnace, the flame passing between the crucible and the side of the furnace, without impinging on either, then round the crucible in an upward double spiral. The best results were obtained when combustion was complete in the furnace itself. Care was taken to keep the furnace lining free from excrescences, and to repair faults immediately, and the life of the lining was lengthened in this way; in general the entire lining was renewed two or three times a year.

Mr. C. M. WALTER read a paper on "Metal melting by means of high pressure gas." He pointed out that there was now, at Birmingham, as part of the gas distributing system, some 24 miles of mains carrying gas at a pressure of about 12 lb. per sq. in., and that in places where a supply of high-pressure gas was not directly available, a reciprocating type of compressor, capable of compressing 10,000 cb. ft. of gas per hour to a pressure of 12 lb. per sq. in., could be installed at a cost of about £300 (pre-war prices), whilst the total cost of working would be about 1½d. per 1000 cb. ft. of gas compressed and delivered, with power at ¾d. per horse-power hour. He gave a detailed description of a furnace of 60 lb. crucible capacity, fitted with a single high-pressure injector burner (see Eng. Pat. 1872 of 1911; this J., 1912, 221) and brief descriptions of larger furnaces. These furnaces showed many advantages; the economy effected owing to reduction in metal losses in brass melting would alone more than outweigh the extra fuel cost compared with coke. In a test under foundry conditions with twelve 50-lb. high-pressure gas-fired brass-melting furnaces, the gas consumption was 7.6 cb. ft. per lb. of metal melted, whilst for melting cupronickel (80 : 20) in a 130 lb. furnace the consumption was 9.4 cb. ft. per lb., and for melting 72 : 28 cartridge metal in a 160-lb. furnace, 6.2 cb. ft. per lb. In a battery of twelve 130 lb. furnaces for melting brass for the production

of 100-lb. billets, the gas consumption was 5.9 cb. ft. per lb. of metal melted, and the maintenance cost 0.7d. per cwt. of metal melted. The maintenance cost of a 60-lb. furnace was about 1.65d. per cwt. of metal melted. For the melting of brass for medium and light cored castings, the gas consumption was about 12 cb. ft. per lb. of castings produced, the metal loss amounting to about 4% of the metal melted. The use of high-pressure gas had proved specially advantageous for melting aluminium and its alloys, and one firm alone, in Birmingham, used 25,000 cb. ft. of high-pressure gas per hour for that purpose. For melting pure nickel and for melting swarf or scrap in large pots, excellent results had been obtained by use of a double injector burner supplied with gas at a pressure of 4 lb. per sq. in. and air at 20-in. water gauge (as could be obtained with a high-pressure fan); a mixture velocity of 10,000 ft. per min. in the burner tube was thus attainable.

A paper entitled "Metal melting," by Messrs. H. M. Thornton and H. Hartley, was read by Mr. THORNTON, who pointed out that the cost per B.Th.U. was much higher for gas than for coke, and hence an increased thermal efficiency was essential to obtain successful results with gas firing. The thermal efficiency was lower the higher the pouring temperature of the molten metal. In test experiments on brass melting the metal was poured at a temperature 100° C. above the liquidus curve of the alloy; a 20% increase in gas consumption would be required to obtain a pouring temperature 100° C. higher than this. The experiments were made with a 70-lb. crucible furnace in which the furnace gases passed first through a metal preheating chamber and then around the air supply pipes. For a pouring temperature of 1000° C. yellow brass was melted with an expenditure, per lb. of metal melted, of 1200 B.Th.U. on the basis of six successive melts, 1030 B.Th.U. for 12 melts, and 960 B.Th.U. for 20 melts. With a pouring temperature of 1000° C. the loss of zinc from yellow brass by vaporisation could be reduced to 1.5% (on original zinc), but with a pouring temperature of 1180° C. the loss was about 6%. The lowest losses of zinc appeared to be obtained when a charcoal covering and a small amount of flux were used together.

An "Electric resistance furnace for melting in crucibles," devised by Dr. H. C. Greenwood and Dr. R. S. Hutton, was described by Dr. HUTTON. The furnace was constructed of sixteen upright carbon rods, 1 in. diam. and 19 in. long, arranged in a 13 in. circle and connected in series, by graphite blocks, alternately at top and bottom, to form two opposite pairs of eight rods each. A mixture of carborundum, fire-sand, and sodium silicate was pasted round the rods. The heat insulation consisted entirely of kieselguhr, but a better system would be a ring of carborundum bricks encircling the carbon rods and outside this an inner layer of fire-sand, and an outer layer of kieselguhr. The furnace was designed primarily for melting nickel-silver, and a test run of two heats (3 hours and 1 hr. 35 min. respectively; charge 90 lb.) indicated that with five heats per day, starting cold, the energy consumption would be 42.5 kilowatt-hours per cwt., corresponding to a cost of 2s. 8d. per cwt. with power at 0.8d. per unit. The thermal efficiency of the furnace was about 22%, as compared with about 6% for a gas-fired furnace, and the new plumbago crucible showed practically no change in appearance after several heats.

A paper entitled "Ideals and limitations in the melting of non-ferrous metals," by Mr. C. HERING, was read by the Secretary, Mr. Shaw Scott. The paper summarised the principles underlying the best possible conditions for the melting of metals—chiefly from the standpoint of the thermal

engineer—and indicated the directions in which progress might be made and the limitations imposed both by theory and practice.

The Secretary also read a paper by Mr. H. S. PRIMROSE, on "Metal melting in a simple crude oil-furnace." The furnace, the whole of which was above the floor level, consisted of a rectangular box of mild steel plates bolted together, lined with firebrick set in ganister so as to form a circular well. The bottom of the furnace was in one piece, and oil and air were supplied through a special burner brick which caused the oil spray to spread out in conical form and to enter the furnace with a tangential motion. When low-pressure burners were used, small high-speed electric fans, capable of producing about 12 oz. air pressure (20—22 in. water gauge), could be used to operate four furnaces simultaneously. Under these conditions the oil consumption was slightly more than 2 galls. per 100 lb. of metal melted, and 100 lb. charges of brass could be melted and poured in 35 mins., and 200 lb. charges in 50—55 mins. The furnace could be operated by unskilled labour, was easy to repair, and the pots lasted longer than in gas furnaces.

Mr. H. L. REASON gave a brief abstract of a paper on "Coke-fired furnaces," pointing out that these were more largely employed still than any other type. Furnaces of square section gave lower fuel consumptions than those of circular section and were easier to repair. An average temperature of 1250° C. was obtained in a natural-draught coke-fired brass furnace, and a temperature of 1600° C. was attainable. The melting loss averaged 5%, chiefly zinc. The greatest drawback to coke furnaces was the trouble due to clinkering, but considerable improvement in this respect had resulted from the use of furnace bottoms of the types devised by Hall (Eng. Pat. 4991 of 1915; this J., 1916, 426) and by Wigley (Eng. Pat. Appl. No. 7431 of 1916), in which loose fire-bars were mounted in a frame so that air could enter at the sides above the bars as well as up between the bars. In the event of the bars becoming choked, sufficient air could enter from the sides to ensure proper combustion, and the loose bars could be readily removed through an opening in front of the furnace.

A brief description of a "Producer-gas-fired crucible furnace" was given by Mr. T. TEISEN. The furnace (see Eng. Pat. 15,887 of 1915; this J., 1917, 36) was similar in principle to furnaces used very successfully for glass-melting in Sweden. The producer is built in the furnace and the gas passes direct to the furnace chamber, of circular section, containing six crucibles. The furnace gases are utilised to preheat the secondary air by the continuous recuperative system, the recuperator being constructed of firebrick tubes, of rectangular section, and so shaped that when assembled, conduits for the air are formed between the tubes. In a similar furnace for melting glass, using wood as fuel, the air was preheated to 1010—1060° in this way. For metal melting it had been found that the furnaces were economical in regard to fuel consumption, and the life of the crucibles was increased, and the metal loss reduced in comparison with furnaces fired with solid fuel.

Sir T. K. ROSE said that the advantages of gas firing seemed to be generally admitted. It was unfortunate that the papers afforded no data for a direct comparison of the relative efficiencies of high- and low-pressure gas. Some of the figures given on the one hand by Mr. Hocking, and on the other by Mr. Walter, would appear to indicate that no advantage as regards gas consumption was gained by using high-pressure gas for the metals of relatively low melting point.

Dr. R. S. HUTTON said that Mr. Hocking's record of results over a long period was very valuable.

He knew of no similar record from other sources. The record showed that gas firing had passed from the experimental to the commercial stage, but he wished to warn the gas interests that if continued and general success was to be achieved, there must be a regular supply of gas of uniform quality and pressure, and furnaces must be designed to permit of easy control and operation by untrained workmen. He could confirm Messrs. Thornton and Hartley as to the considerable economy of gas consumption resulting from preheating the metal.

Mr. H. J. YATES confirmed Mr. Walter's statements as to the value of using air under pressure. With gas at ordinary pressure and air at 3 lb., he had obtained gas consumptions of 5.8–6.7 cb. ft. per lb. of metal melted for cupronickel, 2.9–3.5 cb. ft. for brass, and 1.8 cb. ft. for copper. With careful management it should be possible to obtain 80 heats per pot.

Mr. L. C. HURVEY said that a good practical test of the satisfactory working of a gas furnace was to have a damper in the flue and a small hole in the furnace cover, when so long as a small flame burned at this hole, they could be sure that the furnace atmosphere was reducing. A trustworthy comparison of gas, oil, and coke-fired furnaces could be made only if each type were used under the requisite conditions for obtaining maximum efficiency, and he considered that neglect of this consideration detracted from the value of the comparative figures given by Mr. Brook in the first part of his paper. The double-jacketed tilting furnace, with the outer jacket cooled by air, which was capable of taking 6 cwt. charges and was poured direct, had proved of great value recently, owing to the saving of labour it allowed, and it might be said to have saved the situation so far as the output of brass for munitions of war was concerned.

Dr. W. ROSENHAIN thought that the high efficiency claimed for gas-fired in comparison with coke-fired furnaces was rather surprising, having regard to the fact that the solid fuel had first to be converted into gas. Was it not probable that the results were due partly to the low efficiency of existing coke furnaces, and that the latter might be improved, so as to give much higher efficiencies? Little regard was at present paid to the thermal conductivity of furnace materials, although a considerable proportion of the total heat was consumed in heating the furnace itself. It was possible to reduce the loss of heat from the furnace, but then the temperature of the inner wall increased, and the life of the furnace lining was diminished. This pointed to the need of research in regard to refractory materials. In many cases, at present, the practice appeared to be to avoid the problem of suitable refractory materials by air cooling the outer wall of the furnace. In pit furnaces there might be considerable loss of heat by conduction through the earth, and it was probable that the efficiency would be increased by interposing an insulating layer between the furnace and the earth. He could confirm Mr. Hocking as to the value of applying a carborundum wash to furnace linings. In coke-fired pit-furnaces it was a question of heat loss by conduction versus loss by radiation. With progressively increasing thickness of the wall of the furnace, the loss of heat was first reduced, but subsequently again increased owing to increased loss by conduction. It was surprising that furnaces fired direct with gas from a producer built in the furnace had not been adopted to any considerable extent for the melting of non-ferrous metals, having regard to the high value of such furnaces in the steel and glass industries. The continuous recuperative system of utilising the heat of furnace gases possessed many advantages over the discontinuous regenerative system, the chief disadvantage being the higher

cost of repairs. Electric furnaces were likely to become of steadily increasing importance in view of the increasingly stricter requirements as to purity of metal and accurate control of temperature and furnace atmosphere. In a gas furnace the atmosphere was of necessity non-homogeneous, or it would be explosive; hence it was reducing in some places and oxidising in others. The induction type of electric furnace appeared to be the most promising, for in this type the heat was generated in the metal itself.

SIR GERARD MUNTZ stated that as compared with figures of 10, 12, and 25% which had been mentioned for metal losses in melting, he considered that an average of 14% was high enough for coke-fired furnaces. One of the greatest difficulties in melting metals was the absorption of gases, leading to unsound castings. Research was needed in regard to the absorption of gases by brass, bronze, copper, and cupronickel; it was probable that different metals absorbed different gases and at different temperatures. He agreed with Dr. Rosenhain that the electric furnace would be used to an increasing extent in the future, its great advantages being the ease of control of temperature, the freedom from deleterious gases, and freedom from dirt.

Mr. H. HARTLEY said that the great differences between the results of special tests and of ordinary working in the factory indicated that efficient control of the operation of the furnace was essential. Probably better results would be obtained with furnaces of smaller size; the number of heats would be increased and this would result in a higher over-all thermal efficiency.

Mr. C. W. SPEERS pointed out that at the present time the economical use of crucibles was of special importance, as the most important material used in their manufacture came from abroad. He would advocate the payment of a bonus to workmen for all heats above a given number obtained from one crucible. The life of a crucible could be prolonged considerably by leaving the gas on whilst pouring. He also referred to an electric furnace in which the crucible itself was used as a resistance-heater (see Eng. Pat. 21,626 of 1912; this J., 1913, 1019).

Mr. S. BRAYSHAW said that in ordinary works practice, over a period of 18 months, nickel had been melted as a cost of 1s. 9d. with gas as compared with 4s. 2d. with coke. He had obtained a temperature of 1800° C. in a gas furnace with gas and air preheated, the air being at 2 lb. pressure. He thought that in the case of gas furnaces the future would lie with those using low-pressure gas and air at a few oz. (not more than 12 in. water gauge) pressure.

Mr. BARTLEY pointed out that the efficient operation of furnaces depended largely on the workmen. There were two possible lines of advance; one by raising the workmen to a higher level by training, and the other by seeking to improve mechanical devices and so eliminate the human element as far as possible.

Prof. T. TURNER expressed the opinion that the heat losses were mostly up the chimney. The volume, temperature, and composition of the chimney gases must be known and controlled. He had found that for melting a few lb. of metal in the laboratory, good results were obtainable with a simple electric furnace consisting of two carbon bars, about 3 in. thick, between and in contact with which was fitted a dish made of a mixture of clay with one-third of its weight of ground retort carbon; the carbon bars did not get very hot and hence did not burn away.

Mr. A. G. ROXBURGH gave several instances of the successful use of gas-fired furnaces. In one case in which swarf, sweepings, etc., were melted in a 12-cwt. pot, the gas consumption was 12–14

cb. ft. per lb. of metal melted. This high result was found to be due to the combustion space being too large, and by suitably modifying the furnace the gas consumption was reduced to somewhat more than 5 cb. ft.

Other papers were read in addition to the contributions to the discussion on metal melting.

Mr. O. W. ELLIS read a paper, "The general properties of stampings and chill castings in brass of approximately 60/40 composition," and a note on the "Machining properties of brass." It was shown that in finished brass stampings (Cu 55—65%) the Brinell hardness was inversely proportional to the copper content. There was no simple relation between the time of machining and the copper content or Brinell hardness. Annealing subsequent to stamping was desirable to obtain uniformity. A temperature below 650° C. was better than one above 650° C. for annealing. In practice it had been found that cold-rolled brass rods with a Brinell hardness of 140 could be machined almost as easily as stampings with a Brinell hardness of 70, and Mr. Ellis suggested an explanation of this difference based on the microstructure.

Prof. T. TURNER pointed out that the direct linear relationship between the Brinell hardness and the copper content was true only over a very limited range and when no impurities were present.

Dr. W. ROSENTHAL said that the hardness of cold-worked metals was largely strain-hardness, which differed from structural hardness in that it was anisotropic, *i.e.*, it was different in different directions. This might account for the different machining properties of cold-rolled rods and stampings. Strain-hardness might be removed by the local softening due to heat developed by the point of the tool.

Mr. J. H. ROBINSON stated that the results of Mr. Ellis were very valuable technically, in that they showed that to obtain the best results in regard to mechanical, physical, and machining properties, it was necessary to keep as closely as possible to the 60 : 40 composition for brass.

Dr. S. W. SMITH read a paper on "Surface tension and cohesion in metals and alloys," which was discussed by Sir T. K. Rose and Dr. F. C. Thompson.

A note by Dr. R. Seligman, entitled "Aluminium production by electrolysis; a note on the mechanism of the reaction," was taken as read. In this note it was pointed out that the view generally held that carbon monoxide was the sole gaseous product of the reduction of alumina by the electrolysis of a fused mixture of cryolite and alumina with a carbon anode, was incorrect. In laboratory experiments reproducing the conditions of large-scale practice, gases containing more than 3 vols. of CO₂ to 1 vol. CO had been obtained. To obtain comparable results in laboratory tests, the furnace should be heated independently and not by the current used for electrolysis, as in large scale work, because the heat loss was relatively much greater from small than from large furnaces. The consumption of anode carbon in works practice was considerably lower than was theoretically possible if carbon monoxide was the only gaseous reaction product. It was suggested that the primary gaseous product of the electrolysis was oxygen, and that whether oxygen, carbon dioxide, or carbon monoxide resulted was dependent upon such factors as temperature, current density, physical properties of the carbon anode, and rapidly with which the gases were removed.

Dr. F. C. Thompson read a paper on the "Annealing of nickel-silver (Part II.)." (For Part I., see this J., 1916, 472.) He described tests

made with an alloy containing Cu about 60, and Ni 10%, prepared under works conditions. The mechanical properties were ascertained by means of Arnold's alternating stress tester, which had been found of great value for non-ferrous metals as well as steel. When close annealed in iron pots at 800° C., the alloy had the maximum ductility after 5 hours, and satisfactory results were obtained after annealing for a shorter period even than this. The alloy melted in clay crucibles proved superior to that melted in plumbago. Ductility and toughness were improved by deoxidising with cupromanganese. Tempering and quenching experiments carried out in connection with the transition point which had been observed at 300°—400° C. in nickel-silver, gave results from which it was concluded that nickel-silver which has been annealed at 700° C. until equilibrium has been established, will consist of: (a) a stable B form when very slowly cooled, (b) a metastable A form when very rapidly cooled by quenching, or (c) a mixture of A and B when cooled at an intermediate rate. The A and B forms are soft and ductile, whereas mixtures of A and B are relatively harder and brittle. The B form may be regarded as analogous to fully annealed pearlite in steel, the A form to austenite, and mixtures of A and B to hardenite or troostite or sorbitic forms.

Research work on the simpler nickel-silvers might throw light on the nature of the hardening of steel.

Industrial Notes.

INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

THE International Catalogue of Scientific Literature is an outgrowth of the Catalogue of Scientific Papers published by the Royal Society of London. The Royal Society has issued twelve large quarto volumes giving the titles of papers published from 1800—1883, arranged under authors' names, and is now completing the author catalogue for the nineteenth century by issuing a series of volumes containing the titles of papers published in the years 1884—1900. Three of these volumes, containing authors' names from A to H, are already published. A subject index for all papers published from 1800 to 1900, each volume dealing with a separate science, is also in preparation by the Royal Society, the volumes for Mathematics, Mechanics, and Physics having been published. An absolutely complete record of the scientific literature of the nineteenth century will thus be available.

The continuance of such work into the twentieth century was obviously beyond the resources of a single society and demanded international co-operation. After lengthy preliminary discussions a conference was held in London in 1896 at which it was resolved unanimously to compile and publish a complete catalogue of scientific literature arranged according both to subject matter and authors' names, the preparation being commenced from January 1st, 1901.

The material for the catalogue is collected in the various countries by local organisations established for the purpose and generally State-aided. The final editing of the material for printing and publication is done by a Central Bureau in London directed by an International Council.

Dr. H. Forster Morley has throughout acted as Director of the Central Bureau. Seventeen branches of science are included in the scheme,

an annual volume being published for each. The entries in the subject index are in one of the following five languages: Latin, English, French, German, and Italian. In the authors' index the title in the original language is given followed by the translation into one of the above languages. The scope of the Catalogue comprises all original contributions, whether published in scientific or trade journals or as independent pamphlets or books, but not patents.

The object of this note is to make the Chemistry volume better known to industrial chemists, to which end the scheme of arrangement will be described. A separate volume with the reference letter D is issued for Chemistry, though chemical papers having special reference to other sciences are also included in the volumes for these sciences. The authors' index requires no explanation, though the fact that key numbers are attached to each paper gives some clue to the subject matter over and above what can be deduced from the actual title.

The subject index is classified under a novel system based in reality on that adopted in most text books. Key numbers are given to each section, a schedule of classification being printed at the beginning of each volume. The primary divisions are the specific chemistry of the elements, 0100; organic chemistry, 1000; analytical, 6000; industrial, 6800; theoretical, 7000; physiological, 8000; and agricultural chemistry, 8500. The object of the system, which is in reality very simple when mastered, is that a single section will give the user references to all the literature in the field, whereas numerous references to an ordinary subject index would be required, and even then important papers might be overlooked owing to their having non-descriptive titles. A worker in any subject will remember his particular key number without difficulty and at once find the pertinent pages in the catalogue. A good example of the time saved is afforded by the carbohydrate section. The 1913 issue of the Catalogue refers to 153 papers under the key numbers 1800—1850, classified on 5 pages, to find which probably one hundred different references in the annual index of this journal would be necessary.

Each element receives a key number, but they are arranged in the usual sequences: every paper in which reference is made to this element is collected under this number. Thus a worker interested in phosphorus compounds will find all the entries relating to it under 0570 and further that the papers within the section are subdivided under general, atomic weights, compounds, phosphides, hydrides, oxides, phosphoric acid, sulphides. The organic section is divided into hydrocarbons 1100, alcohols 1200, acids 1300, aldehydes 1400, ketones 1500, amino compounds 1600, azo compounds 1700, each section being further sub-divided into 10 paraffins, 20 unsaturated open chain, 30 benzenoid, 40 reduced benzenoid and cyclic derivatives.

The analytical and industrial sections are subdivided arbitrarily on lines very similar to those adopted in our abstracts, but the recollection of the key number very much facilitates reference. The physical section is sub-divided in considerable detail, and nowhere else are the references to this subject so complete. It should be emphasised that the key numbers are attached by experts who read the original papers, so that a vast amount of information is indexed to which the original title of the paper would give no clue.

The Catalogue forms by far the quickest and at the same time completest form of reference in any branch of chemistry, and it may be commended to manufacturers as likely to save a considerable amount of time when the literature has to be consulted.

The Catalogue is published in London by Harrison and Sons, St. Martin's Lane, W.C., the cost of the Annual Volume being 37s. 6d. Vol. XIII, of section D was published in November last, and contains the material received from September, 1914, to September, 1915. E. F. A.

WAR MAKESHIFTS IN GERMANY.

No one who has had the opportunity of reading the German chemical journals which have been issued since the outbreak of the war can fail to have been struck by the way in which they have served as a focus for the German characteristics of forethought and resourcefulness. Most of the national wants have been foreseen long before they occurred, and whenever it has been possible the chemist has found a substitute, although not always an efficient one.

Many of the devices which have been suggested or adopted have been mentioned from time to time in this Journal, but in most cases incidentally, and in connection with other questions, and a short summary of the steps which Germany has taken to meet some of her most pressing needs may therefore prove of interest.

Early in 1914 Germany foresaw that the struggle upon which she had then determined would be essentially a petrol war, and that every gallon of petrol would be required by her fighting services, and so the outbreak of the war found all the motor vehicles in Berlin, down to the taxi-cabs, provided with engines adapted to consume either petrol or alcohol. As some difficulties were experienced in using alcohol by itself, systematic experiments were made with mixtures of alcohol with benzene and other hydrocarbons, and the formulae giving the best results were published in the chemical journals.

The first plant for the fixation of nitrogen from the air was established in Germany not many months before the war, and at the present time the bulk of the nitrates required for the manufacture of her explosives is derived from that source. Nor is this the only direction in which nitrogen obtained from the air has been utilised. With the increasing strictness of the British blockade it became essential to discover a substitute for nitrogenous feeding-stuffs for horses and cattle, about 500,000 tons of which had been imported prior to the war. To meet this deficiency it was suggested to the authorities that a special yeast, which had a vigorous growth, but produced no alcohol, should be cultivated and pressed on a large scale. This work has been carried out under the direction of the Institute of Brewing in Berlin. Enormous shallow tanks, like swimming baths, have been erected, and in the bottom of these are fitted pipes to maintain the optimum temperature for the growth of the yeast, which is cultivated in a medium prepared from refuse material from the sugar works mixed with suitable salts, including ammonium salts obtained synthetically from the air. The compressed yeast is stated to be suitable not only as a nitrogenous fodder, but also for human food. It is estimated that before long Germany will be in a position to obtain from this source the whole of the nitrogenous fodder she requires, and that she will never again be dependent upon the outside world for her supplies.

In connection with feeding-stuffs it is significant that attention should at once have been directed to the utilisation of kitchen refuse. Within two months after the outbreak of the war a notice was issued by Prussian municipalities that all householders were required to sort their kitchen refuse. All fatty material was to be kept separate, whilst the vegetable material was to be saved for fodder.

As subsequently organised, more especially in the larger towns, it was prescribed that the fatty material should be taken to specified soap works, where the glycerin was to be separated and the soap returned to the householder. No one is allowed to make any soap privately.

One difficulty in dealing with the vegetable matter was the necessity of drying it quickly to prevent putrefaction, and it was suggested that the waste heat of the gas works should be utilised in this way, although subsequent issues of the journal do not state whether this has been done. Still more recently attention has been directed to the annual loss of potatoes by disease, and it is suggested that frost-bitten or diseased potatoes should be dried and used as an ingredient of fodder, or that they should be used in the preparation of starch. Whilst Germany has been making use of kitchen refuse in this way for over two years it is only within the last month that any proposal to prevent this loss in this country has been put forward.

The lack of oils and fats has been Germany's greatest difficulty and she has only been able to supply her wants of nitroglycerin at the expense of the health of the community. Hence the chemical papers have constantly published the results of the analyses of little-known home-grown seeds, which have never before been regarded as possible sources of oil. It has been shown that asparagus and other vegetable seeds contain a considerable proportion of oil, though it is doubtful whether they would repay the labour of extracting it. In two cases, however, the suggestion of the chemist has borne fruit. Horse-chestnuts are now systematically collected both for the separation of the large amount of oil which they contain, and for the preparation of a saponin extract to take the place of soap; whilst in Southern Germany the National Women's Guild has made itself responsible for the collection of the enormous quantities of cherry stones, which were previously thrown away. These are crushed and the kernels separated by an ingenious method of treatment with a solution of a salt of such specific gravity that the kernels float on the surface while the shells sink. The kernels are then dried and the oil expressed in the usual way. By means such as these Germany has made great additions to her supplies of oils, but the deficiency is too great to be materially alleviated by any device short of the synthesis of fat.

Mention might also be made of the various detailed experiments which have been carried out to discover palatable substitutes for tea, coffee, and cocoa, and of those upon which the composition of the so-called war-bread has been based. In every direction the German places himself in the hands of the expert chemist, and it is only the lack of raw material in certain essential particulars, which has prevented the chemist from solving every material difficulty with which Germany is now face to face.

C. A. M.

POTASH RECOVERY AT BLAST FURNACES AND CEMENT WORKS.

During the last year or two schemes have been put in operation in America for the recovery of potash as a by-product in certain manufactures, such as iron and Portland cement.

As regards the former, an account of what has

been done by the Bethlehem Steel Company was given recently before the American Institute of Mining Engineers by Mr. R. J. Wysor, the superintendent of the blast furnaces. An analysis made five years ago of the fine yellowish fume removed from the bottom of the stove checker-work showed the presence of about 15% of potash soluble in water. Further investigation proved that considerable quantities of the material could be recovered, but the prices offered for it for fertilising purposes did not at that time justify the cost of the operation. But the situation was changed with the rise in price caused by the war, and for some time past the dust has been sold at a good profit. The average potash content in the ore mixture charged into the furnaces is found to vary between 0.27 and 0.29%, the soda ranging from 0.13 to 0.63%, and calculations indicate that for each ton of pig iron produced nearly 60 lb. of the alkali oxides are charged in. Some of this alkali passes out with the gas, some with the slag, and some in other ways. At Bethlehem all the gas for the stoves and boilers, as well as for the gas engines, is washed, except from one furnace, in a tower spray washer, and it might be supposed that practically all the alkaline material in the dust, most of it being readily soluble in water, would thus be removed. In fact, the bulk of it is washed out, but it is remarkable that much of the water-soluble alkali does remain in the gas current leaving the washers, and about 21% of the potash, but apparently only about 5% of the soda, entering the primary washers, passes through them. A possible explanation is that the particles of fume are in such a fine state of subdivision as to escape contact with the relatively large drops of water. The water-soluble content of the dry ignited dust recovered from the stoves and boilers, having previously passed through the wet washers, varies from 5 to 20%. In the period between April 1, 1915, and July 1, 1916, the alkaline dust collected amounted to 36 car-loads with a total weight of 1073 tons, and from it 106 tons of water-soluble potash was obtained. But the amount recovered is an insignificant part of the total potash charged into the furnaces, two-thirds of which, or about 15 lb. per ton of pig iron produced, is lost in the wash-water and stove and boiler-house stacks. With the object of securing higher economy experiments have been carried out with a Cottrell electric dust precipitator, connected to the raw gas main leaving one of the dust catchers. These have shown that practically all the dust and fume entering the treater can be precipitated, and as several samples analysed had a potash content of 10%, the dust leaving the dust catcher is evidently much richer in potash than the relatively heavy particles retained by it. Mr. Wysor expressed the view that in the future dry cleaning will be adopted in many blast furnace plants, with the reclamation of many thousands of tons of potash now lost.

At the Hagerstown works of the Security Cement and Lime Company a Cottrell plant was installed last year for the recovery of potash from the kiln gases by the aid of high-tension current at 76,000 volts. The power supply is three-phase current at 440 volts and 60 cycles, and the electrical equipment consists of four 15 h.p., 10 k.v.a., 220 volt single phase 60-cycle, 1800 r.p.m. motor generator sets, each directly connected to the shaft of a rotary rectifier, and four 220 to 70,000 volt 60-cycle 10 k.v.a. transformers of special construction. The volume of gas handled is approximately 180,000 cub. ft. a minute at a temperature of 900° F., and with two kilns 7 ft. by 100 ft. and three 8 ft. by 125 ft. the production of dust averages from 20 to 25 tons a day of 24 hours. The dust contains from 5 to 10% of potash in the form of potassium sulphate, and is in a very finely divided state.

Correspondence.

DETERRENT TO FLIES.

SIR,

There is a need for a substance slowly vaporisable at 40° to 50° C., in crude form, cheap, soluble in or miscible with water, which will be a deterrent to flies and fatal to maggots, which can be used for rapidly stopping fly-breeding under the circumstances now frequent on the Western front and elsewhere. This is under investigation, with other such problems, and we have ample facilities for testing the deterrent effect on flies and the fatal effect on maggots, of any substance. We have already investigated a large number of pure chemicals and are seeking the basis of correlation between chemical structure and insecticidal action. But, while the theoretical is of interest, it is the immediate practical necessity we are considering, and success will probably lie with some crude product, an intermediate in some organic process, a particular fraction in some distillation, or the like: it may depend for its action on the presence of impurities and we cannot at present indicate any one class of compound likely to contain it. We have tried a series of hydrocarbons, products of mineral oil distillations; thanks to the help of tar and coke oven distillers, we are trying this series of products: it will help greatly if, without application to individual firms, we could manage to get quite small samples of other products likely to be available, even the most wild and unlikely ones. Generally speaking we want products with boiling points between 60° C. and 300° C.; they need not be pure, but it is necessary to know what their main ingredient is; and we want things commercially available in some quantity. That the possible range is wide will be indicated by the fact that such diverse things as oleic acid, ionone, mustard oil, tetrachlorethane, wood creosote, bromoform, phenol, monomethylaniline, crude acetamide, and mesityl oxide, are interesting us. The difficulty is to get what is available and we are anxious to pay for small samples of, say, four ounces of available substances, which might possibly be useful. Will firms able to help send things? Anything sent will be tested and its insecticidal value determined: unless there is any objection, we propose to publish results and obviously we cannot test and report on proprietary insecticides. We would welcome visits from chemists or directors of chemical manufacturing companies, and would gladly show them what is being done. *I think enough has been done to justify the hope that we will find the ideal preventer of fly-breeding*, and if we can do this it will materially help the war and be valuable hereafter: it would assist very materially if we could get the help of the technical knowledge of what is avail-

able, which can only be got if technical chemists and producers will assist us.

Yours very truly, N. MAXWELL-LEFROY.

Imperial College of Science,

South Kensington, S.W.

To the Editor of the

JOURNAL OF THE SOCIETY OF CHEMICAL INDUSTRY.

FLAVINE.

SIR,

With reference to the article on "Flavine and Brilliant Green: new and powerful antiseptics" in the Journal of Feb. 15th, it is rather unfortunate that such a partiality for the name "Flavine" exists. There were already two substances to which this had been applied. Watt's Dictionary indicates that Flavine is β -diaminobenzophenone; in the colour trade, Flavine is understood to mean a certain grade of quercitron bark extract (see Schultz and Julius' Organic Colouring Matters). Now we have the name applied to a third substance.

Yours faithfully, R. A. PHILLIPS.

114, Clements Road, East Ham, E.

To the Editor of the

JOURNAL OF THE SOCIETY OF CHEMICAL INDUSTRY.

Obituary.

CYRIL DOUGLAS McCOURT.

Second Lieut. Cyril Douglas McCourt was born in 1883 and was educated at St. Charles' College, North Kensington, and at the City and Guilds of London Central Technical College, where, after gaining his Diploma in Chemistry, he served for a brief period as Private Assistant to Professor Armstrong.

In 1903 he was appointed Chief Chemist to the Morgan Crucible Company, Ltd., which post he resigned six years later in order to collaborate with Professor Bone (then of the University of Leeds) on the industrial applications of the new principle of incandescent surface combustion, which collaboration speedily resulted in the many important inventions comprised under the "Bonecourt" system of surface combustion. He was subsequently appointed consulting chemist to the Morgan Crucible Company, Ltd., which position he held up to the date of his death.

Shortly after the outbreak of the war he abandoned research work in order to join the Army. He laid down his life whilst gallantly leading, as Bombing Officer, an attack made in France on the night of 8th October, 1916.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each, to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.

United States.—1s. each, to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—

Patent number, date, name of patentee, and title of invention.

French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56, Rue Ferou 8. Paris (3c.)

Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

Chemical engineering equipment; Recent developments in —. H. D. Miles. Amer. Inst. Chem. Eng., Jan., 1917. J. Ind. Eng. Chem., 1917, 9, 161—166.

VACUUM drum dryers are now extensively used. An essential feature of the apparatus is that the

liquid is pumped into a small pan immediately below the drum, so that the latter does not dip into the main body of liquid; difficulties due to agitation and foaming of the liquid are thus avoided. The apparatus may be used for the recovery of dry sulphite waste from the waste liquors of paper pulp mills. An atmospheric drum dryer has been found to yield good

results in drying concentrated sodium benzenesulphonate solution. A new feature in a β -naphthol distilling apparatus is the condensing and receiving system, the vapours being drawn into an air-cooled condenser pipe, which leads into a steam-jacketed three-way valve connected with two receivers. The receivers are used alternately, and each contains a steel box in which the β -naphthol solidifies. A direct-heated shelf retort is made for use in the manufacture of sulphanilic and naphthionic acids, and for the recovery of high boiling solvents from waste; it consists of a chamber provided with heating ducts passing from one side through an opening on the opposite side. The shelves are placed between the ducts, and the retort may be worked at ordinary pressure or under reduced pressure. For the recovery of nitric acid from waste nitrating acids, an apparatus is used in which a strong current of air is passed through the waste acid contained in the retort; the hot gases from the furnace pass through double U-pipes in the retort (these pipes are always covered by the liquid). The vapours leaving the retort are conducted to condensers, and thence to a washing tower where the air is freed from nitric acid vapours. In this apparatus there is no formation of sediment during the distillation.—W. P. S.

PATENTS.

Drying and treating sewage sludge, copra, and other materials in bulk; Apparatus for —. R. H. Annison, London. Eng. Pat. 103,521, Jan. 28, 1916. (Appl. No. 1367 of 1916.)

THE material to be treated falls from a hopper in the top of a casing on to a heated table, over which it is moved by an endless conveyor having scraper plates projecting outwards. The scraper plates may be notched or recessed in irregular order to mix the material. At the further end of the table the material falls on to a second table, over which it is moved by another scraper conveyor, and then on to a third table over which it is moved by the returning portion of the conveyor, the scraper plates projecting on both sides for this purpose. After passing over another pair of tables, if necessary, the material is fed through valves to tubes, troughs, or channels containing spiral conveyors. The tubes may be of fireclay or the like. Hot air is blown in at the bottom of the casing through adjustable louvres or shutters, and passes up in a zig-zag path to heat the tables. (See also Eng. Pat. 12,670 of 1914; this J., 1915, 732.)—W. F. F.

Drying: Method and apparatus for —. J. J. Kruger, Copenhagen. Eng. Pat. 103,621, Sept. 16, 1916. (Appl. No. 13,163 of 1916.)

THE substance to be dried is surrounded by hygroscopic material and placed in a perforated casing of approximately the same shape as the substance to be dried. The perforated casing is surrounded by an outer shell, and a heating medium passed through the space between the casing and the shell causes the evaporation of the moisture absorbed by the hygroscopic material from the substance to be dried without damaging the latter.—W. H. C.

Drying apparatus. E. E. Siler, Assignor to The Universal Drying Machine Co., Chicago, Ill. U.S. Pat. 1,213,962, Jan. 30, 1917. Date of appl., Feb. 15, 1915.

THE material to be dried is moved over a slightly inclined drying bed by a conveyor carrying rotary agitators. The drying bed consists of two superposed members, the lower perforated and the upper having a series of inclined openings registering with the lower perforations and all pointing

in one direction. The material is conveyed over the bed in this direction, and air passes upward through the bed. The apparatus is contained in a casing from which the moist air is withdrawn at the top.—W. F. F.

Annealing furnaces heated by gaseous fuel. Alldays and Onions Pneumatic Engineering Co., Ltd., and P. W. Alldays, Birmingham. Eng. Pat. 103,593, May 18, 1916. (Appl. No. 7117 of 1916.)

IN an annealing furnace having a floor of great strength, the burners are arranged on either side of the furnace chamber, and the waste gases escape through flues arranged on the sides of the hearth below the floor level. The liquid or gaseous fuel and the air are pre-heated by being passed through pipes located in the waste-gas flues.—W. H. C.

Liquid-treating apparatus. A. Jensen, San Francisco, Cal. U.S. Pat. 1,213,879, Jan. 30, 1917. Date of appl., Aug. 16, 1915.

A NUMBER of helical tubes forming an agitator are mounted concentrically on a hollow, rotating, horizontal shaft to which one of the tubes is connected, the others being connected to separate conduits within the shaft. The shaft is journaled in the opposite walls of a casing, and treating liquids may be passed independently through the helical tubes in either direction. Air is exhausted from the casing.—W. F. F.

Vaporising or concentrating liquids, solutions, emulsions, suspensions, and like substances; Method of —. G. A. Krause, Munich, Germany. U.S. Pat. 1,213,887, Jan. 30, 1917. Date of appl., Nov. 29, 1916.

THE finely divided substance is injected upwards into a vertical cylindrical chamber from a nozzle. A heated gaseous drying medium is injected tangentially at the bottom of the chamber so as to pass upwards to the outlet in a spiral path of uniform diameter around the jet of substance to be desiccated.—W. F. F.

Filler mediums; Method and apparatus for cleansing —. A. L. Genter, Salt Lake City, Utah. U.S. Pat. 1,214,152, Jan. 30, 1917. Date of appl., Nov. 5, 1915.

TO facilitate the cleansing and improve the filtering capacity of a filter medium having flexible sides, a rapid succession of impulses is imparted to the opposite sides of the filter medium by directing a current of the liquid to be filtered to one side and of cleansing medium to the other.—W. H. C.

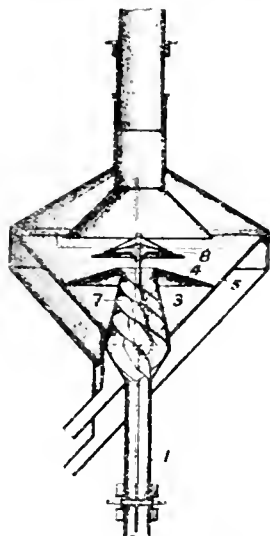
Pressure-filter. W. M. Jewell, Assignor to Jewell Engineering Co., Chicago, Ill. U.S. Pat. 1,214,167, Jan. 30, 1917. Date of appl., June 15, 1914.

PIPES embedded in the gravel below the fine material forming the filter bed, are provided with strainer heads extending downwards, through which water is discharged downwards and laterally, in jets, to wash the filter bed.—W. H. C.

Colloids; Manufacturing —. W. M. Grosvenor, Ridgewood, N.J., and L. A. Beecher, Newtonville, Mass. U.S. Pat. 1,214,299, Jan. 30, 1917. Date of appl., Oct. 7, 1913. Renewed June 30, 1915.

TO preserve the submicroscopic structure of the colloid so that the substantially dry colloid is capable of rapid hydration and dehydration and of rapidly adsorbing dyes, the colloid is first superhydrated and then dehydrated in gradual stages.—W. H. C.

Dust-separator. M. F. Williams, Assignor to Williams Patent Crusher and Pulverizer Co., St. Louis, Mo., U.S. Pat. 1,214,219, Jan. 30, 1917. Date of appl., Feb. 3, 1916.



DUST-LADEN air enters by the pipe, 1, through the enlarged portion, 3, provided with a spiral diaphragm, 7, which imparts a whirling motion to the current, into the chamber, 5. It is then deflected downwards by the baffle, 8, over the spreader-plate, 6.

—W. H. C.

Gases; Separation of — by diffusion. [Preparation of hydrogen from water-gas.] R. Wussow, Charlottenburg, Ger. Pat. 295,465, Apr. 15, 1915.

THE separation of the different components of a gas mixture is brought about by leading the gas over the surface of permeable or absorbing media. These media may be either solid or liquid, and different forms may be used simultaneously to separate the different constituents of a complex mixture: moving permeable surfaces may be used to accelerate the diffusion. The diffused gas may be removed from the farther side of the diaphragm by maintaining a low pressure or by circulating an indifferent gas, such as steam, ammonia, or carbon dioxide, which afterwards can be easily removed by solution or condensation. Diffusion may also take place through several media in succession, each of which causes a partial separation. As an example of the process, using a layer of water as permeable medium, at 0° C. this would absorb 85.2 times as much carbon dioxide as hydrogen, and at 20° C. 19 times as much. A plant has been devised on this principle for the manufacture of hydrogen from water-gas. It is claimed that with water-gas at 3.0 Pf. per cb. metre (0.01d. per cb. ft.), a product containing 99% H₂ can be prepared at a cost of 6.1 Pf. per cb. metre (0.02d. per cubic foot).—J. N. P.

Gaseous mixtures; Separation of the constituents of —. G. Claude, Assignor to Soc. l'Air Liquide (Soc. Anon. pour l'Étude et l'Exploit. des Proc. G. Claude), Paris, U.S. Pat. 1,212,455, Jan. 16, 1917. Date of appl., May 23, 1914.

SEE Fr. Pats. 175,297 and 175,316 of 1914; this J., 1916, 31.

Gases; Purification of —. G. Claude, Assignor to Soc. l'Air Liquide (Soc. Anon. pour l'Étude et l'Exploit. des Proc. G. Claude), Paris, U.S. Pat. 1,212,456, Jan. 16, 1917. Date of appl., June 20, 1914.

SEE Fr. Pat. 471,162 of 1913; this J., 1915, 163. Sodium hydroxide or other suitable substance may be used in place of lime.

Fluid-cooling apparatus. G. H. Walker, Worcester, Assignor to Heenan and Froude, Ltd., Manchester, U.S. Pat. 1,213,042, Jan. 16, 1917. Date of appl., Jan. 11, 1916.

SEE Eng. Pat. 2411 of 1915; this J., 1916, 291.

Separating solids from liquids; Apparatus for —. W. Russell, London, Assignor to The Dorr Co., Denver, Colo., U.S. Pat. 1,214,593, Feb. 6, 1917. Date of appl., Oct. 27, 1916.

SEE Eng. Pat. 11,666 of 1915; this J., 1916, 953.

Raising or forcing liquid; Method of —. H. A. Humphrey, London, Assignor to Humphrey Gas Pump Co., U.S. Pats. (A) 1,214,791 and (B) 1,214,792, Feb. 6, 1917. Date of appl., July 22, 1911. (A) Renewed June 27, 1916.

SEE Fr. Pat. 128,296 of 1911; this J., 1911, 1118.

II A.—FUEL; GAS; MINERAL OILS AND WAXES.

Coke-oven; Occurrences in the — during carbonisation. D. V. Hollingworth, Coke-Oven-Managers' Assoc., Gas J., 1917, 137, 197—198.

THE author refers to the researches of Lomax, Aitken, Bedson, and Wheeler, which indicate that coal is composed of two definite types of substances, one easily breaking up at low temperatures, yielding paraffins, the other requiring a higher temperature yielding principally hydrogen. The former, or resinous, portion produces the caking or fusing properties, and is easily oxidised by exposure to air until it no longer produces a coherent coke. Just at the time when the heat of the oven breaks down the stability of the coke, several important factors come into play and influence the character and amounts of the products formed. If the moisture content is abnormal, the yield of all products is diminished, whilst coal containing much iron will give far less ammonia than one free from iron; the presence of lime has the reverse effect. All iron pyrites should be scrupulously removed from the coal. The nature of the substances produced is largely dependent on the temperature. The valuable products obtained at different temperatures should be withdrawn from the oven as soon as possible. Moisture in the coal plays a great part in modifying the reactions and preventing the destruction of gases first formed. In the absence of the protective action of steam, it has been frequently demonstrated that with high temperatures much of the ammonia is decomposed to cyanogen, and with very high temperatures to free nitrogen. Coal should be used in as fresh a condition as possible, storage bunkers being designed with this end in view, avoiding pockets in which appreciable quantities of slack may remain undisturbed. A minimum amount of sulphur and shale should be ensured by careful attention at the picking belts and washer, the moisture in the slack being brought as near 9% as possible. Intensity of heating should be controlled, and ovens should be raised or lowered in temperature *en masse* and not individually. It is a better plan to raise or lower the gas pressure rather than adjust the gas-cocks, whilst the lowest damper consistent with a clear atmosphere in the flues should be aimed at. Ovens should be well filled with level charges and discharged in regular order. The speed of removal of products from the oven should be controlled by ensuring a regular cooling of the gases, keeping the ascension pipes and mains quite clear, using main governors, levelling the slack, and regulating the vacuum in the mains so as to leave just the slightest pressure on the oven when at the

maximum output. The use of a properly installed gas meter in conjunction with a recording calorimeter is advocated.—J. E. C.

Distillation process in the vertical [gas] retort.
J. N. E. Teune and P. J. Kummel. *Het Gas.*
Gas J., 1917, 137, 248—249, 341—342.

OBSERVATIONS are recorded on the working of intermittent vertical retorts which had been in use for two and a half years at the South Gas Works, Amsterdam. The object was to study the course of the carbonisation process over the whole twelve-hour period, during the last two of which steam is normally blown through the charge. The quantity and quality of the gas made during each hourly period was determined, and also the temperature in the charge at two points, one near the top and the other 45 in. above the bottom. The same coal (Graf Bismarck) was used in all cases. The average gross calorific value of the gas was 558 B.T.U. per cb. ft., and the yield of ammonia 0.301% of the coal or 26.2 lb. of ammonium sulphate per ton. The make of gas was 13,696 cb. ft. per ton. On modifying the process by steaming the charge at a lower pressure but for a longer time—from the end of the fifth to the end of the eleventh hour—the make of gas was slightly raised (13,880 cb. ft.), while the average gross calorific value remained practically the same (554 B.T.U. per cb. ft.). The ammonia yield rose to 0.3607% of the coal or 31.4 lb. of ammonium sulphate per ton. By inserting a pipe from below into the charge, it was possible to examine the quality and condition of the gas at various points in the core during distillation. It was concluded that carbonisation occurs from the wall of the retort inwards, and that the gas ascends in the main along the wall. Only at the beginning of a period does a portion of the gas evolved pass upwards through the core. Afterwards this is arrested by the deposition of tarry matter which chokes the passages through the coal until the later stages.—H. J. H.

Benzol recovery from coal-gas; Physico-chemical considerations on —. T. F. E. Rhead. Midland Jun. Gas Assoc., Jan. 25, 1917. Gas J., 1917, 137, 207—211.

THE author deals with the effect of viscosity, temperature, and composition on the efficiency of creosote as a washing medium for extracting benzol from coal gas. In the case of washable products of coal gas dissolved in creosote, each dissolved body exerts a fraction of its own maximum vapour pressure equivalent to the percentage in which it occurs in the creosote. From a series of vapour pressure curves given, the percentage of these constituents which the gas could carry if saturated may be ascertained. From further data the author deduces the fact that creosote can remove the toluene from 3.55 times the quantity of gas which saturates it with respect to benzene, and solvent naphtha from 10.7 times the same amount. The effect of temperature on the rate of solution, using 100 and 50 galls. of creosote per ton of coal respectively, is shown in a series of curves. A suitable wash oil for benzol extraction should not give off any large proportion of light oils when steam distilled, must take up heat quickly and cool quickly, must flow or spray readily at the washing temperature, must not emulsify with water, and must not give up naphthalene to the gas. The influence on viscosity of various factors is indicated by curves, showing effect of temperature, naphthalene content, distillation tests, etc., and the author sums up his observations in the following conclusions:—(1) Efficiency of washing is improved by using a cold oil. (2) The lighter oils in creosote help the

washing process by lessening the viscosity, but are readily distilled out by steam and contaminate the benzol. (3) Naphthalene tends to lower the viscosity but under certain conditions may pass into the gas. (4) Creosote fractions boiling above 300° C. greatly increase the viscosity. (5) A good creosote should be as fluid as possible at 10° to 15° C., give little oil distillate when steam distilled, and contain a minimum amount of naphthalene. (6) Much improved cooling is obtained by using a creosote of which the viscosity rises very little when cooled to 10° to 15° C., and the benzolised oil is more readily heated. (7) Efficiency of washing is improved by increasing the intimacy of contact between oil and gas. Washers on the spraying or atomising principle appear to offer the best field for development in this direction. (8) Specific gravity is no criterion as to whether a mixture of blast-furnace and coal-tar creosote is "spent" or not, viscosity being the best test. (9) Sufficient creosote should be in circulation to prevent the removal of light oils leaving a creosote of high viscosity.—J. E. C.

Oil-washing for [recovery of] benzene and toluene [from coal gas]. W. G. Adam. Gas J., 1917, 137, 343—344.

THE oil-washing of town gas by the Gas Light and Coke Co., London, was commenced in 1913, and its retention as a permanent feature of gas manufacture is favoured, in the interest of the maker and consumer of gas and of the conservation of national resources. While the benzol present in town gas furnishes about 50% of the illuminating power, it supplies only about 5% of the calorific power, and the former is no longer regarded as of prime importance. 1000 cb. ft. of gas sold at 2s. 6d. contains the vapours from about 2 gallons of benzol, having a sale value of about 2 shillings as a liquid fuel. The author holds that it should be sold as such, and any enrichment of the town gas stripped of benzol, when necessary, should be made by oil gas from cheap gas oil. Of the sulphur compounds left in the gas after oxide purification, oil washing removed a considerable proportion, leaving about 20 grains per 100 cb. ft. The naphthalene content could also be reduced to about 4 grains per 100 cb. ft., at which no distribution troubles were experienced. A "green oil" with sp. gr. 1.098, and yielding 80% of distillate up to 371° C., is recommended as wash oil. By using it, "strong" benzols could be produced, requiring a smaller quantity of sulphuric acid and soda than usual in the washing process. The following method of testing the benzol is recommended:—1000 c.c. of the sample is distilled up to 175° C., a fractionating column being used. The residue is creosote. After washes with alcoholic caustic soda, strong sulphuric acid, and water, the distillate is dried over calcium chloride and refractionated at the rate of 1 drop per second, an 8-bulb Young and Thomas column being used. Fractions are collected, (a) up to 85° C., (b) 85°—105°, (c) 105°—115°, (d) 115°—165° C. The specific gravities of fractions a, b, and c, when paraffins are absent, are 0.883, 0.878, and 0.868 respectively. If lower, a correction for paraffins can be applied according to the differences observed. The quantity of benzene may be taken as $a + \frac{1}{2}b$, toluene as $\frac{1}{2}b + c$, and solvent naphtha as equal to d.—H. J. H.

Calorific power of gas; Measurement of the —. Official method used by the Paris Municipality.
L. Girard and P. Lauriol. Gas J., 1917, 137, 202—205.

A FULL description of the apparatus, methods, and calculations adopted by the Services Généraux d'Éclairage of Paris for the calorimetric testing

of town gas is given. The two following formulae are used:—

$$C_1 = \frac{P(T_s - T_e)}{V} \text{ and } C = \frac{P(T_s - T_e)}{V} - 4.94p,$$

in which C_1 and C are the gross and net calorific values respectively, V is the volume of gas (in cubic metres) burnt in test, P is the weight of water (in kilos.) passing through the calorimeter during the test, T_e and T_s (in degrees C.) are the temperatures of water at the inlet and outlet of the calorimeter, and p is the quantity of water (in grms.) condensed during passage of 120 litres of gas. The figures are corrected for moisture in the gas and for error in the meter. Special precautions are taken to ensure the sample of gas being taken from a large volume of gas in the main, to keep the water used at the temperature of the town supply, and to keep the temperature of the testing room constant during the test. A typical schedule of a test with all the necessary corrections is given, and also of tests for checking the meter and thermometers.—J. E. C.

Mineral lubricating oils; Apparatus and method for testing the emulsification of—P. H. Conradson. Amer. Soc. for Testing Materials, June, 1916. J. Ind. Eng. Chem., 1917, 9, 166—167.

To determine the emulsification and demulsification values of lubricating oils (see Philip, this J., 1915, 697) 20 c.c. of water and 100 c.c. of the oil to be tested are placed in a 250 c.c. cylinder having an internal diameter of about 1½ in. Steam at ordinary pressure is passed into the mixture through a tube reaching to the bottom of the cylinder, and the churning with steam is continued for 15 mins. after the temperature of the mixture has reached 200° F. (93° C.) or when steam as such escapes from the cylinder. The cylinder is then immersed for 1 hour in water at 130° F. (54° C.) and its contents are examined for the following: (1) The volume of separated clear or turbid water; (2) the volume of separated emulsified layer (an indication of the emulsion-forming property of the oil); (3) the volume of clear separated oil (percentage of demulsification); (4) the percentage of moisture in the separated oil; this quantity should be deducted from the demulsification value.—W. P. S.

Possible partial substitution of nitre cake for sulphuric acid in the manufacture of sulphate of ammonia. Parrish. See VII.

Black damp in mines. Burrell and others. See XIXB.

PATENTS.

Coke-oven. L. Wilputte, New Rochelle, N.Y. U.S. Pat. 1,213,988, Jan. 30, 1917. Date of appl., June 19, 1916.

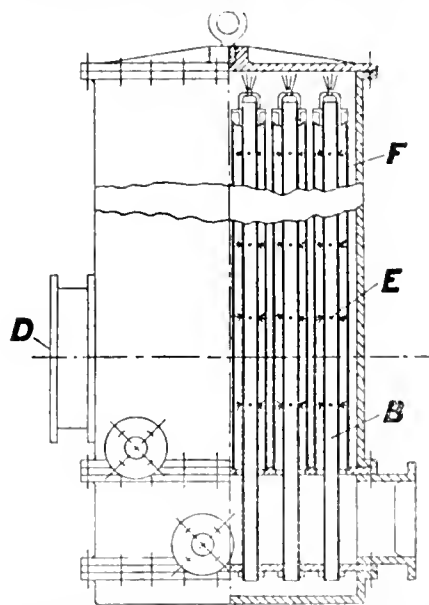
A COKE-OVEN structure is formed with vertical heating flues communicating with a horizontal passage at their upper ends, the openings in which are regulated by pairs of hinged dampers which may swing into position so as to meet edge to edge. The edges of the dampers are provided with registering notches to form a communicating passage when in closed position.—W. F. F.

Generators for suction gas and the like; Shells of—A. R. Bellamy and C. James, Grantham. Eng. Pat. 103,529, Feb. 2, 1916. (Appl. No. 1576 of 1916.)

The lower parts of the shells or casings of the different elements in plant for manufacture of suction gas and the like, are constructed of an outer casing and an inner metallic lining of somewhat less dimensions. The space between the two is filled with cement or the like.—J. E. C.

Gas cooler and washer. J. E. Christopher, Wigan. Eng. Pat. 103,561, Mar. 27, 1916. (Appl. No. 4487 of 1916.)

A COMBINED gas cooler and washer consists of a group of washing units, each unit consisting of a pair of concentric tubes, B and F. The inner tube,



B, is supplied with cooling liquid, which passes through apertures, E, and serves as washing medium in the concentric space. The outer surface of these units is also sprayed with the liquid to increase the area of cooling surface. The gas is subdivided into thin films in the concentric spaces, which are arranged so that their total area approximates to the area of the gas inlet, D. —J. E. C.

Aromatic bodies and gas; Process for the production of—from petroleum oils. F. W. Mann and M. L. Chappell, Berkeley, Cal., Assignors to Standard Oil Co., Richmond, Cal. U.S. Pat. 1,214,204, Jan. 30, 1917. Date of appl., Feb. 3, 1916.

PETROLEUM oils containing oils of the carbocyclic series are dehydrogenated under a pressure of 1 to 4 in. of mercury below atmospheric and at temperatures of 600°—750° C., in the presence of 500—800 cu. ft. of air for each 15—20 galls. of oil and also a contact substance such as the lower oxide of nickel.—W. F. F.

Conveying charges of material from one level to another. [Transferring coke from gas retorts to gas producers.] A. E. White, London. From Riter-Conley Manufacturing Co., Leedsdale, Pa., U.S.A. Eng. Pat. 103,697, Feb. 9, 1916. (Appl. No. 1928 of 1916.)

Pulverised fuel; System for feeding—V. Z. Caracristi, Albany, N.Y., Assignor to Locomotive Pulverized Fuel Co. U.S. Pat. 1,214,753, Feb. 6, 1917. Date of appl., Oct. 4, 1913.

SEE Eng. Pat. 13,067 of 1915; this J., 1917, 200.

Producer or other gas; Process for the treatment and recovery of tar and ammonia liquor from—Q. Moore, Glasgow. U.S. Pat. 1,215,300, Feb. 6, 1917. Date of appl., Jan. 26, 1915.

SEE Eng. Pat. 2650 of 1914; this J., 1915, 131.

Petroleum and other liquids ; Process and apparatus for distillation and fractionation of—. H. L. Burleson, San Francisco. and P. W. Prutzman, Santa Maria, Cal., U.S.A. Eng. Pat. 103,710, Feb. 18, 1916. (Appl. No. 2455 of 1916.)

SEE U.S. Pat. 1,180,237 of 1916 ; this J., 1916, 626.

Motor fuel ; Production of—suitable for use in high speed internal combustion engines. W. A. Hall, London. Eng. Pat. 103,720, Mar. 4, 1916. (Appl. No. 3302 of 1916.)

SEE Fr. Pat. 481,066 of 1916 ; this J., 1917, 127.

Separation of gases by diffusion. [Preparation of hydrogen from water-gas.] Ger. Pat. 295,463. See I.

IIb.—DESTRUCTIVE DISTILLATION ;
HEATING ; LIGHTING.

PATENT.

Centrifugal separator [for removing tar and oils from wood distillation vapours]. E. H. French, Smethport, Pa. U.S. Pat. 1,212,473, Jan. 16, 1917. Date of appl., Nov. 2, 1910.

SEE Ger. Pat. 294,333 of 1911 ; this J., 1912, 914.

III.—TAR AND TAR PRODUCTS.

Wood-tar pitches ; The free carbon of—. H. K. Benson and L. L. Davis. J. Ind. Eng. Chem., 1917, 9, 141.

ACETONE is suggested as a solvent in the determination of free carbon in wood-tar pitches ; carbon bisulphide is unsuitable for the purpose. In the following table are given the solubilities of different bitumens in acetone and carbon bisulphide respectively ; in each case, the residue insoluble in one solvent was again extracted with the other solvent :—

	Insoluble in carbon bisulphide.		Insoluble in acetone.	
		Residue insoluble in acetone.		Residue insoluble in carbon bisulphide.
	%	%	%	%
Douglas fir pitch	67.7	59.7	57.7	57.8
" " "	62.5	30.1	31.6	31.1
" " "	93.1	35.3	34.6	34.4
" " "	60.2	22.0	21.5	21.3
Hard wood pitch	18.7	3.1	2.9	2.7
" " "	59.9	18.0	17.5	17.4
Coal tar "pitch" ..	27.4	27.4	57.5	27.1
" " " "	18.4	18.0	35.3	18.5
" " " "	22.7	22.6	37.1	22.3
" " " "	17.4	17.1	33.0	16.9
Petroleum asphalt	4.1	4.0	27.1	3.9
Trinidad asphalt	42.6	42.1	69.0	41.8

Coal-tar pitches may be classed with the native and manufactured asphalts as regards the determination of free carbon.—W. P. S.

Phenols ; Identification of—. *Studies in identification.* II. E. E. Reid. J. Amer. Chem. Soc., 1917, 39, 304—309.

p-NITROBENZYL bromide reacts readily and quantitatively with alkali phenoxides, with the formation of stable nitrobenzyl ethers, which are readily purified by crystallisation from dilute alcohol and are suitable derivatives for the identification of phenols. The reaction is carried out by boiling in 95 % alcoholic solution on the water-bath for one hour

a molecular proportion of *p*-nitrobenzyl bromide with an excess of phenol and a molecule of sodium hydroxide. Water is then added to dissolve the sodium bromide, and the ether crystallises out on cooling. For the *p*-nitrobenzyl ethers of the following phenols the melting points are as given : Phenol, 91° C. ; *o*-cresol, 89.7° C. ; *m*-cresol, 51° C. ; *p*-cresol, 88° C. ; thymol, 85.5° C. ; eugenol, 53.6° C. ; and vanillin, 124.5° C.—G. F. M.

Sulphonic acid groups in aminosulphonic acids ; Displacement of—by halogen atoms. J. J. Sudborough and J. V. Lakhumalani. Chem. Soc. Trans., 1917, 111, 41—50.

SULPHONIC acid groups in the ortho- or para-positions but not in the meta-position to an amino-group are quantitatively displaced by halogen elements when these are presented to the substance in aqueous solution in the case of bromine, in glacial acetic acid with chlorine, or as iodine monochloride. Thus 2,6-dibromosulphanilic acid gave with bromine, sulphuric acid and *s*-tribromoaniline, and a similar result was obtained with 4,6-dibromoaniline-2-sulphonic acid. Iodine monochloride gave with these acids 2,6-dibromo-4-iodoaniline, and 2,4-dibromo-6-iodoaniline respectively. Chlorine gave a mixture of chlorodibromoanilines and tribromoanilines. Experiments with aniline-*o*-sulphonic acid and aniline-*p*-sulphonic acid indicated that the *o*-sulphonic group is the more readily replaced. The carboxyl group in the *o*- and *p*-positions to an amino-group was also replaceable, though with greater difficulty, by bromine, but chlorine and iodine either failed entirely to effect displacement or gave only small yields of the halogen derivative.—G. F. M.

Recent developments in chemical engineering equipment. Miles. See I.

Physico-chemical considerations on benzol recovery from coal gas. Rhead. See IIa.

Oil washing for [recovery of] benzene and toluene [from coal gas]. Adam. See IIa.

PATENT.

Production of aromatic bodies and gas from petroleum oils. U.S. Pat. 1,214,204. See IIa.

IV.—COLOURING MATTERS AND DYES.

Indigo in Bihar ; Java—. D. J. Reid. Agric. J. India, 1917, 12, 1—26. (Compare this J., 1915, 952 ; 1917, 130.)

THE results of experience in growing indigo in Bihar from 1904—15 are tabulated. On account of the periodical flooding of the country at the time when the seed plant must be in the ground, and the doubt as to whether any remedy will be found for diseases such as "wilt" and "psylla," it is considered probable that if a regular and full supply of Java seed is to be secured, some other locality will have to be discovered for seed growing. Research should be directed towards increasing the wilt-resisting power of the plant by selection and to improving the indican content of the leaf. In the author's experience indigo is not killed outright by standing water, and wilt is not affected to any great extent by climatic influences.—F. W. A.

Dyes as sensitisers of carbon tissue and gum paper. Waagö. See XXI.

PATENTS.

Disazo dyes. A. Clausius, Dessau. B. Schoner, Barackenlager Rothemark, and O. Siebert, Dessau, Assignors to Act.-Ges. für Anilinfabr., Berlin. U.S. Pat. 1,213,075. Jan. 16, 1917. Date of appl. Aug. 26, 1916.

SEE Ger. Pat. 293,657 of 1915; this J., 1916, 1150.

Chromium compound [of an azo dyestuff]; Green — and process of making same. G. Engi, A. Grob, and F. Straub, Assignors to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,213,608. Jan. 23, 1917. Date of appl. Nov. 10, 1915.

SEE Eng. Pat. 15,061 of 1915; this J., 1916, 831.

Process for thickening or filtration of colours and the like. Ger. Pat. 295,577. See XIII.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Recent developments in chemical engineering equipment. Miles. See I.

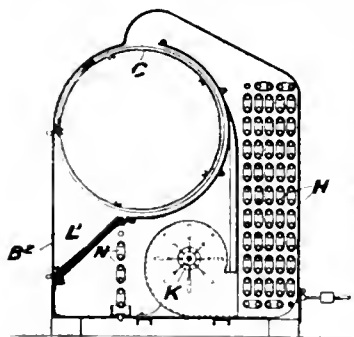
Constituents of wool fat. Röhmnn. See XII.

PATENTS.

Fabric coating, drying, and solvent-recovery apparatus. C. F. Hopewell, Newton, Mass. U.S. Pat. 1,212,613. Jan. 16, 1917. Date of appl. Oct. 27, 1911.

A NUMBER of rotary heated mangles in a vaporising chamber are maintained at successively higher temperatures. The coated fabric is guided through the vaporising chamber with its back against the rotary elements of the mangles, and a circulating current of gas containing a solvent is maintained in contact with the face of the coating to retard the drying of the face of the fabric, so that the expulsion of volatile materials from the coating will proceed from the fabric towards the face of the coating.—F. W. A.

Drying apparatus [for fibrous materials]. F. Balzer, Chicago, Ill., Assignor to Troy Laundry Machinery Co., Ltd. U.S. Pat. 1,213,999. Jan. 30, 1917. Date of appl. Apr. 27, 1914.



Air is circulated by the blower, K, in succession over the heating coils, L, around the rotary foraminous drying cylinder, C, through the screen, L, for removing lint, and over the device, N, for removing moisture. A door, B², is provided in the casing through which the screen, L, is withdrawn

for cleaning.—W. F. F.

Waterproofing fibrous materials; Machine for —. A. O. Tate, Montreal, Canada, Assignor to Tate Electrolytic Waterproofing Co., New York. U.S. Pat. 1,215,077. Feb. 6, 1917. Date of appl. Feb. 20, 1915.

IN a machine for waterproofing fibrous materials, the material is passed between pairs of electrodes, and means are provided for subjecting the materials to a different electrolytic agent on each side thereof.—F. W. A.

Fur; Process for treating —. W. P. Braun, Brooklyn, N.Y. U.S. Pat. 1,215,246. Feb. 6, 1917.

HAIR or fur for hatters' stock, after removal from the hide, is boiled with a solution of sodium carbonate; the stock is formed, and shrunk or felted by the application of hot water.—J. F. B.

Plastic composition and process of making the same. H. Lieber, New York. U.S. Pat. 1,213,115. Jan. 16, 1917. Date of appl. Mar. 28, 1914.

THE composition consists of peat, a portion of which has been treated by the viscose process to produce a binding agent which cements the unconverted portion to a coherent mass.—J. F. B.

Sulphur dioxide gas and liquid reclaimer. Process of making sulphite liquor. A. F. Richter and T. L. Dunbar, Watertown, N.Y. U.S. Pats. (A) 1,213,114 and (B) 1,213,415. Jan. 23, 1917. Dates of appl. (A) July 11 and (B) Oct. 9, 1914.

(A) AN apparatus for recovering gaseous and liquid products from a sulphite digester comprises a cooler discharging into a separator, a second cooler for the gas from the separator, and a liquor receptacle for the liquid from the separator; a gas conduit connects the second cooler with the bottom of a sulphur dioxide reclaiming tower, and a liquor-delivery conduit leads from the liquor receptacle to the top of the tower; a return pipe is provided from the bottom of the tower to the liquor receptacle, and means are provided for circulating the liquor through the system. (B) For making sulphite liquor, the products from a digester are separated into sulphur dioxide and spent liquor; the spent liquor is mixed with sulphite liquor and the mixture treated with sulphur dioxide from a burner; the excess sulphur dioxide from the burner is mixed with calcium bisulphite to form the sulphite liquor mentioned above, and the gas recovered from the digester products is mixed with the liquor derived from the combined operations.—J. F. B.

Paper machine. C. E. Pope, Holyoke, Mass. U.S. Pat. 1,211,712. Feb. 6, 1917. Date of appl. Mar. 6, 1916.

IN the drying portion of a paper machine the units of the upper tier of cylinders are placed substantially in the same vertical plane as the corresponding units of the lower tier, and the drying felts and guide rolls are so arranged that the web has a very short exposed travel in passing from a lower cylinder to the upper cylinder vertically above it, and a comparatively long exposed travel in passing from an upper cylinder to the lower cylinder of the next pair. The web of paper is held against the lower cylinder until it reaches a point where it is travelling horizontally on the upper surface of the cylinder; it is stripped from the cylinder at this point and directed into an entrance formed between the upper cylinder and the upper felt, the guide roll of the upper felt being so placed that the felt passes on to the cylinder in a line substantially radial to the companion lower cylinder.—J. F. B.

Resin size for paper manufacture; Apparatus for preparing —. B. Kniffler, Winchester, and W. A. Oppen, Stoneham, Mass. U.S. Pat. 1,215,034. Feb. 6, 1917. Date of appl. Sept. 14, 1914.

THE apparatus consists of a closed size-containing vessel with pipes both at the top and the bottom, through either of which steam under pressure may be introduced. Means are provided for forcing the heated size under pressure from the lower part of the vessel through a filtering device into a delivery pipe. The latter terminates in a pressure-preserving obstruction having a restricted dis-

charge orifice beneath the surface of water in an emulsion-container, so that the size emerging through the orifice in a fine stream is suddenly relieved of high pressure and heat, and immediate emulsification is effected.—J. F. B.

Protective and non-penetrative covering and the like. G. Lynch, London. U.S. Pat. 1,213,118, Jan. 16, 1917. Date of appl. May 13, 1916.

SEE Eng. Pats. 6300, 9366, 3190, 9491, and 16,760 of 1915; this J., 1916, 887.

Secreting [carroting] fur and hair; Process for —. L. F. Paris, Paris. U.S. Pat. 1,213,403, Jan. 23, 1917. Date of appl. Mar. 3, 1914. Renewed June 20, 1916.

SEE Eng. Pat. 5409 of 1914; this J., 1914, 610.

Threads of artificial silk, films, and other objects; Process for obtaining —. L. Ledue, Couture St. Germain, and H. Jacquemin, Maransart, Belgium. U.S. Pat. 1,214,931, Feb. 6, 1917. Date of appl. Mar. 14, 1913.

SEE Fr. Pat. 454,061 of 1913; this J., 1913, 865.

Process for impregnating wood, stone, fabrics, etc. Eng. Pat. 101,205. See IX.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Dyeings; Production of [brown] — by oxidation on the fibre. O. Diehl, Farber-Zeit., 1916, 27, 145.

THE development of dyeings from catechu in combination with copper and ammonium salts is accelerated by ageing in an ammoniacal atmosphere; fabric impregnated with catechu and treated as usual with chromate yields a dark coffee-brown shade. Intense brown shades are obtained in the same manner using *p*-phenylenediamine, redder than those obtained with chlorate and vanadium; the oxidation is too rapid unless large amounts of ammonium chloride or calcium chloride are introduced. The following printing paste is recommended: 850 grms. of a mixture containing 30 grms. of Paramine Extra, 137 grms. of water, and 687 grms. of thickener; 60 grms. of copper chloride solution (prepared from 25 grms. of copper sulphate crystals in 60 grms. of water and 25 grms. of barium chloride in 60 grms. of water), 29 grms. of Rongalite solution (1:9), and 100 grms. of thickener, which last-named is obtained from 750 grms. of wheat starch, 3200 grms. of water, and 200 grms. of acetic acid of 7° B. (sp. gr. 1.051).

—F. W. A.

PATENTS.

Dyeing and like apparatus; Perforated beams for —. J. T., and E. Brandwood, Bury, Lancs. Eng. Pat. 103,772, July 31, 1916. (Appl. No. 10,758 of 1916.) Addition to Eng. Pat. 17,355 of 1914 (this J., 1915, 26).

IN order to secure the periphery of the inner nickel flange still further from contact with outside bodies when the beam is rolled on a floor, and to simplify the method of making the liquid-tight joints between the inner and outer flanges, the inner nickel flange is made of lesser diameter than the outer flange, with its surface flush with the inner edge of the latter, and the joint between the two flanges is made by spinning or pressing the edges of the nickel flange or annulus into recesses in the outer flange.—F. W. A.

Dyeing vegetable fibres; Process of —. G. D. Burton, Boston, Mass. U.S. Pat. 1,214,007, Jan. 30, 1917. Date of appl. Apr. 22, 1914.

DEGUMMED fibres are dyed by treatment with a solution of the natural colouring substance originally present in the fibre and a mordant, and afterwards with a "colour-setting" agent. —B. N.

Acid colours; Fixation of — on cotton. F. W. Weeks, Edgworth. U.S. Pat. 1,213,045, Jan. 16, 1917. Date of appl. Aug. 12, 1916.

SEE Eng. Pat. 102,291 of 1916; this J., 1917, 80.

Process for impregnating wood, stone, fabrics, etc. Eng. Pat. 101,205. See IX.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Arsenic in sulphuric acid; Critical examination of Lunge's method for the rapid determination of —. J. B. Pérégryn, Ann. Chim. Analyt., 1917, 22, 24—25.

LUNGE's volumetric process, in which a measured quantity of the acid is diluted and the contained arsenic reduced by sulphur dioxide and determined in neutral (or sodium bicarbonate) solution by means of standard iodine, gives slightly lower results than the standard method involving fusion of the precipitated arsenious sulphide with oxidising mixture, precipitation as silver arsenate, and volumetric determination of silver in the latter; but the process is expeditious, and satisfactory results may be obtained by the use of an arithmetical factor.—W. E. F. P.

Zinc blende; Roasting of —. M. Hutin, Monit. Scient., 1917, 7, 25—35.

IN view of the rising price of pyrites, the use of blende and mixed zinc ores from Algeria and Tunis as a source of sulphur for sulphuric acid manufacture is becoming more general. The residue from the roasting is more valuable than in the case of pyrites, especially with ores rich in copper; the smelters pay for the roasting and sometimes for crushing. On the other hand the roasting of blende is more troublesome, necessitating more highly skilled labour, and the high temperature required causes more rapid deterioration of tools and furnaces as well as of the Glover towers. The nitrate consumption is often higher, and the presence of fluorspar in the blende causes deterioration of the lead chambers. The following quantities of blende were roasted in 1912: United Kingdom, 50,125 tons; Holland, 13,550; Germany, 191,690; Belgium, 138,390; France, 59,050; Austria-Hungary, 9780 tons.—W. R. S.

Sulphur in roasted pyrites, etc.; Critical examination of Lunge's dry method for the rapid determination of —. J. B. Pérégryn, Ann. Chim. Analyt., 1917, 22, 26—27.

LUNGE's method—in which the sulphur content of pyrites cinder, etc., is calculated from the loss of alkalinity sustained by pure sodium bicarbonate when gently heated in admixture with the material with free access of air (in an open nickel crucible)—gives results consistently lower, by $\frac{1}{4}$ to $\frac{1}{3}$ of the amount present, than those obtained by the *aqua regia* method. The process is satisfactory for control work, provided the necessary precautions as to heating, etc., are observed; and the results are not vitiated by the presence of lead or alkaline-earth sulphates in the cinder, since fritting or fusion of the charge is avoided. (Compare Lunge and Stierlin, this J., 1906, 138.) —W. E. F. P.

Orthophosphoric acid; Acidimetric determination of —, D. Balareff. *Z. anorg. Chem.*, 1916, **97**, 143–146. *J. Chem. Soc.*, 1917, **112**, ii., 101.

PHOSPHORIC acid usually contains an appreciable quantity of carbon dioxide, from which it is freed in the control experiments by heating for several hours in a gold vessel in a stream of purified air. It is then diluted with water free from carbon dioxide. Wagenaar's method (*Pharm. Weekblad*, 1911, **48**, 845) gives satisfactory results if the lead nitrate is added at the Na_2HPO_4 stage, but not otherwise. In Glaser's method, the third hydrogen ion is titrated by adding calcium, strontium, or barium chloride after the solution has become neutral to phenolphthalein, and again titrating until a permanent red coloration is obtained. This only gives accurate results in the presence of an excess of strontium chloride. The following method is recommended. The dilute solution is first titrated until the red shade of methyl orange disappears. The second ion is titrated until phenolphthalein becomes a clear red. The solution is then diluted with water free from carbon dioxide, and a neutral solution of silver nitrate is added. The titration is continued with laemoid as an indicator.

Nitre cake; Possible partial substitution of — for sulphuric acid in the manufacture of sulphate of ammonia. P. Parrish. *Gas J.*, 1917, **137**, 345–347.

THE suggested substitution of nitre cake for sulphuric acid in making sulphate of ammonia has not been enthusiastically received by manufacturers. The author, however, considers that as an emergency measure the production of a mixed salt is quite practicable. Damage to the lead work of the saturator need not be feared if the nitre cake does not contain more than 0.5% of undercomposed nitrate. The manurial qualities of the mixed sulphate produced should, according to Rothamsted experiments, be satisfactory, due to some beneficial action of the sodium sulphate. A mixed salt containing 10% of sodium sulphate is regarded as the limit to substitution in practice. If the quantity of nitre cake to attain this, is added dissolved in water, the saturator liquor will become too dilute. In the absence of a method of adding the nitre cake in the form of a solid, the author recommends introducing it dissolved in the sulphuric acid fed into the bath. The nitre cake, broken up into small pieces, is dissolved in sulphuric acid in a lead-lined tank, heated by closed steam coils, and the hot solution is then used as saturator feed. By having tanks in duplicate, one can be feeding the saturator while a fresh solution of nitre cake is made up in the other. Twelve-hour periods are worked. A fairly uniform mixed salt can be made, free from undue acidity. To make 100 tons of mixed salt containing 10% of sodium sulphate, 14.7 tons of nitre cake (32% H_2SO_4) and 87.8 tons of 70% sulphuric acid or 76.8 tons of 80% acid are required.—H. J. H.

Sodium and potassium carbonates; Double salts formed by —, J. W. Bain and C. E. Oliver. *Trans. Roy. Soc. Canada*, 1916, [iii.], **10**, 65–66. *J. Chem. Soc.*, 1917, **112**, ii., 87.

THE production of pure potassium carbonate from the ash of seaweeds, wood ashes, and the residues from sugar factories is rendered difficult by the formation of the double salt, $\text{K}_2\text{CO}_3 \cdot \text{Na}_2\text{CO}_3 \cdot 12\text{H}_2\text{O}$. According to dilatometric observations, this double salt decomposes at 35° C. in accordance with the equation $3(\text{K}_2\text{CO}_3 \cdot \text{Na}_2\text{CO}_3 \cdot 12\text{H}_2\text{O}) = 2\text{K}_2\text{CO}_3 + \text{K}_2\text{CO}_3 \cdot 3\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} + 26\text{H}_2\text{O}$. The new double salt thus formed appears to decompose at about 130° C.

Potassium cyanide; Rate of hydrolysis of — in aqueous solution. J. Zawidzki and T. Mieczynski. *Kosmos (Lemberg)*, 1914, **38**, 1366–1375. *J. Chem. Soc.*, 1917, **112**, ii., 81–82.

STUDY of the kinetics of the auto-hydrolysis of potassium cyanide in aqueous solution at 100°, 110°, and 120° C., led to the following conclusions: (1) In dilute aqueous solution (0.25–2.0 molar), the reaction $\text{KCN} + 2\text{H}_2\text{O} = \text{H}_2\text{CO}_3\text{K} + \text{NH}_3$ is of the first order; (2) the temperature-coefficient is normal, the values being about 2.26 at 100°–110° and about 2.06 at 110°–120° C.; (3) the presence of an excess of the reaction products (NH_3 and HCO_2K), as well as of other salts and bases, has no appreciable effect on the rate of hydrolysis; (4) organic acids have a feeble accelerating action; (5) alcohols, particularly glycerol, have a much more pronounced accelerating action, which appears to depend on intermediate and side reactions.

Aluminium hydroxide; Solubility of — in solutions of ammonia and ammonium salts. E. H. Archibald and Y. Habasian. *Trans. Roy. Soc. Canada*, 1916, [iii.], **10**, 69–70. *J. Chem. Soc.*, 1917, **112**, ii., 93.

THE solubility of aluminium hydroxide in ammonia increases at first with the strength of the ammonia solution, reaches a maximum, and then decreases. These relations are considered to be connected with the formation of a more crystalline modification of aluminium hydroxide in contact with the concentrated ammonia. In presence of ammonium chloride or nitrate, the solubility of the hydroxide is considerably decreased. The addition of potassium nitrate increases the solubility to a marked extent.

Silver chloride and lead chloride; Reduction of —, A. Gawalowski. *Oesterr. Chem.-Zeit.*, **19**, 150–151. *J. Chem. Soc.*, 1917, **112**, ii., 88.

PRECIPITATED silver chloride is reduced to metallic silver by means of zinc in a few days. " AgNH_2 " gives with zinc and mercury a silvery-grey, dendritic silver tree, whilst with zinc, copper, tin, and mercury it yields at first black, dendritic deposits, which after a time become converted into silver-white dendrites. Sealy, crystalline leaflets of lead are formed by the reduction of aqueous lead chloride by zinc, whilst in the presence of ammonia the lead is precipitated in powdery, black microcrystals. If the deposit containing ammonia is acidified with dilute sulphuric acid, the odour of nitrous acid is observed, and lead is almost instantaneously precipitated in dendritic crystals.

Lead subiodide, and an improved method for preparing lead suboxide. Solubility of lead iodide. H. G. Denham. *Chem. Soc. Trans.*, 1917, **111**, 29–41.

LEAD suboxide was prepared by heating lead oxalate in a vacuum at temperatures above 270° C. but not exceeding 375° C. The pressure of the evolved gases not being allowed to rise above 5 cm. It formed a dark-coloured powder which above 335° C. became paler in colour and less reactive. When mixed with four times its weight of silica and treated with the vapour of dry methyl iodide at a maximum temperature of 202° C. in an atmosphere of nitrogen, it was converted quantitatively into lead subiodide, which formed a bright yellow powder having only about one-ninth the solubility in water of the normal iodide at 25° C. The subiodide is slowly oxidised by air, is completely decomposed by acids, and is resolved by heat into a mixture of lead and the normal iodide.—G. F. M.

Iodides; Interference of thiocyanates, ferrocyanides, and ferricyanides in the detection of— with palladium. L. J. Curtman and B. R. Harris. J. Amer. Chem. Soc., 1917, 39, 266—270.

AN excess of palladium is favourable to the detection of iodides in the presence of thiocyanates; otherwise precipitation of palladous thiocyanate or formation of soluble potassium palladodithiocyanate may prevent palladium being available for the precipitation of iodides. The interference due to ferrocyanides and ferricyanides may in most instances be overcome by boiling the reaction mixture.—T. H. B.

Alkaline-earth oxalates. W. O. de Coninck. Ann. Chim. Analyt., 1917, 22, 23—24.

THE precipitate obtained by allowing very dilute mixed solutions of barium nitrate and oxalic acid to stand for one month had the composition, $2\text{BaC}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$. It was insoluble in water at 0° or 12°C .; slowly dissolved by warm, and partly decomposed by boiling water; decomposed by strong mineral acids; slowly attacked by strong formic and acetic acids; and decomposed by prolonged contact with alkalis and ammonia. Attempts to prepare a corresponding calcium compound by similar means resulted in the formation of a mixture of oxalates in which $\text{CaC}_2\text{O}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ and $\text{CaC}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ appeared to predominate. The hydrated acid oxalate of strontium, $\text{SrC}_2\text{O}_4 \cdot \frac{1}{2}\text{H}_2\text{C}_2\text{O}_4 \cdot 3\text{H}_2\text{O}$, was obtained by mixing a moderately strong solution of strontium chloride with an equal volume of fuming hydrochloric acid and then adding 3 volumes of a concentrated solution of oxalic acid. This salt was insoluble in cold water, but slightly soluble on warming and converted into $\text{SrC}_2\text{O}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ on boiling.

—W. E. F. P.

Magnesium pyrophosphate obtained by calcining magnesium ammonium phosphate; Colour of—. D. Balareff. Z. anorg. Chem., 1916, 97, 149—160. J. Chem. Soc., 1917, 112, ii., 90—91.

THE grey or black colour often observed in ignited magnesium pyrophosphate has been attributed by Karaoglanoff to traces of organic matter. According to the author, the colour is only observed when the pyrophosphate has the dense form which results from incandescence during ignition. Reagents which remove the coloration do so by altering the texture of the precipitate, allowing oxygen to enter and oxidise the carbon. The colour depends on the water of crystallisation present. The moist, crystallised salt with $6\text{H}_2\text{O}$ yields a snow-white residue on ignition, but if kept for some weeks over phosphoric oxide, it becomes grey when ignited. There is no appreciable difference of weight between the white and coloured residues, but the grey pyrophosphate is less readily soluble in hot dilute nitric acid than the white variety. The addition of filter-paper fibres to $\text{MgNH}_4\text{P}_2\text{O}_7 \cdot 6\text{H}_2\text{O}$ causes the precipitate to darken on ignition, but if moistened two or three times with water, the residue is white. Dark residues are often obtained even when asbestos is used for filtering. Secondary changes often occur in the precipitation and ignition of the phosphate. The various methods of decolorising the residue give the same results if precautions are taken against loss. Moistening with water and adding a few crystals of ammonium nitrate removes the colour rapidly and completely.

Copper sulphide enrichment; Some reactions involved in secondary—. E. G. Zies, E. T. Allen, and H. E. Merwin. Economic Geology, 1916, 11, 407—503. J. Chem. Soc., 1917, 112, ii., 91—92.

COPPER sulphate solutions react with natural sulphides, a part of the copper being precipitated,

this being the process which is concerned in the secondary enrichment of sulphide deposits. In the experiments the minerals were used either in the form of lumps, so that the colour of the product could be determined, or more often in powder. In the latter case, the powder was sifted through silk bolting cloth, only that part being taken which passed through a cloth with 125 meshes to the linear inch and was retained by a 200 mesh. The finest flour, which adhered to the particles in sifting, was removed by washing with alcohol. The minerals after the experiment were examined microscopically and analysed. The reactions were carried out at the ordinary temperature in special glass containers in a shaking apparatus, and at higher temperatures in sealed tubes of Jena glass or silica, heated vertically in an oil-bath. When artificial sulphides were used, they were prepared by precipitation and washing, and were dried and heated in hydrogen. Pyrites is altered to covellite and chalcocite with cupric sulphate solutions. Chalcopyrite and bornite undergo the same change, whilst pyrrhotite is altered to chalcopyrite, and probably to bornite. The order of stability is: chalcopyrite, covellite, chalcocite, the last being the most stable of all, although even it is slowly altered, yielding metallic copper and sulphuric acid. The intermediate products, chalcopyrite and covellite, are most likely to be obtained when a large surface of the original sulphide is exposed to a dilute solution of cupric sulphate. Increased temperature accelerates the reactions without greatly altering their nature, but secondary reactions, such as the formation of cuprous sulphate and hydrolysis to hematite, are more marked at higher temperatures. Cuprous sulphate appears to accelerate the reactions. An increased concentration of sulphuric acid retards the above reactions. A reversal of the enrichment reactions has not been observed. Galena is more reactive than any other of the sulphides examined. The enrichment of galena, blende, pyrrhotite, and bornite is accelerated by the presence of sulphuric acid.

Sulphide sols; Reversibility of —, and the protective action of hydrogen sulphide. S. W. Young and W. R. Goddard. J. Phys. Chem., 1917, 21, 1—13.

A DIALYSING parchment cylinder was suspended in a glass vessel and provided with inlet and outlet tubes for the circulation of either water or hydrogen sulphide solution. The outer vessel was fitted with a gas-tight cover through which passed a funnel and a glass stirrer. After filling the apparatus with water, a slow stream of water saturated with hydrogen sulphide was circulated through the inner cylinder, whence some of the hydrogen sulphide diffused into the water of the outer vessel. A solution of a salt of cadmium, zinc, mercury, lead, or arsenic was then admitted a few drops at a time, at considerable intervals, to the outer vessel by means of the funnel. By reacting with hydrogen sulphide, a sulphide was formed which became dispersed throughout the solution by means of the stirrer. The free acid formed by the reaction was gradually removed by diffusion into the dialysis vessel, the solution in which was repeatedly renewed. The influence of the presence or absence of hydrogen sulphide on the colloidal state of the sulphide in the outer vessel could then be observed by circulating alternately hydrogen sulphide solution and pure water for long intervals through the inner vessel. Removal of the hydrogen sulphide from the sol in this manner ultimately caused flocculation of the sulphide in every case, and re-admission of the dissolved gas caused, in time, re-dispersion. Upon repetition it was noticed that the time required for coagulation tended to become longer

and that for re-dispersion to become shorter. It would appear that the dispersed substance in the sulphide sols is a dissociable compound of the sulphide with hydrogen sulphide, while the flocculated sulphides are either free from hydrogen sulphide or contain relatively little of it. Zinc sulphide sols were exposed to hydrogen sulphide in sealed tubes at pressures of this gas varying from 0.5 to 4 atm. Above 0.5 atm. a marked dispersive effect leading to a clearing of the sol was first obtained. This action was most marked with the gas at 1.5 to 2 atm. After standing a few months the sulphide was gradually precipitated, though the sols at about 1.5 atm., where the protective action of the hydrogen sulphide was at a maximum, were the last to flocculate. The protective effect of hydrogen sulphide against the flocculation of zinc sulphide by potassium chloride was also found to reach a maximum at about 2 atm. A thermal reversibility of zinc sulphide sols in contact with hydrogen sulphide was observed in the sealed tubes containing hydrogen sulphide under pressure. When heated, a flocculation of the sol took place, but after standing in the cold, re-dispersion occurred. The results indicate that hydrogen sulphide may exhibit on the one hand a specific dispersive action, and on the other a coagulating effect as an electrolyte.—J. N. P.

Copper sulphide: Colloidal solutions of—
S. W. Young and R. Neal. *J. Phys. Chem.*, 1917, 21, 14—31.

COPPER sulphide sols were prepared by agitating well washed copper hydroxide or carbonate or freshly precipitated copper sulphide with an aqueous hydrogen sulphide solution. The reaction was conducted in absence of air and over a period of several days. When desired, the free hydrogen sulphide was removed by dialysis. By adding electrolytes, dispersion was inhibited, the results at like concentrations being proportional to the flocculating powers of the electrolytes. Anomalous results were obtained, however, with alkali hydroxides, which caused a marked initial acceleration of the rate of dispersion, followed by the normal flocculating action. The stability of the sols was found to be greatly increased by the presence of hydrogen sulphide. Measurements made with the addition of electrolytes showed that the concentration of electrolyte necessary to cause flocculation in 24 hours is independent of the origin and method of preparation of the sol, and, within wide limits, is independent of the dilution of the sol, and of the presence or absence of free hydrogen sulphide. The relative flocculating powers of the chlorides of potassium, calcium, and aluminium, were found to be in the ratios 1:39:875. The rate of migration of the sol in an electric field was found to be largely influenced by the origin of the sol, increased by dilution of the sol, and accelerated by the addition of electrolytes, but in a way which bore no apparent relation to the flocculating value of the electrolyte used. The acceleration of the migration rate seemed to be represented by an expression of the form SKA , where K is the migration rate of the original sol, A a function of the concentration (perhaps of the conductivity) of the electrolyte added, and S a factor depending on some specific property of the particular sol used. The migration rate was greatly reduced by hydrogen sulphide and increased by its removal, the effect being readily reversible. Bubbling air or oxygen through a sol containing hydrogen sulphide affects the migration rate merely by displacing hydrogen sulphide. Re-saturation with hydrogen sulphide restored the rate to its normal value.—J. N. P.

Nitric oxide: Action of—on metallic peroxides suspended in water. B. C. Dutt and S. N. Sen. *J. Proc. Asiatic Soc. Bengal*, 1914, [N.S.], 10, 287—291. *J. Chem. Soc.*, 1917, 112, ii., 85.

WHEN nitric oxide is passed into a suspension of lead peroxide in water, a mixture of lead nitrite and nitrate is formed, the nitrate being formed by the oxidation of a portion of the nitrite by the excess of lead peroxide. With barium peroxide in water, nitric oxide yields only barium nitrite.

Monazite deposits in Ceylon. Board of Trade *J.*, Mar. 8, 1917.

THE Mineralogical Department of Ceylon announces the discovery of substantial deposits of monazite in the island. A start has been made in working the deposits in two districts of the Southern Province and in Kudaramallie, in the North-Western Province. The necessary plant for magnetic separation has been ordered.

Radium emanation: Release of—from water at different temperatures by the bubbling method. J. Moran. *Trans. Roy. Soc. Canada*, 1916, [iii.], 10, 57—66. *J. Chem. Soc.*, 1917, 112, ii., 63.

EXPERIMENTS, in which a constant current of air was bubbled through a solution of radium at temperatures ranging from 16.5° to 80° C., show that the emanation removed by the air increases with the temperature. When this method is employed in the estimation of the radium content, the solution should be kept at a constant and measured temperature.

Sublimed sulphur and its adulteration. Fonze-Diacon. *Ann. Falsif.*, 1916, 9, 333—339.

SUBLIMED sulphur as collected from the subliming chamber is graded into *grésil*, *éponges*, *grappillons*, and *candi* according to its degree of fineness. A sample taken from the floor of a chamber contained 32.7% of sulphur insoluble in carbon bisulphide, whilst another of equal fineness taken from the wall at the height of about 1 m. contained 30% of insoluble sulphur. A third sample, taken at about 2.5 m. from one of the vapour inlets, was much coarser and consisted of a mixture of the first three grades. A fourth sample, collected about 2 m. from a vapour inlet, was still coarser, and consisted of *éponges* containing only 0.3% of insoluble sulphur, whilst a sample of *candi* collected directly above an inlet consisted of large fused masses which were practically free from insoluble sulphur. The proportion of insoluble sulphur stood in direct relationship to the degree of fineness, and this also applied to commercial sublimed sulphur. The very pure sublimed product collected from the middle of the floor of the chamber passed through a 100-mesh, and (with prolonged shaking) through a 210-mesh sieve, and when fractionated by partial sifting yielded three fractions containing 30.3, 30.5, and 30.3% of insoluble sulphur respectively. In the case of the second sample the *grésil* retained by a 100-mesh sieve contained 10.1%, the coarse flowers retained by a 240-mesh sieve contained 12.5%, and the fine flowers which passed through that sieve contained 15.5% of insoluble sulphur. A very pure commercial sample as used in vineyards contained 28.2% insoluble sulphur. It passed through a 100-mesh sieve, but by treatment on a 210-mesh sieve was separated into coarse and fine flowers containing respectively 27.3 and 29.5% of insoluble sulphur. A coarser commercial product was separated into *grésil* (retained by a 100-mesh sieve), and coarse and fine flowers, containing 16.1, 19.6, and 26.3% of insoluble sulphur respectively; whilst a badly-made product of poor quality yielded *grésil* with 2.3%, coarse flowers with 4.8%, and fine flowers

with 18.7% of insoluble sulphur. In every instance of pure sublimed samples the ratio of the insoluble sulphur in the *grésil* to that in the coarse powders was less than unity. Any decrease in the proportion of insoluble sulphur on keeping is immaterial, since it affects all the fractions of the sulphur. The addition of 20 to 25% of ordinary powdered sulphur to sublimed sulphur causes this ratio to exceed unity. The insoluble sulphur is determined by treating 1 to 2 grms. of the sample with three successive portions of carbon bisulphide or 30 minutes each time, separating the extracts by centrifuging, and drying the insoluble residue in the water oven.—C. A. M.

Recent developments in chemical engineering equipment. Miles. See I.

Banana stalks as a source of potash. Billings and Christie. See XVI.

Manufacture of cream of tartar in South Australia. Hargreaves. See XVIII.

Electroanalysis of tin without platinum electrodes. Batuecas. See XXIII.

Titration of sulphates of some divalent metals by the electric conductivity method. Harned. See XXIII.

PATENTS.

Hydrocyanic acid gas; Process of generating —. C. J. Marvin, Assignor to The Braun Corporation, Los Angeles, Cal. U.S. Pat. 1,214,206, Jan. 30, 1917. Date of appl., Feb. 13, 1915.

HYDROCYANIC acid gas is generated by dropping a solution of 1 part of cyanide in 2 parts of water, in small quantities at a time, into a hot solution of sulphuric acid obtained by diluting the concentrated acid with an equal quantity of water. —B. V. S.

Perborate of sodium; [Electrolytic] manufacture of —. Deutsche Gold- u. Silber-Scheidenanstalt, vorm. Roessler, Frankfurt, Germany. Eng. Pat. 100,778, Mar. 2, 1916 (Appl. No. 3185 of 1916). Under Int. Conv., June 30, 1915. Addition to Eng. Pat. 100,153 of 1916; dated Mar. 10, 1915 (this J., 1917, 83).

IN the manufacture of sodium perborate by the electrolysis of an alkaline solution of borax, as described in the chief patent, improved yields are obtained by increasing the current density, more especially at the anode. In the examples given, the electrolytic efficiency was increased from 3.55% to 33.5% by increasing the current density at the anode from 1000 amp. per sq. m. up to 4000, with a cathode density of 820; and from 14.4% to 20.5% by increasing the cathode density from 1000 to 2000, with an anode density of 1000. —B. V. S.

Arsenates; Production of metal —. E. C. R. Marks, London, Assignee of T. A. Mitchell, Reading, Mass., U.S.A. Eng. Pat. 101,029, July 24, 1916. Under Int. Conv., July 23, 1915. (Appl. No. 10,407 of 1916.)

SEE U.S. Pat. 1,183,315 of 1916; this J., 1916, 737.

Nitrogen compounds; Process of preparing —. C. Krauss, Cologne-Braunsfeld, and P. Staehelin, Knapsack, Germany. U.S. Pat. 1,212,504, Jan. 16, 1917. Date of appl., Dec. 6, 1913. Renewed Dec. 8, 1916.

SEE Fr. Pat. 464,750 of 1913; this J., 1914, 549.

Alkali and alkaline-earth sulphides; Manufacture of —. H. Specketer and W. Hofmann-Griesheim, Assignors to Chem. Fabr. Griesheim-Elektron, Frankfurt, Germany. U.S. Pat. 1,212,702, Jan. 16, 1917. Date of appl., Dec. 17, 1910.

SEE Fr. Pat. 424,417 of 1910; this J., 1911, 747.

Sulphur dioxide gas and liquid reclaiming. Process of making sulphite liquor. U.S. Pats. 1,213,411 and 1,213,415. See V.

VIII.—GLASS; CERAMICS.

Glass; Annealing of —. F. Twyman. Soc. Glass Tech., Feb. 15, 1917.

WANT of annealing in glass leading to fracture is due to the presence of internal stress. Glass behaves at all temperatures as a viscous liquid, and exhibits a continuous and gradual variation in viscosity from almost zero at high temperatures to almost infinity at 0° C. In molten glass there is no permanent internal stress, whilst at ordinary temperatures glass is almost perfectly elastic, so that stress cannot originate at either high or low temperatures. At high temperatures internal stresses, if any, die away very quickly, but between this high temperature and the low temperature at which glass acts as an elastic solid, there is a region where internal stress may take several minutes or even hours to die away. It is this region of temperature which is important in annealing, and care must be exercised in cooling a glass object through its "annealing range" in order to free it from internal stress.

The author described the method employed to determine the annealing temperature of various glasses, and then showed that the mobility (*i.e.*, inverse viscosity) of glass doubled for each 8° C. rise in temperature. Results were given showing the rapid rise of mobility with rise of temperature. Thus, a certain glass kept at 420° C. required a period of eighty-three hours for internal stress to disappear, whilst at 580° C. the same glass was freed from stress in 0.3 second. The actual annealing temperature, *i.e.*, the temperature at which stress easily disappears and yet low enough not to cause deformation of the object, differs widely for various glasses. It is a matter of wide importance to the manufacturer to know the annealing temperature of his glass. For example, suppose the annealing temperature of a glass is 500° C., *i.e.*, stress will almost disappear from the glass at this temperature in about three minutes. Then if the glass is held at 420° C. it would require forty-five hours to anneal, whilst if kept at 580° C. it would probably go out of shape.

Annealing. S. English. Soc. Glass Tech., Feb. 15, 1917.

To obtain some knowledge of the rate of annealing at various temperatures, small glass rods were heated at the required temperature in an electric furnace, observations being carried out by means of a special apparatus built up of two Nicol prisms and a system of lenses. The well-known rings and cross as seen in an uniaxial crystal were always observed in the rod under experiment, and as the experiment proceeded the rings expanded and passed from the circle of light, the rate at which they disappeared being a measure of the rate of annealing at that temperature. The times necessary for the last four rings to disappear in the case of a chemical resistant glass were for various temperatures as follows:—500° C. 1230 mins.; 550° 50 mins.; 600° 20 mins.; 625°

12 mins. The times required for the field of view in the apparatus to become perfectly dark, i.e., until all stress had disappeared, were at 550° C., 570 mins.; 600°, 270 mins.; 625°, 18 mins.; 650°, 10 mins.

Since the annealing of glass is the relieving due to incipient softening of internal strains, the temperature at which annealing proceeds at a fairly rapid rate may be obtained by finding the temperature at which glass will yield to external forces. The apparatus for carrying out this work was described, and curves were given showing results with actual glasses.

The optical and mechanical methods of determining annealing temperatures as described by the author, yield results in close agreement, and prove that the annealing temperature of glass is considerably below the temperature of actual softening.

PATENTS.

Glass. G. A. Macbeth; G. D. Macbeth, exor., Assignor to Macbeth-Evans Glass Co., Pittsburgh, Pa. U.S. Pat. 1,211,202, Jan. 30, 1917. Date of appl., Apr. 12, 1915.

A GLASS is formed by fusing a mixture containing 1500 parts of a foundation batch for clear glass, 121 of alumina, 135 of fluorspar, and 150 parts of sodium silicofluoride. The fluorspar may be replaced by any other fluoride containing 50 per cent. of fluorine, and the silicofluoride by another fluoride. The alumina may range from 80 to 160 parts, the fluoride from 100 to 170, and the silicofluoride from 100 to 200 parts.—A. B. S.

Annealing beer. J. Plante, Verdun, Quebec. U.S. Pat. 1,211,217, Jan. 30, 1917. Date of appl., May 15, 1913.

AN annealing oven is provided with a movable pan for holding articles and with a heating device therefor. Hot air from the top of the oven is drawn through an opening into a vertical chamber in the oven wall by an adjacent injecting nozzle supplied with fluid under pressure, and the mixture passes into the oven through an opening below the pan.—W. F. F.

Brick-kiln. J. T. Underwood, Dayton, Ohio. Assignor to Underwood Engineering Co., Detroit, Mich. Re-issue 14,251, Jan. 16, 1917, of U.S. Pat. 1,105,724, Aug. 4, 1914. Date of appl., Apr. 3, 1916.

Air and gas under pressure are admitted through burners at the floor level of the kiln, near its circumference. The exit flues are arranged so that the pressure of the gases inside the kiln is greater than that of the outer atmosphere. In order to prevent leakage through the walls of the kiln, they may be coated externally.—A. B. S.

Refractory product and method of manufacturing same. Manufacture of plastic products. A. P. Taylor and J. D. Runyan, Assignors to The Charles Taylor Sons Co., Cincinnati, Ohio. U.S. Pats. (A) 1,212,846, and (B) 1,212,847, Jan. 16, 1917. Dates of appl., Dec. 8, 1915, and July 11, 1916.

(A) FLINT clay is calcined and any impurities which are thereby made visible are picked out. The calcined clay is mixed with highly refractory kaolin and plastic kaolin and the mixture is shaped and burned in the customary manner. (B) Flint clay is prepared for use in the manufacture of refractory products by calcining it and then separating the impurities thus rendered visible.—A. B. S.

IX.—BUILDING MATERIALS.

Underground building work; Destruction of — by the sulphur of peat soils. H. Kühl. Z. angew. Chem., 1916, 29, 335—336.

THE author draws attention to the fact, overlooked by Thörner (this J., 1916, 855), that underground cement work may be destroyed by soluble sulphates as well as by free sulphuric acid formed from the so-called "reactive sulphur." The destructive action of soluble sulphates has been shown by Candlot and by Michaelis to be due to the formation of a voluminous, almost insoluble double compound of calcium aluminate and calcium sulphate, $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot 3\text{CaSO}_4$.

Sulphur of peat soils; Nature of the —. W. Thörner. Z. angew. Chem., 1916, 29, 363—364.

IN reply to Kühl (see preceding abstract), it is pointed out that most peat soils contain only small quantities (a few tenths per cent.) of calcium and magnesium sulphates, too small to have an appreciable injurious action on vegetation and underground building work. In the case of peat soils near the sea, the soil water may contain considerable amounts of the salts mentioned and will then undoubtedly cause injury to underground cement structures, but such action is due to the composition of the soil water and is not typical of peat soils.

PATENTS.

Wood, stone, fabrics, etc.; Process for impregnating — Elektro-Osmose Akt.-Ges. (Graf Schwerin Ges.), Frankfurt, Germany. Eng. Pat. 101,205, Apr. 5, 1916 (Appl. No. 5021 of 1916). Under Int. Conv., Aug. 18, 1915.

THE material (stone, wood, fabric, etc.) is impregnated with a 2—10% colloidal solution of chemically pure silicic acid in water (see Eng. Pat. 9237 of 1914; this J., 1914, 719). Textile materials so impregnated possess a finish which is particularly suitable for absorbing basic dyestuffs. Fibrous materials impregnated in this manner are fireproof "to a surprising degree."—A. B. S.

Plastic compositions and slabs for building and other purposes. J. C. G. Sperti and L. S. Burt, London. Eng. Pat. 103,775, Aug. 2, 1916. (Appl. No. 10,881 of 1916.)

A PLASTIC composition for roofs, partitions, floors, slabs, etc., is made of sawdust 50%, finely ground burned magnesite 25%, and pumice powder 25%, with sufficient magnesium chloride of 18—25° B. (sp. gr. 1.14—1.21) to make a semi-dry mixture and with or without the addition of colouring matter and raw linseed oil. A protected reinforcement may be embedded in this composition if desired. The addition of 1 gallon of raw linseed oil to 25 gallons of the magnesium chloride solution prevents contraction during the setting of the composition and also brightens and preserves the colour.—A. B. S.

Heat insulating chambers, walls, floors, and ceilings; Manufacture of —. J. Davies, Liverpool, and W. H. Jones, Wallasey, Cheshire. Eng. Pat. 103,839 of 1916. (Appl. Nos. 1510, Feb. 1, 1918, May 1, and 6535, May 6, 1916.)

A NON-CONDUCTING covering or heat-insulating material for walls, floors, etc., is built of independent units or slabs, each composed of a primary layer of tough organic material, such as compressed cork, which is coated on the inner face with a secondary layer of oxychloride or Portland cement in a plastic state, which is pressed into the primary layer and then dried.—A. B. S.

Roadway composition. R. F. Tompkins, New York, Assignor to The Binder Co. U.S. Pat. 1,213,555, Jan. 23, 1917. Date of appl., Aug. 15, 1913.

The composition consists of a road base, a filler, and an insoluble metallic compound of an aromatic organic acid, such as tannic acid.—A. B. S.

Binding composition for roads, etc. R. F. Tompkins, New York, Assignor to The Binder Co. U.S. Pat. 1,211,972, Feb. 6, 1917. Date of appl., Aug. 15, 1913.

A BINDING composition for roads, etc., is composed of a hygroscopic aromatic glucoside and a material insoluble in and resistant to water, such as a resinous substance or a fixed oil.—A. B. S.

Rotary cement-kiln gases; Recovery of material in the form of dust from —. L. Stevens, Assignor to Jermin and Stevens, Alpena, Mich. U.S. Pat. 1,214,725, Feb. 6, 1917. Date of appl., Aug. 19, 1915.

The flue gases from rotary cement-kilns are mixed with water, which is converted into steam by the heat in the gases, and the gases thus cooled are passed through a dust-separator which precipitates the suspended matter in a dry condition. The quantity of water mixed with the gases is increased or decreased automatically as the temperature of the gases rises or falls.—A. B. S.

Cement; Manufacture of —. J. F. Goddard, London. U.S. Pat. 1,211,910, Feb. 6, 1917. Date of appl., May 5, 1915.

SEE Eng. Pat. 13,512 of 1914; this J., 1915, 426.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Rust from iron plates; Removal of —. F. W. Watson. J. Chem., Met., and Min. Soc., S. Africa, 1916, 17, 109.

A FINELY crushed mixture of 2 parts of sodium bisulphate and 1 of common salt is wetted until cohesive, applied to the iron plate, and left on till the plate is clean. The action is much more rapid if the plate is scraped every 2–3 hours and scrubbed with a wire brush and water, and the treatment repeated. When clean the plate is well washed, finally with an alkaline solution, and dried quickly.—W. R. S.

Manganese in steel; Determination of —. J. A. Cashmore. Chem. News, 1916, 114, 239.

IN the following method the delicacy of the precipitation of iron by neutralising with ammonia is avoided. One or two grms. of the sample is dissolved by means of hydrochloric acid and potassium chlorate, and after expelling free chlorine, the solution is diluted to 400 c.c., heated to boiling, and boiled for two mins. with a slight excess of zinc oxide emulsion to precipitate the iron. The precipitate is filtered off and washed with hot water; precipitation of zinc hydroxide in the filtrate is disregarded. The filtrate is heated to 60° C., treated with 1 gm. of ammonium persulphate to oxidise the manganese, and boiled with excess of ammonia. After filtering, the precipitate of hydrated manganese peroxide is washed with strong ammonia solution to remove zinc, then with hot water, dried, and ignited. Greater accuracy is obtained by dissolving the ignited residue of Mn_2O_3 in hydrochloric acid, adding a few c.c. of nitric acid, and re-precipitating the manganese with ammonium persulphate and ammonia.

Chromium; Determination of — in ferrochrome. W. Herwig. Stahl u. Eisen, 1916, 36, 646–650. J. Chem. Soc., 1917, 112, ii., 101–105.

THE volumetric estimation of chromium in ferrochrome by means of potassium permanganate gives low results if the theoretical titer number for chromium as recorded in the text-books (0.319 instead of the empirical number 0.3165) is used. On the other hand, accurate results are obtained by the sodium thiosulphate and potassium bichromate methods. The following shortened sodium thiosulphate process gives results accurate to 0.3%, and can be completed in an hour. The powdered sample is passed through a sieve of 270 meshes to the sq. cm., and 0.5 gm. is fused in an iron crucible with sodium peroxide (5–6 grms.), gentle heat being applied for about a minute until the metal has dissolved in the fused mass, after which it is heated, with gentle agitation, for two minutes with the full Bunsen flame. The somewhat cooled crucible is transferred to a beaker containing about 350 c.c. of water at 60°–80° C., the beaker immediately covered with a clock-glass, and the water cautiously boiled for five minutes to decompose the sodium peroxide completely; after being cooled, the solution is diluted to 500 c.c. and passed through a double filter. 100 c.c. of the filtrate is diluted to about 300 c.c. with water, treated with potassium iodide (1 gm.) and hydrochloric acid (sp. gr. 1.124, 40 c.c.), and, after 1 min., titrated with sodium thiosulphate. Decomposition of ferrochrome by magnesium carbonate mixture is frequently incomplete. After being sifted, the specimen should be ground for two to three hours in an agate mortar, and the mixture must be heated for at least an hour with a powerful blow-pipe flame. The residue from the first operation must be once more, at least, similarly treated.

Gold; Volatility of — at high temperatures in atmospheres of air and other gases. W. Mostowitsch and W. Plehnoff. J. Russian Metall. Soc., 1915, 419–431. Met. and Chem. Eng., 1917, 16, 153–151.

FUSED samples of purified gold, of 0.2 to 0.5 gm. weight, were placed in an unglazed porcelain or quartz boat and submitted to a stream of gas for measured intervals, extending up to $2\frac{1}{2}$ hrs., while heated in a Heraeus furnace to temperatures between 1100° and 1400° C. The metal was weighed before and after each experiment by means of a micro-balance. In atmospheres of oxygen, nitrogen, carbon monoxide or dioxide, no loss of weight could be detected at temperatures up to 1400° C. With hydrogen, however, volatilisation was observed, amounting at 1400° C., after an interval of 25 mins., to 0.98 mgrm., corresponding to a loss of 0.25%. The vaporisation was accompanied by a deep red colouring of the silica boat and the heating tube, due to the formation of a colloidal solution of gold in the quartz. This action is analogous to similar phenomena shown by copper when heated in hydrogen, and leads to the supposition that, at temperatures above 1200° C., an unstable hydride such as Au_2H_2 is successively formed and decomposed.—J. N. P.

Australian zinc industry. Ch. of Comm. J., Mar., 1917.

A NEW company, the Zinc Producers' Association Proprietary, Ltd., has recently been formed to handle all zinc concentrates produced within the Commonwealth. This is the largest and most powerful metal combination in the Southern Hemisphere and one of the most important in the world. The Commonwealth's annual output of zinc ores and concentrates amounts to 150,000 tons, and the gross value of metal is not less than

£5,000,000. All of the zinc-producing companies of Australia are members. The association is founded on a co-operative basis. One of the fundamental principles is "equality of treatment" to all members, irrespective of the tonnage of output. The Commonwealth Government is represented on the board, thus safeguarding the interests of the general community. As the result of the Commonwealth Prime Minister's efforts in England the spelter question has been settled as far as Great Britain and Australia are concerned. A contract has been entered into for a large supply of zinc concentrates per annum for Great Britain during the currency of the war, with the option of increasing the quantity.

To meet post-war conditions a comprehensive scheme covering the whole output of Australia has been adopted. The British Government has entered into a definite agreement for a term of ten years to take a minimum of 100,000 tons of Australian concentrates at satisfactory prices. As to the remainder, arrangements have been made whereby Australia will treat locally 10% of the whole of the zinc concentrates produced in the Commonwealth. Of the spelter thus produced, the British Government has further contracted to take up to 45,000 tons per annum of spelter and electrolytic zinc produced in Australia for a period of ten years. The post-war requirements of France and Belgium and other Allies are being considered.

In order to deal more effectively with the zinc concentrates reserved to Australia under the scheme, a company called the Australian Electrolytic Zinc Company has been formed. Contracts for power have been arranged with the Tasmanian Government; technical experts have been engaged and the company promises to be one of the foremost industrial concerns in the Commonwealth. Towards securing capital for Australian zinc industries the Imperial Government undertakes to advance a substantial sum at the same rate of interest as is paid by the Imperial Government, if required, to finance Australian zinc works until war restrictions are removed. The Mount Lyell company is embarking upon a new venture, and promises to be a large producer of electrolytic zinc. The enlargement of the Port Pirie zinc distillery is receiving attention. Zinc specialists have been engaged to undertake the modernization of the zinc distilling plants in Australia, and also to install and work the electrolytic zinc processes.

Aluminium scrap and swarf and cupro-nickel scrap; Government control of —.

THE Ministry of Munitions has issued orders governing the conditions under which the above metals will be controlled. The full text of the orders will be found in the issues of the *Board of Trade Journal* of March 7th and 15th respectively.

Zinc-lead smelting plant at Ekibastus, Siberia. Eng. and Min. J., 1917, 103, 266.

IN the annual report of the Irtysh Corporation, Ltd., the progress in building and putting into operation the great zinc and lead-smelting plant at Ekibastus, Siberia, which is to treat the ore of the Ridder mine, was summarised. In the zinc plant proper, the first duplex Merton calciner started in May, 1916, and one block of retorts followed in August. The zinc-distillation furnaces are of modern type, gas-fired and regenerative. Each block has an estimated output of 150 tons of spelter a month. For the first eight weeks of operation the output of spelter was about 90 tons, and the management is looking forward to a rapid increase in this up to full capacity. Additional calciners are nearing completion, and a second block of zinc retorts was to be ready by the end

of 1916. The plant has been laid out for an installation of 20 blocks of zinc furnaces, of which it is expected to have six completed by the end of 1917. Construction work on the lead-smelting plant is well advanced. The smaller of the two blast furnaces should be ready to go into commission early in 1917 and the larger one during the summer. This plant will treat the lead concentrates received from Ridder and the residues from the zinc retorts. Adjacent to the lead plant a lead refinery is being erected. It will consist of softening and drossing furnaces, desilverisation kettles, a Howard press and stirrer, and a tilting furnace for the distillation of the zinc crusts from the desilverisation kettles. The bullion refinery will produce pure gold and silver. Work on the bullion refinery is advancing, and should be completed as soon as needed.

Glucinum [beryllium]: Melting point and heat of fusion of —. G. Oesterheld. Z. anorg. Chem., 1916, 97, 1—6. J. Chem. Soc., 1917, 112, ii., 89.

GLUCINUM, prepared electrolytically from sodium glucinum fluoride, was pressed into pastilles and fused in a magnesia tube in hydrogen. The product contained 99.5% Gl, the principal impurity being the carbide. Heating and cooling curves gave the value $1278 \pm 5^\circ \text{C.}$ for the melting point. An approximate determination of the heat of fusion by comparing the duration of the arrests when equal volumes of gold and glucinum were cooled under similar conditions, gave 277 cal. per grm., whilst Crompton's rule, atomic weight \times heat of fusion \div absolute temperature of fusion = 2, gave the value 341. Glucinum has the largest heat of fusion of any metal, corresponding with its high melting point and low atomic weight.

Glucinum [beryllium]: Alloys of — with aluminium, copper, silver, and iron. G. Oesterheld. Z. anorg. Chem., 1916, 97, 6—10. J. Chem. Soc., 1917, 112, ii., 89—90.

GLUCINUM and aluminium are miscible in the liquid state and do not form a compound. The freezing-point curve has two branches, with an eutectic point at 614°C. and 4 atomic % Gl. Solid solutions are only formed at the glucinum end of the series up to 3 atomic %. The sections may be etched with dilute sodium hydroxide. It has not been found possible to alloy glucinum and magnesium, as the latter boils below the melting point of the former. The alloys with copper are complicated. The freezing point of copper is first lowered, solid solutions being formed up to 10 atomic % Gl, and beyond this the liquidus and solidus, which are separated by a very small interval, have an unusual form, passing through a minimum and a point of inflexion. The β -solution breaks up at a lower temperature; there being an eutectoid point at 575°C. and 31 atomic % Gl. There is a short ascending branch corresponding with the separation of a γ -solution, and then the freezing-point curve rises to a maximum at the composition Cu_2Gl_3 , beyond which it has not been possible to follow the alloys. The δ -solution contains from 70 atomic % Gl upwards. The transformation of β into α and γ was confirmed by quenching experiments. The eutectoid has a structure very like that of the pearlite of steel. The compound Cu_2Gl_3 is reddish-grey. The alloys may be dissolved in nitric acid for analysis, and the copper estimated by electrolysis. Silver and glucinum give a simple eutectiferous system, the eutectic point being at 878°C. and 16 atomic % Gl. Solid solutions are only formed to the extent of about 8 atomic % at the glucinum end of the series. A transformation point of 748°C. has been observed, and as pure glucinum is not allotropic, it is suggested that a compound may be formed.

The alloys increase in hardness and diminish in ductility as the glucinum increases. The alloys with iron have been examined up to 21% Gl by weight. There is an eutectic point at 1155° C. and 38.4 atomic % Gl, the region of solid solutions extending to 29%. The β - α -transformation of iron is lowered by glucinum, becoming constant at 650° C. The compound, which may have the formula FeGl_2 , is darkened by sodium hydroxide.

ERRATUM.

This J., Feb. 28, 1917, page 220, col. 1. "*Counter current decantation in the cyanide process*," line 8 from bottom of abstract, for "6-0209c. (0-01045d.)" read "2c. (1d.)."

Roasting of zinc blende. Hutin. See VII.

Critical examination of Lunge's dry method for the rapid determination of sulphur in roasted pyrites, etc. Pérégriu. See VII.

Some reactions involved in secondary copper sulphide enrichment. Zies and others. See VII.

Reduction of silver chloride and lead chloride. Gawalowski. See VII.

Electroanalysis of tin without platinum electrodes. Batuecas. See XXIII.

PATENTS.

[*Briquetting iron ores and flue dust.*] *Binding material and method of preparing same.* M. Freiburger, Charlottenburg, Germany. Eng. Pat. 7010, May 10, 1915. Addition to Eng. Pat. 15,919 of 1913 (see Fr. Pat. 460,954 of 1913; this J., 1914, 85).

THE binding material is produced by heating a mixture of highly basic aluminosilicates, or burnt lime and iron oxide or hydroxide, or an ore relatively high in lime, to a temperature below the sintering point. It is mixed with ores poor in lime, and the mixture briquetted below sintering temperature. If an ore contains an excessive proportion of lime, it is heated to below the sintering temperature, and a sufficient proportion of uncalcined ore is added to prevent expansion of the resulting briquettes. The ore or flue dust may also be elutriated, the fine portion being mixed and heated with burnt lime or basic aluminosilicate, and used to briquet the coarse portion. The binding mixture may be produced by wet grinding; the lime may be dry-slaked, or slaked with the wet fine portion from the elutriation.—W. R. S.

Steel or ingot iron; Manufacture of——. B. Talbot, Middlesbrough. Eng. Pat. 103,569, Apr. 5, 1916. (Appl. No. 4996 of 1916.)

A FURNACE is used which contains two or more separately tilting hearths, each of which is used for independent mixing or refining. (See also Eng. Pats. 22,767 of 1903 and 9110 of 1904; this J., 1904, 939; 1905, 444.)—W. R. S.

Steel ingots; Apparatus for treating——. E. J. Flynn, jun., Woodlawn, Pa. U.S. Pat. 1,212,470, Jan. 16, 1917. Date of appl., Mar. 10, 1916.

THE intermediate portion of the floor of a soaking pit is made of gradually increasing height from each end towards the centre, thus providing a pair of supports for the ingots; the pit has also an abutment on each side wall extending inwards. These supports and abutments are adapted to contact respectively with the inner corners of a

pair of opposed ingots, and with their outer sides. The ingots are thus maintained in an upright position, spaced from each other and from the sides and bottom of the pit, to obtain equal distribution of heat round them.—T. H. B.

Steel and iron; Process of making——. S. S. Knight, Berkeley, Cal. U.S. Pat. 1,213,896, Jan. 23, 1917. Date of appl., Feb. 18, 1914.

IN the manufacture of iron or steel in a basic open-hearth furnace, a layer of ferrous material low in carbon, such as steel or wrought iron scrap, amounting to 10 to 20% of the entire weight of the charge, is introduced directly on to the bottom of the furnace, and heated until reduced to a pasty condition, thus forming a protective layer. Burnt lime or limestone to the extent of 5 to 20% of the entire charge is added, then additional charges of ferrous material and carbonising material of a non-ferrous nature, chiefly free carbon, until the entire charge is completed. The temperature is then rapidly raised so as to melt the ferrous material, highly carbonised ferrous material being added, if necessary, to obtain a bath containing about 0.50 to 0.90% carbon. The heating is continued so as to reduce rapidly the quantity of materials other than iron and the metal is finished and drawn off as usual.—T. H. B.

Steel; Alloy with——. F. D. Taggart, Wyomissing, Pa. U.S. Pat. 1,213,973, Jan. 30, 1917. Date of appl., Oct. 31, 1916.

THE steel contains carbon 1.25–2.50, chromium 1.50–3.00, and vanadium 0.25%, the minor elements present not exceeding 1%.—W. R. S.

Furnaces; Electric——[for production of zinc and other metals]. F. Cochlovius, Buchschlag, Hessen, Germany. Eng. Pat. 16,602, Nov. 24, 1915. Under Int. Conv., Nov. 24, 1914.

THE reducing chamber of a rotary electric furnace, for the production of zinc and other like metals, in which the heat is produced by the resistance offered by the charge to the passage of the current, is subdivided into two or more compartments by partitions, and one or more phases of a polyphase current is supplied to each compartment. The central portions of the partitions are cut away, thus forming centrally an undivided chamber, or the partitions may be provided with perforations. A separate condensing apparatus is supplied for each compartment of the reducing chamber.—B. N.

Zinc; Recovery of——. C. H. Fulton, Cleveland, Ohio, Assignor to D. B. Jones, Chicago, Ill. U.S. Pat. 1,213,180, Jan. 23, 1917. Date of appl., July 17, 1916.

GROUND and calcined zinc ore is mixed with coke and a carbonaceous binder, such as pitch, in such proportions that when made into compact briquettes under pressure and subjected to subsequent distillation, the briquettes will maintain their form and volume. The briquettes are preheated to drive off the volatile matter of the binder and convert the latter into coke, then interposed as a continuous resistor between the electrodes of a closed electric furnace. A current is passed to heat them to a distilling temperature, and the zinc is recovered from the evolved vapour.—T. H. B.

Zinc-furnace. G. Londress and L. Rogers, Clarksburg, W. Va. U.S. Pat. 1,213,922, Jan. 30, 1917. Date of appl., June 27, 1914. Renewed Mar. 4, 1916.

IN a zinc dross furnace, a closed, inclined, cylindrical

cal chamber or dross compartment is surrounded by a spiral flue through which the gases from fireboxes beneath pass to a stack. At the lower end of the dross compartment, and adjoining the fireboxes, is a spelter box containing removable kettles adapted to receive molten zinc discharged from openings in the vertical end wall of the cylindrical chamber.—W. E. P. P.

Metals; Plating of — J. A. Law, London. From The Thermic Plating Process Co., Inc., New York. Eng. Pats. 16,867 and 16,868, Nov. 30, 1915. (See also Eng. Pat. 23,576 of 1911; this J., 1916, 123.)

THE metal to be plated (e.g. iron) is coated with a suspension of the plating metal (e.g., copper) and/or a reducible compound of the latter with carbon or other reducing agent in a spreading vehicle (e.g., crude petroleum having an asphaltic base) and heated to a temperature (2000° F., 1090° C.) sufficient to effect the necessary reduction and union.—W. E. P. P.

Aluminium; Process of plating — L. W. Bugbee, Assignor to American Optical Co., Southbridge, Mass. U.S. Pat. 1,244,271, Jan. 30, 1917. Date of appl., Dec. 4, 1916.

THE aluminium article is connected with a source of electricity and submerged in a plating bath. During the plating operation the article is subjected to an abrasive blast, the initial rate of abrasion being greater, and the final considerably less, than the rate of plating.—W. R. S.

Metal scrap; Treatment of — E. R. Sutcliffe and T. G. Hirst, Leigh, Lancs. Eng. Pat. 103,553, Mar. 8, 1916. (Appl. No. 3155 of 1916.)

SCRAP such as shavings, borings, turnings, etc., is prepared for melting by intimately mixing it with 1—3% of moistened flux (borax, soda, or potash) so that the metal particles become coated, and then briquetting the product under heavy pressure without addition of a binding agent.—W. R. S.

De-tinning and the like; Apparatus for — I. Hall, Birmingham. Eng. Pat. 103,836, July 11, 1916. (Appl. No. 452 of 1916.)

THE articles to be de-tinned gravitate from the inlet to the outlet of a slowly rotating, inclined cylinder mounted inside a concentric fixed cylinder lined with firebrick or other refractory material. Flames from gas burners are directed into the annular space between two cylinders. The articles are fed in, at the higher end, through a hopper, the outlet of which is in register, once every revolution, with an opening in the inner cylinder. The products of combustion escape from outlets in the upper part of the outer cylinder.—T. H. B.

Aluminium alloy. W. A. McAdams, Bay Shore, N.Y. U.S. Pat. 1,242,374, Jan. 16, 1917. Date of appl., Apr. 15, 1914. Renewed June 6, 1916.

THE alloy consists of about 128 parts of aluminium, 46 parts of zinc, and 29 parts of copper by weight.—T. H. B.

Ore mixtures; Separating finely divided — in vacuum vessels. F. A. M. Schiebel, Frankfurt, Germany. U.S. Pat. 1,242,566, Jan. 16, 1917. Date of appl., June 25, 1915.

THE ore pulp is subjected to successive vacuum treatments, each higher than the preceding one. The separating chambers each have the shape of

an upright cone with a discharge orifice at the top, overlying which is a vacuum bell. The bells and the chambers are connected in series by valved conduits, so that different degrees of vacuum may be produced in the various bells, at the same time maintaining a desired liquid level in one of the chambers and permitting a flow of liquid to an adjacent chamber through one of the conduits. A portion of the metallic particles present is removed from the pulp by each successive vacuum treatment.—T. H. B.

Molten metal in ingot moulds; Compound for covering the top of — J. E. Sheaffer, Burnham, Pa. U.S. Pat. 1,212,825, Jan. 16, 1917. Date of appl., Apr. 20, 1916.

THE exposed surface of molten metal is protected by a mixture of pulverised anthracite and petroleum oil in about the proportion of one quart of the latter to 100 lb. of anthracite.—T. H. B.

Concentrating ores, minerals or earths; Device for use in — or for like purposes. M. T. Taylor, Carn Brea, Cornwall. Eng. Pat. 103,858, Feb. 14, 1916. (Appl. No. 2201 of 1916.)

Lead alloys; Manufacture of — F. C. Frary, Niagara Falls, N.Y., and S. N. Temple, St. Paul, Minn., U.S.A. Eng. Pats. 101,208 and 101,209, July 19, 1916. Under Int. Conv., Aug. 13, 1915. (Appl. Nos. 10,154 and 10,155 of 1916.)

SEE U.S. Pats. 1,158,674 and 1,158,675 of 1915; this J., 1915, 1256.

Aluminium; Recovery of — from composite materials containing aluminium and silicon, such as clay, bauxite, or the like. J. E. Pollak, London. From Weaver Co., Milwaukee, Wis., U.S.A. Eng. Pat. 103,716, Mar. 1, 1916. (Appl. No. 3083 of 1916.)

SEE Fr. Pat. 481,056 of 1916; this J., 1917, 144.

Tungsten metal; Process for producing homogeneous bodies of chemically pure — of any desired shape. O. Voigtländer and H. Lohmann, Essen, Germany. U.S. Pat. 1,212,426, Jan. 16, 1917. Date of appl., Dec. 2, 1913.

SEE Eng. Pat. 27,369 of 1913; this J., 1915, 875.

Metals; Method of reducing — [electrolytically]. R. J. McNitt, Niagara Falls, N.Y., Assignor to The Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,214,808, Feb. 6, 1917. Date of appl., May 12, 1915.

SEE Fr. Pat. 466,205 of 1913; this J., 1914, 600.

Annealing furnaces heated by gaseous fuel. Eng. Pat. 103,593. See 1.

XI.—ELECTRO-CHEMISTRY.

Titration of sulphates of some divalent metals by the electric conductivity method. Harned. See XXIII.

Electro-analysis of tin without platinum electrodes. Batnevas. See XXIII.

PATENTS.

Machine for waterproofing fibrous materials. U.S. Pat. 1,215,077. See V.

Electrolytic manufacture of perborate of sodium. Eng. Pat. 100,778. See VII.

XII.—FATS; OILS; WAXES.

*Control of fats, oils, oilseeds and their products.
New branch of the Ministry of Munitions.*

THE Ministry of Munitions announce that, by arrangement with the Ministry of Food and the Board of Agriculture, they have assumed control of all fats, oils, oilseeds and their products, including oilcake, soap, and margarine. A new Branch of the Explosives Department of the Ministry is being organised under Mr. Alfred Bigland, M.P., as Controller, assisted by a Consultative Committee representing other Government Departments. Mr. Bigland has for over a year had charge of the interests of the Ministry of Munitions in respect of oils, fats, and oilseeds, required for the extraction of glycerin for use in the manufacture of propellant explosives. The Secretary of the new Branch is Mr. C. W. Bird, to whom communications should be addressed at the Oils and Fats Branch, Department of Explosives Supply, Ministry of Munitions, Storey's Gate, London, S.W. 1.

It is particularly desired that representations to the Controller of Oils and Fats, etc., should be put forward through trade associations and kindred bodies, and not by individuals and firms, in order to avoid unnecessary multiplication of correspondence.

Mineral oils will not be dealt with by the new Branch but by the existing Munitions Petroleum Supplies Branch. Essential oils, butter, and lard are also outside the scope of the new Branch's activities.

Oil testing. A. H. Gill. J. Ind. Eng. Chem., 1917, 9, 136.

1. *A test for oils by salting-out their soaps.* The test depends on the varying quantities of sodium chloride required to salt-out the soaps prepared from different oils. Two grms. of the oil is saponified with 5 c.c. of 10% sodium hydroxide solution (adding alcohol, if necessary), the mixture is evaporated to dryness, the residue dissolved in warm water, the solution cooled, neutralised with hydrochloric acid, using phenolphthalein as indicator, and then diluted to 50 c.c. Ten c.c. of this solution is placed in a bottle and titrated with sodium chloride solution (320 grms. per litre) until the lather just fails to persist for 5 mins. From the quantity of hydrochloric acid used, and this titration with sodium chloride, is calculated the amount of sodium chloride (in grms.) required to precipitate the soap from 1 gm. of oil. The following results were obtained with various oils:—Olive oil, 2.4—2.2; cottonseed oil, 10.6—11.6; linseed oil, 8.0—8.6; oleomargarine, 2.8; butter, 1.2—1.4 grms. of sodium chloride per gm. of oil. In the case of coconut oil soap, an end-point in the titration was not obtainable. II. *Test for gelatinous matter in linseed oils.* When linseed oil is saponified and the resulting soap solution shaken with petroleum spirit, the amount of suspended matter which separates at the junction of the two liquids appears to vary with the drying properties of the oil, the largest quantity being found in oils which are slowest in drying. Ten grms. of the oil is saponified with 20 c.c. of 10% sodium hydroxide solution, and the soap solution is diluted with warm water to 225 c.c.; 25 c.c. of this solution is placed in a test-tube (6 × 1 in.), 8 c.c. of 86° gasoline (sp. gr. 0.618) is added, the mixture shaken, and then centrifuged for 3 mins. at 1800 revs. per min. Ordinary linseed oil gave a layer of sludge, nearly 10 mm. in thickness, between the two layers of liquid, whilst an artists' oil yielded a sludge layer less than 5 mm. in thickness.—W. P. S.

Brazilian oil-seeds. E. R. Bolton and D. G. Hewer. Analyst, 1917, 42, 35—45.

(1) *Elæis guineensis*. The pulp oil and kernel oil are suitable for the same purposes as the palm oil and palm-kernel oil of commerce, but the characters of the fats differ considerably from those of the African products. The Brazilian kernel oil would be regarded as more valuable than the African kernel oil, whilst the pulp oil is less useful than the African product. (2) *Astrocaryum vulgare*, Mart., is another palm which grows in Maranhão, Pará, and the Amazon valley. The pulp oil is of a pale straw colour and has the consistency of vaseline. It prepared from fresh fruits, so as not to contain more than 10% of free fatty acids, it would be suitable for the manufacture of margarine. The kernel oil is a firm solid fat resembling ordinary palm-kernel oil. (3) *Astrocaryum species*. This palm, known locally as *Murumuré*, yields a kernel oil which could be used as a substitute for cacao butter and coconut "stearine." (4) *Acrocomia sclerocarpa*, Mart., is a palm which forms large forests in Paraguay. It yields a pulp oil closely resembling palm oil, but of somewhat less value. The kernel oil melts at a lower temperature than ordinary palm kernel oil. The crude fat is suitable for soap-making and when refined would be particularly suitable for the manufacture of margarine. (5) *Mucimilitiana regia*, Mart. (Anajá or kokerite palm) yields a firm, white, somewhat brittle kernel oil, which is odourless, and suitable for use as an edible fat. (6) *Cocos syagrus*. Two distinct types of this palm occur, the kernels of which give different yields of fats which are practically identical in character and suitable for food. (7) *Attalea funifera*, Mart. The pulp contains only about 1% of oil. The kernels, the shells of which are extremely difficult to crack, yield a fat resembling coconut oil, but somewhat softer. It is suitable for margarine. About 6000 tons of the kernels have been exported in two years. (8) *Eucarpus batara*. The oil prepared by the natives from the pulp of the fruit of this palm closely resembles olive oil in its physical and chemical characters, and is particularly suitable for use as a salad oil. (9) *Virola bichenhyba*, Humb., known as *Ucuhuba*, belongs to the Nat. Order, *Myristicaceæ*. It produces seeds which contain an essential oil of characteristic odour, and a fat, which, when refined, is odourless and neutral. Acid and decomposed fats yield a good candle material when distilled. (10) *Myristica platysperma*, Spruce. The kernels contain a cream-white, hard, brittle fat consisting chiefly of myristin. (11) *Pentaclethra filamentosa* is a leguminous plant, the seed-kernels of which yield a golden oil which deposits "stearine" at 20° to 21° C. The oil is readily saponified but yields a soft soap of poor colour. If refined it would probably be edible. The kernels are also rich in proteins. (12) *Pentaclethra macrophylla* is closely allied to *P. filamentosa*. The seeds are most generally known as *Maboula panza* beans. They yield an oil (sp. gr. 0.917 at 15° C.) with properties practically identical with those of 11. (13) *Caryocar species*. The kernels produce a firm, brittle, white fat, which would be suitable, in admixture with oils, as a margarine fat or lard substitute. (14) *Marins* from Maranhão and Pará are seeds of unknown botanical origin, the kernels of which yield a viscous, deep yellow oil, which could possibly be used, in admixture with mineral oils, as a lubricant. (15) *Pachira species*. The kernels, which have an odour of liquorice and fennugreek, yield a semi-solid fat with an odour of liquorice, which, however, does not prevent its being used for soap-making. (16) *Mahuba-rana*. These seeds of unknown botanical origin yielded a dark-coloured fat, which might be suitable as a candle material. (17) *Carapa guianensis*, Aubl., is

known as *Andiroba*. The oil, which is prepared by the natives, has anthelmintic properties, and is unfit for food, though it could be used for soap-making. (18) *Omphalea megacarpa*, Hemel, which belongs to the *Euphorbiaceae*, produces seeds known as *cayeté nuts*. The kernels yield an oil (sp. gr. 0.9218 at 15° C.), with the physiological properties of castor oil, but differing therefrom in its analytical characters, in not being optically active, or very viscous, and in being only slightly soluble in alcohol. The following table gives the yields and characters of the fats obtained from these seeds.

	Native names	Yield.	Melting point.		Solidif. point.	Saponif. value.	Refractive index (Zeiss) at 40° C.	Iodine value.	Free fatty acids as lauric acid in kernel oil and oleic in pulp oil.	Un-saponif. matter.
		%,	Incipient fusion. ° C.	Complete fusion. ° C.	° C.				%,	%,
1. (2 samples):	<i>Caiete</i> ..									
Pulp		46.9—49.7	22—24.0	30—30.5	21.9	197.4	18.5—51.5	78.1—88.3	20.8—20.5	—
Kernel		31.7—36.7	28.5—28.0	30.2—31.0	27.3—27.8	231.1—220.2	40.5—42.7	25.5—31.0	0.55—0.33	—
2. Pulp	<i>Tucum</i> , <i>Donara</i>	37.5	27.0	35.0	—	220.2	52.5	46.4	43.8	0.75
Kernel		43.5—52.5	29.4—30	30.6—32.5	28.6	210—215.2	36.3—37.5	12.2—	0.51—1.65	—
3. Kernel	<i>Murumuru</i>	38.6—40.2	33	34	32.5	237.0	36.8	13.91	0.36	—
4. Pulp	<i>Paraquari</i>	63.7	—	—	21.9	189.8	40.5	12.4	55.8	—
Kernel	<i>Paraquari</i>	53.4—61.8	21	22—25.8	19.4—24.9	237—246	37.2—40.1	16—30	0.4—1.7	—
5. Kernel	<i>Anaia</i> , <i>Cokrite</i>	60.15	26	28.5	—	240.9	38.3	16.56	0.33	—
6. Blunt fruits, kernel	<i>Piririma</i>	32.1	21	29	26.8	252.5	37.4	12.5	3.2	—
Pointed " " "		23.0	21	25.7	—	—	36.2	13.4	2.97	—
7. Kernel	<i>Babassu</i>	65—68	22.2	26.1	22.7	246.9	37.1	16.3	2.80	—
8. Pulp	<i>Curuá</i> , <i>Pabaá</i> , <i>Batava</i>	—	—	—	7.0	191.8	52.5	78.2	0.48 as oleic acid	1.1
9. Kernel	<i>Cenhuba</i>	6.4	41.7	43.3	40.0	220.3	50.9	14.1	17.5	3.2
10. Kernel		59.3	41.0	42.5	39.8	239.5	37.1	4.98	3.72	—
11. Kernel	<i>Parou-cary</i>	50.90	—	—	14.0	177.0	52.8	68.96	0.20	—
12. Kernel	<i>Mabada</i> , <i>Panza</i> , <i>Owala</i>	50.78	—	18.4	14.1	181.3	57.8	100.4	0.08	1.37
13. Kernel	<i>Savara</i> , <i>Antis</i>	70.30	30.5	37.0	28.6	197.6	46.2	11.86	0.10	—
14. Kernel	<i>Murins</i> ..	62.27	—	—	liquid below 0° C.	196.2	90.3	124.2	8.7	—
15. Kernel	<i>Mitaurana</i>	58.03	18—31	40	—	206.7	47.2	41.7	3.57	—
16. Kernel	<i>Mahubana</i>	70.9	19.0	44.0	—	215.1	41.7	20.98	22.0	4.0
17. Kernel	<i>Andiroba</i> , <i>Crab</i>	57.85	—	28.0*	—	197.0	50.0	62.2	18.6	0.56
18. Kernel	<i>Carapá</i> , <i>Cayeté</i>	66.75	—	liquid	—	192.2	58.4	115.8	0.10	0.49

* Portion liquid at 15° C.

— C. A. M.

Palm oil; Colour tests for —. A. H. Gill. J. Ind. Eng. Chem., 1917, 9, 136—139.

The colour reaction for palm oil (green coloration with acetic anhydride containing a trace of sulphuric acid) described by Crampton and Simons (this J., 1905, 351) is quite untrustworthy. The test is really one for carotin rather than for palm oil, and the reaction is given by any oil which contains carotin, e.g., palm oil, butter, sesame oil, etc. —W. P. S.

Wool fat; Constituents of —. F. Röhlmann. Biochem. Zeits., 1916, 77, 298—328. J. Chem. Soc., 1917, 112, i, 78.

As a result of attempts to separate the constituents of wool fat, the author draws the conclusion that it consists of a mixture of the esters of cholesterol and of alcohols of the fatty series, including ceryl alcohol and alcohols with a smaller number of carbon atoms. He was unable to confirm the presence of carnaubyl alcohol or of ischolesterol. The fatty acids are apparently

cerotic, palmitic, and stearic acids in the more solid constituents of the fat. The more liquid constituents of the fat contain, in addition to free cholesterol, a mixture of alcohols of an oily nature, and the fatty acids are probably stearic and palmitic acids, and an optically active acid (hydroxystearic acid?), together with resin acids. From the more solid constituents of the fat there was found, in addition, mixed with the fatty acids, a substance, m.pt. 103° C., which may be the anhydride of lanoceric acid. Carnaubic acid, which has been described as a constituent of wool fat, is regarded as a mixture of cerotic acid with

acids containing a smaller number of carbon atoms.

PATENTS.

Soap-like detergents and manufacture thereof. W. Feldenheimer. London. Eng. Pat. 103,535, Feb. 3 and Mar. 13, 1916. (Appl. Nos. 1668 and 3748 of 1916.)

A MIXTURE of spent soap lyes, 25, china-clay or "killas" (see Eng. Pat. 7920 of 1914; this J., 1915, 500), 25, and soft soap, 7.5 parts by weight, with or without the addition of 1 to 2% of "nitre." The china-clay is mixed with the lye heated previously to 80° C., and the soap, in solution and also heated to 80° C., is added.—W. P. S.

Apparatus for drying and treating sewage sludge, copra, and other materials in bulk. Eng. Pat. 103,521. See 1.

Method of making food compositions [from peanuts]. U.S. Pat. 1,213,854. See XIXA.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.**PATENTS.**

Carbon-black; Process and apparatus for making — W. O. Snelling, Pittsburgh, Pa. U.S. Pat. 1,213,915, Jan. 30, 1917. Date of appl., Oct. 11, 1915.

A CARBONACEOUS flame is allowed to impinge upon a surface which is maintained at a temperature above 100° C., but below the temperature of the flame. This is achieved by the use of a plate of sufficient thickness to ensure that there is a substantial difference between the temperatures of its lower, carbon-collecting surface and its upper surface, which is in contact with a cooling liquid.—E. W. L.

Colours and the like; Process for thickening and filtration of — J. Jung, C. In-Ehrenfeld, Ger. Pat. 295,577, Jan. 12, 1915.

THE liquid carrying the colour in suspension is passed under pressure through a series of independent filter-cells, and the resulting paste is conveyed to a receptacle in which a vacuum filtering drum is mounted eccentrically. Compressed air is supplied to the space between the drum and the receptacle, the inlet opening for the paste being sealed by the paste itself. The cake which forms on the outer surface of the drum is compressed by an adjustable, curved, spring-like member, and is subsequently removed by a scraper. The surface of the drum is kept clean by a rotating brush near the inlet opening for the paste.

Condensation product from phenols and formaldehyde. L. Berend, Amöneburg, Germany. U.S. Pat. 1,211,414, Jan. 30, 1917. Date of appl., Mar. 19, 1914.

ARTIFICIAL soluble and fusible resins are obtained by condensing crude cresol containing *m*-cresol, or a mixture of *p*-cresol and *m*-cresol, with "a formaldehyde body" in about such quantity as the quantity of *m*-cresol in the mixture will call for, expelling and recovering the unused cresol from the product. —E. W. L.

Varnishes, paints, and other protective or coating preparations; Manufacture of — H. Terrisse, Geneva, Switzerland. Assignor to The Indestructible Paint Co., Ltd., London. U.S. Pat. 1,211,611, Feb. 6, 1917. Date of appl., Apr. 22, 1915.

SEE Eng. Pat. 23,054 of 1914; this J., 1916, 57.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Rubber; Wet combustion in the nitrosite combustion method for the direct determination of — L. G. Wesson and E. S. Knorr. J. Ind. Eng. Chem., 1917, 9, 139—140. (See this J., 1914, 703.)

THE nitrosite is prepared in a chloroform solution and the latter is filtered into a round-bottomed flask, and evaporated. Meanwhile the portion insoluble in chloroform is also dried and extracted repeatedly with ethyl acetate dried previously over calcium chloride, the extracts being filtered into the same flask. The ethyl acetate is then evaporated and the residue in the flask treated with 15 c.c. of water containing 1 drop of hydrochloric acid, which is evaporated rapidly by the use of a current of dry air. The dry residue is heated for a further 30 mins., and then oxidised by the gradual addition of a mixture of 10 grms. of potassium bichromate and 75 c.c. of sulphuric

acid. The gases evolved are passed through a series of U-tubes containing, in order, sulphuric acid and bichromate, water containing a drop of the preceding mixture, granular zinc, calcium chloride, soda-lime (weighed), and soda-lime and calcium chloride (weighed). Heat is applied to the combustion flask to complete the oxidation, and the last traces of carbon dioxide are swept over into the absorption tubes by means of a current of air free from carbon dioxide. When 0.5 gm. of rubber is taken for the determination, the weight of carbon dioxide found multiplied by 61.8181 gives the percentage of $C_{10}H_{16}$ in the sample.—W. P. S.

Rubber; Aniline method for the determination of mineral fillers in — O. H. Klein, J. H. Link, and F. Gottsch. J. Ind. Eng. Chem., 1917, 9, 140—141.

ONE gm. of the finely-divided rubber is extracted with acetone for 4 hours, then dried at a low temperature, and transferred to a weighed centrifuge tube; 50 c.c. of pure aniline and 5 c.c. of nitrobenzene are added, the tube is covered, and the mixture is heated at 160° C. until solution of the rubber is complete. This requires from 3 to 18 hours, or more. After cooling, ether is added to fill the tube, and the contents of the tube are mixed and centrifuged for 15 mins. at 1500 revs. per min. The supernatant liquid is then decanted, and the residue centrifuged four times with ether, using 25 c.c. each time. The contents of the tube are then dried at 100° C., and weighed. The ethereal solutions decanted from the tube are united, and evaporated, and the residue is ignited in a silica basin; the weight thus found is added to that of the residue in the tube. The addition of nitrobenzene causes more rapid solution of the rubber.—W. P. S.

Rubber products; Determination of mineral matter in — J. P. Périgrin. Ann. Chim. Analyt., 1917, 22, 27—29.

THE results obtained by the direct incineration of rubber being inaccurate, owing to the losses of zinc, antimony, lead, etc. incurred, the use of anisole as a solvent for the organic constituents is recommended. 1—2 grms. of the rubber (raspings) is digested with 50—100 grms. of anisole at 100° C. for 6 hrs. or until the rubber ceases to swell; a large excess of pure benzene is then added, and the mixture allowed to stand for several days, after which the mineral matter is readily separated by centrifugal means.

—W. E. F. P.

Diphenylbutadiene. Johlin. See XX.

PATENTS.

Vulcanising plastics [rubber]; Process of — C. J. Rendall, Naugatuck, Conn. Assignor to Boston Rubber Shoe Co. U.S. Pat. 1,213,905, Jan. 30, 1917. Date of appl., May 13, 1915.

RUBBER, or similar material, is partially vulcanised in contact with air heated to vulcanising temperature, and at a pressure sufficient to prevent blowing. It is then allowed to cool, also under air pressure, and vulcanisation is afterwards completed in contact with wet steam at vulcanising temperature and pressure.—E. W. L.

XV.—LEATHER; BONE; HORN; GLUE.

Tanning materials from British Malaya. Ch. of Comm. J., Mar., 1917.

THE total value of gambier imports (in bales) into the Straits Settlements from the Malay States,

British North Borneo, and Netherlands India was £208,060 in 1913, £170,231 in 1911, £293,317 in 1915, £251,874 in 1916 (nine months). The values of the exports were £211,535 in 1913, £198,101 in 1911, £300,261 in 1915, and £267,187 in 1916 (nine months); the greater part of the exports went to the United Kingdom, United States, and France. Exports of cube gambier were valued at £165,031 in 1913, £150,723 in 1911, £153,131 in 1915, and £158,368 in 1916 (nine months); the largest consumer is British India, where it is used, as in Malaya, for chewing. In Europe, America, Australia, and South Africa, it is largely used for tanning. Cutch is imported into the Straits Settlements from Brunei and Sarawak, and is then re-exported, the value of the exports having been £10,638 in 1913, £37,918 in 1914, £16,935 in 1915, and £21,370 in 1916 (nine months); before the war Germany was the largest consumer, but recently increasing quantities have been sent to Great Britain.

PATENTS.

Gelatinising substances: Methods for finely dividing —, Akt.-Ges. für Chem. Prod. vorm. H. Scheidemandel, Assignees of E. Sahn, Berlin, Eng. Pat. 100,073, Feb. 10, 1916. (Under Int. Conv., Feb. 10, 1915. (Appl. No. 2016 of 1916.) Addition to Eng. Pat. 15,365 of 1915.

SEE U.S. Pat. 1,195,099 of 1916; this J., 1916, 1029. The liquid into which the gelatinising substance is introduced, consists of machine oil having a viscosity of 6 (Engler) at 50° C.

Manufacturing colloids. U.S. Pat. 1,211,299. See I.

XVI.—SOILS; FERTILISERS.

Acid soils: Investigations on the acidity of —, S. Osugi and T. Uetsuki, Ber. Ohara Inst. Landw. Forschungen, 1916, 1, 27—52.

Two 100-gram. portions of a soil were treated respectively with 400 c.c. of $N/10$ potassium chloride solution and the same amount of $N/10$ solution of potassium acetate. After standing for two days, with frequent agitation, the clear liquids were boiled, and the acidity determined by titrating with $N/10$ sodium hydroxide; the silicic acid and alumina-contents were also determined. It was found that the alumina in the filtrate from the potassium chloride extract was 10—20 times greater than that in the filtrate from the acetate extraction, but the acidity of the former was only $\frac{1}{2}$ — $\frac{1}{3}$ that of the latter. Various acid soils were then treated similarly and the filtrates analysed, with the result that the soils were shown to exert a selective capacity for adsorbing bases, and that the amount of bases adsorbed was equivalent to the sum of the exchanged bases and the acid liberated. Investigations of a soil in various stages of disintegration, taken from an orchard of the Ohara Institute, and including the mother rock—a quartzitic diorite, and its end-product—a red clay, showed that the percentage of bases diminished with increased weathering, and that the acidity, the loss on ignition, and the adsorptive capacity increased correspondingly. Similar experiments on artificially prepared hydrated aluminium silicates showed that their degree of acidity was closely related to the amount of base they contained.

When a soil undergoes active weathering, basic constituents are strongly adsorbed by the colloidal substances set free, and when such soils are treated with a salt solution, free acid is produced. Since the aluminium compounds present in a soil are attacked and dissolved much more readily by dilute hydrochloric than by dilute acetic acid, it is obvious that the potassium chloride extract of a soil will contain more dissolved alumina than an extract made with potassium acetate. An acid soil is to be regarded as a soil deficient in basic constituents.—E. H. T.

Plants: The injurious and stimulating actions of acids upon —, I. Onodera, Ber. Ohara Inst. Landw. Forschungen, 1916, 4, 53—110.

THE existence of free inorganic acids in soils is probably due to over-application of inorganic fertilisers, and the presence of organic acids to excessive dressings of organic manures. In investigating the influence of acids upon the germination of barley, rice, and red clover, the seeds were sorted with sodium chloride solution (sp. gr. 1.1), thoroughly washed, air-dried, and then planted in purified moist sea-sand contained in Petri dishes, to which the solution of acid was also added. The dishes were kept nearly covered and the moisture content was maintained constant. The experiments were performed in duplicate, the number of germinated seeds was counted daily for 11 days, and in some cases the lengths of the sprouts were measured. The acids used were formic, acetic, lactic, sulphuric, hydrochloric, and nitric, in concentrations varying from $N/33$ to $N/500$. Formic acid stimulated the germination of barley but not that of rice or red clover; in each case a concentration above $N/100$ proved injurious. Acetic acid much accelerated the growth of barley but hindered germination at above $N/50$. Rice responded less, and all concentrations lower than $N/71$ had the same effect; above that strength this acid retarded germination. Lactic acid did not stimulate red clover seeds, and solutions stronger than $N/83$ proved harmful to the sprouts. In solutions stronger than $N/100$, the mineral acids adversely affected the plants. Sulphuric acid in all concentrations used retarded the germination of barley and red clover, but accelerated that of rice up to the sixth day. Nitric acid weaker than $N/100$ markedly stimulated both germination and growth. By weighing the clover plants at the end of the experiments, it was found that the average effect of the three mineral acids was about the same as that of the three organic acids. The effect of acids upon the growth of young barley, rice, soya bean, rye, bean (*Phaseolus vulg.*, L.), and radish plants was investigated in water cultures containing 0.125% of Sach's solution, of acidity $N/2880$, the growth being under observation for 12 days. The concentrations above which harmful effects ensued varied considerably. Thus for lactic acid and rice it was $N/125$, and for the same acid on rye, beans, and radishes $N/1500$. For the mineral acids the maximum concentrations were $N/250$ for rice and $N/500$ for barley. In general, plant growth was considerably stimulated by moderately concentrated acids, and in particular by nitric acid (used in the form of urea nitrate) containing 0.05 gram. per litre. The latter fact, taken in conjunction with the favourable stimulating action on germination, should prove of great importance in manuring. The order of toxicity of the acids investigated was: hydrochloric (greatest), sulphuric, formic, butyric, acetic, nitric, and lactic. Plants grown in an acid culture develop abnormally in height, their root development is quickly arrested, but the growth of the foliage is continuous.—E. H. T.

Acid phosphate and raw rock phosphate: Relative availability of— in Indiana field tests. S. D. Conner. J. Ind. Eng. Chem., 1917, 9, 154—155.

FIELD tests with various crops (maize, wheat, hay, potatoes) showed that the use of acid phosphate as a fertiliser yielded far better results than were obtained by the use of raw rock phosphate: soils treated with the latter, however, yielded better crops than did the untreated soil.—W. P. S.

Polash; Banana stalks as a source of—. H. E. Billings and A. W. Christie. J. Ind. Eng. Chem., 1917, 9, 153—154.

DRIED banana stalks contain 16.46% of potash (K₂O) and, as a fertiliser, compare favourably with dried kelp. When charred and leached, 1 ton of the dried stalks yields 27 lb. of 90% potassium carbonate. (See also Ellis, this J., 1916, 456.)
—W. P. S.

Oranges: Effect of fertilisers on the composition and quality of—. H. D. Young. J. Agric. Res., 1917, 8, 127—138.

NEITHER potash nor phosphate exerted any effect on oranges grown at the Californian University Citrus Experimental Station. The application of nitrogenous manures gave coarser fruit with a little less juice and a slightly lower sugar content, and this result was the same whether the nitrogenous fertiliser was applied alone or in conjunction with potash or phosphate, or with both. In every case where nitrogen was applied, the fruit contained an increased percentage of that element.
—E. H. T.

Field trials; Experimental error in—. C. Miyake. Ber. Ohara Inst. Landw. Forschungen, 1916, 1, 111—121.

THE magnitude of the experimental error involved in estimating a crop of barley, and a rice crop, at Morioka (Japan) was determined by subdividing each field into one hundred small unit plots ($\frac{1}{100}$ th acre), and harvesting the grain on combinations of 3, 5, and 10 units selected in different ways. The standard deviation decreased as the number of combined units was increased, and it was always smaller when the units were chosen at random than when adjacent units were selected. The probable error for the barley was $\pm 3.3\%$, and for the rice $\pm 1.8\%$. For English crops and unit plots of $\frac{1}{100}$ th acre, Hall and Russell recorded $\pm 5\%$. In estimating the total yield of a field crop by this method of partial harvesting, it is advisable to use various methods of sampling. Of the six methods employed, the "scattering" and the "diagonal" gave the best results. In the former, ten plants were taken from each of ten small unit plots situated in different parts of the field; in the latter, two ropes were stretched diagonally across the field and the plants growing nearest to them were selected.—E. H. T.

Possible partial substitution of nitre cake for sulphuric acid in the manufacture of sulphate of ammonia. Parrish. See VII.

PATENTS.

Fish meal and the like; Manufacture of—. W. West, Grimsby, Lincoln. Eng. Pat. 103,493. Jan. 17, 1916. (Appl. No. 746 of 1916.)

FISH offal, for the production of fish meal, is treated in the inner receptacle of a double-walled vessel, steam being passed into the annular space through inlets in the outer wall, and thence to the material through perforations in the inner vessel.

Steam may also be supplied from a perforated pipe, extending substantially the whole length of the double-walled vessel.—B. N.

Potassium [salts]; Process of extracting— from minerals. H. Blumenberg, Los Angeles, Cal., Assignor to E. B. Mapel, New York. U.S. Pat. 1,214,003, Jan. 30, 1917. Date of appl., Apr. 3, 1916.

A REFRACTORY mineral containing potassium, such as feldspar, is powdered, mixed with an equal quantity of powdered sodium nitrate or an alkaline-earth nitrate, and heated to 1200°—1500° F. (650°—815° C.) in a closed chamber till the liberation of oxides of nitrogen ceases. The fused mass is ground, treated with sulphuric acid, the solution filtered off, and the potassium sulphate separated from other salts by crystallisation. The potassium in the mineral is thus rendered available as a commercial fertiliser.—W. F. F.

Manure or fertiliser; Manufacture of an artificial—. A. Messerschmitt, Stolberg, Germany. U.S. Pat. 1,214,346, Jan. 30, 1917. Date of appl., Oct. 25, 1916.

POTASSIUM minerals, e.g., silicates, mixed with phosphates and a basic substance, are calcined, and then treated with a hot concentrated solution of calcium nitrate.—B. N.

XVII.—SUGARS; STARCHES; GUMS.

Levulose; Determination of— in presence of dextrose. L. Loewe. Proc. Soc. Exper. Biol. and Med., New York, 1916, 13, 71—72. J. Chem. Soc., 1917, 112, ii. 49.

THE method depends on the yellow coloration developed after boiling and addition of a 0.2% solution of orcein and an 85% solution of phosphoric acid; the yellow colour becomes orange on addition of alkali. The test is made quantitative by colorimetric comparison with a standard levulose solution treated with the reagents. Levulose was detected in 1 c.c. of a 0.05% solution. Sucrose interferes, owing to hydrolysis by the acid.

d-Glucose [dextrose]; Studies on the forms of— and their mutarotation. C. S. Hudson and J. K. Dale. J. Amer. Chem. Soc., 1917, 39, 320—328.

FOR the purpose of studying the mutarotation coefficient of glucose, pure α - and β -glucose were prepared in quantity by the following method. "Corn sugar," prepared by the acid hydrolysis of corn (maize) starch, was dissolved in five times its weight of water, decolorised with decolorising carbon, and evaporated *in vacuo* to a syrup, containing 70—75% of solids, and to this an equal weight of glacial acetic acid was added. Crystallisation soon commenced and was complete in a few hours, giving a yield of 60—70% of pure glucose after drying in a vacuum at 50° C. From this purified glucose β -glucose was obtained by dissolving 500 grms. in 50 c.c. of water and adding 600 c.c. of hot glacial acetic acid, with stirring. Crystallisation commenced in the hot liquid and the crystals, filtered off with the aid of suction, consisted of 93% β -glucose. By recrystallising twice from concentrated (1 in 1) ice-cold aqueous solution, with the addition of alcohol, a pure product was obtained having an initial rotation of +19.0°. α -Glucose is the predominating form when crystallisation occurs slowly at ordinary temperature from somewhat dilute acetic acid. Thus the addition of 1000 c.c. of glacial acetic acid to a solution of 500 grms. of glucose in 250 c.c. of water gave, after washing with alcohol, a pure α -glucose which had an initial rotation of -110° .
—G. F. M.

Syrups for canning and preserving. J. B. McNair. J. Ind. Eng. Chem., 1917, 9, 151—153.

TABLES are given showing galls, of water or oz. of sugar per gall, of syrup required to change a syrup from a given degree Brix to another given degree Brix at 17° C., and for similar changes in the sp.gr. of the syrup. The tables are calculated from the empirical formula: $y = 1.4x + 0.002512x^3$, where x = degrees Brix of syrup and y = the oz. of sugar added per gall. of water at 17° C. (See also this J., 1916, 701.)—W. P. S.

Double salts formed by sodium and potassium carbonates. Bain and Oliver. See VII.

PATENT

Maltose and process of making the same. F. J. Hemig, Assignor to Crown Maltose Co., Chicago, Ill. U.S. Pat. 1,214,160, Jan. 30, 1917. Date of appl., Feb. 12, 1915.

STARCH in solution is subjected to the action of diastatic enzymes, the solution is then sprayed into a drying atmosphere, and the resulting dry substance, consisting of spheroidal particles containing more than 90% of reducing sugars, calculated as maltose, is collected.—W. P. S.

XVIII.—FERMENTATION INDUSTRIES.

Wine: Microanalysis of— M. Ripper and F. Wohack. Z. landw. Versuchs-Wesen, Oesterr., 1916, 19, 372—381. J. Chem. Soc., 1917, 112, ii., 106.

WOHACK'S method of estimating glycerol in wine (this J., 1915, 974) has been modified to render it suitable for micro-analysis. 0.5 c.c. of wine which has been evaporated to half its original volume and treated with barium acetate and tannin (100 c.c. of wine, 10 c.c. of 10% barium acetate solution, and as much tannin as can be placed on the point of a knife) is brought into a decomposition flask and treated with 1.5 c.c. of hydriodic acid (sp. gr. 1.96). The decomposition vessel is a quartz or glass tube filled with platinised quartz or platinised asbestos, and is shielded from direct contact with the flame by asbestos paper and iron gauze. The rest of the process is the same as that previously described. The complete process, including evaporation of the wine, occupies 1½ hrs., and gives very accurate results with a minimum expenditure of time, labour, and cost.

Cider vinegar: Volatile reducing substance in— R. W. Balcorn. J. Amer. Chem. Soc., 1917, 39, 309—315.

THE volatile reducing substance present in the distillate from cider vinegar consists largely, if not wholly, of acetyl-methyl-carbinol, $\text{CH}_3\text{CH}(\text{OH})\text{CO}\cdot\text{CH}_3$, which is shown to be a normal constituent of cider vinegar. From the distillate diacetylphenylsazone was prepared and identified, but that it originated from the carbinol and not from diacetyl was proved by the fact that dilute solutions of the latter were yellow in colour, had no reducing properties, and gave a quantitative yield of the dioxime, whereas the vinegar distillate was colourless and gave no dioxime.—G. F. M.

Cream of tartar: Manufacture of— in South Australia. W. A. Hargreaves. S. Aust. Dept. of Chem., Bull. No. 3, 1916, 1—12.

THE imports into the Commonwealth of Australia for the year 1913 amounted to 2101 tons of cream of tartar and 180 tons of tartaric acid, of which

S. Australia took 190 tons and 65 tons respectively. The average value of cream of tartar works out at £87 and of tartaric acid at £120 per ton. The average annual production of wine in S. Australia is close on 3 million gallons, of which just about one-half is distilled for spirits, at a stage too early for the deposition of any quantity of argol. It is estimated that during storage in casks for two years, 1—6 lb. of argol separates per 1000 galls. of wine, so that from the wine which is not distilled 2½—2¼ tons of cream of tartar should be available per annum, on the basis of a 70% yield from the argol. A very much larger quantity is obtainable from the lees, in which cream of tartar amounts to about 30% of the dry substance. The quantity of wet lees per 1000 gallons of wine varies within wide limits according to circumstances; a conservative estimate gives 6000 galls. of thick lees from 250,000 of wine; the thick lees contains 2.35 lb. of dry solids per gall. One and a half million gallons of wine should therefore yield 11¼ tons of cream of tartar, and it should be possible to obtain a further similar amount from the wine used for distillation, by separating the lees for treatment. The recovery of cream of tartar from the grape marc has not received detailed attention, but if the mares contain about 3% of the salt, there should be a still larger supply, possibly up to 100 tons, available from this source. Cream of tartar may be prepared from argol by treating the material with sodium carbonate, extracting the readily soluble sodium potassium tartrate, and decolorising the solution with animal charcoal, then liberating the acid potassium tartrate by sulphuric acid. For the treatment of the lees, Rasch's neutral process is quite satisfactory. The material is roasted at about 150° C. to decompose the proteins and colouring matters, so that a clear filtrate may be obtained on extraction. The residue is extracted with hot water or mother liquor so as to yield a 6% solution, from which the tartar is crystallised on cooling and then decolorised and purified by recrystallisation. For the treatment of mares, the alcohol may first be recovered in specially adapted stills and the tartar crystallised gradually in shallow wooden vessels from the distillation residue.—J. F. B.

Utilisation of ammonium chloride by yeast. Hoffman. See XIXA.

XIXA.—FOODS.

Yeast [bakers']; Utilisation of ammonium chloride [as food] by— C. H. Hoffman. J. Ind. Eng. Chem., 1917, 9, 148—151.

FURTHER experiments on the use of ammonium chloride as a yeast food (see this J., 1916, 1030) show that, during the progress of fermentation of dough, the ammonium chloride is utilised by the yeast and is converted into yeast-protein. This is confirmed by the fact that the ammonium salt disappears most rapidly between the third and fifth hours of the fermentation, and also by the fact that ammonia cannot be recovered from the fully fermented bread. That there is no increased gas production when yeast is grown in a sucrose solution containing ammonium chloride, whilst a large increase occurs when the salt is added to dough (which contains the necessary substances for yeast production), indicates that the ammonium chloride is a yeast food and not a mere enzyme stimulant. The disappearance of the ammonium chloride cannot be attributed to enzymes of the flour or to bacterial action, for in a dough made of flour, water, salt, sugar, and

ammonium chloride, to which no yeast was added, the amounts of ammonia recoverable at the time of mixing and after 5 hours were identical.—W.P.S.

Proteins ; Adsorption of tin by — and its relation to the solution of tin by canned foods. B. C. Goss. J. Ind. Eng. Chem., 1917, 9, 144—148.

THE solution of tin by canned foods is not dependent on, or proportional to, the acidity alone, and, in the case of foods of relatively slight acidity which dissolve large amounts of tin, the greater part of the tin is in the form of an insoluble and stable complex. The tin after being dissolved from the lining is removed from solution by the proteins, carbohydrates, etc., present. Whether this is due to adsorption of tin ions or to hydrolysis of the tin salts with subsequent adsorption of the stannous hydroxide, in either case the acid is regenerated and able to dissolve more tin. The former explanation seems to be the more probable, since tin is taken up equally well by proteins even from concentrated acid solutions. The reaction differs, however, from a true adsorption in that it is not reversible. It appears, from the results of artificial digestion experiments, that the greater part of the tin is so firmly adsorbed in the food that it will be eliminated directly in the digestive processes and will not exert the characteristic physiological action of soluble tin salts.

—W. P. S.

Brazilian oil seeds. Bolton and Hewer. See XII.

Effect of fertilisers on the composition and quality of oranges. Young. See XVI.

Syrups for canning and preserving. McNair. See XVII.

PATENTS.

Margarine ; Manufacture of —. K. Erslev, Nijmegen, Holland. Eng. Pat. 103,634, Jan. 26, 1916. (Appl. No. 18,627 of 1916.)

FROM 0.1 to 1 % of calcium or magnesium glycolate or lactate, or from 0.5 to 2 % of sodium or potassium glycolate, or a mixture of such salts, is added to the fat or ingredients in order to preserve the buttery aroma of the margarine. (See also Eng. Pat. 2013 of 1915 ; this J., 1916, 324.)—W. P. S.

Food compositions [from peanuts] ; Method of making —. J. C. Fleming, Boston, Mass. U.S. Pat. 1,213,854, Jan. 30, 1917. Date of appl., Nov. 14, 1916.

SHELLED peanuts (earthnuts) are treated with cold borax solution to remove the inner skins, then subjected to the action of steam under pressure until disintegrated into an emulsion-like mass, which is mixed with a cereal and dried. The oil may be removed before the cereal is added.

—W. P. S.

Fruit juices ; Process of preparing and preserving —. H. F. Cheney, Los Angeles, Cal. U.S. Pat. 1,214,134, Jan. 30, 1917. Date of appl., July 7, 1915.

JUICES of citrus fruits are filtered, centrifuged to remove all pulp except a small quantity for flavouring and colouring purposes, then mixed with sugar, and sterilised at 155° F. (69° C.).

—W. P. S.

Alimentary pastes ; Drying machine for —. A. Tegoli, Assignor to Tegoli Drying Apparatus Manufacturing Co., Ltd., Santa Rosa, Cal. U.S. Pat. 1,214,239, Jan. 30, 1917. Date of appl., May 24, 1916.

A DRYING chamber is provided with air-circulating

chambers at either end. A fan circulates the air through the drying chamber and circulating chambers, and an air passage connecting the two circulating chambers extends over the top of the drying chamber, means being provided for regulating the flow of air from this passage into the drying chamber. Fresh air is admitted to one of the circulating chambers, whilst the other is fitted with an outlet.—W. P. S.

XIXB.—WATER PURIFICATION ; SANITATION.

Mines ; Black damp in —. G. A. Burrell, I. W. Robertson, and G. G. Oberfell, Bureau of Mines. Bull. 105, 1916. 88 pages.

"BLACK DAMP" is best defined as an accumulation of carbon dioxide and nitrogen in excess of the percentage found in pure atmospheric air. Changes in mine air are dependent on the velocity of the air in the mine passages, the amount of coal with which it comes in contact, the amount of methane given off by the seam, the extent to which the coal reacts with oxygen, and the temperature and moisture content of the mine air. Men are able to work for a long time in an atmosphere containing 3—4 % of carbon dioxide, but with less efficiency, and fatigue occurs sooner. Even 1—2 % of the gas diminishes efficiency. Rapid breathing is produced more quickly by an excess of carbon dioxide than by a corresponding deficiency in oxygen, and when due to the latter cause points to serious danger. The susceptibility of mice and canaries to an atmosphere poor in oxygen is about the same as that of men ; they cannot therefore be used to give warning of such atmospheres to exploring parties. The chief cause of the depletion of oxygen and increase of carbon dioxide in mine air is the reaction between the oxygen and the coal, as a result of which some of the oxygen is occluded in the coal, some is converted to water and carbon dioxide (the amount of this last is never equivalent to the oxygen absorbed), while the larger part is retained in combination, possibly with unsaturated constituents of the coal. Explosive mixtures of methane and air become non-explosive when the oxygen in the atmosphere falls below about 11 %. Carbon dioxide has only a slightly greater effect than nitrogen in reducing the explosibility of methane-air mixtures. In 111 samples of mine air collected from 29 mines, the percentage of black damp varied from 0.14 to 82.92 %, and the average percentage of carbon dioxide in the black damp was 11.5 and of nitrogen 89.5 %. A large number of analyses are given in order to show how the composition of mine air changes in traversing the workings. Black damp containing methane may be lighter than air. Details are given regarding the percentage of oxygen necessary to support the combustion of various flames in presence of varying amounts of nitrogen or carbon dioxide. The paper includes a bibliography and numerous references in the text and also deals with the atmospheric conditions in certain metal mines and their relation to the presence of decaying timber, etc.—F. C.

PATENTS.

Air ; Treating and simultaneously sterilising —. R. P. Van Calcar, Oegstgeest, and J. Ellerman and H. J. Martijn, The Hague, Netherlands. U.S. Pat. 1,215,222, Feb. 6, 1917. Date of appl., Mar. 15, 1913.

SEE Eng. Pat. 4018 of 1911 ; this J., 1915, 245.

Apparatus for drying and treating sewage sludge, copra, and other materials in bulk. Eng. Pat. 103,521. See I.

Process of generating hydrocyanic acid gas. U.S. Pat. 1,214,206. See VII.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Eucalyptus Australiana; *Essential oil of* ——. R. T. Baker and H. G. Smith. Proc. Roy. Soc., N.S. Wales, 1916, 49, 511. Perf. Essent. Oil Rec., 1917, 8, 50. (See also this J., 1916, 978.)

THE average working yield of oil is from 2.5% in June to 5.4% in October, from the green leaves and terminal shoots. The crude oil from an experimental complete distillation showed:—sp. gr. 0.9157 at 15° C.; n_D^{20} 1.4614; solubility 1:1.2 in 70% alcohol. It contained 70% of cineol and a little piperitone, to which the peppermint odour of the leaves is due. Samples of oil distilled in the first hour contained from 69.5 to 81% of cineol; a sample of the "second hour" oil contained only 20%. The oil distilled in the third hour was very small in quantity and also contained 20% of cineol. J. F. B.

α -Pinene; *Isomerisation, polymerisation, and formation of additive products of* ——. H. J. Prins. Chem. Weekblad, 1916, 13, 1264—1276. J. Chem. Soc., 1917, 112, i, 90.

ON warming a solution of levorotatory α -pinene in glacial acetic acid at 60°–70° C. with 5% of phosphoric acid (sp. gr. 1.7), *l*-limonene is formed, with development of heat. Strong mineral acids, and aluminium, ferric, and zinc chlorides convert α -pinene into a product resembling colophony. α -Pinene combines with water, alcohol, and organic acids, forming alcoholic derivatives of the borneol or terpineol type.

Sabinols; *Isomeric* ——. V. Paolini and G. Rehora. Atti R. Acad. Lincei, 1916, [v], 25, ii, 377–381. J. Chem. Soc., 1917, 112, i, 90.

DISCORDANT values have been given by different investigators for the physical constants of sabinol, but no attempt seems to have been made to separate stereoisomeric modifications. The authors have prepared from savin oil a sabinol hydrogen phthalate, $\text{CO}_2\text{H}\cdot\text{C}_6\text{H}_4\cdot\text{CO}_2\cdot\text{C}_{10}\text{H}_{15}$, which recrystallises in tufts of white, silky needles, m. pt. 95° C., $[\alpha]_D^{20} = -14.63'$ (in methyl alcohol). Hydrolysis of this ester yields sabinol, b. pt. 208° C., sp. gr. at 15° C., 0.9518, $n_D^{20} = 1.4895$, $[\alpha]_D^{20} = +7.56'$, and treatment of the sabinol with phthalic anhydride yields solely the hydrogen phthalate just described. These two compounds appear to be definite chemical individuals. That savin oil contains no other isomeric sabinol has been shown in the following manner. The uncrystallisable syrup obtained after removal of the solvent from the mother liquors of the hydrogen phthalate was converted into the strychnine salt, which, when crystallised several times and hydrolysed with cold, dilute hydrochloric acid, gave only the acid phthalate described above. Strychnine sabinol phthalate, $\text{C}_{30}\text{H}_{46}\text{O}_6\text{N}_2$, crystallises in shining, white needles, m. pt. 200°–201° C.

Diphenylbutadiene. J. M. Joldin. J. Amer. Chem. Soc., 1917, 39, 291–293.

THE hydrocarbon, $\text{C}_{16}\text{H}_{14}$, m. pt. 49° C., obtained by the dehydration of acetophenone-pinacene with acetic anhydride, is regarded with certainty as diphenylbutadiene although no characteristic derivatives could be obtained with bromine. The substance readily polymerises with the formation

of viscous resins. Acetophenone-pinacene was conveniently prepared by the action of magnesium methyl iodide on benzil in ethereal solution.

—G. F. M.

Benzaldehyde; *Determination of chlorine in synthetic* ——. M. S. Salamon. Perf. and Essent. Oil Rec., 1917, 8, 41–42.

THE following simple technical method gives satisfactory results, only very slightly lower than the values obtained by the Carius method:—About 1 gm. of the benzaldehyde is heated in a retort with 10 c.c. of concentrated sulphuric acid and 5 c.c. of strong nitric acid. The heating must be very gradual, and the mixture should not be allowed to froth until the end of the operation. The fumes are collected in a solution of silver nitrate and heating is continued until no farther precipitate is produced, which will require somewhat less than three hours. The silver solution is then acidified with nitric acid, boiled to decompose any sulphite, and the chloride is determined in the usual way.—J. F. B.

Vanillin; *Qualitative test and colorimetric method for the determination of* ——. C. Estes. J. Ind. Eng. Chem., 1917, 9, 142–144.

WHEN vanillin is heated with acid mercuric nitrate solution, a violet coloration is produced which is characteristic of vanillin, and the intensity of the coloration is directly proportional to the quantity of this substance present. In the case of alcoholic vanilla extracts, 5 c.c. of the sample is placed in a 50 c.c. flask, 6 c.c. of water and 1.5 c.c. of the reagent (see below) are added, the flask is placed in boiling water for 20 mins., then cooled rapidly, its contents diluted to 50 c.c., and the coloration obtained compared with that given by a known quantity of vanillin under the same conditions. The procedure is the same for non-alcoholic extracts except that only 1 c.c. of the reagent is required. The acid mercuric nitrate solution is prepared by dissolving mercury in twice its weight of nitric acid (sp. gr. 1.42) and diluting the solution with 25 times its weight of water. The results obtained agree with those found by the gravimetric method.—W. P. S.

Adrenalin solutions; *Physiological and chemical evaluation of the activity of* ——. J. S. White. Pharm. J., 1917, 98, 159–160.

ADRENALIN solutions gradually deteriorate owing to oxidation, advancing decomposition being indicated by the solution becoming first pink, then red, and finally brown. In the pink solutions the loss of activity is too small to be determined by physiological tests, but red solutions show a measurable loss of activity, and brown solutions are unfit for use. The addition of sulphurous acid to adrenalin solutions masks these colour changes but in no way retards oxidation. Adrenalin preparations are best standardised by determining the transitory rise in blood pressure after intravenous injections of known amounts. The pink coloration obtained by heating a dilute solution of adrenalin with potassium iodate and hydrochloric acid is extremely sensitive and permanent and is proportional to the amount of adrenalin present. 5 c.c. of a 1:50,000 solution of pure adrenalin with 5 c.c. of dilute hydrochloric acid (2.5 c.c. of $N/10$ HCl in 100 c.c.) and 5 c.c. of 0.2% solution of potassium iodate, on heating almost to boiling point and allowing to stand 15 minutes, gives a coloration which can be exactly matched by mixing 1 part of a 2% solution of potassium-platinic chloride in dilute hydrochloric acid with 3 parts of a 1.2% solution of cobalt chloride in dilute hydrochloric acid, and then suitably diluting,

and this standard can then be employed to standardise solutions of adrenalin colorimetrically. Results obtained by the colorimetric method are only comparative and may differ widely from results of physiological tests.—T. C.

Antipyrine: Determination of — M. François. J. Pharm. Chim., 1917, 15, 97—105.

THE gravimetric method for the determination of antipyrine as iodoantipyrine gives less accurate results than the volumetric method, which consists in titrating an alcoholic solution of antipyrine containing mercuric chloride with an alcoholic solution of iodine until a permanent yellow colour is obtained, one molecule of antipyrine under these conditions absorbing two atoms of iodine. The alcoholic solution of iodine, which rapidly loses strength on keeping, is best standardised against an alcoholic solution of pure antipyrine.—T. C.

β -Hydroxybutyric acid: Gravimetric determination of — D. D. Van Slyke. Proc. Soc. Exp. Med., New York, 1916, 13, 131. J. Chem. Soc., 1917, 112, ii., 107.

IF 175 c.c. of a β -hydroxybutyric acid solution containing 9% of sulphuric acid, 2% of mercuric sulphate, and 0.25 grm. of potassium bichromate is boiled under a reflux condenser for one hour, 7.7 mgrms. of the acetone compound of mercuric sulphate is precipitated for each mgrm. of β -hydroxybutyric acid present. The acid may vary from 1 to 9 mgrms. without affecting the ratio if the concentrations of the other reagents are kept constant.

Identification of phenols. Reid. See III.

PATENTS.

α -Dimethyl- γ -piperidines, substituted in the α -position, including their N-methyl derivatives: Manufacture of — H. M. Judd and G. A. R. Kon, London. Eng. Pat. 103,541, Feb. 5, 1916. (Appl. No. 1768 of 1916.)

BY using sodium in amyl alcohol instead of sodium or aluminium amalgam for reducing the corresponding γ -piperidones, the resulting piperidine derivative is almost entirely the physiologically active isomer instead of a mixture of two isomers. A better yield is obtained and the trouble of isomerising the mixture is saved. Details are given of the reduction of vinylacetoneamine (aaa-trimethylpiperidone).—B. V. S.

Formaldehyde: Manufacture of — G. Calvert. London. U.S. Pat. 1,213,740, Jan. 23, 1917. Date of appl., Dec. 24, 1915.

SEE Eng. Pat. 811 of 1915; this J., 1916, 328.

Arseno compounds: Complex — and process of making same. P. Karrer, Frankfurt, Assignor to Farb. vorm. Meister, Lucius, und Brüning, Höchst, Germany. U.S. Pat. 1,214,921, Feb. 6, 1917. Date of appl., Dec. 10, 1915.

SEE Eng. Pat. 17,182 of 1915; this J., 1916, 489.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

Half-tone process: Experiments on the — A. J. Bull, W. J. Smith, and E. L. Turner. Phot. J., 1917, 57, 8—11.

THE effects of variations in different parts of the

process of production of a half-tone print were examined. In one set of experiments a step-print on glossy bromide paper was used as subject and the reproductions were compared with it, measurements being made in a specially designed photometer and results plotted in percentages of reflected light. The number of variables is so great and some of them so difficult of exact control that in most cases a number of negatives were prepared and an average one selected for the preparation of the half-tone block. The effect of variations in the shape of the stop, of relative aperture of lens, of lead ferricyanide and copper-silver methods of intensification, "flashing" (exposure to white paper), and variations in the screen distance, were all tested, but in no case were more marked differences obtained than might be due to variations in wet collodion plates. In the second set of experiments, a carbon step print was used as subject, the photometer was altered to suit its surface, and dry plates were used instead of wet ones. The general conclusions are that round and square stops give practically the same effect, that wet collodion plates and gelatin dry plates yield different gradations, that differences produced by variations of the stops are small, and that the type of dot formation and rendering of gradation are independent of magnification if the aperture ratio is kept constant.—B. V. S.

[Photographic] plate speeds. O. Bloch. Phot. J., 1917, 57, 51—61.

IN working out a standard method to examine the variation, if any, of plate speeds with different developers, several complications were met with which show that the H. and D. speed of a plate is not constant but varies with the conditions of exposure and development, the variations not being similar in all plates. Both intensity scale (wedge screen) and time scale (sector wheel) exposures were used; in the former case it was shown that there was no appreciable selective colour absorption of the wedge, and in the latter case the intermittency failure was avoided by using only single revolutions of the wheel, slow and uniform motion being given by a gramophone motor. It was found that for all plates, within certain exposure limits, and using developers to which bromide had been added, definite H. and D. speeds were obtained (depending partly on the developer) but only above certain limiting values of gamma, which are often quite high. With slightly restrained or unrestrained developers some plates (generally of the fast developing type) have definite speeds for all normal ranges of gamma, but the exposure conditions are still limited. With other plates, generally of the slow-developing, fast portrait type, the H. and D. speed is higher for short development for which there is no distinction between under and correct-exposure, the whole plate curve being practically a straight line; each gamma has its own inertia value which increases with gamma until the curve becomes normal; in some cases, however, this occurs only with higher gammas than would be obtained in normal use. The failure of the reciprocity law, for one emulsion examined, is not completely expressed by Schwarzschild's rule (for equal effects $I_1 t_1 = I_2 t_2$) a lower gamma being obtained for the same development where I is high and t short. The actual value of $\log i$ obtained in a measurement is therefore dependent on the composition of the developer, the γ obtained in development, the value of q , the nature of the exposure (time or intensity scale), and the actual values of time and intensity, as well as on the plate; there is also the possibility of the change of the plate with age. Results are given of comparisons on various plates of developers all to the same formula apart from the reducer.

made with metol-quinol, metol, quinol, pyro-soda, ortol, and glycin, the times of development being varied to suit the developer. With the same six reducers, on one plate, developing in each case to a γ of about 1, quinol and, in a more marked degree, glycin gave low H. and D. numbers, while the other four gave very nearly the same results. A method is given of determining the velocity constant of development (K) depending on a simple evaluation of D_x and the formula $K = \frac{1}{t} \log_e D_x = d$. It is suggested that a simpler method of marking plate speeds should be adopted, or that the manufacturers should agree to a standard method. B. V. S.

Latent image: The influence of time upon the

H. J. Channon. *Phot. J.*, 1917, 57, 72—81.

DETAILS are given of some of a large number of experiments started in 1891 with the object of ascertaining the effect of time on the latent image. In one set of experiments all the exposures were made together and subsequently developed at intervals of several years, and in another set the exposures were made at intervals of several years and then developed together. The chief effects are loss of density, particularly in the high densities, and general veil which appears to have the effect in some cases of a supplementary exposure in improving shadow detail. Both effects vary considerably with different makes of plate. Photoregression was noticed in two cases where the plates were already old at the time of exposure. Experiments were also made to determine the effect of air and moisture on photoregression and veil. B. V. S.

Dyes as sensitisers of carbon tissue and gum paper

H. Waago. *Amator-Fotografen*, Jan., 1917, 6. *J. Phot.*, Feb. 23, 1917, 96.

AN account is given of the work of A. A. Meisling (*Dansk Fotografisk Tidsskrift*, Nos. 9 and 10, 1916) on the hardening effect of various substances on gelatin, gum, etc., under the influence of light. In addition to chromium compounds, which are the chief agents used in the carbon and gum processes, the hardening effect is produced by other substances including Erythrosin, Auramine, and other aniline dyes. The hardening is attributed to the formation of formaldehyde. Erythrosin-sensitised papers may be prepared by soaking the carbon or pigment tissue for a few minutes in a solution of 1 part of the dye in 10,000 of water. Neither paper is sensitive when quite dry, but the gum paper needs only a little moisture and can be used in contact with the negative: the carbon paper requires to be quite damp and must be protected on both sides with celluloid during printing. Both papers are equal to the bi-chromate-sensitised tissues in speed to daylight, and faster to artificial light, and they also keep better.

B. V. S.

"Hypo" [sodium thiosulphate]; Removal of — from photographic plates by washing with water.

A. V. Elsdon. *Phot. J.*, 1917, 57, 90—94.

THE rate of removal of "hypo" from fixed plates was determined by fixing the plate in a known quantity of "hypo" solution, removing and draining, transferring to a definite quantity of water for a definite time, repeating this washing three times, and finally determining the amount of "hypo" removed from the plate each time and left in it after the last washing. It was found that there is no adsorption of the "hypo" the removal being in agreement with Ostwald's

equation $x_n = \left(\frac{a}{m+a} \right)^n x_0$ where x_0 and x_n represent the original and final amounts of "hypo" for

n washings, a the volume of solution left in the plate, and m the volume of each washing water, if the time in the washing water is long enough to ensure equilibrium between it and the solution in the film. At 60° F. (15.5 C.) equilibrium is nearly reached in 2 minutes and quite reached in 5 mins. With washing periods of 1 min. and draining periods of $\frac{1}{2}$ min. after each washing, the "hypo" was removed practically completely by 3 washings of 1 oz. each for a plate $3\frac{1}{2}$ in. \times 2 $\frac{1}{2}$ in. B. V. S.

PATENTS.

Photographic paper. A. C. McCloskey, Philadelphia Pa., Assignor to Process Paper Manufacturing Co. U.S. Pat. 1,213,925, Jan. 30, 1917. Date of appl. Aug. 12, 1915.

PHOTOGRAPHIC printing paper, sensitised with ferric salts, is provided on the back with a coating of ferrous salts which prevents staining during development and is removed in the clearing solution. B. V. S.

Photographic processes. J. H. Christensen, Søllerød, Denmark. Eng. Pat. 103,890, Mar. 1, 1916. (Appl. No. 3421 of 1916.)

SEE Fr. Pat. 481,149 of 1916; this J., 1917, 104.

Cinematograph films; Movable plate applicable to the manufacture of positive — and process of obtaining the same. A. Boularan, dit Deval, Paris. U.S. Pat. 1,212,416, Jan. 16, 1917. Date of appl. May 20, 1915.

SEE Eng. Pat. 7753 of 1915; this J., 1916, 754.

Manufacturing colloids. U.S. Pat. 1,214,299. See I.

XXIII.—ANALYSIS.

Potassium: Determination of — as per chlorate. G. P. Baxter and M. Kobayashi. *J. Amer. Chem. Soc.*, 1917, 39, 249—252.

ALCOHOL containing 0.1% of perchloric acid is found to dissolve as little potassium perchlorate as any practicable mixture, though the salt is appreciably soluble even in that liquid. Absolute alcohol must be used, as the solubility of the perchlorate is fairly sensitive to the presence of small proportions of water in the alcohol. The recommendation of Davis (this J., 1912, 1045) to wash with a liquid already saturated with the salt is endorsed. With a solution saturated at 0° C. there is no danger of deposition of salt owing to change of temperature, and such a solution gives no precipitate when treated at 0° C. with a large amount of sodium perchlorate. In presence of sodium chloride some of the sodium salt is retained by the potassium perchlorate; the precipitate should, therefore, be re-dissolved and the solution again evaporated with perchloric acid. The precipitated potassium perchlorate is transferred, after washing by decantation, to a platinum-sponge crucible, dried at 200° C., and weighed. The washing liquid saturated with potassium perchlorate is prepared by dissolving a suitable proportion of the salt in the alcohol at a high temperature, before adding the perchloric acid.—T. H. B.

Sulphates of some divalent metals; Titration of — by the electric conductivity method. H. S. Harned. J. Amer. Chem. Soc., 1917, 39, 252—266.

In a titration of a solution of magnesium sulphate with standardised sodium hydroxide solution, the electric conductivity changes little, if at all, during the course of the reaction, but after an amount of sodium hydroxide equivalent to the magnesium sulphate has been added, the conductivity increases suddenly owing to the high mobility of the hydroxyl ion. A sharper end point is obtained if, instead of sodium hydroxide, a reagent is added which will precipitate both ions of magnesium sulphate from the solution; the conductivity then falls rapidly during the course of the reaction, and rises rapidly after the reaction is complete. Such a reagent is barium hydroxide, when the solution contains a sulphate of a metal which possesses a difficultly soluble hydroxide. In using barium hydroxide it is necessary to remove all carbon dioxide from the solution and to keep it free from carbon dioxide during the titration. This necessitates a special form of apparatus, in which the solution can be boiled under reduced pressure. The electrodes should remain stationary with regard to each other and in respect to their position in the solution. The titrating solution must be run into the cell without coming into contact with carbon dioxide. Diagrams are given of typical curves obtained from titration of various sulphates by plotting bridge wire readings against c.c. of barium hydroxide solution. The method can be used for the determination of magnesium in magnesium sulphate, in a solution containing magnesium sulphate, calcium sulphate, and sulphuric acid, and in dolomite. The sulphates of copper, nickel, and cobalt can also be titrated by this method, but the titration of cadmium sulphate did not give accurate results because of its strong tendency to form an oxysulphate which is difficultly soluble.—T. H. B.

Molybdenum; Determination of — by potassium iodate. G. S. Jamieson. J. Amer. Chem. Soc., 1917, 39, 246—249.

The molybdenum solution is reduced by passing through a tube containing 30-mesh amalgamated zinc, and received directly into a hydrochloric acid solution of iodine monochloride, and the molybdenum is estimated by titration with potassium iodate. The latter readily oxidises the molybdenum to Mo_2O_5 and a sharp end point is obtained when conversion into the pentoxide is complete. The iodine monochloride solution is prepared by dissolving 10 grms. of potassium iodide and 6.44 grms. of potassium iodate in 75 c.c. of water in a glass stoppered bottle, adding 75 c.c. of concentrated hydrochloric acid, then 5 c.c. of chloroform, and adjusting to a faint iodine colour by violent shaking, adding dilute solutions of iodide or iodate as required. Exposure of the zinc during the reduction causes no error in the titration, as would be the case if permanganate were used, because any hydrogen peroxide formed does not react with iodine monochloride or potassium iodate. After reduction the titration is effected rapidly at first, then slowly, with thorough shaking, until the chloroform indicator is decolorised. It is important to maintain not less than 10% of actual hydrochloric acid in the solution to prevent hydrolysis of the iodine monochloride during the titration, and to keep the solution thoroughly cooled and in a shaded place during the titration, especially if much molybdenum is present, to obtain a sharp end point. The equation involved is $\text{KIO}_3 + \text{Mo}_2\text{O}_3 + 2\text{HCl} = \text{Mo}_2\text{O}_5 + \text{I}_2 + \text{KCl} + \text{H}_2\text{O}$. Further oxidation to MoO_3 is very slow (2 to 3 days).—T. H. B.

Tin; Electroanalysis of — without platinum electrodes. T. Batuecas. Anal. Fis. Quim., 1916, 14, 495—511. J. Chem. Soc., 1917, 112, ii., 106.

GUZMAN'S method (this J., 1915, 1227) has been applied to the estimation of stannous and stannic tin in salts and of the metal in alloys, using a copper cathode and a graphite anode. Hydrochloric acid is employed as electrolyte in the analysis of tin salts, a mixture of hydrochloric and tartaric acids in the separation of tin from zinc and from cadmium, and an ammoniacal tartrate solution in the separation of tin from silver.

Ammonium phospho-molybdate precipitate; Occlusion of iron by the —. E. H. Archibald and H. B. Keegan. Trans. Roy. Soc. Canada, 1916, [iii.], 10, 67—68. J. Chem. Soc., 1917, 112, ii., 95.

THE factors which influence the occlusion of iron by ammonium phospho-molybdate have been examined. In the case of dilute solutions, the amount of occluded iron is independent of the quantity of iron in the solution, but in more concentrated solutions it increases with the quantity of dissolved iron. For solutions of the same iron concentration, the quantity of occluded iron increases somewhat more rapidly than the concentration of the phosphoric acid. The dilution of the solution has no appreciable influence on the amount of occluded iron when the quantities of iron and phosphoric acid remain the same. The iron is occluded at the time of precipitation, and is not removed by washing. It is suggested that a definite chemical compound is formed.

Measurement of the calorific power of gas. Official method used by the Paris Municipality. Girard and Lauriol. See II A.

Apparatus and method for testing the emulsification of mineral lubricating oils. Conradson. See II A.

The free carbon of wood tar pitches. Benson and Davis. See III.

Identification of phenols. Reid. See III.

Critical examination of Lunge's method for the rapid determination of arsenic in sulphuric acid. Pérégriin. See VII.

Critical examination of Lunge's dry method for the rapid determination of sulphur in roasted pyrites, etc. Pérégriin. See VII.

Acidimetric determination of orthophosphoric acid. Balareff. See VII.

Interference of thiocyanates, ferrocyanides, and ferricyanides in the detection of iodides with palladium. Curtman and Harris. See VII.

Colour of magnesium pyrophosphate obtained by calcining magnesium ammonium phosphate. Balareff. See VII.

Release of radium emanation from water at different temperatures by the bubbling method. Moran. See VII.

Sublimed sulphur and its adulteration. Fonze-Diacon. See VII.

Determination of manganese in steel. Cashmore. See X.

Determination of chromium in ferrochrome. Herwig. See X.

Oil testing. Gill. See XII.

Colour tests for palm oil. Gill. See XII.

Wet combustion in the nitrosite combustion method for the direct determination of rubber. Wesson and Knorr. See XIV.

Anilom method for the determination of mineral fillers in rubber. Klein and others. See XIV.

Determination of mineral matter in rubber products. Pérégriu. See XIV.

Experimental error in field trials. Miyake. See XVI.

Lavulose: Determination of in presence of dextrose. Loewe. See XVII.

Microanalysis of wine. Ripper and Wohack. See XVIII.

Determination of chlorine in synthetic benzaldehyde. Salamon. See XX.

Qualitative test and colorimetric method for the determination of vanillin. Estes. See XX.

Physiological and chemical valuation of the activity of adrenalin solutions. White. See XX.

Determination of adipiprine. François. See XX.

Gravimetric determination of β -hydroxybutyric acid. Van Slyke. See XX.

Trade Report.

Prohibited exports.

By an Order in Council, dated March 12th, exportation of the following is prohibited to all destinations:—Calcium carbide, potassium and sodium prussiates and mixtures containing them, sodium cyanide and mixtures containing it, raw cotton, uranium and its alloys and ores, oleaginous kernels, nuts, seeds, and products of all kinds, baking powder, malt extract.

Restricted occupations order.

THE Minister of Munitions has issued an Order, dated 28th February, ordering that the occupier of a factory, workshop, or other premises shall not, except as herein provided, take or transfer into employment in any industry or occupation mentioned in the Schedule, whether to fill a vacancy or otherwise, any man who has attained the age of 18 and has not attained the age of 61, whether the man has previously been so employed or not.

The occupier of any factory, workshop, or premises may, however, take or transfer men into his employment with the consent of the Director-General of National Service given on the ground that the employment is expedient for the purpose of executing a Government contract, or on the ground that the work on which the men are to be employed is of national importance, but subject in all cases to any conditions which the Director-General may impose: and an employer may take

back into his employment any man who has joined His Majesty's naval or military forces, on his retirement from those forces under proper authority, if the man is taken back in accordance with an undertaking given by the employer before the man joined.

Work which is directly or indirectly required for the purpose of any Government contract must be given priority over any other work in that industry or occupation.

The following are among the trades mentioned in the Schedule: Manufacture of bottles for beer, wines, spirits, and aerated waters; manufacture of bricks (other than firebricks) and tiles; manufacture of china and earthenware; glass beveling, engraving, silvering, and staining; papermaking; manufacture of wall paper; manufacture of linoleum, oil-cloth, and table baize; manufacture of aerated waters; brewing and malting; manufacture of sugar and chocolate confectionery; electro-plating; manufacture of photographic apparatus and materials.

Priority of work in certain industries.

ACCORDING to an Order of the Minister of Munitions, dated March 8th, the work in certain industries is to be divided into three classes, A, B, and C; work of class A must in all cases take priority over work in Class B or C, and work in Class B over work in Class C, irrespective of the date of the order. Class A comprises work under a Government contract, "certified war work," or merchant shipping work certified by the Board of Trade to be munitions work. Class B comprises the repair of existing industrial machinery where necessary to obtain continuity of work in the United Kingdom; the maintenance of reasonable stocks of materials or articles necessary as component parts of work or goods to be carried out or supplied under orders or contracts to be executed under Class A or B; and export orders and other contracts or orders certified by the Board of Trade, Admiralty, War Office, Ministry of Munitions, or Director-General of National Service, as of sufficient importance. Class C comprises all work not in Classes A or B.

The Order applies to all work carried on in establishments to which directions as to priority have already been given, also to all trades, and manufactures in or of metals and machinery, pottery and glass trades, textile trades and manufactures, linoleum, oilcloth, and table baize manufacture, the manufacture of coal tar products, dyestuffs, and other chemical products, and of lubricating oils and other lubricants, oil seed crushing, manufacture of soap, candles, fertilisers, paints, colours, varnishes, paper, leather, and coke, rubber trades and manufacture, waterproofing of fabrics and paper, and electricity, gas, and water services.

Books Received.

MINES AND QUARRIES. GENERAL REPORT, WITH STATISTICS, FOR 1915, BY THE CHIEF INSPECTOR OF MINES. PART II.—LABOUR. [Cd. 8143.] Price 1d. PART III.—OUTPUT. [Cd. 8441.] Price 3d.

PART II, of this publication contains a general report and statistics relating to persons employed, and accidents at mines and quarries in the United Kingdom, and to the enforcement of the Mines and Quarries Acts.

PART III, contains statistics of the quantity and value of various minerals raised in the United Kingdom (see this J., 1917, 280).

Journal of the Society of Chemical Industry.

No. 7. VOL. XXXVI.

APRIL 16, 1917.

No 7, VOL. XXXVI.

Official Notices.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY.

The first volume of these reports will be issued during this month. The manuscript of some of the sections not having come to hand, the volume will not be as comprehensive as was at first proposed, but it was decided to present an incomplete volume rather than delay publication any further.

CROSS AND BEVAN ESSAY PRIZE OF £20 AND LATHAM RESEARCH GRANT OF £300.

The Council have pleasure in announcing that a gift of £20 has been made by Messrs. Cross and Bevan as a prize for an essay on "The Interconnection of Economic Botany and Chemical Industry."

A further sum of £300 has also been presented by their friend, Mr. T. P. Latham, of Weybridge, to be paid in three annual instalments to such one of the competing essayists as may be judged to be of conspicuous ability, as a grant towards his expenses, on the condition that he apply himself, during three years, to research of approved character on a subject cognate with that discussed in his essay.

The immediate object of the donors is to promote the study of economic botany with special reference to its bearing on chemical industry, giving the widest possible interpretation of the relationship.

They desire, under the auspices of the Society, to assist in forming public opinion in this direction and to discover and further the career of a student of promise who may wish to devote himself to work in such a field.

The Essay Prize will be open to all members of the Society who are British subjects. The Research Grant will be limited to competitors under 25 years of age at the time of sending in the essay.

Essays are to be submitted to the Council of the Society not later than the close of the year 1917. The awards will be made promptly. Neither the prize nor the first grant will be given unless the essayist or essayists shall be deemed to have real merit. The Latham Research Student will be required to submit a report at the close of each year, to satisfy the Council that he has made and is likely to make proper use of the grant.

Canadian Section.

*Meeting held at Toronto, on Thursday,
February 15th, 1917.*

MR. S. B. CHADSEY IN THE CHAIR.

THE FUNCTION OF COLLOIDAL CHEMISTRY IN PAPER MAKING.

BY JUDSON A. DECEW, B.A.SC.

It is the object of this paper to point out some of those problems that are met with in the manufacture of pulp and paper, in which colloidal chemistry has an important function.

The cellulose materials of fibrous character from which paper is made are gel-forming colloids.

The only exception to this would be that paper which is made from asbestos, where crystalline material having a fibrous structure is felted into a continuous web, by paper-making processes. Even in this case, however, it is necessary to add colloidal material in order to obtain a satisfactory product.

The paper-making fibres proper consist of cellulose or ligno-cellulose, either natural or prepared. Cotton is the natural cellulose, but cellulose fibres may be produced from the various ligno-cellulose fibres, by eliminating the products of lignification.

The gel-forming properties of cellulose and its compounds are already well known from the extensive use in the arts of the solutions of nitro-cellulose, acetylcellulose, and cellulose xanthate (viscose). These products are the result of chemical treatments which eliminate entirely the fibrous structure in producing the colloidal solution. These processes have very little importance in paper-making, for there the colloidal properties required are developed by mechanical treatment, with but slight alteration in the fibre structure. Under grinding action the fibres may swell by the absorption of water until they have a greatly increased weight, the phenomenon being known as hydration.

For making many kinds of paper, fibres containing more or less water of hydration are required, for the colloidal properties of the fibre produce both transparency and increased strength in the product, and at the same time reduce the capillarity. In those kinds of papers where opacity or capillarity are desired, or where the rate of production is paramount, it is obvious that structure is the essential element and that hydration must be avoided. For illustration, book papers should have bulk and opacity. Blotting paper must have the maximum absorption or capillarity, and news paper must be made at the maximum speed. In such papers the fibres lie rather loosely upon each other, so that as a result the book paper has a soft feel and is not transparent, the blotting paper has a maximum of interstices, and the news paper has given up the water with which it was associated on the paper machine with the greatest of readiness. This is all due to the natural stiffness of fibres which may contain water to the point of saturation, but have not been swelled with water of hydration.

Those papers which have acquired special properties as a result of the development of the colloidal properties in the cellulose, such as grease-proof, writings, bonds, wrappings, etc., have greater density, hardness, rattle, translucency, and strength than those already mentioned as made from unhydrated material.

The greatest density and translucency are seen in the grease-proof or "glacine" papers. The voids in these papers have been filled by pressing tightly together in the manufacturing process the cellulose fibres which have been previously beaten until they have taken on a gel-like character. The density of these papers is such that they do not absorb oils, and they have become known as grease-proof papers. Writing and bond papers must be hard and fairly strong, and consequently the paper stock from which they are made must receive a considerable amount of hydrating beating treatment.

Wrapping papers vary considerably in character, but that which has the greatest strength and wrapping qualities, is the one which has been made from fibres that have been brought to a very colloidal state by long beating, without reducing

the length of fibre. Such paper is known in the trade as "brown" or "white kraft."

One kind of wrapping paper, known as "water finish," is made translucent by wetting the paper and crushing the fibres together by means of hot calender rolls. In this case the colloidal property of the cellulose is made evident by means of pressure alone. No increased strength, however, is obtained in this way such as results from the drying together of well hydrated fibres.

Methods of hydration. The usual method employed for making cellulose fibres more colloidal in character, is to mix, crush, or beat the fibres in cold water. The more drastic the grinding and crushing action, the more rapidly will the material become gel-like in character. This action may be accelerated by chemical means, as for instance by making the cellulose absorb a small amount of caustic alkali and then by treating with carbon bisulphide to obtain a thiocarbonate reaction. This does not dissolve the cellulose but develops a very hydrated condition in the product.

Some hydration takes place in cellulose fibres by mere contact with cold water, but the amount of hydration is limited and the time factor is long. The amount, however, is enough to cause trouble when a hydrated product is not desired. For instance, in the manufacture of news print paper, which is produced at the rate of over 600 ft. per minute, the extra amount of hydration obtained from allowing the wet pulp to be in the vats for 24 hours is sufficient to cause such sticking on the presses of the machine that considerable time and paper may be lost. This is why there is always difficulty in starting up fast machines on Monday morning, when the stock has been stagnant for 24 hours.

It has been found that lignocellulose fibre, such as jute or wood, does not gel so readily by cold mechanical treatment as does cellulose, but conversely to the cellulose, its hydration is accelerated by the application of heat. In the production of ground wood, it was soon found that the best results were obtained by just supplying enough water to the stone to carry the pulp away. As a result the friction of the grinding develops high temperatures at the grinding surface, which reduce the adhesion of the fibres, and a better product is then produced.

When wood which has been previously boiled or steamed is ground to pulp, the fibres are found to have a more pliable and hydrated character and they will make a stronger paper than that produced from untreated wood. The brownish colour of steamed ground wood suggests that some hydrolysing action had been the indirect cause of hydration.

Coating materials. Glue and casein are two well-known colloids which are used for binding white pigments on to the surface of papers known as coated papers. After being impregnated by these colloids, the dried papers are more resistant to the penetration of oils, and consequently they take clearer impressions from printing inks. These colloids are seldom used by mixing them in the wet paper stock, except in very small quantities where it is desired to increase the colloidal properties of other materials.

Fillers. Papers are often loaded with such fillers as China clay, talc, or other insoluble substances, in order to impart special properties such as opacity and a smooth surface.

It is desired in such cases that as much of the loading as possible be retained in the paper, and not carried away in the water draining from the paper machine wire. Some clays are more colloidal in character than others, but the colloidal properties may be developed in any clay by the use of a small amount of caustic soda. There is still some doubt as to whether this degree of dispersion is desirable or not, but it is probable that

the colloidal filler will give the best results if it is used in conjunction with the coagulants used for sizing the paper.

Sizing or waterproofing. To ensure that writing paper will resist the penetration of ink by capillary attraction of the fibres, and also to assist the ink to dry on the surface and thus give the line with proper depth of colour, the fibres are coated while in the heating engine with a water-repellant substance which will destroy their capillarity. The material which is universally used for this purpose is ordinary colophony rosin, and it is distributed throughout the paper-making material in the form of a colloid. In order to produce colloidal rosin it must first be brought into solution, the usual means being either a partial or complete saponification. The amount of saponification required will depend upon the means available for diluting the soap, without forcing any rosin from solution.

When ordinary means of dilution are employed, at least three-quarters of the rosin should be saponified, but there are means available for diluting a rosin soap, when but one-half of it is saponified, in such a manner that the unsaponified portion will remain in solution in a soap diluted to 50 or 100 times its volume. If this unsaponified rosin is not visible as suspensoids it must be in colloidal solution. If this product is now coagulated by means of a salt of aluminium, it will produce a highly colloidal precipitate of rosin and alumina. If this material has been deposited evenly over the paper fibres, it will destroy their capillarity and produce a resistance to the penetration of water and inks (sizing process). When rosin is in colloidal solution in a highly diluted soap, a portion of it can be taken up by the fibrous material by adsorption. The effect of rosin, deposited in this way, upon the capillarity of the fibres is very great, because its distribution will be perfect. The efficiency of the coagulated rosin will depend largely upon its bulk and degree of hydration, and we have in this an explanation of the fact that rosin in the form of coarse emulsions is ineffective for sizing purposes. It is obvious that a particle of rosin which has been floating in suspension, cannot be precipitated as a colloid.

The older methods of making and using rosin soap for waterproofing necessitate a more or less complete saponification of the rosin. From such solutions, even when greatly diluted, the fibres can adsorb but a small amount of rosin, and when the solutions are coagulated with aluminium sulphate, only about one-third of the rosin is thrown out of solution in the form of hydrated rosin acids, the rest being deposited in the form of aluminium resinate, which is often basic in character, and is but moderately efficient as a water repellent. From our knowledge of the properties of resins as compared with rosin itself, we would expect that a colloidal precipitate of rosin to hold its water of hydration more tenaciously than the colloidal resinate. If this is true then the colloidal rosin will withstand the drying action of the paper machine more effectively and will not crumble so easily by dehydration. The observed facts are very well explained on this basis.

In the past the literature on this problem has been quite confusing, because the subject has been considered entirely from the standpoint of chemical reactions, without any reference whatever to the physical state of the material.

Colloidal by-products in pulp making. *Sulphite waste.* In the production of cellulose from wood by the bisulphite process, about 60% of the wood becomes soluble, in the form of a sulphonie-lignone complex. This material is generally a waste product, but some uses have been developed for it based upon its colloidal properties. It is used as a binder in briquetting, in road-making

and in foundries in making cores. It has adhesive properties somewhat similar to those of dextrin, although it has not the same adhesive strength. If it could be bleached or decolorised, however, it would make an excellent substitute for other adhesives where only moderate strength is required. At the present time there is a great demand for this material in the concentrated liquid form or in the powder. The powdered product can be made by spraying the liquids into chambers with hot gases.

Black soda liquor. In the manufacture of cellulose from wood by the use of caustic soda, the lignin becomes dissolved in the form of sodium compounds. At the present time the organic matter is burnt off in incinerators, the alkali being recovered as carbonate and recausticised. If this organic waste is distilled instead of being calcined a fair amount of wood alcohol and acetone can be obtained from it. A distillation treatment, however, is very difficult to apply owing to the great viscosity of this colloidal mass, and most of the work in this direction up to the present time has not resulted in the establishment of a profitable process.

Losses from colloidal dispersion. In the manufacture of both chemical pulp and ground wood, there are certain mechanical losses due to the fact that some of the material has lost its original structure and exists as minute particles in the dispersion medium. In the straining or washing of the pulp this fine material will be largely carried away in the waste waters.

As regards mechanical pulp this is shown by the fact that the difference in yield between coarse and very fine grinding may be as much as 10%. The difference in yield of cellulose from the cooking processes, however, may be as much as 20% with varying treatments. When the cellulose itself is attacked by an excess of the chemicals or when these are improperly employed, a part of the cellulose may be dissolved and part lost as a structureless colloid.

In the mechanical process of making paper on a machine, there are always losses of colloidal and suspended matter in the water draining from the machine wire. It is to be hoped that means may yet be devised for recovering this material in an efficient and satisfactory manner, but its nature is such that it does not respond readily to either straining, filtration, or sedimentation systems.

A full appreciation of the physico-chemical problems involved in these various processes should aid materially in arriving at their proper operation and control, and if any of this discussion serves to make the art of paper-making a little more clearly understood the object of this paper will have been fully attained.

Liverpool Section.

Meeting held at the University on Friday, January 26th, 1917.

MR. JOHN GRAY IN THE CHAIR.

NOTES ON THE SPLITTING OF CASTOR OIL.

BY R. O. JONES.

As early as 1825 Chevreul and Gay-Lussac entrusted us with the key of the chemistry of fats and oils. The progress made since that time can scarcely be deemed satisfactory and a vast unexplored region undoubtedly still remains.

Within the last few years, however, the study of oils and fats appears to have received a sudden impulse, due probably to the introduction of butter substitutes and of hydrogenated fats. Phenomena such as the drying of oils, the development of rancidity, and polymerisation of oils, can scarcely be understood until clear insight into the constitution of the substances under investigation has been obtained. Much work has certainly been carried out, but we are not yet in a position to state that the composition of a single natural fat or oil is known with certainty.

In this paper a few of the properties of castor oil, or more correctly, perhaps, of castor oil fatty acids, will be dealt with.

This oil has several characteristics which differ in a marked manner from those of other fats or oils. Its insolubility in ether and its solubility in alcohol, its high viscosity and the transparency of its sodium soap, may be quoted as examples. These properties are attributed to its chief constituent, namely, *ricinolein*.

In order to render the latter part of these notes more explicit, I shall give a brief résumé of the investigations carried out upon ricinoleic acid. It should be noted that in all cases the fatty acid has been prepared by direct saponification of the oil.

Hazura and Grüssner* maintained that the fatty acids derived from castor oil consisted of a mixture of ricinoleic and *iso*-ricinoleic acids. This is, however, doubtful, in view of the work of Haller,† who was able to identify one acid only. Of the other constituents of the oil, 1% of dihydroxystearic acid was discovered by Juillard, together with some stearic acid. From a consideration of the iodine value and acetyl value, it is calculated that castor oil consists of about 93% of ricinolein.

The constitution of ricinoleic acid first proposed by Goldsobel,‡ namely:



has been verified by Haller and Brochet,§ who prepared the perozonides of the esters and identified the products obtained on treatment with sodium carbonate.

An acid of the above constitutional formula is likely to prove interesting from the theoretical point of view. It contains an asymmetric carbon atom and an ethylenic double bond, and is also a hydroxy acid.

We surmise, therefore that the acid should be capable of existing in two isomeric forms due both to the carbon atom and also to the double bond. This is actually the case. Castor oil itself is optically active, and similarly the ricinoleic acid prepared from it has a specific rotation $[\alpha]_D = +6.25^\circ$ to 7.5° in acetone solution (Walden).

The *lævo* acid has not yet been isolated. Again, on treatment with nitrous acid, it is converted into its geometrical isomer, ricinelaic acid, a crystalline solid, m.pt. 52° – 54° C. (Wohlenburg). These are comparable to the well-known fumaric and maleic acids.

The condensation products theoretically possible owing to the presence of both the hydroxyl and carboxylic groups are numerous, and for comparison these have been tabulated (see Table I.)|| We shall have occasion to refer to some of these later.

According to H. Meyer,** ricinoleic acid polymerises on standing into polyricinoleic acid, accompanied by a reduction in the iodine value and an increase in the specific gravity. The polymerised product is reconverted into the original

* Monatsh. f. Chem., 1888, 469.

† Comptes rend., 1907, 462.

‡ Berichte, 1887, 962.

§ Comptes rend., 1910, 496.

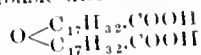
|| *cp.* Z. angew. Chem., 1913, 316.

** Arch. d. Pharm., 1897, 184.

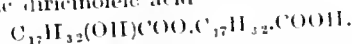
acid on boiling with alcoholic potash. Wohlenburg noticed a fall in the neutralisation value from 188.2 to 170.9 in 5 months.

The reactions occurring on treating the fatty acids and castor oil itself with sulphuric acid, forming the so-called Turkey red oil, have been the subject of various investigations.

Amongst other products, Juillard* claims to have isolated dibasic diricinoleic acid



monobasic diricinoleic acid

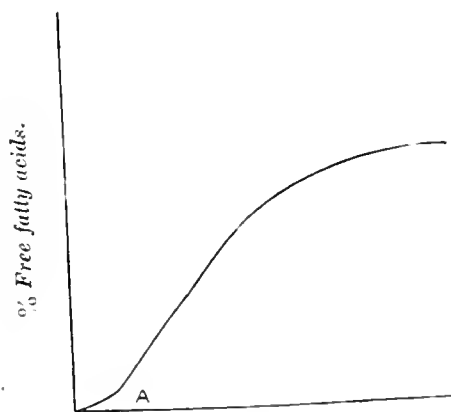


and dihydroxystearic acid.

He maintains also that polymerisation proceeds further, giving rise to the formation of di-, tri-, tetra-, or penta-ricinoleic acids. This view is contested by Scheurer Kestner, who believes that the highest polymerisation product of this nature is di-ricinoleic acid where the combination is due to the splitting off of water from two hydroxyl groups, whereas those of Juillard are of ester formation.

Rassow and Rubinsky† have investigated the products formed when ricinoleic acid is heated alone and in the presence of various catalysts. They come to the conclusion that under the conditions of their experiments, that is, up to a temperature of 150° C., the products obtained are the polyricinoleic acids of the ester type. Such a change was greatly accelerated in the presence of small quantities of sulphuric acid, the neutralisation value falling as low as 25%.

With the above remarks upon the extent of our knowledge of ricinoleic acid and its general properties, I shall proceed to describe the work carried out on the "splitting" or "hydrolysing" of castor oil, by two well-known methods, namely:—



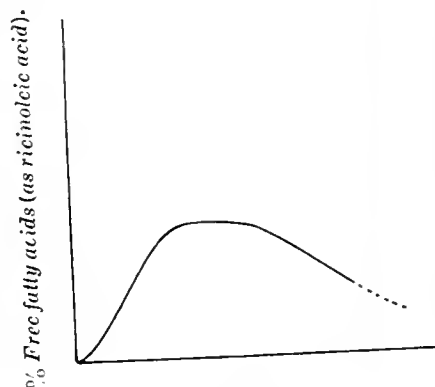
Time.
FIG. I.

1. Hydrolysis by means of Twitchell's reagent.
2. Hydrolysis by water under pressure in the presence of bases, generally termed "autoclave splitting."

The results may be found of interest as no information upon the splitting of castor oil could be gathered from published literature.

(1) Twitchell's reagent, a product obtained by the action of sulphuric acid upon a mixture of oleic acid and a hydrocarbon such as benzene or

naphthalene, has an accelerating effect upon the hydrolysis of fats by steam. The oil is placed in a covered wooden vat together with a small quantity of the saponifier. Steam is then blown vigorously through the liquid for several hours. The extent of hydrolysis can be followed by a determination of the acid value in the usual manner.



Time.
FIG. II

When the desired splitting effect has been obtained, the mixture is acidified, whereby the emulsion formed is broken and the fatty acids are obtained clear on the surface.

In the case of ordinary fats and oils, the splitting effect increases with time and if the results are plotted a curve of the type shown in Fig. I. is obtained. The rate of hydrolysis is slow at the start up to the point of inflexion A. This is probably due to the influence of free fatty acids upon the interfacial tensions between the oil and water phases. A lowering of the tension aids the formation of an emulsion, thereby creating an increased surface contact between the oil and water, and this effect is obtained after the production of a small percentage of fatty acids. The hydrolysis then proceeds quite normally, the rate of splitting decreasing as it approaches 100%.

In the case of castor oil, the results which are tabulated below show the anomalous character of the hydrolysis.

Time.	% Free fatty acids calculated as ricinoleic acid.		
	A.	B.	C.
After 6 hours	51.4	55.0	55.3
After 12 hours	55.2	55.8	61.3
After 18 hours	61.6	62.0	61.9
After 24 hours	48.5	50.0	44.5

Batches A and B are the same oil—C is a different oil.

The results when shown graphically have the general form represented in Fig. II.

In this case it is obvious that secondary reactions tending to lower the acid value have taken place.

The product during "twitchelling" had darkened slightly. It was but partially soluble in cold alcohol, but totally soluble in hot alcohol. The insoluble portion dissolved readily in petrol ether. Both portions, however, were acidic and titrated readily to a definite end point in a petrol ether-alcohol mixture.

On boiling away these solvents and dissolving the soaps in water, there was no indication of the presence of either unsaponifiable substances or substances saponified with difficulty.

* Bull. Soc. Chim., 1891, 11, 280.
† Z. angew. Chem., 1913, 318.

The twitchelled product gave the following constants:—

Iodine value	88.83
Free fatty acids (calculated as castor oil fatty acids)	44.5%
Equivalent weight (by titration)	669.6
Saponification value	195.5
Glycerin content	0.1%

Saponification with alcoholic potash reproduced fatty acids having the same constants as the original ricinoleic acid. The change, however, could not be brought about with aqueous caustic soda. It is obvious therefore that they are fairly stable acids.

We shall return to a discussion of the probable products formed when the results of the splitting by the "autoclave" method have been indicated.

(2) This is a method adopted for the rapid production of fatty acids and consists in heating the oils or fats under steam pressure in the presence of small proportions of bases such as lime, magnesium oxide, or zinc oxide and zinc. In our case the splitting was effected under 200 lb. pressure per sq. inch, in the presence of 0.75% zinc oxide and 0.25% zinc. With most oils the splitting is practically complete (98–99%) within 1½–2 hours.

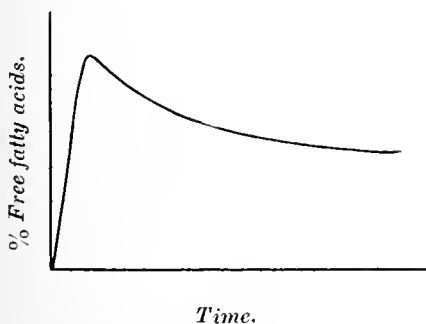


FIG. III.

The results given below are typical of those obtained in the case of castor oil.

Time.	% Fatty acids as ricinoleic acid.
1 hour	75.7
2 hours	69.1
3 hours	58.1
4 hours	56.0
5 hours	55.6
6 hours	55.3
7 hours	54.0
8 hours	52.9
9 hours	51.0

These are represented graphically in Fig. III. The general form of the curve obtained is seen to resemble closely the one obtained by "twitchelling." There is one difference obvious. In the autoclaving the system approaches an equilibrium when an apparent splitting of 50% has taken place, whereas in the "twitchelling" curve the equilibrium point, though not actually determined, is much below this figure. In one case the percentage of fatty acids was reduced as low as 33%.

The product obtained possessed a much darker colour than the twitchelled product. It was partially soluble in alcohol, almost entirely in petrol ether, leaving a small proportion of a semi-solid mass.

The alcohol-soluble portion was a light coloured viscous liquid similar to castor oil and which readily titrated to a definite end point. The ether-soluble portion was a deep-red coloured fluid of high viscosity. This substance proved

to be the iron salts of acids of equivalent weight 917.6, the colour being entirely due to the presence of iron derived from the autoclave. The acids derived from these salts were of a good colour. It should be noted that substances of a lactone or lactide constitution could not be isolated from this portion.

All these acids could be reconverted into the original ricinoleic acid by means of alcoholic potash. This proved impossible in aqueous solution.

The following are the constants for the original castor oil and the several products.

	Original castor oil.	Autoclaved mixture.	
Acetyl value	171.0	70.8	
Saponif. value	175.8	192.6	
Iodine value	83.6	88.0	
Free fatty acids (as ricinoleic acid)	6.0%	51.0%	
Glycerin content	—	0.05%	
		Alcohol-soluble acids.	Acids derived from iron salts.
Saponif. value		191.4	—
Iodine value		87.7	88.5
Free fatty acids as ricinoleic acid ..		63.0%	32.7%
Equivalent weight		476.7	917.6

The results have also been tabulated in Table I. for comparison with the theoretically possible products. An examination of these figures makes the following conclusions obvious:—

1. The iodine values have scarcely been affected and therefore the changes in the fatty acids are not to be attributed to the unsaturated carbon linkages.

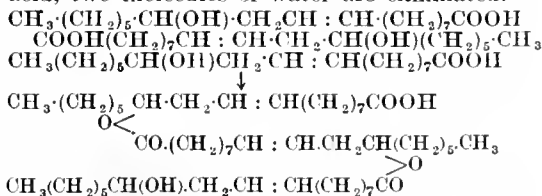
2. The reduction in the acetyl values indicates that the phenomena are due to a condensation of some form in which the hydroxyl groups take part.

3. The reduction in the acid values can therefore only be due to a combination of a hydroxyl and a carboxylic group with the splitting off of water.

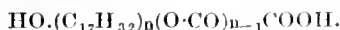
We can therefore dispose of the formation of the first six theoretically possible condensation products as highly improbable, and if formed they can be present but to a small extent.

Similarly the isolation of stable lactones or lactides was not found possible. The titrations at all stages were exceedingly sharp and it is concluded that these also are not formed.

The constants of the products prove definitely the presence of the so-called polyricinoleic acids, that is, the ester acids, both in the twitchelled and autoclaved products. These acids are formed by the elimination of a molecule of water from a hydroxyl group of one molecule and the carboxylic group of another. Thus in the case of triricinoleic acid, two molecules of water are eliminated.



The acids may be represented by the general formula:—



It has been previously pointed out that condensation of the fatty acids proceeded during autoclaving as far as 50%, at this point the system

approaching equilibrium, whilst during twitchelling, the apparent fatty acid content was reduced as low as 33%. This is exactly what would have been expected, since the conditions during autoclaving, carried out under steam pressure, are adverse to the splitting of water.

No attempt was made to isolate the several polyricinoleic acids. It is, however, evident that acids at least as high as the tetra acid were formed, as those isolated from the iron salts had an equivalent value of 917.6. These higher acids were found to be very slightly soluble in alcohol, whilst the lower acids were readily soluble, thus confirming the observations of Rassow.

The conclusions arrived at concerning the splitting of castor oil can be summarised thus:—

1. The hydrolysis of the castor oil, both by means of Twitchell's saponifier and also by the autoclave process, is practically complete, as is shown by the percentage of glycerol left in the products obtained.

2. The apparent low yield of free fatty acids is due to the formation of ester-acids, the so-called polyricinoleic acids, by the condensation of the ricinoleic acid molecules.

This work was primarily of a private nature, and I wish to express my gratitude to Messrs. Lever Brothers, Limited, and especially to Mr. J. Gray, as director, for their permission to publish these results.

Meeting held at Liverpool on Wednesday, 28th February, 1917.

PROF. E. C. C. BALY IS THE CHAIR.

THE MODERN WHALE OIL INDUSTRY.

BY WILLIAM MANSBRIDGE.

The whaling industry has, from one cause or another, experienced many fluctuations of prosperity and vicissitude, now a flourishing industry, then after a few decades not worth pursuing, Hull, Dundee, Glasgow, and the seaport towns of

TABLE I.

Condensation products of ricinoleic acid theoretically possible.

	Equivalent weight by titration.	Sap. value.	Acetyl value.	Iodine value.
1. Ricinoleic acid. $C_6H_{13}.CH_2.CH_2.CH:CH(CH_2)_7.COOH$	298.3	188.1	188.1	85.2
2. Saturated lactone. $C_6H_{13}.CH_2.CH_2.CH_2.CH_2.CH_2.CH_2.CO$	0	188.1	188.1	0
3. Saturated lactide. $C_6H_{13}.CH_2.CH_2.CH_2.CH_2.CH_2.CO$	0	188.1	188.1	0
4. Glycidic acid. $C_6H_{13}.CH_2.CH_2.CH_2.CH_2.CH_2.CO$	298.3	188.1	0	0
5. Half saturated dimeric acid. $C_6H_{13}.CH_2.CH_2.CH:CH(CH_2)_7.CO$	596.5	188.1	188.1	42
6. Ricinoleic anhydride. $C_6H_{13}.CH_2.CH_2.CH_2.CH_2.CH_2.CO$	—	194.2	194.2	87.8
7. Dibasic dimeric acid. $C_6H_{13}.CH_2.CH_2.CH_2.CH_2.CH_2.CO$	289.2	194.2	0	87.8
8. Unsaturated lactone. $C_6H_{13}.CH_2.CH_2.CH_2.CH_2.CH_2.CO$	0	200.4	0	90.6
9. Unsaturated lactide. $C_6H_{13}.CH_2.CH_2.CH_2.CH_2.CH_2.CO$	0	200.4	0	90.6
10. Polyricinoleic acids. Di-ricinoleic acid	578.5	194.2	97.1	87.8
Tri-ricinoleic acid	858.7	196.2	65.4	88.7
Tetra-ricinoleic acid	1138.9	197.2	49.3	89.2
Penta-ricinoleic acid	1419.2	197.9	39.6	89.5
Constants of products obtained by				
A. Twitchelling	669.6	195.5	—	88.8
B. Autoclaving:—				
(a) Mixture	590.4	192.6	70.8	88.0
(b) Alcohol-soluble acid	476.7	191.4	—	87.7
(c) Acids derived from iron salts	917.6	—	—	88.5

the Eastern States of America, all had their period of supremacy, and now Tonsberg and Sandfjord in Norway occupy the first place as head quarters for fitting out whaling expeditions.

Just previous to 1868 whaling as an industry had languished, was in fact moribund; true, the pursuit of the Greenland whale and the sperm whale, as yielding the most valuable products, was still carried on, but as a whole the industry had reached such a point that it would soon have ceased to have had any particular importance as a source of oil.

This state of affairs was the result of a variety of circumstances. The increasing difficulty of the chase owing to the disappearance of the animals from their usual haunts, the increasing rarity of the two kinds chiefly sought, the fact of the hand harpoon having reached its limit as an effective weapon, and the great development of the mineral oil industry introducing a powerful competitor for purposes of lubrication, all combined to reduce the profits to vanishing point.

In 1868 a Norwegian whaler named Svend Foyn, of Tonsberg, introduced his gun-harpoon and from the start met with great success; the next three or four years were spent in perfecting the new weapon. Modern whaling dates from this event and soon Svend Foyn by his captures in the Varanger Fiords had demonstrated the efficiency of his methods and that whales could still be caught in numbers on the coast of Norway, the powerful sulphur-bottom and less valuable finback and humpback could now be taken and made to pay. In 1877 a competing company appeared and by 1886 there were nineteen companies with 35 whaling ships engaged in the waters adjacent to the Norwegian coasts. Coincident with the gun harpoon came the use of steam vessels; the harpoon weighing 4—5 cwt. and its heavy gun required a steady platform and a fairly large boat. Operations at this period were conducted from land stations where the captured whales were taken to be stripped of their blubber; thus the old time whaling ship with its complement of oar-propelled boats for chasing was superseded, at any rate for this kind of work.

But this prosperity was not without interruption; the cod fishermen and others, believing that the operations of the whaling fleet damaged their industry, sought and obtained a law prohibiting whaling on the coasts of Norway and in consequence the business suffered a serious setback.

During the period 1868—1904 17,745 whales were taken on the Norwegian coasts, the best year being 1885 with 1287 captures. In the earlier part of this time the blubber alone was utilised but, as it was realised that whales were becoming scarcer, other uses for the whale carcase were sought, the result being that the land stations began to make bone meal and whale guano from the parts usually thrown away.

In 1894 whalers began to visit the Faroe Islands with success, and eventually there were 6 stations with 13 to 17 whaling ships having their headquarters in the islands. Fishing in narrow seas as in Irish and Scottish waters was not very productive, although the one or two companies operating there still do very well. At the opening of the 20th century we find the Norwegians extending their methods to Newfoundland, Iceland, and Spitzbergen with considerable success.

In 1904—5 it was discovered that the South Pacific and South Atlantic were frequented by whales in immense numbers, land stations were established in South Georgia, the South Shetlands, the Falkland Islands, and Kerguelen, and at the present time these waters supply 80—90% of the whale oil production of the world.

The floating factory now becomes necessary to the economical development of the industry; it is

the modern counterpart of the old-time whaling ship, but the fires, fed with exhausted blubber, have given place to steam and the open "try-pots" to "press cookers," while on the floating factories the oil when ready is run into tanks and brought home in bulk instead of in casks.

The vast distances in the Southern oceans make such an arrangement of primary importance, and the employment of a floating factory is, in its effect, as important and far-reaching as the earlier influence of the gun-harpoon; it allows the chase to be carried right up to the edge of the Antarctic ice where the natural difficulties of maintaining a land station are practically insurmountable, and besides saves much time by following up the fishing fleet.

The usual method of working such distant waters as the South Pacific and the South Atlantic is for the floating factory to sail with supplies for the land stations towards the end of summer. This cargo consists of coal, provisions, building material, machinery and general stores, including empty barrels, the coal being carried in the oil tanks. After discharging at say South Georgia, the tanks are cleaned out ready for oil and the factory ship, accompanied by its fleet of fishing vessels, departs for the cruising ground which may be at the edge of the Antarctic ice. The actual pursuit and killing of the whale is done by small steamers of about 120 tons: the gun is mounted in the bows and naturally the skill of the gunner is an important matter. On sighting a whale the vessel is allowed to drift near enough to the animal as it rises to blow within range, the harpoon is fired into it, out goes the thick cable, and if the shot has been a good one the whale is soon alongside, wound in by the steam winch and inflated through a hollow lance to make it float easily; as many as four may be secured in this way and taken to the floating factory on to the land station for disposal. The bomb harpoon, frequently employed, has as explosive head fired by a time fuse and if well planted in the whale death quickly ensues.

The floating factory is often an old liner filled with tanks for the reception of the oil; even the ballast tanks are utilised for the same purpose; some have a few large tanks built into them, others have as many as 80 or 90 small tanks; barrels from the land stations are carried in the 'tween decks, and the upper deck amidships is occupied by the "cooker tanks," as the digesters in which the blubber is rendered or "tried out" are called. The cooker tanks are arranged in pairs; they are strong iron vessels capable of standing a pressure of 100 lb. per sq. inch, with a wide manhole at the top for charging and one near the bottom for discharging the exhausted blubber, and perhaps one pair will be fitted with extra large openings 4 ft. diam. for the reception of bones, such as ribs and vertebrae; curved iron plates are used to provide a free passage for the steam through the mass of blubber.

Arrived alongside the operation of "flensing," which consists in stripping the blubber from the dead whale, is at once commenced; huge pieces are hoisted on board, put through the chopping machine, taken up by an elevator and dropped into the cooker, steam is turned on, and after a sufficient period, generally six to eight hours, the oil is run off through a system of separating tanks to get rid of the free water, then into the store tanks in the lower part of the ship.

The process of cooking is of very great importance; upon the skill and care with which it is conducted depends whether the oil will reach the market in good condition or much depreciated in value, hence the cook shares with the gunner the honours of a successful voyage. As the largest number of cargoes arrive during March to July it follows that a large part of the season's oil is

upwards of six months old, and it may even be eighteen months old when marketed, so that unless properly cooked it will keep badly and in consequence fetch a lower price when landed. The ambition of most cooks is to produce a very pale oil; this is not an easy matter even from very fresh whales if the oil is well cooked, but unfortunately quite simple if undercooked. I have been informed that cold pressing with hydraulic presses has been tried with the object of obtaining a very pale coloured oil, but, as might be expected, the oil quickly became rancid and bad in other ways, and the idea was soon abandoned. The best cook is one who is able to get the largest yield of pale oil with the best keeping qualities; this also best fills the requirements of both parties, the producer of the oil and the merchant who buys it from him. It has always been my advice to the captains of floating factories to make a well cooked oil that will grade "No. 1" and let the superfine colour go, because if stored it always depreciates and falls to No. 1 standard or lower; they generally see the force of this, particularly as nowadays they do not get a premium for extra pale oil.

From the point of view of oil production the most valuable whale is the sulphur-bottom, *Balanoptera sibbaldii*, Gray (*sulphureus*, Cope), which belongs to the class called rorquals and known as "finners," but if other products are taken into account the Greenland Right whale, *Balaena mysticetus*, is easily first, because of the value of the whalebone obtained from its mouth, with the Sperm whale *Physeter macrocephalus*, L., which furnishes spermaceti and is also the source of the very valuable substance known as ambergris, a good second. The sulphur-bottom whale is considered to be the largest known animal, either living or extinct, of the earth; it often attains a length of 90 feet with a yield of 100 barrels of oil, the record being taken by an authentic specimen measuring 96 feet in length which gave 140 barrels of oil. The "bone" obtained from this species is harsh and brittle and, compared with true whalebone, of little value, since it only fetches £35 to £45 or even less per ton, according to condition, whereas that furnished by the Right whale brings about £2500 per ton at the present day. The "bone" from the different species of rorqual is known as "finners," which term is also extended to the animal that bears it. The humpback, *Megaptera longimanus*, Rudolphi, abounds in Southern waters and is taken up to 50 feet in length; it gives 25—40 barrels of oil, while the finback, the gamest and most sporting of whales, grows to 70 feet but is also poor in oil, yielding 25—45 barrels. The bottlenose whale, *Hyperodon rostratum*, Miller, is chiefly hunted in the North Atlantic, the oil being very similar in constitution to that of the sperm whale; the animal is only of middle size, attaining a length of 20—30 feet, but gregarious in herds of about a dozen it well repays the chase. Altogether there are upwards of seventy kinds of whales, but many of them are considered by authorities to be only varieties or geographical races of predominant species.

I have often heard the opinion expressed that if they go on killing whales at the present rate, it will not be long before the industry must again suffer a decline and be scarcely worth following. In order to obtain information on this point I have made many enquiries from captains regarding the length of time occupied in growth; most replies have been to the effect that they do not know, but the best opinion indicates that whales grow very rapidly. As one captain who had given much thought to the matter, referring to the humpback, put it, the calf just before birth is about 16 ft. long and when weaned some two months later is about 24 ft. in length, so that when two years old the whale might very well be full grown or nearly so. If this opinion be correct, and I do not doubt it myself seeing that all the conditions of

the environment are conducive to rapid growth, viz. abundance of food, warm water in the breeding grounds, and with few enemies powerful enough to do much injury combined with a fairly rapid rate of natural increase, it will be a long time, even at the present rate, before whales will be perceptibly diminished in numbers. This view is supported by the figures for 1911, as in that year we find that after 35 seasons of modern hunting in European water 1165 whales were taken; yielding an average of 35 barrels of oil per whale; in the same year the Southern Norwegian catch in the south seas is recorded as 12,635 whales giving 306,000 barrels of oil, or an average of nearly 25 barrels for the Norwegian catch in those waters. I think the above figures sufficiently indicate that we may expect a good supply of whale oil for many years to come; this is the more gratifying in view of the importance of the industrial applications of the oil, especially during the last few years. The world's production of whale oil for the last six seasons is shown in the following table, partly taken from the Anglo-Norwegian Trade Journal:

Year.	Locality.	Whales taken.	Norwegian production. Barrels.	% of total.	Total production of world.
1911.	Iceland ..	352	11,800	—	—
	Faroe Isles ..	257	6,900	—	—
	Shetland and Hebrides ..	412	13,800	—	—
	Spitzbergen ..	144	5,500	—	—
	Total Europe	1,165	38,000	—	—
	South Seas ..	12,635	306,000	—	—
			341,000	71.6	485,000
1912.	Whole world	—	—	—	875,000
1913.	"	—	600,000	77.0	775,000
1914.	"	—	575,000	78.0	735,000
1915.	"	—	475,000	75.0	630,000
1916.	"	—	367,400	58.0	634,500

The contribution of different fisheries for the last two years is as follows:—

	1915. Norway.	1916. World.
South Shetlands	195,000	216,000
South Georgia	136,700	329,400
Australia		13,000
Alaska	34,800	18,000
Faroe Islands		no data
Africa		40,000

As illustrating the magnitude of the fleet of vessels engaged in whaling in 1912, there were:—

54 floating factories of 155,174 tons total.
9 cargo ships of ... 21,098 tons total.
267 fishing vessels of ... 100/120 tons each.
A few of the last being 150 tons each.

Some of the floating factories have now been chartered for carrying other kinds of oil, and it is possible that there will be a falling off in the amount of whale oil produced because of this, but I think it will prove to be only temporary.

Crude whale oil is graded according to colour, as will have been gathered from the preceding references, but during the last few years there has been an increasing tendency to make the free fatty acid test a basis of contracts. As a matter of experience it is found that an oil which falls below the highest figure representing the limit of free fatty acid for a particular grade, will also conform to the accepted colour standard for that grade; there are exceptions, as for instance when an oil is discoloured by iron salts, but these are rare.

The accepted grades are known as No. 0, No. 1, No. 2, No. 3, and No. 4. No. 0 and No. 1 are now generally classed together, the former being regarded as a superfine No. 1; the colour varies from pale

straw colour to fine pale yellow. No. 2 is amber yellow and No. 3 pale brown, while anything too dark to be classed as No. 3 is regarded as No. 4, unless it is very bad coloured when it is referred to as "dark whale oil." In the year 1912 samples representing some 650,000 barrels, or about three fourths of the entire production for the year, passed through my hands; the colour was measured in the Lovibond tintometer and the resulting average was adopted as a standard, which has met the views of both sides of the trade so well that no suggestion for an alteration has been expressed. In conjunction with Mr. J. W. Lovibond a set of standard glasses was prepared and these have proved very useful for the rapid examination of samples so necessary when a large cargo has to be rapidly discharged.

In order to examine crude whale oil in the tintometer it is necessary to warm it slightly in order to melt the stearine; a temperature of 75°–80° F. is sufficient for the purpose. The oil as delivered by the ship, always contains moisture which should not exceed 0.5%. The sample must not be heated sufficiently to drive off water, and besides, this would probably darken the oil to some extent, neither must filtration be resorted to as thereby colour might be removed. Considerable care is therefore needed to obtain accurate results, but a little practice will soon overcome any difficulty in the preparation of the sample.

The colours in Lovibond's neutral tint series are as follows:—

	Red.	Yellow.	Blue.
No. 0	1.8	+ 5.6	+ 0.8
No. 1	5.0	+20.0	+2.0
No. 2	7.0	+30.0	+1.9
No. 3	26.0	+80.0	+1.5
No. 4	Not required.		

All in one inch standard cell.

Modern whale oil is a very different thing from the evil smelling stuff most of us have encountered in our early days; now even the dark coloured qualities are not really objectionable, while the pale kinds are quite sweet, possessing no disagreeable taste or smell.

On account of its proximity to several great soapworks and accessibility to the industrial centres of Lancashire and Yorkshire, Liverpool is especially well-placed as a port and has with commendable enterprise and foresight provided excellent facilities for handling, receiving, and distributing whale oil. As has already been stated, a large proportion of the oil arrives in bulk, being carried in tanks on board ship. This has to be analysed and graded on arrival at the port, and when, as is often the case, the ship contains a large number of tanks, this is an important matter. The oil is pumped from the ship into large storage tanks, and in spite of the difficulties connected with this class of oil, a ship carrying 30,000 barrels in bulk can be very expeditiously discharged. From the storage tanks on shore the oil is easily delivered into tank wagons or barrelled off and put on rails alongside for distribution inland, or, if desired, delivery can be given direct from the ship either in bulk or in barrels.

So efficient is the method of dealing with whale oil at Liverpool and Birkenhead that many captains prefer those ports on account of the special facilities provided for them.

Taking 1916 as an example, two-thirds of the oil imported into the U.K.—amounting to 351,000 barrels—was brought to Liverpool and a corresponding proportion in previous years.

In a future paper I hope to deal with the industrial and technical uses of whale oil more fully.

DISCUSSION.

The CHAIRMAN asked what were the uses to which the oil and its products were ultimately put.

Dr. E. F. ARMSTRONG said that whale oil was the first oil to be bought upon a chemical analysis, buyers had set up a standard for grading the oil, not by colour but by the free fatty acid content. The degree of saturation of the fatty acid in an oil depended on the climate it came from, for instance linseed oil, obtained from a mild climate, was unsaturated, but coconut oil from a tropical climate was highly saturated.

Mr. A. E. LEVEY asked for information regarding the quantity of hardened whale oil employed in margarine manufacture. He believed there was a close time when whales might not be hunted.

Mr. J. FOX thought that if the crew of a whaler were paid by results it might have considerable influence on the proportion of the different qualities brought to market. He thought the No. 2 grade was really spoiled No. 1 due to careless treatment in the rendering. Some information regarding the proportion of the products obtained by distillation would be interesting.

Mr. MANSBRIDGE replied that whale oil was used principally in soap making and in the manufacture of edible fats, oleine for the textile trades, leather dressing, and lubricating. In regard to chemical testing he recalled how a Norwegian had fitted a laboratory on his floating factory and employed a chemist to grade the oil as it was made; the result had been that they went too near the limit and on arrival in port it was found that the oil had deteriorated into the next lower grade. There was no law as to a close time for whales, but the whaler tried to avoid killing cow whales with calves. The bonus system of payment ensured the best quality of oil possible.

According to the method of distillation adopted for the treatment of the fatty acids, the yield of pitch varied from 5% to 15%, but leaving that out of the question, the yield of hard stearine (setting point about 135° C.) would be about 15%, soft stearine 25%, and the balance oleine.

Communication.

THE NATURAL ACCELERATOR OF PARA RUBBER.

BY HENRY P. STEVENS.

In various papers * I have shown that certain constituents normally present in raw rubber are necessary for the satisfactory vulcanisation of the latter. These constituents are (1) the nitrogenous complex or "insoluble" constituent which is almost wholly insoluble in benzene, chloroform, and similar solvents, (2) matters which can be extracted with acetone—mainly resins. I have also shown that the insoluble constituent can be replaced by other nitrogenous matter such as peptone, to a lesser extent by casein, and to a slight extent by non-nitrogenous substances such as starch. But I have not succeeded in satisfactorily replacing the acetone-soluble constituents (mostly natural resinous matter) by other resins such as colophony. From this it may be inferred that the active constituent contained in the acetone extract consists of matter other than resin although the latter harks largely. The removal of the nitrogenous matter has the effect of retarding vulcanisation but does not affect the stability of the caoutchouc or the vulcanised rubber. The

* This Journal, December 16, 1912, p. 1099. Also Kolloid Zeits., 1912, 11, p. 69; 1913, 12, p. 46; 1914, 14, p. 91. Reports of the 5th Int. Congress of Applied Chem., 1912, 25, p. 581.

removal of the acetone-soluble matters not only tends to retard vulcanisation, particularly when the rubber is compounded with litharge, but also reduces the stability of the caoutchouc and renders it more readily oxidisable. Numerous analyses failed to reveal any direct relationship between the percentage of nitrogen and the vulcanising properties of raw rubber.

In recent papers* Eaton and Grantham have described the effect produced by allowing wet coagulated latex to stand for a few days before washing and drying. This results in a more rapidly vulcanising crêpe rubber. From the results of tests made on rubber prepared by Mr. Morgan, chemist to the Rubber Growers' Association, in Malaya, I am able to confirm this. Eaton and Grantham also found that this rapidly vulcanising rubber contained less nitrogen than ordinary sheet or crêpe, loss of nitrogen taking place during drying and crêping. On the other hand, smoked rubber did not show a loss of nitrogen in similar circumstances. I have obtained the following results by means of duplicate determinations on samples of rubber prepared by Mr. Morgan on three consecutive days. Each vertical column represents samples prepared from portions of the same coagulated latex.

TABLE I.
Air-dried.

	1st day.	2nd day.	3rd day.	Mean.
Nitrogen %.				
(1) Dried without rolling, i.e., "slab"	0.40	0.39	0.35	0.38
(2) Dried for 14 days without rolling, then crêped and dried	0.30	0.29	0.32	0.30
(3) Dried after rolling, i.e., ordinary sheet	0.47	0.46	0.46	0.46
(4) Crêped next morning and dried, i.e., ordinary crêpe	0.47	0.46	0.45	0.46

Smoke-dried.

	1st day.	2nd day.	3rd day.	Mean.
Nitrogen %.				
(5) Smoked without rolling, i.e., "slab"	0.48	0.50	0.45	0.48
(6) Smoked for 14 days, then crêped and smoke dried ..	0.50	0.50	0.48	0.49
(7) Smoked after rolling, i.e., ordinary smoked sheet ..	0.46	0.44	0.45	0.45
(8) Crêped next morning and smoke dried, i.e., "smoked crêpe"	---	0.49	0.47	0.48

It will be seen that the results on the three days agree well with one another. The figures for ordinary sheet rubber, whether air-dried or smoke-cured, remain about the same, 0.44 to 0.47%, on all three days. Of the air-dried specimens, the slab (1) contains less nitrogen than the ordinary sheet (3) although it must originally have retained more of the nitrogenous serum. This loss is more pronounced after washing (2). The nitrogen content of crêpe (4) is practically identical with that of sheet (3). There is evidently no appreciable quantity of serum in the sheet which can be washed out by crêping.

The ordinary smoked sheet (7) contains approximately the same amount of nitrogen as the air-dried sheet (3), but the other forms of smoke-cured rubbers (5), (6), and (8) contain more nitro-

gen. This would be expected in the case of the smoked slab (5) on account of the additional serum retained, provided that the smoke curing prevented putrefaction and consequent loss of nitrogen. The slightly higher figures for nitrogen in (6) and (8) can only be explained on the assumption that a little nitrogenous matter is absorbed from the smoke.

As the air-dried slab (1) contains less nitrogen than the air-dried sheet (3) or crêpe (4), it is obvious that the loss of nitrogenous matter on "maturing" of slab is greater than can be accounted for by the decomposition of the additional serum retained through not rolling. Hence the loss of nitrogenous matter is not confined to the soluble nitrogenous matter of the serum but includes the insoluble nitrogenous matter coagulated with the caoutchouc itself.

The nitrogenous matter is not evenly distributed throughout sheet and slab rubber. During drying, a part of the serum oozes from the surface and dries down to a water-insoluble scale or varnish-like film, and the nitrogen content of the surface layer is appreciably higher than that of the interior portions. Means are now adopted for preventing the formation of this surface film, and ordinary sheet does not show the same differences in nitrogen content between the surface and interior layers that it did a few years ago. Thus, to quote from some analyses made in 1913.

TABLE II.

	Percentage of nitrogen.		
	In surface layer.	In middle layer.	Difference.
Sheet rubber, without surface scale, cured on			
Estate A	0.44	0.33	0.11
Estate B	0.43	0.39	0.04
Sheet rubber showing surface scale, cured on			
Estate A	0.60	0.33	0.27
Estate B	0.60	0.32	0.28

Or again, taking sample B 1 for the third day (Table I.), and separating into approximately equal parts consisting of outside and inside portions, the nitrogen content of the former amounted to 0.55% and of the latter to 0.35%. This slab showed a very marked surface scale, but it is evident from the figures for the first two samples, that the scale does not wholly account for the concentration of nitrogenous matter on the surface of the rubber and that part of the excess is present in the surface layers.

The above figures also show that very misleading results may be obtained for the nitrogen content of sheet and slab rubbers unless the precaution is taken of thoroughly mixing the specimen dry on the roller mill previous to removal of the sample for analysis.

I have already referred to the replacement of the protein naturally present in latex by nitrogenous substances from other sources, such as peptone and casein. Eaton and Grantham, however, as a result of certain experiments of their own, have come to the conclusion that peptone and casein have little or no effect on the rate of vulcanisation.* They used a crêpe rubber for these experiments, that is to say, a rubber washed free or almost free from natural accelerators but containing the full complement of protein matter necessary for normal vulcanisation. Peptone, in its power to promote vulcanisation, is roughly

* This Journal, July 15, 1916, p. 723. Eaton and Grantham say that my figures "do not appear very convincing" but fail to justify this statement.

* This Journal, July 15, 1916, p. 715 *et seq.*

equivalent to the natural protein matter, and consequently the addition of peptone to a rubber already containing sufficient nitrogenous matter for complete vulcanisation will have a very slight effect. Eaton and Grantham have themselves shown that the heat-coagulable proteins which separate on concentration of latex serum have, when added to ordinary crêpe rubber, little or no influence on the rate of vulcanisation.* The natural insoluble nitrogenous matter, peptone and other complex proteins, must be sharply differentiated from the simpler amino compounds produced by their putrefaction or from the synthetical accelerators. These simpler bodies are far more effective in promoting vulcanisation. Hence they accelerate vulcanisation in a rubber such as ordinary washed crêpe already containing sufficient protein matter for normal vulcanisation. On the other hand, a complex substance such as peptone is not so active and consequently does not produce appreciable acceleration. We require to distinguish clearly between (1) the complex nitrogenous substance (protein) which is necessary for normal vulcanisation but which can hardly be termed an accelerator, and (2) simpler nitrogenous derivatives (which will later be shown to consist of the simpler nitrogenous bases) which are more effective than the proteins and are true accelerators. The latter are able to produce appreciable acceleration in an ordinary raw rubber, while the former cannot. To gauge the effect of the former substances as catalysts or promoters of vulcanisation, it is necessary to start with a rubber from which the natural insoluble nitrogenous constituent has been removed. This was the method adopted in our experiments described in 1914. Work of this nature is very tedious because the removal of this natural nitrogenous constituent requires large volumes of solvents and long standing to allow the insoluble nitrogenous matter to deposit. A further series of experiments has now been made with rubber from which practically the whole of the nitrogenous material has been removed, and which carries the matter a stage further than the published work of Eaton and Grantham. The rubber was freed from nitrogenous matter by standing in the dark with cold benzene for a period of one to two years. The clear supernatant solution of rubber was then poured off and the rubber recovered from this by spontaneous evaporation without artificial heat. The original raw material was an unsmoked sheet rubber containing 0.48% of nitrogen. After removal of the insoluble matter the "protein free" rubber contained only 0.07% of nitrogen. Separation of the insoluble matter was very complete, and it is probable that this small residue of nitrogen was present in some soluble form.

The following "mixes" were made up, based on the simple formula of rubber 100 parts, sulphur 10 parts:—

- (1) Untreated sheet.
- (2) "Protein free" sheet.
- (3) "Protein free" rubber +3% of the heat-coagulable proteins which separate out as a flocculent precipitate on concentrating the serum expressed in sheet making.
- (4) "Protein free" rubber +1½% of the evaporated liquors after removal of the flocculent precipitate referred to above.
- (5) "Protein free" rubber +3% of *l*-methyl-inositol extracted from the residual liquors. This represents about the maximum amount of this crystalline substance ordinarily found in sheet rubber.†
- (6) Rubber rich in protein, being the residue of rubber and solvent after pouring off the clear benzene solution.

The following results were obtained. All samples were cured under the same conditions (3 hours at 135° C.), so as to illustrate the effect of the different constituents. The quantity at my disposal was insufficient for a series of vulcanisations:—

TABLE III.

	(1)	(2)	(3)	(4)	(5)	(6)
Breaking load (grms. per sq. mm.)*	1360	590	700	940	280	810
Final length (original length=100)	1010	1160	1040	860	1110	630
Tensile product	136	68	73	81	32	51
Coefficient of vulcanisation	3.66	1.60	3.08	5.28	1.32	6.44
Nitrogen calculated on raw rubber %	0.48	0.05	0.57	0.35	0.05	1.81

* For details of method of testing see this Journal, Aug. 31, 1916, p. 873.

In experiments of this type particular attention should be paid to the figures for the coefficient of vulcanisation. Tensile figures are more difficult of interpretation, as a low breaking load may be caused not only by under or over vulcanisation, but by the adulteration of the rubber itself.

The results clearly show the effect of the different nitrogenous constituents on the vulcanising properties of the rubber. Taking the samples in order:—

(2) Shows that the removal of the insoluble nitrogenous matter causes a greatly reduced rate of cure. The breaking load has fallen to less than one-half. On the other hand, the final length (elongation) is greater and the coefficient of vulcanisation is much lower.

(3) Shows that the addition of the insoluble matter which separates from the mother liquor or serum on evaporation causes an increased rate of vulcanisation. In fact, this insoluble matter behaves like the natural protein matter retained in ordinary crêpe rubber. This sample shows higher breaking load as against sample (2), lower final length and higher coefficient of vulcanisation. In fact, the coefficient of vulcanisation is almost equal to that of the original untreated rubber, sample (1). Eaton arrived at the conclusion that this insoluble matter had no effect on the rate of vulcanisation. His mistake arose from taking rubber already containing its full complement of nitrogenous matter instead of working with a rubber from which the latter had been removed. Although the effect of adding the insoluble matter to sample (2) is so marked, it is quite possible that the effect of adding it to sample (1) would have been inappreciable.

(4) Illustrates the effect of the addition of soluble nitrogenous matter. The effect is similar to that of the insoluble nitrogenous matter as shown in sample (3), but much more pronounced. The breaking load is higher, the final length is much less, and the coefficient of vulcanisation now much exceeds that of the original rubber, sample (1), although the percentage of nitrogen it contains is much less and the amount of this soluble matter added in sample (4) was only half that of the insoluble matter added in sample (3). The efficiency of this soluble matter is no doubt due to its containing protein decomposition products. In the main it will consist of *l*-methyl-inositol. The mother liquor from which the soluble matter was obtained was sent home* in a bottle filled to the brim. The odour was very slight and the liquor of a light brown shade which, however, darkened on evaporation. It would therefore appear that it is possible to produce

* *loc. cit.*, p. 725.

† Pickles and Whitfield, Proc. Chem. Soc., 1911, 27, p. 111.

* Supplied by Mr. S. Morgan, Chemist to the Rubber Growers' Association in Malaya.

a substance acting as an accelerator from the mother liquors of coagulated latex by keeping these in a vessel filled to the brim, the practical exclusion of air preventing the formation of putrefactive odours. Sample (1) may be regarded as artificially prepared "slab."

Sample (5) shows that the effect of the addition of the methylinositol is to retard vulcanisation. The breaking load is lower and the coefficient of vulcanisation is also lower than in the corresponding sample (2).

Sample (6) contains a large excess of the insoluble nitrogenous matter (protein) naturally present in rubber. Its effect has been to increase the rate of cure. Both samples (1) and (6) are much over vulcanised. Better results from the physical standpoint would have been obtained with shorter cures. Nevertheless the figures clearly illustrate the effect of the particular nitrogenous matter on the rate of vulcanisation. The percentage of nitrogen in sample (6) is 1.81, in sample (1) it is only 0.35. Yet the effect of the larger proportion of nitrogenous matter on the coefficient of vulcanisation and physical properties in sample (6) has not been very much greater than that of the small proportion of soluble nitrogenous matter in sample (4). This clearly illustrates the difference between the action of the insoluble and soluble nitrogenous matters respectively.

The conclusions to be drawn from these results are that complex nitrogenous matter (protein) promotes vulcanisation, and that naturally present in the rubber is necessary to secure vulcanisation within reasonable limits of time and temperature. There are, however, simpler nitrogenous substances, probably formed by the decomposition or gradual breaking up of the complex proteins by the action of micro-organisms,* which are far more active as vulcanising agents than the proteins themselves.

It has been stated that crêpe made from "slab" or matured coagulum vulcanises more rapidly than ordinary crêpe. It must therefore contain an appreciable quantity of accelerating base although the rubber has been put several times through differentially geared washing rollers in a stream of water. The figures already quoted show that loss of nitrogenous matter takes place and unwashed slab should therefore vulcanise faster than slab which has been washed and crêped. This has been put to the test.

A matured slab, prepared from unrolled latex,† was taken and divided into two parts. One part (2) was cut into thin slices with a knife and allowed to air dry. The remainder (3) was washed on a crêping machine and the crêpe air dried. The two samples were mixed in the proportion of 99 parts rubber and 10 parts sulphur and vulcanised for one, two, and three hours at 135° C. Sample (1) is a "mix" of pale crêpe rubber and sulphur in the same proportions to serve as a control. For results see Table IV.

The figures both for the physical tests and the coefficient of vulcanisation show that (2) and (3) cure much faster than the control sample (1). It must be remembered that the coagulum (slab) from which (2) and (3) were prepared was matured to the maximum extent, for the rubber was not used for some two or three months after coagulation. The results also show that the unwashed slab (2) cures faster than the washed slab (3). This is most clearly seen from the figures for the coefficient of vulcanisation, that for the unwashed slab being higher than for the washed and crêped slab in all three cures. The physical test figures also correspond, the final length being higher for the slower curing sample (3) than for (2) throughout. The breaking load figure is higher for the faster

curing sample (2) so long as the rubber is not grossly overcured, that is for the one and two hours' cure.

To carry the matter a stage further, various experiments were made for the purpose of extracting the soluble nitrogenous matter from crêpe rubber. The rubber was cut up into small pieces and digested for several days with either water or very dilute sulphuric acid. In all cases it was found possible to extract some nitrogenous matter from the rubber, even in the case of the thinnest pale crêpe which had been rapidly coagulated and converted into crêpe within three hours of adding the acid for coagulation. The amount so obtained was, however, very small in comparison with that extracted from crêpe prepared from matured coagulum or slab. Thus, in one experiment, 200 grms. of each was cut up finely and extracted with sufficient water to cover the rubber for ten days. The temperature was maintained at about 40°–50° C. during the first half of this period and then gradually raised to boiling point. The decanted liquor from the pale crêpe was almost colourless and gave only a slight precipitate with tannic acid. The liquor extracted from the crêpe obtained from the matured slab was brown in colour and gave a relatively heavy precipitate with tannic acid. The weights of the tannic acid precipitates calculated as percentages on the original rubber were 0.03% and 0.26% respectively. These figures will not represent the whole of the soluble protein matter present as repeated extractions would be necessary, but they illustrate the relative proportions retained by the rubber. After removal of the more complex nitrogenous substances (protein, etc.), by means of tannic acid and barium hydroxide, the amount of organic base remaining was determined by precipitating with phosphotungstic acid—with the usual precautions. The percentages of base weighed as phosphotungstate and isolated from the liquors were 0.0006 and 0.058 for the pale crêpe and the crêpe prepared from matured slab respectively.

In a similar manner 100 grms. each of ordinary thin pale crêpe and crêpe from matured slab were extracted for several days with 2% sulphuric acid. After removing the soluble proteins with tannic acid, and the excess of tannic acid with barium hydroxide solution, the bases were precipitated with phosphotungstic acid and gave the following amounts calculated on the raw rubber taken: for the pale crêpe 0.002% and for the crêpe prepared from matured slab 0.032%. As before, these figures apply to the first extraction only, nevertheless they are very small amounts, taking into consideration the fact that they represent a very much smaller proportion of base. The bases themselves must be very efficient accelerators if these small quantities produce the observed differences between the two varieties of crêpe. One can only suppose that long digestion with water or weak acids removes but a small part only of the bases present in the rubber.*

Some measure of the efficiency of the organic bases produced during putrefaction of latex serum results from the following experiments:—In the preparation of sheets, each from 2000 c.c. standardised latex on an estate in the East, the residual liquor from each pan, after standing, was concentrated and forwarded by Mr. S. Morgan in small bottles. The liquor was in each case made up with water to fill the bottle to the brim to prevent oxidation in transit. On arrival, the stoppers, which had been waxed, were found in good condition; the contents of the bottles varied in colour from pale yellow to brown, and contained a flocculent precipitate of coagulated proteins.

* Eaton and Grantham, *loc. cit.*

† Furnished by Mr. S. Morgan.

* With regard to the great difficulty of extracting nitrogenous substances from rubber compare D. Spence, *Koll. Zeit.*, 1914, 15, p. 268.

The contents of the bottles had little or no putrefactive odour.

Portions of 90 grms. each of the pale crêpe rubber used in the control sample (1) were mixed with 10 grms. sulphur with the addition of the substances mentioned below:—

(4) A portion of the evaporated contents of one bottle after filtering off the coagulated proteins. Weight taken 1.5 grms.

(5) The bases isolated by means of phosphotungstic acid—weight of base (crude) taken = 0.14 gm.

(6) Similar to (5), but in the place of isolating the bases the compound with phosphotungstic acid (weighing 1.29 grms.) was taken.

(7) Similar to (5), except that the base added was separated from the united contents of five bottles, equivalent to the residual liquor from 10,000 litres of standard latex. Weight of base isolated = 0.59 gm. This was soluble in alcohol.*

(8) A similar mix to those already described, but containing one gram of moist "accelerene" (paranitrosodimethylamine)† in place of the bases isolated from residual liquors. The one gram of moist accelerene corresponded to 0.92 gm. of the dry substance.

The "mixes" were vulcanised under the same conditions as before, that is to say for one, two, and three hours at 135° C., with the following results:—

product. Accelerene is said to be an exceptionally active product.

If the coefficients of the samples be compared at the three cures, it will be seen that they preserve the same order in each cure, consequently a study of the first cure alone is sufficient to illustrate the relative effect of the ingredient added to the mix, although many of the specimens are not fully vulcanised at this cure. The following conclusions may be drawn:—

(A) The artificial accelerator "accelerene" has the greatest effect. Present to the extent of 0.92%, it produces a greater degree of vulcanisation in one hour than is obtained with the control sample (3) in three hours.

(B) The samples containing natural accelerator isolated from the residual liquors (5) and (7) show an increase in the rate of vulcanisation but not in proportion to the amounts taken. It is characteristic of accelerators that smaller amounts are proportionally more effective than larger quantities. Sample (7) contains approximately four times the amount of natural base as is contained in sample (5), but the effect produced is barely doubled.

(C) It is interesting to note that the coefficient and also the physical test figures for sample (7) are very similar to those for samples (2) and (3). When it is remembered that (7) consists of ordinary pale crêpe to which has been added the natural accelerator isolated from the residual liquor, whereas (2) and (3) consist of "slab"

TABLE IV.

Sample No.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
One-hour cure.								
Breaking load (grms. per sq. mm.)	370	950	830	560	430	160	770	1030
Final length (original length=100)	1170	1070	1090	1050	1080	990	1070	770
Tensile product	37	101	90	58	47	16	81	79
Coefficient of vulcanisation	1.16	2.73	2.42	1.93	1.57	1.28	2.69	5.31
Two-hours' cure.								
Breaking load (grms. per sq. mm.)	800	1620	1530	1030	870	600	1650	—
Final length (original length=100)	1090	960	988	1010	1000	1060	950	—
Tensile product	87	155	151	104	87	63	157	—
Coefficient of vulcanisation	2.67	5.24	5.09	3.47	3.81	2.75	5.29	—
Three-hours' cure.								
Breaking load (grms. per sq. mm.)	1710	1350	1630	1410	1660	1400	730	—
Final length (original length=100)	990	770	840	890	910	970	670	—
Tensile product	169	104	137	125	151	135	48	—
Coefficient of vulcanisation	3.86	7.02	6.80	5.41	5.09	4.29	7.16	—

The effect of the accelerator, whether the natural base in samples (4) to (7) or the artificial accelerator (accelerene) sample (8), is most easily followed by noting the figures for the coefficient of vulcanisation. The effect of the "accelerene" is so great that sample (8) is already appreciably overcured in one hour. It was not therefore included in the two and three hours' cure. It must, however, be remembered that the amount taken was 0.92 gm. whereas sample (7) with the largest proportion of natural base contained only 0.59 gm. The artificial accelerator gave a coefficient of 5.31 in one hour and the natural accelerator in smaller amount gave a coefficient of 2.69 in one hour and 5.29 in two hours. Hence we may conclude that the artificial accelerator is somewhat more powerful than the natural. 0.92 part of the former producing double the effect of 0.59 part of the latter.

Improved methods of separating the natural accelerator may, however, result in a more efficient

rubber in which the residual liquors are largely retained and allowed to putrefy, it would seem to be fairly proven that the rapid vulcanising qualities of slab are due to the bases formed during putrefaction.

(D) Sample (4) gives a higher coefficient than the control and vulcanises more rapidly. This sample contained 1.5% of residual liquors obtained merely by evaporation and consists chiefly of substances other than the natural bases. Its effect is consequently less pronounced. 1.5% produces a rubber vulcanising but little faster than (5) containing only 0.14% of natural bases.

(E) Sample (6) shows that the natural bases in the form of phosphotungstate are almost as effective as the same quantity of base in the free state.

An analysis of the figures for physical tests leads to the same conclusions as those for the coefficient, but the matter is more complicated from the fact that samples considerably overcured give low results for breaking strain similar to the undercured samples. The fully cured samples give higher results and the slightly overcured the highest of all.

* A detailed examination of the base or mixture of bases is being undertaken.

† Peachey's Eng. Pat. No. 4263 of 1914.

The organic bases separated and used in these experiments are not volatile or not readily volatile. The putrefaction of latex serum might well give rise to volatile bases and such are indeed formed. Their presence can be shown by cutting up matured slab into small pieces and distilling in steam.

In general the experimental results show that the rapid curing property of matured coagulum is due to organic nitrogenous bases formed during putrefaction, as small quantities of these bases can be extracted from the rapidly curing rubber which has undergone putrefaction, while only a trace can be extracted from the ordinary pale crêpe. Further, that similar bases can be extracted from the residual liquors and very small quantities of these bases have been shown to have very marked effect in promoting vulcanisation.

I am indebted to the Rubber Growers' Association for permission to publish the results contained in this paper, and to Mr. S. Morgan for preparation of the specimens of raw rubber.

Industrial Notes.

REFRACTORY MATERIALS RESEARCH.

A conference on research in refractory materials was held at the rooms of the Iron and Steel Institute on March 22nd, at which representatives were present from the Geological Survey, National Physical Laboratory, Ceramic Society, Faraday Society, Institute of Metals, Institution of Gas Engineers, Society of British Gas Industries, Institution of Mining and Metallurgy, Iron and Steel Institute, Society of Chemical Industry, Association of British Chemical Manufacturers, and Society of Glass Technology.

A general debate took place on the question as to what steps might be taken to organise and promote research work on refractory materials and on the raw materials used in their manufacture, and a Committee consisting of Mr. A. Cliff, Prof. J. W. Cobb, Dr. R. T. Glazebrook, Sir Robert Hadfield, Mr. Cosmo Johns, Dr. J. W. Mellor, and Dr. A. Strahan, with Mr. F. S. Spiers as Secretary, was appointed to report to a later meeting of the conference on the following subjects:—

(A) The extent of the research work on refractory materials already in progress.

(B) The facilities for research existing in this country.

(C) The facilities existing for collecting published information on refractory materials and making it generally available.

The Committee is to invite representatives of the principal industries and Societies represented at the Conference to furnish them for the purpose of their report with a schedule of the problems calling for immediate action, and a statement of the special requirements of the industry they represent.

THE WAR AND OUR SUPPLY OF DRUGS.

At a meeting of the Royal Society of Arts held on February 28th, Mr. F. A. Hocking, Pharmacist to the London Hospital, discussed this subject, basing many of his remarks upon the practice of the London Hospital, which, with its 17,000 in-patients and 170,000 out-patients annually, affords very valuable and representative data for a discussion such as the present.

The subject is considered under three sections:—
1. What drugs were in use before the war, and

to indicate to what extent we were dependent upon Central Europe for their supply.

2. The difficulties arising out of the war, and to what extent these have been surmounted.

3. The period after the war.

The drugs in use before the war and their origin.

Medicinal plants. The greatly extended use of substances of definite chemical composition derived from the mineral kingdom or prepared in the chemical laboratory has tended to reduce the use of vegetable drugs, for the constant composition of the former presents great advantages over the often varying constituents of the latter.

For these and other reasons it comes about that, of the large numbers of drugs described in a text-book of Vegetable Materia Medica, some are occasionally prescribed by medical practitioners; some are to be seen only in a museum; some are constituents of the "heal-alls" of domestic medicine; and others are in demand by the patent medicine proprietor.

The list of drugs actually used in the London Hospital in the year 1914, for the purpose of this paper regarded as a peace year, includes about eighty of vegetable origin. Of this number some, such as alkanet root, are used merely for colouring; others, as orange peel, for flavouring; and some, as orris root, for perfuming; while a few, as tragacanth, are employed for pharmaceutical, as distinguished from medical, purposes.

Very few of the most important drugs are derived from Central Europe. Several are cultivated or grow wild within the borders of the British Empire; thus cinchona bark comes from India and Ceylon, as well as from non-British parts of the world, cinnamon bark from Ceylon, Buchu leaves from South Africa, senna leaves from India, and also Egypt, quassia wood from Jamaica, Nux vomica seeds, the source of strychnine, from India, castor-oil seeds also from India, as well as sandal-wood oil, and ipecacuanha root of sound quality comes from Johore.

Many come from non-European countries outside our Empire, such as camphor, a Japanese Government monopoly, Cascara bark from the United States of America, Calumba root from Africa, Ipecacuanha root from Central America as well as from Johore, Rhubarb root from China.

Of those which are supplied by Europe, some are imported from neutral or allied countries—thus, ergot comes from Russia and Spain, squill from the Mediterranean shores.

Ultimately there is a short list of medicinal plants formerly derived from enemy countries. They are aconite root, belladonna root and leaves, colchicum corn, digitalis leaves, gentian root, henbane leaves, opium, and possibly valerian root. Of these it is generally admitted that digitalis grows wild in this country in sufficient quantity for all our needs; and it is stated that very large quantities of wild colchicum corn, i.e., meadow saffron, have been gathered in this country during the past two years; hence little difficulty seems to exist.

For opium we are not entirely dependent on Eastern Europe, Persian opium having been for long an article of commerce, and since the outbreak of war Indian opium has been imported for the production of morphine—in fact, the world's supply of this alkaloid is to-day practically all produced from Indian opium.

Gentian root is but one of a number of bitters of equal value; hence any deficiency is not of great importance.

Indian or Japanese aconite might be used probably to supply any shortage of the European article.

The real difficulties were in connection with belladonna root and leaves, hyoscyamus leaves,

and possibly valerian. There may perhaps be one or two others which have a localised use in different parts of the country. Egyptian henbane tends now to render the cultivation of other Solanaceous plants a matter of indifference, and Japanese valerian root has been used for the European article.

It is difficult to estimate accurately the real extent of the deficiency because, for instance, while some people bemoan the shortage of English belladonna root, yet others are able to obtain their requirements. The shortage of belladonna and foxglove leaves cannot be so great as is supposed, for even during the war appreciable quantities of the English-grown products have been exported.

Even if the cultivation of these few plants be necessary, much caution is required. It cannot be stated too often that the demand is and must be strictly limited.

Drugs are used only by a minority of the population and medicinal doses are generally small, so that a very little over-production will soon render these drugs a glut on the market, and reduce prices to a non-remunerative level.

In view of what has been said, it seems that too much attention has been directed to a difficulty which is scarcely so urgent as has been represented; hence, may it not be asked if the energy at present being devoted to growing medicinal drugs might not be better utilised in the production of foodstuffs?

Substances obtained from the animal kingdom. Of these one was exclusively German, namely lanolin, a very useful basis for ointments. With this exception no one country can claim a monopoly of such articles as beeswax, honey, pepsin, and dry thyroid gland.

Alkaloids. The number of alkaloids or their salts used in the London Hospital in the year 1914 was about fifteen. Of these, seven—namely, apomorphine, acetomorphine, morphine, codeine, caffeine, strychnine, and emetine—were, and of course are, manufactured in England on a large scale, not merely for home consumption, but also for export, and we may claim that for both quality and quantity the English products were easily first. It is true Germany sold these drugs, but it is not easy to determine what proportion was of German manufacture and what of English manufacture bearing a German label, for it is established that Germany imported appreciable quantities of these British-made alkaloids.

It cannot be claimed that English quinine dominated the world, for it is produced in the United States of America, France, Germany and Italy; but the home manufacturer had a good share of the world's trade, and, as regards the quality of English quinine salts, an official investigation by the Italian Government some years ago showed them to be second to none.

Cocaine and theobromine were manufactured in this country, but relatively not on a large scale.

For the remaining alkaloids in the list we were undoubtedly dependent on enemy countries, as the very small quantities that may have been made here were almost negligible. They include atropine, eserine, and homatropine, so important in ophthalmic practice, as well as some alkaloids of less frequent use.

It is of interest to note that the alkaloid, acetomorphine, was discovered by a Scotch chemist, and subsequently manufactured and put on the market by Germany, who, however, had to purchase English morphine for its production; while another, cotarnine, was also put on the English market by a British firm long before the German product was boomed under a fancy name.

Acids. Four of these, including lactic and tannic acids, were probably German; the remainder are English products, prepared in some instances

from raw materials existing here, and in other instances from raw material imported from non-European countries, but the supply of which is largely controlled by British capital and enterprise, as in the case of boric acid. The raw material for citric acid is an Italian Government monopoly.

Salts. The group includes important remedies, as calomel, corrosive sublimate, silver nitrate, bismuth carbonate, sulphate of iron, sodium bicarbonate, potassium bromide and iodide, and many others. It will suffice to state that we depend upon home production for the majority of these compounds. For many the raw material is found in England, for others, as bismuth, it is imported from America; for some, as mercury, from Spain; and for others, by no means the least important, from Germany. Reference will be made to this a little later.

Simple compounds of carbon. The majority of the twenty simple compounds of carbon are of great importance to the physician and surgeon. The group includes the general anæsthetics, ether, chloroform, and ethyl chloride; the antiseptics, carbolic acid, creosote, and iodoform, and also alcohol and glycerin. All of these were and, of course, are produced here in large quantities and of indisputable quality.

The other articles in this group are of much less importance. Three are of Teutonic origin, and the remainder English or American productions.

Complex compounds of carbon. The pre-war source of the great majority was Germany; very few of them were obtainable elsewhere, except possibly from Switzerland. France produced adrenalin (synthetic), and also digitalin. An English house made chlorbutol, and occasionally small quantities of two or three others; but for more than thirty out of the forty we were dependent on Central Europe.

The members of this group are not all of equal importance. One or two are dyes, used merely to give a distinctive colour to certain lotions, and one or two are substances whose medical value has not been fully established; but the majority comprises some very important drugs, such as antipyrin, chloral hydrate, novocain, phenacetin, resorcin, saccharin, salicylic acid, aspirin, salol, veronal, together with salvarsan and neo-salvarsan.

The difficulties arising out of the war.

With the outbreak of war there was also an outbreak of profiteering, but this difficulty may be regarded as in some sense avoidable.

The real difficulties were comparatively few, but very formidable, and became intensified as the British blockade of Germany became more stringent. They were associated mainly with the supply of raw material, particularly of potash and of bromine, and the supply of synthetic and some other drugs. The main difficulty in connection with potash lies in the direction of the supply for artificial manures, for the relatively small requirements of medicine and of the arts have been met without very great difficulty, but, of course, at a high price.

Prior to the war the world's supply of bromine was derived from the United States of America and from Germany, and the producers in these two countries had entered into arrangements whereby competition was largely eliminated, in consequence of which the Americans kept away from European markets. The blockade left the Americans masters of the situation, and at one time the price of potassium bromide was 25s. per lb., as compared with 1s. 6½d. per lb. in July, 1914.

It is instructive to set beside this enormous rise the moderate variations in respect of the prices of drugs the raw material for which is obtained within the Empire or is controlled by British enterprise and capital. Two instances will suffice

for comparison. The production of iodine from Chili saltpetre is largely controlled by Britain; hence the price of potassium iodide, which in July, 1914, was 12s. per lb., rose to 15s. per lb. only in December, 1915, and has since fallen to 12s. 2d. per lb., practically the pre-war price.

Similarly, the price of morphine in July, 1914, was 9s. per ounce. On the outbreak of war with Turkey it rose to 13s. 6d. per oz., at which price it still remains.

Bromine, however, is now being prepared in France from sea water in large quantities, and at a price which enables it to compete with the American product.

These two problems of potash and of bromine, so essential in the treatment of nervous disorders, do not seem to have attracted public attention to the same extent as the question of synthetic drugs.

A great deal of undeserved blame has been heaped on the heads of English firms manufacturing medicinal chemicals because they did not immediately undertake the production of these synthetic drugs, but it is forgotten that the resources of British firms were taxed to the utmost in their endeavour to cope with the sudden and enormous demand for essentially British products for the needs of the Allied armies and of the civil populations; hence they had neither time nor staff to devote to fresh work. The extent of these demands far exceeds the conception of all who are not directly associated with this work.

In the next place, it is not possible to raise armies of millions of men and have at the same time a surplus of labour to draw upon for new commercial enterprises, and plant and processes cannot be improvised in a day, which have occupied the enemy years of thought and labour in bringing to their present state of perfection. For these and other reasons very little was done in the early months of the war.

A start was, however, first made in the East End of London with the production of salicylic acid and its compounds, and in the early spring of 1915 the London Hospital received 1 cwt. of British-made sodium salicylate of excellent quality.

Aspirin was the next item to be tackled, and although the early attempts were not satisfactory, difficulties have now been surmounted, and more than one manufacturer is turning out tons of this article of the highest degree of purity.

Atropine sulphate, so essential in ophthalmic practice, and originally derived from Central Europe, is now being produced from Egyptian henbane in large quantities by at least two English firms.

It is unnecessary to give detailed records of recent British achievements. It will suffice to mention a few of the "German" drugs now being produced in this country: absolute alcohol, lanolin, butyl chloral hydrate, paraldehyde, lactic acid, homatropine, phenacetin, saccharin, salol, xeroform, novocain, salvarsan, and potassium permanganate.

It is interesting to note that the chemical laboratories and staffs of various university colleges throughout the kingdom have been pressed into this work.

The period after the war.

It will be generally admitted that the scientists of these islands are fully equal to the solution of all questions relating to synthetic drugs involving chemical knowledge both general and particular. And with the passing of the war there will also pass most of the difficulties with which manufacturers have at present to contend, particularly as regards provision of plant and of labour. Discussions of the turn of events after the war have centred, therefore, round what may be termed the commercial and financial aspects of the question.

It is assumed without doubt that the enemy countries will put forth the most strenuous efforts to regain the trade enjoyed by them before the war. Profiting by the lower rate of wages ruling in Germany as compared with those in this country, and aided probably by State subsidies, it is expected they will offer synthetic drugs at prices with which British manufacturers, if left entirely to their own resources, will be unable to compete.

If the production of synthetic drugs established here during the past two years is to survive the war, then some form of State aid seems to be necessary. Difference of opinion exists as to the form which Government assistance should take. Firms which have had but limited experience of chemical manufacturing on a commercial scale ask for subsidies from Parliament. They desire to buy their experience and to build up a business at the expense of the State. Firms, however, which are in possession of extended experience in the production of medicinal chemicals, having already tackled the new problem successfully, ask only for State assistance of a legislative character in order to ensure that the newer industries shall have a fair chance of surviving. Some suggest that importation of synthetic drugs from enemy countries should be entirely prohibited for a period of years following the war; others suggest the imposition of a tariff which, while sufficiently high to give British firms a reasonable chance of competing with the German, should at the same time not be so excessive as to penalise the consumer.

Public bodies which are large consumers of drugs, such as the Voluntary Hospitals and the Municipal and other infirmaries, can render much help in support of such legislative action by collectively agreeing to refuse to buy synthetic drugs emanating from Central Europe, even though such refusal may involve a slight extra cost to the ratepayer. Is British patriotism strong enough to support such a step on the part of the governing bodies of these institutions?

The question of legislative assistance is by no means a simple one. For example, how is it proposed to deal with the competition of neutral countries. The United States is already a serious competitor to be reckoned with in the English market, and, in spite of high freights and insurance, the American can sell his goods in England at a lower price than the Englishman. In some cases the difference is not great; in others there is no comparison: thus some tons of American phenacetin were recently sold in London at about one half the price of the English product.

Is then a tariff to be imposed on all non-British synthetic drugs, or only on the German article? British manufacturers and scientists recognise that legislative protection does not by itself constitute a royal road to success. Co-operation among themselves is highly desirable in arranging that too many firms are not engaged on turning out the same products; it has also been pointed out that by organisation and mutual concession the cost of manufacture can be reduced to a minimum if some firms undertake the production of essential intermediate substances for the use of other firms engaged in working up the ultimate synthetic drug. Further, it is to be noted that certain intermediate products are required very largely in the dye industry, and upon the development of the latter to some extent depends the success of the synthetic drug industry.

There is a further question upon which there has been much agitation for many years, and concerning which there is also some difference of opinion. Endeavours have been made to persuade successive Governments to grant the use of duty-free alcohol on the grounds that the high duty handicaps the Englishman to such an extent as to

make it impossible for him to think of competing with the foreigner who has the advantage of cheap alcohol. The Government has made some concession in permitting the use of a spirit known as "industrial spirit," containing a smaller quantity of the denaturing constituents, but this does not give universal satisfaction. It may be the question will be investigated once again and further concessions granted.

Another complaint for which there is some justification, and which has occasionally been levelled by home manufacturers against the medical profession, is that new drugs of English manufacture put on the market under systematic names understood by all chemists are coldly received by the physician, but when these same drugs are made in Germany and introduced under a fancy name they are received with open arms. For example, acetomorphine, already referred to, was first made and introduced in England by a Scotch firm, but little interest was manifested by the medical profession, whereas the same drug put on the market by the Germans, under the name "Heroin," was taken up with alacrity.

Furthermore, the partiality shown by some medical workers in the field of research for German reagents and solutions is difficult to understand, when it is remembered that British reagents of equal purity are easily obtainable.

One other criticism of our system of medical research is the lack of assistance sometimes accorded in physiologically testing newly discovered drugs of British origin. It is pointed out that the organisation of the German chemical and medical worlds permits of the thorough investigation of the properties of any new remedial agent by experiments on animals, and also by employing it in clinical practice, if there be sufficient ground for expecting good results. It is urged by some manufacturers that similar co-operation be established between British firms and workers in the field of medical research.

FERROCERIUM AND OTHER PYROPHORIC ALLOYS.

A recent issue of the *Engineering and Mining Journal* (1917, [5], p. 212) contains the following notes on pyrophoric alloys:—

About the year 1903 Welsbach discovered that certain alloys of the rare earths, when filed, gave off showers of bright sparks which would readily ignite inflammable gases. It was subsequently found that the best results were secured when employing an alloy containing about 65% iron. The same action takes place with these alloys as with the flint and steel, except that a spark is produced much more easily than with the primitive tinder-box.

The mixture of certain earth metals, often called *misch* metal, consists mainly of the elements cerium, lanthanum, didymium, neodymium, praseodymium, and samarium. All these metals are white to light yellow in colour and not readily oxidised in the air. The commercial *misch* metal varies in character according to the manufacture. For example, the *misch* metal produced by one large German chemical manufacturer is quite soft, whereas that produced by another manufacturer by electric reduction is quite hard and often very brittle. The brittleness in most cases is caused by the presence of silicon as an impurity. Welsbach patented his discovery and for a time monopolised the market. Subsequently the German courts limited the operation of the patent and at one time threatened to annul it entirely.

The price of ferrocereum alloys when first produced was about £12 per kg. Later this was reduced to £2 8s. per kg. and in 1913 to about £1 per kg.

While the original pyrophoric alloy (ferrocereum) manufactured by Welsbach contains nearly 10% iron, the competing products have only about 15% iron, and for the purpose of hardening, about 2% antimony or bismuth is added. Silicon is found in nearly all ferrocereum alloys, because it is either contained in the raw *misch* metal as an impurity or has been absorbed from the clay crucibles in which the alloy is often produced. To produce a low-melting and smooth-casting pyrophoric alloy, certain manufacturers add about 5% copper. Various theories have been advanced to explain the pyrophoric character of ferrocereum alloys, and various authorities claim that it is due to nitrides, hydrides, or suboxides. None of these theories has been substantiated, however.

Several alloys, interesting solely from a scientific standpoint, have been produced with mercury and platinum. The former is highly explosive. The latter alloy, when containing about 25% platinum, possesses the greatest pyrophoric properties of any of the known cerium alloys. A zinc-cerium alloy is especially suitable for the ignition of mine lamps. Cerium alloys containing boron have also been recommended for a like purpose.

By the addition of 25% aluminium or magnesium to the cerium alloys, a very brittle metal is produced, which is readily pulverised. Inferior pyrophoric alloys containing high percentages of carbides are very unstable, and unless protected from the air by a film of oil, readily oxidise and become worthless within a few weeks.

The raw material for the manufacture of ferrocereum is generally the waste from gas-mantle factories, which consume large quantities of monazite sand. After the extraction of the thorium from the sand, there is produced as a by-product what is known as rare earth residues or *misch* metal oxides. Most manufacturers produce ferrocereum by the electrolysis of the anhydrous chlorides of cerium, lanthanum, didymium, etc. A good grade of mixed anhydrous chlorides costs, under normal conditions, about 3s. per kg. The fluorides of the cerium metals have not proved satisfactory, as they produce a thick, pasty metal in which the *misch* metal separates in a fine state of distribution and not in the form of a solid mass as in the case of the chlorides. For the production of ferrocereum by the electrolytic process, it is necessary that cheap current be available. Many manufacturers use ordinary graphite or clay crucibles with large iron cathodes. Others use water-jacketed iron crucibles.

In the early days of the industry, the small pocket lighters, in which the pyrophoric alloy was employed, contained only small pieces of metal weighing from $\frac{1}{2}$ to 1 gm., and these lighters were regarded more or less as scientific toys. At the present time there are two distinct types of lighters on the market, in one of which the pyrophoric alloy is fed in the form of a small stick against a hard steel wheel with a file-like surface; this wheel, when revolved, produces a shower of sparks, which are projected on a cotton wick impregnated with benzine or gasoline. The other type of lighter consists of a long strip of pyrophoric alloy against which a hard steel pin is struck; around this is wrapped an asbestos thread, which is kept saturated, when not in use, with gasoline in a small reservoir constructed in the body of the lighter.

The largest consumption of ferrocereum in the United States is for patent gas-lighters. In Europe, where the match industry is a government monopoly, the main consumption of ferrocereum is for cigar lighters.

MUNITION FACTORY EXPLOSION.

The Committee appointed by the Home Secretary to inquire into the cause of the explosion which occurred in East London on Friday, January 19th, have presented their report, bearing date February 23rd. The report itself will not be published, but the following is a summary of the conclusions at which the Committee have arrived:

(1) The explosion was preceded by a fire which broke out either in the melt pot or in a corrugated iron structure at the top of the building immediately above the melt pot.

(2) The fire rapidly gained a fierce hold, and as the melt pot contained a large quantity of explosive material in a state of confinement, it is probable that the initial detonation took place there.

(3) The evidence available is not sufficient to determine with certainty how the fire was started, but all accidental causes presenting any degree of probability may be eliminated except the two following: (A) A detonation spark produced by friction or impact; (B) spontaneous ignition, due to decomposition, of the material in or about the melt pot.

(4) The possibility of the disaster having been maliciously caused cannot be disregarded, but searching investigation by the police and other authorities failed to discover any evidence which would warrant such a conclusion, and no suspicion fell upon any employee or other person.

The Committee made various recommendations with regard to precautions to be adopted in the manufacture and storing of the explosive in question.

OFFER OF PRIZE FOR METHOD OF DETERMINING THE HARDNESS OF METALS.

Sir Robert Hadfield has placed in the hands of the Institution of Mechanical Engineers the sum of £200, which with any income therefrom may be awarded at the discretion of the Council of the Institution as a prize or as prizes for the description of a new and accurate method of determining the hardness of metals, especially of metals of a high degree of hardness. The ordinary tests of hardness, such as are described in the report of the Hardness Tests Research Committee (Proceedings of the Institution of Mechanical Engineers, 1916, pages 677 to 778) fail to some extent when the hardness of the material exceeds about 600 to 800 Brinell. What is desired is the description of a research for or an investigation of some method of accurately determining hardness suitable for application in metallurgical work in cases in which

present methods partially fail. The Council will consider annually all communications received, and may then award a prize or prizes. But in January, 1922, the offer of prizes will be withdrawn. The Council may award the whole or any part of the sum available at any time if a communication is received which, in their opinion, is of sufficient originality and importance and satisfies the object aimed at; or they may from time to time award portions of the fund not exceeding in all £75 in any one year, for communications which do not completely solve the problem, but which appear to advance the knowledge of methods of testing hardness. A communication should be accompanied by scale drawings of any new apparatus described, or by a model or an example of the apparatus itself. If the communication describes a new invention, likely to be of commercial value, it is desirable that provisional protection should have been obtained before it is submitted for consideration. Communications should be addressed to the Secretary, the Institution of Mechanical Engineers, 11, Great George Street, Westminster, London, S.W.1, and marked "Method of Determining Hardness," and should reach him at least one month before January 1 in any year.

INDIA-RUBBER MANUFACTURERS' ASSOCIATION.

The India-Rubber Manufacturers' Association, Ltd., has recently been incorporated under the Companies Acts, 1908 and 1913, as a company limited by guarantee and not having any share capital, with not more than 100 members. The annual subscription is £10, and the objects of the Association are, *inter alia* :—

(1) To watch over, protect, and advance the interests of india-rubber manufacturers in the United Kingdom.

(2) To protect freedom of trade and liberty of action in relation to the carrying on of the manufacture of india-rubber goods and other allied industries in the United Kingdom.

The association will also deal with labour troubles and with terms of purchase of and specifications for raw rubber and other manufacturing materials. It is proposed to encourage inventions likely to be of value to the rubber trade and also fresh sources of production of raw rubber and other manufacturing materials.

Membership of the Association is confined to *bona fide* india-rubber manufacturers, whose principal works are situate in the United Kingdom.

The Secretary of the Association is Mr. W. G. Wilson, 16, Deansgate, Manchester.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—*s.d.* each to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.

United States.—*1s.* each to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—Patent number, date, name of patentee, and title of invention.

French.—*1 fr. 05 c.* each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56 Rue Ferou 8, Paris (3e.). Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

Air drying. C. Hering. Met. and Chem. Eng., 1917, 16, 187—199.

OF the various methods for drying air, the most practical on the large scale is that of cooling until most of the moisture is deposited and then reheating to the original temperature. Although absolute dryness cannot thus be obtained, it is possible by the use of ammonia refrigerators to reduce the humidity at normal temperatures to 2—1%. In cooling the air it is advantageous

to condense and remove as much as possible of the moisture in the liquid form before the freezing temperature is reached, thereby saving the latent heat of solidification, and this is best effected by the use of a regenerative system. By this system the warm moist air is made to pass in one direction through thin-walled ducts, on the other side of which the cold dry air is passing out in the opposite direction. The saving thus effected in cooling the moist air and heating the dry air may amount to one-half the cost of the total heat. Additional economy may be obtained by cooling

the air somewhat more, while passing through the regenerator, by means of the partially spent cooling liquid or gas coming from the refrigerator. Ammonia refrigerators can be regularly worked to give a temperature of -15°F. (-26°C.); cooled to this temperature and then heated again to 70°F. (21.5°C.), the air would have a humidity of 2.95%. A common way of producing moderately dry air is to spray it with very cold water, but a large amount of spraying water is required. If the spraying water is at 32°F. (0°C.) and perfect cooling of the air to this temperature is assumed, the theoretical effect of the treatment would be a humidity of 24.5% on re-heating to 70°F. (21.5°C.). If the amount of spraying water at 32°F. (0°C.) be limited, so that the air is cooled only to 38°F. (3.5°C.), the humidity would be 31.1% at 70°F. Starting with air originally at the same temperature and 75% humidity, this result could be attained with about 167 lb. of spraying water per 1000 cub. ft. of air. A simple means for working this method on a small scale is by forcing the warm moist air through cracked ice. Assuming perfect interchange of heat units, the air could be reduced to a humidity of 24.5% by the melting of 8.9 lb. of ice per 1000 cub. ft.—J. F. B.

Colloidal solutions; Effect of centrifugal force on —. E. E. Ayres, jun. Amer. Inst. Chem. Eng., Jan. 12, 1917. *Met. and Chem. Eng.*, 1917, 16, 190—196. (See this J., 1916, 676.)

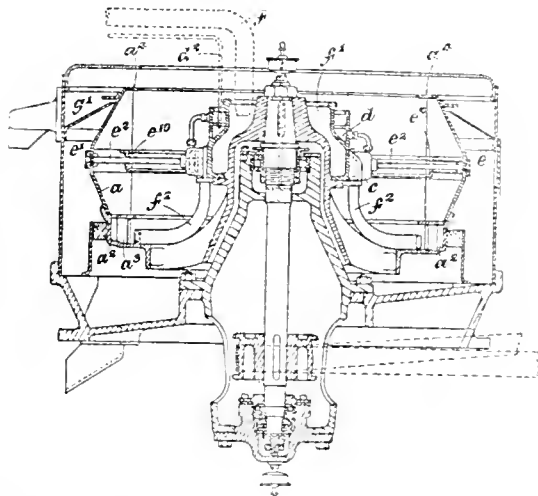
PARTICLES of uniform size suspended in a liquid medium will settle by gravity when the product of their mass in grms. multiplied by 3×10^{13} is as large as 10. When the product is less than 10, a partial subsidence will occur until an equilibrium is established. The only considerable force opposing complete subsidence in this case is osmotic pressure. By the use of a law of distribution which takes into account the opposing forces, it is possible to compute the concentration at any level when the system is in equilibrium. When a particle will not settle completely by gravity, it is possible to cause complete subsidence by the application of centrifugal force when the product of the mass in grms., the force in dynes, and the constant 3×10^{13} is greater than 10. Partial subsidence with the establishment of equilibrium will occur when the product is less than 10. The time required to establish this equilibrium can be computed from a modification of Stokes' law. The highest commercial centrifugal force, 40,000 times gravity, can completely remove particles as small as the lower limit of ultramicroscopic observation, but such a separation will require 33 hours when the suspending medium is water. For less viscous media the time will be shorter; smaller particles can never be separated by this force. Particles just too small to be retained by a fine porcelain filter can be removed in a few seconds. Gases of different densities cannot be separated completely by any force less than about 100 million times gravity. The same applies to true solutions, but gases should be partially separated by a much lower force within a reasonable time, whereas solutions in liquid media would require several weeks.—J. F. B.

PATENTS.

Centrifugal machines and the like. J. Hamill. Wolverhampton. Eng. Pat. 102,407, Feb. 14, 1916. (Appl. No. 2144 of 1916.)

THE machine shown is specially adapted for the clarification of sugar juice. The liquid is supplied by the pipe, f , to the annular chamber, f^1 , from which it passes by the pipe, f^2 , to the lower part, a^2 , of the rotating drum, a , in which blades, a^3 , are provided to rotate the liquid. The lighter impurities are forced toward the inner surface

of the liquid annulus and are collected under the ring a^4 . The heavier impurities collect at the outermost part of the drum, and the liquid escapes continuously by the orifice, a^1 , to the receptacle a^5 . The lighter impurities are periodically ejected through the valve, c , which is operated by admitting water by the pipe, d^2 , to the space, d , from which it passes to a cylinder, e , having a



piston attached to the valve rod, e^2 , which is forced inward by the pressure due to centrifugal force, thus opening the valve. A slow leakage device is provided so that the valve closes again by centrifugal force. This may be done by making the piston movable on the hollow valve rod, so that it uncovers a small escape orifice in the rod when forced inward against a shoulder on the valve rod. A similar axial orifice is placed in the valve head for the discharge of the water. A similar valve, c , is provided for the escape of solid matter as shown. In a modified machine suitable for china clay or sewage sludge, the escape orifice is placed midway along the hollow valve rod, so that the water does not mix with the discharged solid matter. When used for the collection of solids which will not "flow," an escape valve is provided for the lighter material only, and the solid matter is removed by a scraper. The surplus water escapes through a perforated tube surrounding the stem of the valve for the escape of lighter material.—W. F. F.

Separating liquids from solids; Method of —. H. A. Herr, Philadelphia, Pa. U.S. Pat. 1,212,638, Jan. 16, 1917. Date of appl. Dec. 23, 1915.

A MIXTURE of solid and liquid is placed in a vessel rotating at high speed, the liquid being removed by centrifugal force. The speed of the vessel is then reduced, and the solid material removed from the sides by a scraper and discharged by its own force through a port in the bottom which is opened when the speed is reduced.—W. F. F.

Centrifugal separator. M. R. Spehnan, Hyde Park, N.Y. U.S. Pat. 1,212,831, Jan. 16, 1917. Date of appl. July 30, 1915.

A CYLINDRICAL basket is suspended from a vertical, rotating shaft, and a vertical, concentric pipe, movable axially, and provided with radial nozzles, extends downward into the basket. A mixture of liquid and solid to be separated is admitted by the pipe and distributed over the wall of the basket by the vertical movement of the pipe. The solid matter which collects on the inner surface of the basket is removed by jets of fluid directed inwards

from nozzles arranged around the outside of the basket in such a way that the lateral pressures are balanced.—W. F. F.

Water cooling towers and the like. A. G. Evans, North Finchley, Middlesex, Eng. Pat. 103,691, Feb. 5, 1916. (Appl. No. 1752 of 1916.)

WATER to be cooled trickles over a series of inclined wood or metal laths or battens supported at their ends on rails and arranged in trellis form with the short transverse axes of their flat surfaces horizontal. A second series of laths is arranged between the first series with its supporting rails midway between the rails of the first series, so that water dripping from the rails is received on the cooling surface of the laths below. The lower ends of the laths are notched and bevelled, the bevelled portion of the notch directing the greater part of the water on to the lath below instead of on to the supporting rail.—W. F. F.

Packing and jointing material. E. T. Williams, London, Eng. Pat. 103,776, Aug. 1, 1916. (Appl. No. 11,056 of 1916.)

A PACKING or jointing material for hydraulic, steam, pneumatic, or other pipes, glands, bulk-head or watertight doors, hot water or steam tips, valves, boiler fittings, or other water-tight or gas-tight fittings, is composed of indiarubber, 50%, and mineral oxides such as zinc oxide, zinc white, or silica, 50%.—W. F. F.

Mills; Pulverising.—The Raymond Brothers Impact Pulveriser Co., Assignees of J. Crites, Chicago, Ill., U.S.A., Eng. Pat. 103,963, Sept. 20, 1916. (Appl. No. 13,361 of 1916.) Under Int. Conv., July 3, 1916.

The beaters in a conical pulverising chamber through which a current of air is passed, are made to slide along the shaft to enable the distance between the beaters and the fixed conical grinding surface to be adjusted. The chamber is flared towards the discharge end and is provided with a second interior conical surface inclined to the first, and with rotating arms for retarding the outward movement of the material.—W. H. C.

Rotary-beater mill. T. J. Sturtevant, Wellesley, Mass., Assignor to Sturtevant Mill Co., U.S. Pat. 1,212,018, Jan. 16, 1917. Date of appl., July 27, 1916.

THE mill consists of a vertical casing in which a vertical shaft rotates. The casing is provided with fixed grinding faces and the shaft with grinding beaters, which rotate in horizontal planes. The uppermost beaters are of a heavy type and the lower ones of a lighter type.—W. H. C.

Rotary-beater mill. T. J. Sturtevant, Quincy, Mass., Assignor to Sturtevant Mill Co., U.S. Pat. 1,212,119, Jan. 16, 1917. Date of appl., July 27, 1916.

A MILL similar to that described in the preceding abstract is provided with a receiving and detaining table mounted on and rotated with the vertical shaft below the upper heavy beaters.—W. H. C.

Rotary-beater mill. T. J. Sturtevant, Wellesley, Mass., Assignor to Sturtevant Mill Co., U.S. Pat. 1,215,075, Feb. 6, 1917. Date of appl., Mar. 16, 1916.

THE mill has a cylindrical and a conical portion, and beaters to correspond in shape with the mill are suspended from and rotated by a horizontal shaft. The conical part of the mill is provided with a corrugated liner and the corresponding beaters have stepped faces. The beaters can be moved horizontally on the shaft to vary their distance from the liner.—W. H. C.

Impact-pulveriser. R. C. Newhouse, Milwaukee, Wis., Assignor to Allis-Chalmers Manufacturing Co., U.S. Pat. 1,212,991, Jan. 16, 1917. Date of appl., Oct. 20, 1911.

A PULVERISER of the disintegrator type has a number of beaters suspended from the central shaft. The beaters consist of arms having detachable bars at their outer ends. The bars of successive beaters are of different thickness, but the bars of opposite beaters are of like thickness.—W. H. C.

Drying apparatus. J. B. Watson, Willington, Derbyshire, Eng. Pat. 101,139, Oct. 21, 1916. (Appl. No. 15,114 of 1916.)

TWO horizontal chambers are placed end to end and each contains a revolving drum formed of steam-heated tubes mounted in end plates carried by a common shaft. The shaft is directly driven by gearing arranged between the drums. The material is fed into one chamber at the top and is distributed by small plates projecting radially from the drums, and by a conveyor in a side pocket connecting the two chambers. The chambers are also connected at the top by a ventilating passage. One chamber may have an outlet at the top with a suction fan for ventilation, and both chambers may have removable covers at the top, so that both chambers may be ventilated by suction, or one by suction and the other by being open to the atmosphere, or both by being open to the atmosphere. When both are under suction, hot air may be used for ventilation.—W. F. F.

Desiccating apparatus. W. R. Clayton, Evanston, Ill., U.S. Pat. 1,215,316, Feb. 13, 1917. Date of appl., Dec. 2, 1915.

A DESICCATING chamber is built of hollow porous tiles, which are filled with a desiccating material such as calcined gypsum. A false floor is formed above the bottom layer of tiles and a trapped drain is provided to allow the egress of liquids and gases. The chamber is enclosed in an outer sealed chamber with an intermediate layer of waterproof cement.—W. F. F.

Desiccating fluid substances; Process and apparatus for.—R. W. G. Stutzke, Assignor to G. A. Buhl, Chicago, Ill., U.S. Pat. 1,215,889, Feb. 13, 1917. Date of appl., Dec. 28, 1915.

LIQUIDS containing solid substances are sprayed into the tangential inflow portion of a cyclone collector, while a circulation of superheated vapour of the liquid is maintained under pressure from the outlet back to the inlet of the collector. Heat is continuously supplied to the circulating vapour, which is vented from the system, and the desiccated solids are collected within the cyclone collector.—W. F. F.

Evaporating apparatus. J. H. Federler, New York, U.S. Pat. 1,212,469, Jan. 16, 1917. Date of appl., Nov. 26, 1909. Renewed June 9, 1916.

A HORIZONTAL cylinder carrying on its outer surface the substance to be evaporated, rotates within a casing having plates projecting inwards in planes containing the axis of rotation, their inner edges being close to the rotating cylinder. The plates are so arranged with respect to one another that a current of air may be passed transversely backwards and forwards over the substance to be evaporated.—W. F. F.

Evaporator. W. L. DeBaufre, Annapolis, Md., U.S. Pat. 1,213,596, Jan. 23, 1917. Date of appl., Nov. 23, 1915.

A SOLUTION is evaporated, and the vapour dried, and compressed by means of a vapour-actuated

compressor. The solution is heated by the compressed vapour and the exhaust from the compressor combined, and uncompressed vapour from the solution is condensed.—W. F. F.

Vaporising, concentrating, or drying solutions: Method of and apparatus for — G. A. Krause, Munich, Germany. U.S. Pat. 1,213,659, Jan. 23, 1917. Date of appl. Nov. 29, 1916.

THE solution is sprayed into a chamber and passes thence by a wide conduit into a drying chamber. Hot gases are admitted into the conduit near its junction with the drying chamber.—W. F. F.

Evaporator. W. J. Giller, Warsaw, Ill. U.S. Pat. 1,215,140, Feb. 6, 1917. Date of appl. Mar. 10, 1916.

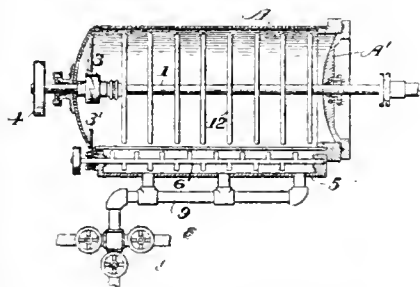
LIQUID is drawn from the bottom of an evaporator by a pump, and passed through a preheater and returned to the upper part of the evaporator in the form of spray. The evaporator has a vapour outlet pipe provided with rows of baffles to keep back any liquid.—W. H. C.

Filter-press; Continuous — D. B. Sweeney, Bayonne, N.J. U.S. Pat. 1,212,844, Jan. 16, 1917. Date of appl. Mar. 22, 1916.

A LONG perforated cylindrical casing is built up of segments and lined with canvas. Feed and discharge pipes are provided at opposite ends, and a screw conveyor within the casing is held out of contact with the sides by strips placed between the segments.—W. F. F.

Filtering apparatus. A. L. Genter, Assignor to Kelly Filter Press Co., Salt Lake City, Utah. U.S. Pat. 1,212,932, Jan. 16, 1917. Date of appl. Mar. 11, 1916. Renewed Dec. 16, 1916.

THE material to be filtered is fed through the pipe, 9, into the trough, 5, which is provided with an



agitator, 6, and is open at the upper part to the casing, A. The latter forms the filter chamber proper and is provided with a hollow shaft, 1, carrying filter leaves, 12. The shaft passes through the end, A¹, which, together with the shaft, slides in and out of the casing. The shaft is rotated by the pulley, 4, and the clutches, 3, 3'. The solid material collects in the casing, A, and the liquid passes through the filter leaves and is discharged through the hollow shaft. When the casing is full of solid matter the feed is stopped, and the end, A¹, together with the shaft and filter leaves, is removed from the casing, carrying the solid matter with it.—W. H. C.

Filtering apparatus. A. L. Genter, Assignor to Kelly Filter Press Co., Salt Lake City, Utah. U.S. Pat. 1,212,933, Jan. 16, 1917. Date of appl. Mar. 11, 1916.

A RECTANGULAR casing with a pyramidal bottom has one side hinged to allow access to the interior. The hinged side is provided with a locking device and a counter-balance. Filter leaves are provided within the casing, each having a valved outlet pipe.—W. H. C.

Furnace. F. Doerinkel, Essen, Germany. U.S. Pat. 1,213,082, Jan. 16, 1917. Date of appl. June 17, 1916.

A CUP-SHAPED vessel, comprising an outer jacket with a refractory lining, is provided with numerous fine perforations and is contained within an outer concentric casing spaced from it at the bottom and sides. The annular space thus formed is closed at the top, and hot gases are injected tangentially into it. The inner vessel is provided with a stand for a crucible.—W. F. F.

Liquid composition [for heating and refrigerating]. H. Hilbert, Pittsburgh, Pa. U.S. Pat. 1,213,368, Jan. 23, 1917. Date of appl. Jan. 10, 1916.

A COMPOSITION, which is relatively non-volatile and remains liquid at low temperatures, is prepared by mixing 60 to 65 parts of water with 35 to 40 parts of glycols of the 1,2-glycol type, such as ethylene-, propylene-, and butylene-glycols.—J. N. P.

Liquids; Apparatus for heating — J. O. Lundberg, Torp Brug, Norway. U.S. Pat. 1,215,011, Feb. 6, 1917. Date of appl. Feb. 28, 1916.

A VERTICAL cylindrical chamber is provided with a series of vertical heating coils, side by side, around the inner periphery of the cylinder, so that a central space is left having a diameter not less than that of the heating coils. The upper ends of the coils are connected to a common stand-box suspended in the top of the chamber, which is supplied by a pipe passing through the side wall of the chamber. A manhole is provided in the top of the chamber having a diameter not less than the diameter of the heating coils.—W. F. F.

Extracting values from bodies; Apparatus for — R. L. Ogden, Rahway, N.J. U.S. Pat. 1,215,182, Feb. 6, 1917. Date of appl. Sep. 22, 1916.

THREE vessels are arranged to contain respectively the solvent, the material undergoing extraction, and the resulting solution. The vessels are connected by pipes provided with check valves, so as to control the flow and allow it to proceed in one direction only. The liquid is forced through the three vessels in succession and back into the first one by increasing or diminishing the pressure of air in the enclosed space in the first vessel. The change of pressure is brought about by alternately admitting water to and withdrawing it from an auxiliary tank, the alternation being effected automatically by means of a valve operated by a float in the water tank.—J. N. P.

Levigation of vegetable, animal, or mineral substances; Method of — Elektro-Osmose A.-G. (Graf Scheyerin Ges.), Berlin. Ger. Pat. 291,667, Jan. 10, 1915.

ELECTRICALLY active bodies are washed out of the material by causing the washing liquid to travel to and fro through perforated electrodes. Electro-negative constituents migrate towards the anode, and electro-positive constituents towards the cathode, and the withdrawal of constituents migrating towards an electrode, against the flow of liquid, is effected by allowing a portion of the liquid to flow away continuously at the electrode concerned.—F. SOPN.

Furnace-gases; Filtering medium for cleaning — F. E. Kling, Youngstown, Ohio, Assignor to L. B. Weidlein. U.S. Pat. 1,215,385, Feb. 13, 1917. Date of appl. Dec. 11, 1915.

DUST is filtered from hot furnace gases by passing them through "steel wool."—W. F. F.

Low temperatures; Method of attaining — H. Mewes, Berlin. Ger. Pat. 291,516, Sept. 6, 1915.

LIQUEFIED gas flowing from the condenser of the

refrigerating apparatus, before utilisation, is cooled further in a surface cooler by the cold expanded gas from an expansion machine which may utilise waste gas from the liquefier.—F. SODX.

Catalytic agent. A. Mittasch, C. Schneider, and H. Morawitz, Assignors to Badische Anilin und Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,215,396, Feb. 13, 1917. Date of appl. June 1, 1911.

SEE Eng. Pat. 8162 of 1911; this J., 1915, 822. Special claim is made for catalysts containing a platinum metal.

Absorption refrigerating apparatus of the reversing type. H. E. Willsie, Cranford, N.J., U.S.A. Eng. Pat. 104,151, Feb. 10, 1916. (Appl. No. 18,410 of 1916.)

Centrifugal machine. T. E. Brown, New York. U.S. Pat. 1,215,337, Feb. 13, 1917. Date of appl. Apr. 22, 1911.

SEE Eng. Pat. 102,281 of 1916; this J., 1917, 74.

Disintegrating, pulverising, or mixing apparatus; Rotary. J. W. Spensley, Manchester. U.S. Pat. 1,215,424, Feb. 13, 1917. Date of appl. Dec. 23, 1915.

SEE Eng. Pat. 1331 of 1915; this J., 1915, 1195.

Drying apparatus. E. J. M. Martini, Paris. U.S. Pat. 1,215,951, Feb. 13, 1917. Date of appl. July 5, 1913.

SEE Fr. Pat. 157,298 of 1912; this J., 1913, 998.

Gas cooling apparatus. Eng. Pat. 103,917. See IIA.

Process of compressing, purifying, drying, and cooling gases. U.S. Pat. 1,213,796. See IIA.

Apparatus for organic chemical reactions. U.S. Pat. 1,213,143. See III.

Apparatus for concentrating sulphuric acid and other liquids. Eng. Pat. 101,034. See VII.

IIA.—FUEL; GAS; MINERAL OILS AND WAXES.

Coal; Water content of— with some ideas on the genesis and nature of coal. E. Mack and G. A. Hulet. Amer. J. Sci., 1917, 43, 89—110.

It is known that the determination of the moisture in air-dried coal, as usually carried out, does not necessarily give the true moisture content of the coal (see Huntly and Coste, this J., 1910, 62). Even drying *in vacuo* with phosphorus pentoxide at air temperature does not remove all water. Considering the development of coal from peat it seems probable that coal is essentially colloidal in character, the constituent particles increasing in size with the ageing of the substance from peat to anthracite. It is generally recognised that there is a concentration layer at the boundary of heterogeneous phases, and where colloid substances are concerned, with relatively large surfaces of contact, such "adsorption" effects may become important. The true moisture of coal is regarded as adsorbed by the colloidal constituents, and even if the condensed moisture layer is only a few molecules thick, it may represent a considerable proportion, by weight, of the coal substance. Such a moisture layer would have an unusually low vapour pressure and hence the apparent dryness of a coal which contains several per cent. of moisture. The true moisture content of a coal may be regarded as a measure of colloidal humic matter present. Owing to the small vapour pressure, no low-temperature method can effectively remove all adsorbed moisture. At the

critical temperature of water (365° C.) all the moisture should be driven off. It was shown, however, that below 250° C. *in vacuo*, the removal of water from coal was nearly complete, while the small evolution of gases indicated that no appreciable decomposition took place. Most probably the gases evolved were also adsorbed. Methods were devised to carry out such moisture determinations. The coal was heated *in vacuo* to 230° C. and the water driven off was condensed and weighed.—H. J. H.

Sardinian lignites in gas manufacture. A. Pacchioni. Bull. Assoc. Ital. Ind. Gas e Acqua. Gas J., 1917, 137, 467—468.

THE author gives results of tests in inclined retorts on lignites from Bacu-Abis and Caput-Acquas. The former appeared to contain two components, one brilliant, black particles similar in appearance to ordinary coal, containing 16.7% ash and 1.62% nitrogen, and having little tendency to agglomerate; the other of dull opaque colour, rich in volatile matter (15.15%), sulphur (7.81%), and nitrogen (3.15%). The author considers the coke produced of little commercial value, and advocates the use of the lignite for production of enriching gas or producer gas. Suitable coke may be made from a mixture of 35% of lignite and 65% of coal, the mixture, though swelling, not giving rise to any insuperable difficulty in distillation. With Caput-Acquas lignite the coke produced is of a light spongy quality, more fragile than that from ordinary coal. The gas obtained from both lignites, when purified, is comparable in quality and quantity with that from English coals, whilst the high content of nitrogen should give a high yield of ammonium sulphate. The analysis of purified gas from Caput-Acquas lignite is given as CO₂ nil, C₂H₄ 8.3%, CO 14.8%, H₂ 31.7%, CH₄ 42.2%, N 2.9%, whilst the yield of benzol and its homologues is given as 8.18 kilos. per ton (practically 2 galls. per ton). The content of sulphur (8.23%) is unusually high, and it is suggested that the lignite be mixed with iron oxide or that the gas be washed with a solution of sulphurous acid.—J. E. C.

Benzol and toluol: Apparatus for determination of— in coal gas. H. E. Copp. Gas J., 1917, 137, 595.

THE series of four wash-bottles used in the ordinary benzol test is replaced by a scrubbing system consisting of a calcium chloride tower filled with glass beads over which oil gravitates from a 3-litre aspirator. Results from 20 cu. ft. of gas by the scrubbing method showed 2.965 galls. per ton as against 2.722 by the older wash-bottle method.—J. E. C.

Ignition [of gases]; "Stepped" —. R. V. Wheeler. Chem. Soc. Trans., 1917, 411, 130—138.

THE researches of Thornton (this J., 1916, 682) appear to show that the curve connecting the minimum igniting current with the pressure in a given mixture of combustible gas and air, consists of a series of vertical and horizontal portions which he terms steps. The present author has carefully determined for a mixture of methane and air (9.5% CH₄) at varying pressures the minimum current passing through the primary circuit which just causes ignition when the spark gap and the rate of break in the primary circuit are both kept constant. His results lead to a perfectly smooth hyperbolic curve, suggesting that Thornton's results are due to some peculiar conditions of experiment. Mathematical analysis of the curve (by A. Greenwell) suggests that the quantities "observed igniting current" and "observed degree of compression" are mutually involved

and that for the true interpretation of the curve the axes of co-ordinates should be inclined parallel to the asymptotes of the hyperbola.—W. H. P.

Tar dehydrating and debenzolising plant. Mottram.
See III.

Silica bricks and some new uses for them. Gray.
See VIII.

PATENTS.

Briquettes; Manufacture of—, F. A. Vogel.
Assignor to General Briquetting Co., New York.
U.S. Pat. 1,212,991, Jan. 16, 1917. Date of appl., July 22, 1916.

AN oily material is heated to and maintained at 250° F. (about 120° C.), while sulphite pitch solution is added and the whole thoroughly mixed. The product is then incorporated with the finely-divided particles of the fuel to be briquetted.—H. J. H.

Washing coal and other minerals; Apparatus for—, P. Habets, Montegnée, and A. France, Liège, Belgium. Eng. Pat. 104,132, Oct. 4, 1916. (Appl. No. 11,099 of 1916.) Addition to Eng. Pat. 22,655 of 1912.

THE troughs of a number of washers in series are arranged at a decreasing inclination between the washers and are provided with interchangeable filling pieces to reduce the effective cross-section of the channel in stages.—J. E. C.

Coal; Treatment of—for use in domestic grates or furnaces. A. Rollason, Long Eaton. Eng. Pat. 103,873, Feb. 17, 1916. (Appl. No. 2536 of 1916.)

FROM 1 to 2% by weight of finely ground calcium carbonate or magnesium carbonate is added to the coal. It is claimed that its thermal conductivity is thereby reduced and that a more rapid and complete combustion occurs in the fire with resultant economy.—H. J. H.

Coke; Increasing the heating power of—, A. Rollason, Long Eaton. Eng. Pat. 103,893, Mar. 3, 1916. (Appl. No. 3196 of 1916.)

FROM 1 to 3% by weight of calcium or magnesium carbonate is added to coke. It is claimed that the coke then burns better and more completely in stoves, furnaces, or forges.—H. J. H.

Coke oven. L. Wilputte, New York. U.S. Pat. 1,212,865, Jan. 16, 1917. Date of appl., July 31, 1912.

THE oven has vertical flues below each of which is a separate regenerator for preheating its own air supply. The air and gas supply to each flue are capable of independent regulation. Each set of flues is divided at the middle into two similar parts, one of which takes the products of combustion from the other. At regular intervals this is reversed.—H. J. H.

Coke oven and method of operation of same. L. Wilputte, New York. U.S. Pat. 1,212,866, Jan. 16, 1917. Date of appl., Apr. 26, 1913.

IN regenerative coke ovens, with vertical flues, the flues in each heating wall are divided into two groups, and the flues of each group are connected with different regenerators or sets of regenerators, whilst both groups are connected with a common gas supply main. Regulating devices are provided to facilitate control of the distribution of air and gas supplied for heating and also of the removal of the products of combustion.—H. J. H.

Coke from pitch; Method of manufacturing—, C. R. Eckerl, Chicago, Ill., Assignor to The Barrett Co., New York. U.S. Pat. 1,213,763, Jan. 23, 1917. Date of appl., Sept. 10, 1915.

IN manufacturing coke from pitch, solid carbonaceous material non-liquefiable by heat is added to prevent foaming; 10% of coke breeze may be added for this purpose.—J. E. C.

Motive fluid; Apparatus for the generation of—, G. M. Clark, London. From Keller Mechanical Engraving Co., New York. Eng. Pat. 103,885, Feb. 26, 1916. (Appl. No. 2911 of 1916.)

FUEL and air are supplied under pressure to a mixing chamber and the mixture passes through a number of passages of gradually decreasing area into a combustion chamber in which it is ignited by a sparking plug or other suitable means. A cooling fluid is sprayed into the combustion chamber, and means are provided for regulating the amount of cooling fluid supplied, by utilising the differential expansion of the outlet tube and a rod of dissimilar metal. In case of higher temperatures the greater coefficient of expansion of the outlet tube, by means of levers and the like, opens an adjusting valve admitting a greater flow of water to the combustion chamber to reduce the temperature to the required extent, and thereby maintain a fairly constant temperature of the motive fluid.—J. E. C.

Gas from liquid hydrocarbons; Apparatus for making—, W. C. Dayton, Buffalo, N.Y., U.S.A. Eng. Pat. 104,023, Feb. 18, 1916. (Appl. No. 2111 of 1916.)

LIQUID hydrocarbons are gasified by heating them, admixed with a suitable proportion of air, to a high temperature in an oil- or gas-fired retort. To maintain uniformity of composition and calorific value in the gas produced when the output fluctuates, a device is provided for causing the oil feed to vary automatically with the air supply.—H. J. H.

Liquid fuel; Apparatus for burning—, C. Ellis, Montclair, N.J., Assignor to Radiant Heating, Ltd., Leeds. U.S. Pat. 1,216,096, Feb. 13, 1917. Date of appl., Apr. 22, 1912. Renewed July 11, 1916.

LIQUID fuel, along with a limited supply of supporter of combustion, is injected into a series of gas-forming chambers containing a porous filling of refractory material. A vaporising temperature is maintained by the partial combustion, and the vapours from each gas-forming chamber are mixed with air under pressure to form an explosive mixture which is caused to pass at high velocity into a combustion bed of granular refractory material. The amount of gas burnt in the combustion devices is regulated by controlling the fuel supply to the gas-forming chamber.—J. E. C.

Gas producers. A. H. Lynn, London. L. A. Riley, New York, and N. E. Rambush, London. Eng. Pat. 15,167, Nov. 2, 1915.

IN an agitating device for gas producers of the rotary grate type, the whole or part of the superficial area of the grate is of an incomplete spiral, screw-propeller, or like form, having gradually rising surfaces terminated by abrupt shoulders of considerable depth. The sides of the grate have the shape of two vertical half cylinders, laterally displaced along their dividing surfaces, which on revolving force the charge towards the producer shell. The ash is deflected by a number of ash ploughs to the exterior annular section of the revolving bowl, whence it may be removed by conveyors, elevators, or the like. The top of the charge is levelled by an agitating device, and

the portion below the surface, tending to agglomerate, is broken up by a similar device, both devices being attached to a water-sealed rotary top.

—J. E. C.

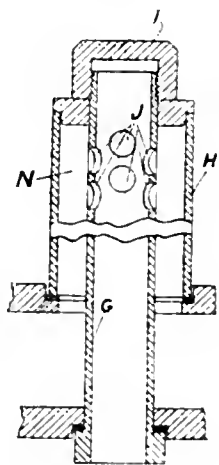
Producer-gas-engine system. C. S. Bradley, New York, U.S. Pat. 1,212,891, Jan. 16, 1917. Date of appl., Feb. 3, 1914.

THE system comprises a combination of a gas producer, an engine, means for introducing fresh air into the producer, means for transferring heat from the producer gas to the fresh air and delivering the cooled gas to the engine, means for introducing burnt gas from the engine into the producer, and means for controlling the proportion of burnt gas to fresh air supplied according to the temperature of the producer gas.—J. E. C.

Producer gas or water-gas mixed with distillation gases; Generator for producing — from bituminous fuels, such as coal, lignite, etc., by alternating working. E. Dolensky, Frankfurt, Ger. Pat. 294,333, July 6, 1915.

THE lower part of the shaft, occupied by coke, is divided vertically by a fire-bridge which terminates below the dividing zone between coal and coke. A hot-air blast is introduced at the base of each compartment in turn, and travelling upwards through the coke, passes over the bridge and downwards in the other compartment to an exit flue. Steam enters at the base of the hotter compartment, following each air-blast, and the resulting water-gas, after undergoing partial combustion with air introduced at the dividing zone, so as to heat this region, passes upwards with the distillation products, to be withdrawn at the top of the generator.—F. SOPX.

Gas cooling apparatus. J. E. Christopher, Hindley, Eng. Pat. 103,917, Apr. 28, 1916. (Appl. No. 6087 of 1916.)



THE gas is conducted through a series of inner tubes, G, and openings, J, to concentric spaces, N, and passing down these concentric spaces in the form of thin layers or films, is brought into intimate contact with the inner surface of the outer tubes, H. The outer tubes are cooled by water, which may be run off at various levels. The total sectional areas of the inner tubes of the concentric spaces, and of the main gas inlet and outlet passages respectively, must be approximately the same, so that the gases may be equally distributed.—J. E. C.

Heavy hydrocarbons: Method of using — as fuel in internal combustion engines. R. Vidal, Asnières, France, Eng. Pat. 103,831, Jan. 3, 1916. (Appl. No. 99 of 1916.)

A MIXTURE of heavy hydrocarbons (e.g., methyl-naphthalenes and ethylnaphthalenes) boiling within 60° C. of one another is used as a fuel for internal combustion engines, the mixture being heated to and used at a temperature of 100° C., i.e., 140° to 150° C. below the mean boiling point of its constituents.—C. A. M.

Distilling oil. G. E. Heyl, London, Eng. Pat. 104,067, Apr. 7, 1916. (Appl. No. 5135 of 1916.)

THE oil gravitates through a series of chambers internally heated by electric arcs to different temperatures, each being connected to a separate condensing plant maintained under reduced pressure. In this way the oil is fractionally distilled continuously.—H. J. H.

Hydrocarbons: Method of and apparatus for distilling —. H. A. Frasch, New York, U.S. Pat. 1,212,620, Jan. 16, 1917. Date of appl., Apr. 16, 1915.

HEAVY hydrocarbons are heated to the decomposition temperature in a retort within a distilling apparatus containing a heating medium (a melted fusible substance) in which the open lower end of the retort is immersed. Heat is applied to the distilling apparatus to melt the heating medium and to bring it to a sufficient temperature to decompose the hydrocarbons. The pressure of the vapour within the retort forces the vaporised hydrocarbon and the non-volatilised residue through the melted heating medium into the distilling apparatus, where they are distilled under reduced pressure and condensed.—C. A. M.

Hydrocarbons: Process of separating — from natural or other gas. Process of compressing, purifying, drying, and cooling gases. W. O. Fell, Bradford, Pa., Assignor to Petroleum Products Co. U.S. Pats. (A) 1,213,795 and (B) 1,213,796, Jan. 23, 1917. Dates of appl., (A) Oct. 3, 1908 and (B) Sept. 26, 1908. (B) Renewed May 5, 1916.

(A) GAS containing condensable hydrocarbons is compressed in the presence of a heat-absorbing material (glycerin) and then cooled, whereby the condensable hydrocarbons are liquefied and can be separated. (B) Gases are purified by compression in the presence of Turkey-red oil, which may be introduced in the form of a fine spray or mist. The Turkey-red oil may be reduced to a temperature considerably below that of the gas. Subsequently it is recovered and used again.—C. A. M.

Purifying [hydrocarbon] oils: Process for —. W. O. Snelling, Pittsburgh, Pa., Assignor to J. T. Milliken, St. Louis, Mo. U.S. Pat. 1,215,732, Feb. 13, 1917. Date of appl., Apr. 8, 1915.

SULPHUR-CONTAINING low-boiling hydrocarbon oils are freed from sulphur by heating or distilling them in the presence of a high-boiling cracked oil capable of absorbing sulphur.—H. J. H.

Coal washing mechanism. E. G. Burks and N. Hayes, Birmingham, Ala., U.S.A. Eng. Pat. 101,121, Sept. 11, 1916. (Appl. No. 12,855 of 1916.)

SEE U.S. Pat. 1,201,143 of 1916; this J., 1916, 1209.

Coke ovens. L. Wilputte, New Rochelle, N.Y., U.S.A. Eng. Pat. 101,127, Sept. 26, 1916. (Appl. No. 13,678 of 1916.)

SEE U.S. Pat. 1,213,988 of 1917; this J., 1917, 332.

Gas-producer plants. E. Dolensky, Assignee of Dellwik-Fleischer Wassergas Ges., Frankfurt, Germany, Eng. Pat. 100,813, July 3, 1916. (Appl. No. 9358 of 1916.) Under Int. Conv., July 5, 1915.

SEE Ger. Pat. 294,333; preceding.

Blast-furnace gases: Apparatus for purifying —. M. E. Feilmann, D. Bagley, and A. H. Smith, London, U.S. Pat. 1,216,677, Feb. 20, 1917. Date of appl., May 1, 1914.

SEE Eng. Pat. 10,311 of 1913; this J., 1913, 971.

Distillation of shale. Eng. Pat. 101,065. See HB.
Distilling coal. Eng. Pat. 101,066. See HB.
Retorts used in the manufacture of hydrogen. Eng. Pat. 101,115. See VII.

Recovering cyanogen and sulphur compounds from fluids. U.S. Pat. 1,213,129. See VII.

Preventing disintegration of refractory materials. Eng. Pat. 103,953. See VIII.

Process of obtaining a hard, fully-burnt, high-grade coke as by-product in the manufacture of lamp-black. Ger. Pat. 291,701. See XIII.

Manufacture of fusel oil or similar products from petroleum. U.S. Pat. 1,211,919. See XX.

HB.—DESTRUCTIVE DISTILLATION ; HEATING ; LIGHTING.

Methyl alcohol and acetone as by-products of the soda pulp industry. White and Rue. See V.

PATENTS.

Distilling coal. G. E. Heyl, London. Eng. Pat. 104,066, Apr. 7, 1916. (Appl. No. 5134 of 1916.)

PULVERISED coal is fed by an extrusion apparatus into a chamber containing an electric heater, e.g., an electric arc or resistance. The coal in rod form traverses the floor of the chamber and is rapidly distilled. The products passing into a condensing system maintained under reduced pressure. By subdivision of the heating chamber, compartments kept at different temperatures are provided, so that distillation and condensation may be carried out fractionally.—H. J. H.

Distillation of shale. G. E. Heyl, London. Eng. Pat. 104,065, Apr. 7, 1916. (Appl. No. 5133 of 1916.)

THE device described in the preceding abstract may be applied to the distillation of shale and the like.—H. J. H.

Kelp and the like: Distilling apparatus for —. J. C. W. Stanley, Santa Cruz, Cal. U.S. Pat. 1,212,579, Jan. 16, 1917. Date of appl., Mar. 7, 1916.

BOXES are arranged at each end of a furnace, and connected by a series of tubes arranged in a common horizontal plane. The material is carried by a series of conveyors back and forth through the tubes, following a sinuous path, and is discharged at the opposite end to the inlet, gases passing away through vents in the boxes. — J. E. C.

Distilling wood: Apparatus for —. A. W. Quattlebaum and B. S. Mooney, Statesboro, Ga. U.S. Pat. 1,215,990, Feb. 13, 1917. Date of appl., June 3, 1913.

THE wood is distilled in a vertical cylindrical retort, which is charged and discharged from above, and is supported on a pier inside a furnace of beehive form. The products of distillation pass out of the retort from below to a condensing system.—H. J. H.

Carbon electrode [for arc lamps] and method of manufacturing same. R. D. Pike, San Francisco, Cal. U.S. Pat. 1,215,700, Feb. 13, 1917. Date of appl., Mar. 13, 1916.

SEE Eng. Pat. 102,615 of 1916; this J., 1917, 127.

Liquid composition [for heating and refrigerating]. U.S. Pat. 1,213,368. See I.

Purifying crude acetate of lime. U.S. Pat. 1,213,721. See VII.

Process of obtaining a hard, fully burnt, high-grade coke as by-product in the manufacture of lampblack. Ger. Pat. 291,701. See XIII.

III.—TAR AND TAR PRODUCTS.

For dehydrating and debenzolising plant. A. E. Mottram, Manchester District Inst. of Gas Eng., Mar. 3, 1917. Gas J., 1917, 137, 164—167.

THE author describes a Wilton tar-dehydrating plant having a capacity of 100 galls. per hr. Tar from an overhead storage tank is pumped through an economiser in which it is heated by the outgoing hot tar. It then enters a coil still at the bottom, being heated during its passage upwards by a Wilton coke-breeze furnace. Leaving the still through a pipe fitted with gauge, thermometer, and safety-valve, it enters a vapour-box near the middle. From the vapour-box the tar flows down into the economiser, whilst the vapours rise and are condensed, the condensed liquid passing into a separator from which liquor is conducted to the liquor well and light oils to a storage tank. The temperature of the still may be controlled by means of the furnace or by the speed of the pump. When making tar for the No. 1 specification of the Road Board, a temperature of 160 to 180 °C. is aimed at and for No. 2 specification, 220 to 240 °C. When the plant is used for debenzolising creosote oil, the latter follows the same course as the tar but at a lower temperature (110 to 115 °C.). The working cost is about 6d. per ton of tar; the total cost of the plant, including storage tanks and barrels, is about £600 to £800. In working up benzolised creosote, a good supply of water is necessary in the condenser, and the addition of a fractionating column after the vapour-box has given improved results.—J. E. C.

Benzol: Rectification of —. W. N. Drew, Midland Inst. Min., Civil and Mech. Eng., Mar. 8, 1917. Gas J., 1917, 137, 514.

THE modern practice in rectifying benzol is to distil unwashed crude benzol, separating it into unwashed fractions of benzol, toluol, and solvent naphtha, the residue being run into a pan where the naphthalene solidifies on cooling. The partly rectified fractions are separately agitated with acid and with caustic soda. 90% benzol has been superseded by standard benzol, giving 95% distillate below 90 °C.; 90% benzol contains about 84% of benzene, 15% of toluene, and 1% of xylene, whilst standard benzol contains about 96% benzene and 4% toluene. The final products are usually standard benzol, 90% toluol, and solvent naphtha, and in working up benzol products "topping up" is frequently adopted. In this case after expulsion of the benzol fraction, the still is allowed to cool and a further supply of crude benzol added. The process is repeated until the still is nearly full of residue, the still then being run for toluol and naphtha fractions. Not more than 5% toluol is permissible in solvent naphtha. The pressure of steam should be constant, preferably not less than 75 lb.—J. E. C.

2-Acetyl-amino-3,4-dimethoxybenzoic acid and 3-acetylaminoveratrole: Nitration of —. C. S. Gibson, J. L. Simonsen, and M. G. Rau, Chem. Soc. Trans., 1917, 111, 69—85.

2-ACETYLAMINO-3,4-DIMETHOXYBENZOIC acid gives on nitration the 6-nitro compound, which on hydrolysis loses carbon dioxide and yields 5-nitro-3-aminoveratrole. 3-Acetylaminoveratrole on nitration gives the 5-nitro derivative, which in turn readily converted into 5-nitro-3-aminoveratrole. The latter compound on diazotisation

and treatment with cuprous cyanide yields the nitrile of 5-nitro-2,3-dimethoxybenzoic acid which readily yields the corresponding acid (m.pt. 171—175° C.), on hydrolysis. 6-Nitro-2,3-dimethoxybenzoic acid, prepared by two different methods, was found to melt at 185°—186° C. (corr.). Under a slight variation of conditions 2-acetylaminio-3,4-dimethoxybenzoic acid gives in addition to the 6-nitro compound a quantity of 4,5-dinitro-3-acetylaminoveratrole, which is also formed when 3-acetylaminoveratrole or its 6-nitro derivative is nitrated with fuming nitric acid.—W. H. P.

Apparatus for determination of benzol and toluol in coal gas. Coppr. See IIIA.

PATENTS.

Cresols: [Electrolytic] oxidation of —. [Preparation of salicylic acid.] U. Pomilio, Francavilla, Italy. Eng. Pat. 103,709, Apr. 18, 1916. (Appl. No. 5687 of 1916.)

Is the oxidation of cresols for the production of the corresponding hydroxy-acids or their salts, an electric current of 5—8 amps. per sq. dm. is passed through a fused mixture of the cresol and an alkali at 200° to 270° C., using electrodes of nickel, nickel-steel, iron, etc. For example, in the production of salicylic acid, a mixture of 3—5 parts of caustic soda and 1 part of water at 110—120° C. is treated with 1 part of 85%—95% *o*-cresol, added in small quantities at a time; the mixture is then heated to 240—250° C., and a current of 5—8 amps. per sq. dm. at the anode passed through.—B. V. S.

Benzenesulphonic acid: Separating — from sulphuric acid and converting the benzenesulphonic acid into a salt. L. M. Dennis, Hhaca, N.Y. U.S. Pat. 1,212,612, Jan. 16, 1917. Date of appl., Dec. 18, 1915.

The mixture of acids is treated with a solvent, such as benzene, which dissolves only the benzenesulphonic acid, and this solution is then treated with a suitable substance to form a salt not soluble in the solvent.—B. V. S.

Diphenylamine: Process of manufacturing —. B. J. Flürscheim, New York. U.S. Pat. 1,212,928, Jan. 16, 1917. Date of appl., June 21, 1916.

ANILINE is heated with ferric chloride, finely divided copper, and iodine.—W. H. C.

Phenol and other substances: Production of —. *Apparatus for organic chemical reactions.* J. W. Aylsworth, East Orange, N.J.; A. M. Aylsworth, and The Savings Investments and Trusts Co., Exors. U.S. Pats. (A) 1,213,112 and (B) 1,213,113, Jan. 23, 1917. Date of appl., Jan. 21, 1916.

(A) PHENOL is obtained by heating a mixture of chlorobenzene and caustic alkali solution, under pressure higher than that of the vapour tension of the mixture, at about 360° C. Chloride and phenoxide are produced, and phenol is liberated from the latter by the action of acid. Where caustic soda is used the proportions are about 1 mol. of chlorobenzene, 2 to 3 mols. of caustic soda, and about 20 mols. of water. (B) An apparatus suitable for the above and similar reactions, arranged for continuous operation, the reacting liquids being mixed in one coil and then pumped through a heated reaction coil.—B. V. S.

Phenol: Manufacture of —. D. Tyret, Stockholm-on-Tees. Eng. Pat. 101,220, Feb. 29, 1916. (Appl. No. 3021 of 1916.)

SEE U.S. Pat. 1,210,726 of 1917; this J., 1917, 208.

Toluene: Process for the production of —. W. B. Sifton, London. U.S. Pat. 1,216,171, Feb. 13, 1917. Date of appl., July 20, 1915.

SEE Eng. Pat. 8886 of 1915; this J., 1916, 248.

Distilling oil. Eng. Pat. 101,067. See IIIA.

Method of manufacturing coke from pitch. U.S. Pat. 1,213,763. See IIIA.

IV.—COLOURING MATTERS AND DYES.

PATENTS.

o-[Hydro]aryazo dyestuffs: Manufacture of copper compounds of substantive — in substance and on the fibre. O. Inray, London. From Soc. Chem. Ind. in Basle, Switzerland. Eng. Pat. 12,932 of 1915; date of appl., May 31, 1916.

SUBSTANTIVE *o*-hydroxyazo dyestuffs (c.g., those described in Eng. Pats. 12,250 of 1915, 101,601 and 102,881; this J., 1916, 1008, 1101, and 1917, 210) are converted into complex copper compounds or prepared in presence of copper salts to obtain the copper compounds direct, in substance or on the fibre. The fastness to washing, and especially to alkali and to acid, is better than that of the parent dyestuffs, and the fastness to light is in certain cases as good as is obtainable with the best vat dyestuffs.—F. W. A.

[Azo] dyes and process of dyeing. J. Flachslaender and P. G. List, Leverkusen, Germany, Assignors to Synthetic Patents Co., New York. U.S. Pat. 1,215,359, Feb. 13, 1917. Date of appl., July 29, 1916.

DIAZO-COMPOUNDS, c.g., diazotised *p*-nitro-*o*-toluidine, are coupled, in solution or on the fibre, with a hydro-*α*-naphthalide, c.g., the tetrahydro-*α*-naphthalide of 2,3-hydroxynaphthoic acid.—F. W. A.

[Anthracene] vat dyes: Green — and process of making them. M. Kardos, Charlottenburg, Assignor to Badische Anilin und Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,216,134, Feb. 13, 1917. Date of appl., June 30, 1913.

SEE Fr. Pat. 458,949 of 1913; this J., 1913, 1101.

[Anthracene] vat dye: Yellowish-brown —. O. Bally and H. Wolff, Mannheim, Assignors to Badische Anilin und Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,216,921, Feb. 20, 1917. Date of appl., Jan. 23, 1915.

SEE Fifth Addition, of Apr. 2, 1910, to Fr. Pat. 365,920 of 1906; this J., 1910, 1197.

o-[Hydro]aryazo dyestuffs: Copper compounds of — and a process of making same. B. Wuth, B. Mayer, C. Jagerspacher, and E. Anderwert, Assignors to Soc. Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,216,760, Feb. 20, 1917. Date of appl., Aug. 3, 1915.

SEE Eng. Pat. 1611 of 1915; this J., 1916, 301.

o-[Hydro]aryazo dyestuffs: Copper compounds of — and a process of making same. C. Jagerspacher and B. Wuth, Assignors to Soc. Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,216,812, Feb. 20, 1917. Date of appl., Oct. 7, 1915.

SEE Eng. Pat. 12,249 of 1915; this J., 1916, 922.

o-[Hydro]aryazo dyestuffs: Metal compounds of — and a process of making same. C. Jagerspacher, Assignor to Soc. Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,216,813, Feb. 20, 1917. Date of appl., Dec. 31, 1915.

SEE Eng. Pat. 16,916 of 1915; this J., 1917, 78.

Monoazo dyes. C. Mensching, Birkenhead, Assignor to W. E. Mounsey, Liverpool. U.S. Pat. 1,217,042, Feb. 20, 1917. Date of appl., Jan. 29, 1916.

SEE Eng. Pat. 10,716 of 1915; this J., 1916, 301.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Methyl alcohol and acetone as by-products of the soda pulp industry. A. H. White and J. D. Rue, Tech. Assoc. of Pulp and Paper Ind., New York. Feb. 7, 1917. Met. and Chem. Eng., 1917, 16, 182—186.

IN laboratory tests with the concentrated black liquor from the digestion of wood by the soda process, favourable results were obtained on destructive distillation by feeding the liquor gradually into an inclined, preheated tubular retort. The liquor entered the retort through a side arm at the middle, and the gases were led off at the upper end, while the carbon accumulated at the lower end. The best results were produced at 550°—600° F. (288—316° C.) with liquors from the digestion of beech and bass woods concentrated to 41·3° B. (sp. gr. 1·37). The average yields were 3·81% of methyl alcohol and 0·56% of acetone by vol. on the aqueous distillate, which was 65·5% of the black liquor treated; the rate of feeding was such that the gases remained in the retort for 15—30 secs. An experimental plant on a larger scale, consisting of 24 retorts constructed of steel well-casing, 12 ft. long and 9·6 in. in diam., with a fall of 3 ft. from end to end, was operated continuously for 3 weeks without serious trouble, but owing to leaks the yields were only about 75% of those obtained in the laboratory. The capacity of the plant was about 1 gall. of thick black liquor per hour; the success was limited by the fact that the feeding of the liquor and the removal of the black ash had to be controlled by hand. The black liquor used had the composition: water, 31·7; organic matter, 40·0; ash, 28·3%. The firing of the retorts was effected by gas, but it could be efficiently carried out by the combustion of the black ash produced, or better of the "carbon" obtained from the black ash after leaching. The methyl alcohol and acetone were practically free from tar and could be readily purified. The quantity of tar obtained amounted to about 11·2% by vol. on the black liquor, and it contained about 50% of phenolic constituents. The loss of soda which takes place in rotary incinerators is eliminated by this process, and the carbon recovered from the ash is sufficient to provide fuel for the whole by-product plant. The net saving by the treatment is estimated at \$1·86 (7s. 9d.) per cord of wood.—J. F. B.

PATENTS.

Lignified vegetable materials; Treatment of — for preserving or restoring their colour. C. F. Cross, London. Eng. Pat. 101,032, Feb. 23, 1916. (Appl. No. 2721 of 1916.)

LIGNIFIED materials, such as paper pulp, textiles, or straw plait, are treated with a solution containing 0·2—0·5% of hydroxylamine or hydroxylamine acetate in order to restore their colour or to make them capable of resisting discoloration under the influence of atmospheric exposure.

—J. F. B.

Drying and conditioning materials [yarn]; Process and apparatus for —. W. W. Sibson and T. Allsop, Assignors to The Philadelphia Drying Machinery Co., Philadelphia, Pa. U.S. Pat. 1,213,519, Jan. 23, 1917. Date of appl., July 28, 1913. Renewed June 20, 1916.

YARN is loosely suspended and subjected to heated air at a relatively high temperature, then to air at a lower temperature, and finally to moist air. These operations are carried out in a chamber which is divided into compartments so that the material may be passed from the drying to the conditioning compartment without coming into contact with cold air.—W. P. S.

Size; Manufacture of — and its application to paper and paper pulp. G. H. Gemmell and S. Milne, Edinburgh. Eng. Pat. 101,012, Feb. 12, 1916. (Appl. No. 2108 of 1916.)

ROSIN is dissolved in a solution of borax or ammonia or a combination of both, with or without the addition of soda. In engine sizing, the diluted size is preferably decomposed with aluminium sulphate before adding to the pulp; the size may also be applied to the surface of the paper, which is subsequently dried at a temperature sufficient to fuse and dry the size.—J. F. B.

Cellulose derivatives; Manufacture of —. J. Koetschet, Lyon, and M. Theumann, St. Fons, France, Assignors to Soc. Chim. Usines du Rhône (anc. Gilliard, P. Monnet, et Cartier) Paris. U.S. Pat. 1,216,162, Feb. 20, 1917. Date of appl., June 19, 1915.

SEE Eng. Pat. 7773 of 1915; this J., 1916, 302.

Film and process of producing same. Manufacture of artificial textile material. L. Lilienfeld, Vienna. U.S. Pats. 1,217,027 and 1,217,028, Feb. 20, 1917. Date of appl., Oct. 20, 1913.

SEE Fr. Pat. 459,972 of 1913; this J., 1913, 1153.

Process for bleaching textile fabrics or like material. Eng. Pat. 101,048. See VI.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

PATENTS.

Bleaching textile fabrics or like material; Process for —. A. Poulson, Widnes, Eng. Pat. 104,048, Mar. 15, 1916. (Appl. No. 3842 of 1916.)

RAW cotton, wool, flax, textile fabrics, paper, or like material is bleached by steeping in a boiling solution of about equal parts of sodium carbonate crystals and sodium bicarbonate and subsequently adding a solution of sodium hypochlorite.—F. W. A.

Chrome colours; Dyeing with artificial —. T. L. Whitehead, London. From Chemical Works, formerly Sandoz, Basle, Switzerland. Eng. Pat. 101,083, Apr. 27, 1916. (Appl. No. 6065 of 1916.)

A CHROMIUM alkali oxalate is added to the dye-bath instead of chromic acid compounds to avoid oxidation of the dyestuff in dyeing wool in one bath with chrome colours such as Indochromine, Gallocyanine, or an *o*-hydroxyazo dyestuff. The chromium alkali oxalate dissociates slowly but completely at the boil, and the chrome lake of the dyestuff is developed on the fibre without premature formation in the dye-bath, as occurs if an organic salt of chromium is used (Eng. Pat. 11,077 of 1894; this J., 1894, 881); the handle of the fibre is not impaired, as is the case after treatment with chromium fluoride.—F. W. A.

Multi-colour printing: Production of azo dyestuffs from nitrosamine colours in —. A. G. Bloxam, London. From Chem. Fabr. Griesheim-Elektron, Frankfurt, Germany. Eng. Pat. 101,108, July 12, 1916. (Appl. No. 9817 of 1916.)

IN multi-colour printing in which steaming is necessary, azo dyestuffs are produced from mixtures of nitrosamines and naphthols or their derivatives (except 2-naphthol-1-carboxylic acid and 2-naphthol-1-sulphonic acid), to which has been added a normal chromate, which forms lakes fast to steaming. By this process it is possible to print simultaneously with tannin dyestuffs and chrome dyestuffs, or sulphurised dyestuffs and vat dyestuffs with nitrosamine colours. After steaming, the colour is developed in a boiling bath containing acetic acid and sodium sulphate, or in a bath containing acetic acid and a dichromate, to which an antimony salt is added in the case of tannin dyestuffs. — F. W. A.

Iron mordants: Firing on textile fibres. P. Schmid, Basle, Switzerland. U.S. Pat. 1,216,847, Feb. 20, 1917. Date of appl., May 23, 1916.

SEE Eng. Pat. 102,310 of 1916; this J., 1917, 80.

Manufacture of copper compounds of substantive α -(hydroxy-azo dyestuffs in substance and on the fibre. Eng. Pat. 12,932. See IV.

[Azo] dyes and process of dyeing. U.S. Pat. 1,215,359. See IV.

Process for making cleaning compounds. U.S. Pat. 1,212,442. See VII.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Kelp for the recovery of potash: The carbonisation of —. J. W. Turrentine, Met. and Chem. Eng., 1917, 16, 196—199.

IN the United States the giant kelps of the Pacific coast offer the best promise for the establishment of a domestic potash industry. Considerable progress has been made as regards the cheap harvesting of the kelp. Drying in the open air, even in the dry climate of S. California, is scarcely feasible on a sufficiently large scale, though it might be assisted by some suitable mechanical device for turning over the material on the floors. Of the artificial drying processes, the use of the direct-heated rotary kiln appears the most promising, preferably when operated on the counter-current principle, with the drying effected in stages. Dry kelp is a powder, weighing about 50 lb. per cub. ft., and containing about 15% of K_2O , and is comparable with the low-grade potash salts formerly imported. The question of freights to distant markets demands the elimination of the organic matter, e.g., by incineration, and if this method be adopted it must be carried out at a temperature below the fusing point of the potash salts (750° C.). Burning in the air does not fulfil these conditions, and all the circumstances point to the method of destructive distillation with the production of gas and possibly the recovery of other useful by-products. It is considered that an adaptation of the continuous vertical coal-gas producers, in which the heat units are carefully preserved, would afford a suitable apparatus for the distillation of kelp. The temperature of working would be lower than that required for coal, and the expansion of the charge would not have to be provided for. Kelp charcoal is porous and easily leached and the reduction in freight rates on the potash salts would fully cover the expenses of treatment. — J. F. B.

Ammonium molybdate solutions: Yellow deposit found in —. A. R. Pentfold, Austral. Pharm. Notes and News, 1917, 13, 17.

THE yellow crystals sometimes deposited from solutions of ammonium molybdate on keeping, have been shown to be hydrated molybdic acid of the formula, $H_2MoO_4 \cdot H_2O$. — B. N.

Oxides of iron: Some problems of the —. R. B. Sosman, J. Wash. Acad. Sci., 1917, 7, 55—72. (See also this J., 1916, 536, 736.)

IN considering the phase ruled diagram of the system iron-oxygen, it is pointed out that the solubility of oxygen in solid iron, although certainly not large, has not been accurately determined. The assumption that FeO is the lowest oxide in equilibrium with metallic iron is based on unsatisfactory data; and the methods commonly given for the preparation of this oxide do not yield pure FeO but mixtures which sometimes have an average composition approximating to it. Analogy with iridium oxide (IrO) suggests that, over some particular range of temperature, FeO may have a higher dissociation pressure than Fe_3O_4 , thus permitting the occurrence of the reaction, $4FeO = Fe_3O_4 + Fe$, which would explain many experimental results and possibly account for the known occurrence of metallic iron in basic rocks such as diabase and gabbro. Magnetite, Fe_3O_4 , melts sharply, at 1580° C., to a mobile liquid which crystallises in octahedra on cooling; the dissociation pressure of this oxide is extremely low, being less than 0.01 mm. of mercury at 1200° and less than 0.005 mm. at 1100° C. The oxides, Fe_2O_3 and Fe_3O_4 , recently investigated by the author at 1100° and 1200° C., seem to form a continuous series of solid solutions, but the melting temperatures (solidus and liquidus curves) have yet to be determined. The dissociation pressure rises so rapidly with increase of temperature that at the melting temperature of the solid solution the pressure of oxygen is probably several atmospheres for compositions which depart much from Fe_3O_4 . The melting point of Fe_2O_3 can be determined only under sufficient oxygen pressure to prevent its dissociation, and it is impossible to predict whether the melting point will be higher or lower than that of magnetite. This type of solid solution presents the special feature of one of the constituent oxides being produced by direct dissociation of oxygen from the other, and raises questions relative to internal structure, the transition of one class of crystal into another (hematite being hexagonal and magnetite isometric), and the factors determining the equilibrium pressure of the oxygen dissociated for a given composition of the solid solution. As regards magnetic properties and polymorphism, the similarity of the temperature-magnetism curves for the magnetic inversions occurring in iron, magnetite, hematite, and various ferrites suggests a common fundamental basis for all. It is quite possible, and appears to be the case with the oxides of iron, that the rapid, reversible type of polymorphic inversion hitherto regarded as denoting merely a molecular rearrangement involving slight changes in crystalline form or symmetry, and therefore less fundamental than the slow and sometimes irreversible type, is in reality the fundamental inversion occurring within the atomic nucleus and thus necessarily producing a corresponding change in the spacing of the atoms. The facts suggest that the magnetic properties and the inversions of iron and its compounds are bound up with the spacing and arrangement of the iron atoms, almost without regard to the other atoms present. The bearing of the above and other considerations on geological questions relating to the oxides of iron is also discussed. — W. E. F. P.

Manufacture of polish [and cement] from felspar.
See XVI.

PATENTS.

Sulphuric acid: Apparatus for manufacture of — H. E. Macadam, Woodford Green, and H. Walker, London. Eng. Pat. 103,877, Feb. 17, 1916. (Appl. No. 2107 of 1916.)

ONE or more towers or structures lined and packed with acid-resisting material are interposed between the Glover tower and the first of the series of lead chambers, and a solution of sodium nitrate is sprayed into the gases as they pass through the tower or towers. At the bottom of the tower, means are provided for drawing-off the denitrated solution. A convenient size for the towers is 9 to 12 ft. high by 4 ft. diameter.—J. B. C. K.

Sulphuric acid and other liquids: Apparatus for concentrating — A. G. Duron, Paris. Eng. Pat. 104,034, Feb. 21, 1916. (Appl. No. 2789 of 1916.)

HOT gases are passed through horizontal flues situated immediately above a series of parallel channels containing the acid to be concentrated, and thence over the surface of the acid itself in the reverse direction. The gases lose heat as they traverse the flues, but they keep their temperature as they pass over the acid owing to contact with the heated under-surface of the flue. The reheating of the gases producing the evaporation is greatest at the point of exit, where the reduction of temperature would otherwise be greatest. The width and surface of the channels, the distance between the acid surface and the lower part of the flue, and the flow of acid, are varied according to the extent of evaporation required, the arrangement being such that there is the largest surface of evaporation, together with the minimum speed of flow and the greatest volume of hot gases, at the point where the acid is weakest. By using four channels, acid of 65–67% concentration can be gradually brought up to 98.3%.—E. H. T.

Lead monoxide: Manufacture of — Patent Corporation, Ltd., Assignees of W. P. Thompson, Liverpool. Eng. Pat. 100,069, Feb. 5, 1916. (Appl. No. 1738 of 1916.) Under Int. Conv., Feb. 6, 1915.

METALLIC lead is heated above its melting point, and is stored in a raised tank, from which it descends to an aspirator under considerable pressure. It flows into the aspirator through a row of small openings, in the form of a fine even spray, and meets many hundreds of times its own volume of highly heated air introduced through slits parallel and at right angles respectively to the row of openings. The resulting dust and hot air are kept in contact with each other at a high temperature until the whole of the lead is oxidised. The chamber which receives the oxidised lead dust for cooling purposes, is surrounded by an air chamber, through which the air supply for the process is aspirated, and the heat of the effluent gases from the lead melting furnace is similarly utilised to heat the pipe or conduit which conveys the molten lead to the aspirator or atomiser. Lead monoxide prepared in this way is specially suitable for the manufacture of white lead by the dry process.—J. B. C. K.

Vitre cake: Utilisation of — I. P. Jewell, Stockport, and P. Spence and Sons, Ltd., Manchester. Eng. Pat. 103,689, Feb. 4, 1916. (Appl. No. 1691 of 1916.)

NITRE cake is heated with a suitable reducing agent, as for instance 25% of iron sulphide in the form of ground pyrites, in a closed iron vessel provided with a mechanical agitator. Sulphur dioxide is evolved, together with some sulphur, which is readily condensed, and a residue of norma-

l sodium sulphate and iron oxide remains. If finely divided iron be substituted for iron sulphide, no free sulphur is liberated, but a steady evolution of sulphur dioxide occurs.—J. B. C. K.

Chromates: Manufacture of — G. N. Vis, Paris. Eng. Pat. 103,696, Feb. 9, 1916. (Appl. No. 1926 of 1916.)

AN ore containing chromium in the form of oxide is heated in a metal vessel with sodium hydroxide (with or without addition of sodium carbonate) to a temperature of 600° to 800° C., the higher temperature being required when sodium carbonate is employed in the mixture. The corresponding compounds of potassium may also be employed. Lime may be added to the mixture, and also chlorides to serve as a flux. Oxygen or air is blown through the molten mass. Examples: A mixture of 300 grms. of chromite and 300 grms. of sodium hydroxide, heated to dull cherry redness and treated with air for 1 hrs., gives a 90% yield of sodium chromate; and a mixture of 200 grms. of chromite, and 280 grms. of sodium hydroxide gives a yield of 97½%.—J. B. C. K.

Formates: Manufacture of — S. H. Katz and E. K. Oritz, Pittsburgh, Pa. U.S. Pat. 1,212,350, Jan. 6, 1917. Date of appl., May 16, 1916.

FORMATES are produced by the interaction of a caustic alkali solution, carbon monoxide, and a volatile alkali such as ammonia. A descending, finely divided stream of the alkali solution meets an ascending stream of mixed ammonia and carbon monoxide in a closed vessel under a pressure of 10–20 atmospheres and at a temperature of 150°–200° C.—B. V. S.

Cleaning compounds: Process for making — A. W. Bishop, St. Louis, Mo. U.S. Pat. 1,212,442, Jan. 16, 1917. Date of appl., Aug. 9, 1916.

A CLEANING solution is obtained by treating a solution of sodium sulphide (20 parts) and sodium hydroxide (3 parts) in water (120 parts) with manganese dioxide (21 parts), and agitating until the sulphurous smell disappears; sodium chlorate (3½ parts) and sifted coal ashes (3 parts) are then added, the liquid allowed to settle for a predetermined time until free chlorine is liberated, the clear liquor decanted off, and mixed with nitrobenzene (4 parts).—B. V. S.

Alkaline-earth metal compounds: Process for producing — E. W. Huber and R. W. Poin-dexter, jun., Los Angeles, Cal. U.S. Pat. 1,213,375, Jan. 23, 1917. Date of appl., July 6, 1914.

AN alkaline-earth sulphate, e.g., strontium sulphate, is subjected to the action of a reducing flame at a temperature of 1200° to 1300° C., and the sulphide produced by this treatment is then exposed while still hot to the action of super-heated steam. The process may be made continuous and carried out in a revolving type of furnace. The hydrogen sulphide evolved in the second stage of the process is employed in the first stage to assist in maintaining a reducing atmosphere.—J. B. C. K.

Cyanogen and sulphur-compounds from fluids: Recovering — F. W. Sperr, jun., Oakmont, Pa. U.S. Pat. 1,213,429, Jan. 23, 1917. Date of appl., Oct. 20, 1915.

A SOLUTION of cyanide and sulphide, or a gas containing hydrocyanic acid, is treated with a solution of a zincate so as to form insoluble zinc sulphide and a soluble cyanide. The precipitated sulphide is separated and cyanide extracted from the solution.—B. V. S.

Cyanogen compounds: [Electrolytic] process of making —. H. Foersterling and H. Philipp, Perth Amboy, N.J., Assignors to The Reessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,211,770, Feb. 6, 1917. Date of appl., June 21, 1910; renewed June 21, 1916.

A METALLIC compound, containing a metal capable of forming cyanogen compounds, is electrolysed and alloyed with another metal. The first metal is vaporised by blowing an inert gas, such as nitrogen, through the molten alloy, and the vaporised metal is treated with nitrogeous and carbonaceous matter. B. N.

Acetate of lime: Purifying crabs —. O. T. Zinkeisen, Assignor to Fore Chemical Works, Inc., New York. U.S. Pat. 1,213,724, Jan. 23, 1917. Date of appl., Jan. 21, 1914.

ORGANIC impurities are precipitated from a solution of crude calcium acetate by boiling with lime, an iron salt, and a bleaching agent. B. V. S.

Alumina and potassium sulphate: Production of — from alundite. E. Blough and T. McIntosh, Assignors to Aluminium Co. of America, Pittsburgh, Pa. U.S. Pat. 1,211,991, Feb. 6, 1917. Date of appl., Feb. 1, 1916.

ALUNITE is mixed with common salt and heated until the latter is decomposed. The sulphates of sodium and potassium produced by the reaction are dissolved out by water, and the potassium sulphate is separated from the solution. The residue from the lixiviation is then heated with the solution of sodium sulphate that remains. The sodium sulphate is thus decomposed and sodium aluminate is obtained. Sulphur dioxide is evolved during the last stage of the process and may be collected and utilised. — J. B. C. K.

Aluminium hydrate (hydroxide): Process for producing —. C. A. Doremus, New York. Assignor to J. S. Hoyt, Darien, Conn. U.S. Pat. 1,215,351, Feb. 13, 1917. Date of appl., Feb. 27, 1911.

A SOLUTION of aluminium fluoride is purified from iron by oxidation and then treated with calcium hydroxide, whereby aluminium hydroxide and a fluoride are precipitated. The former is converted into sodium aluminate by the addition of caustic soda, and the solution is separated and decomposed to re-precipitate the aluminium hydroxide. — E. H. T.

Hydrogen: Retorts used in the manufacture of —. R. and J. Dempster, Ltd., and R. Dempster, Manchester. Eng. Pat. 101,115, Aug. 12, 1916. (Appl. No. 11,113 of 1916.)

THE disintegration of the iron ore caused by the manner of charging it into the retorts (where it is subjected alternately to the action of reducing gases and steam) is obviated by providing the retort with a perforated platform or plate, which is mounted on a vertical shaft and can be raised and lowered from top to bottom of the retort for charging and discharging. The movement is guided by projections or buttresses on the internal walls of the retort, and the platform can be revolved as well as moved vertically. — E. H. T.

Hydrogen [from activated aluminium and water]: Preparation of —. L. Elkan Erben G.m.b.H., Charlottenburg. Ger. Pat. 291,910, Jan. 27, 1916.

ACTIVATION of the aluminium is partially or wholly effected under the influence of heat, which brings about a considerable increase in the yield of hydrogen obtained when the product is subsequently treated with water. — F. SODN.

Lead sulphate: Process of preparing —. International Color and Chemical Co., and A. S. Ramago, Detroit, Mich., U.S.A. Eng. Pat. 190,391, Mar. 2, 1916. (Appl. No. 3176 of 1916.) Under Int. Conv., Apr. 16, 1915.

SEE U.S. Pat. 1,168,118 of 1916; this J., 1916, 309.

Ammonia: Absorbing — and apparatus therefor. C. Bosch, Assignor to Badische Anilin und Soda Fabrik, Ludwigshafen, Germany. U.S. Pat. 1,216,959, Feb. 13, 1917. Date of appl., July 7, 1913.

SEE Eng. Pats. 25,260 of 1912 and 9651 of 1913; this J., 1913, 1155.

Aluminium hydroxide: Manufacture of —. B. Schwerin, Assignor to Elektro-Osmose A.-G. (Graf Schwerin Ges.), Frankfurt, Germany. U.S. Pat. 1,216,371, Feb. 20, 1917. Date of appl., May 13, 1915.

SEE Eng. Pats. 6727 and 7212 of 1915; this J., 1915, 901, 1051.

Sodium bisulphite: Process for the production of —. T. W. S. Hutchins, L. Hargreaves, and A. C. Dunningham, Middleswich. U.S. Pat. 1,216,152, Feb. 20, 1917. Date of appl., Aug. 16, 1916.

SEE Eng. Pat. 10,556 of 1915; this J., 1916, 1015.

Removing sulphur dioxide from metallurgical smoke, etc. U.S. Pat. 1,212,199. See X.

Apparatus for the [electrolytic] production of oxygen and hydrogen gases. U.S. Pat. 1,212,229. See XI.

Preparation of a fertiliser containing ammonium magnesium sulphate and ammonium chloride. Ger. Pat. 291,857. See XVI.

VIII.—GLASS; CERAMICS.

Glass furnaces: Development of — on the Continent. T. Teisen. Soc. Glass Tech., Mar. 15, 1917.

WOOD and peat are used for heating furnaces in Scandinavia in some works, whilst natural gas is used in the United States to some extent. The chief fuel in use for furnaces, however, is either coal or gas. When coal is burned direct, a large excess of heat is necessary to complete the combustion, and if this excess be cut down the waste gases contain a large proportion of carbon monoxide. In the complete combustion of 1 kilogram of coal to carbon dioxide, 8000 calories are set free whilst only 2500 calories are freed if the coal only is burned to carbon monoxide. Thus the presence of carbon monoxide in the waste gases represents a considerable loss of heat. The use of producer gas allows much better combustion to be obtained, so that a large excess of air is unnecessary. A higher temperature results, therefore, particularly if the gas and also the incoming air are delivered hot to the combustion chamber. This preheating of air and gas can be accomplished either by regeneration or by recuperation. In the latest pattern of the Siemens regenerative furnace there are four chambers lined with fire bricks, two of which are being heated by the waste gases whilst the other two are warming up the incoming air and gas. By reversing the direction of flow of air and gas, the chambers which were being heated now supply heat to the air and gas, whilst the others are in their turn heated by the waste gases. This method of regeneration is very useful for large furnaces but is expensive and takes up considerable floor space. In the Hermanssen system of recuperation the air and gas always pass in the same direction and are sufficiently preheated by passing through flues, which are surrounded by the hot waste gases. In 1906—7 the first Hermanssen furnace used for glass melting was burning wood and

melted a batch of 4 cwt. in 10 hours. So perfect is the combustion in the Hermannsen furnace that, at the Costa Works, crystal glass is made in open pots. Furnaces of this type will melt glass during the night for next day, and so the capacity of a furnace should not be judged by the number of pots, but by the amount of glass it will melt. From this point of view the continuous recuperative furnace is more efficient than the regenerative furnace.

Glass: Effect of small amounts of impurities, in particular chlorides and sulphates, in producing turbidity or opacity in —. W. E. S. Turner and J. D. Cauwood. Soc. Glass. Tech., Mar. 15, 1917.

LEAD glass made with Russian potash, though found at first to be quite clear, gradually became milky as it stood at a lower temperature in the pot, or if after the glass had been worked the articles in course of formation were re-heated. Analysis indicated that the three impurities in Russian potash to any extent were phosphate, chloride, and sulphate. Of these three phosphate was not active in producing milkiness, at least up to 1% of the batch mixture, but chloride and sulphate caused opacity. Of the two, sulphate, to the extent of 1% of the batch, produced opacity, when melting at 1300° was carried out until the glass was clear, followed by several hours' heating at 950°–1000°. Under the same conditions, to give opacity, chloride must be present to an extent exceeding 1% of the batch. It is possible to prevent or retard the appearance of milkiness by the addition of borax. The most effective agent, however, is high temperature, by which chloride is volatilised or sulphate decomposed. The results emphasize the need of the introduction of more efficient furnaces, capable of reaching a high temperature. Especially is this so when dealing with the new types of glassware that now have to be produced in this country.

In the discussion that followed, it was pointed out that whilst borax removed the milkiness, on the glass being reheated it again appeared. Thus the best means of removing this defect was to employ a high temperature.

Silica bricks and some new uses for them. W. Gray. Met. and Chem. Eng., 1917, 16, 209–216.

SILICA bricks are manufactured from a sandstone or quartzite of sedimentary origin. In the United States suitable deposits are restricted to certain parts of Pennsylvania, Wisconsin, and Alabama. The ganister rock when crushed should appear splintery, sharp, heterogeneous in form and size, and slightly translucent. A suitable quartzite would contain approximately 97.5% of SiO_2 , 1–1.5% of Al_2O_3 , and 0.75% of other impurities; it should melt at cone 35–36, expand, and swell without perceptible cracking. The total fluxes should not exceed 3%. Two kinds of silica brick are manufactured: ganister or lime-bond brick, rich in silica, in which the bonding agent is lime, and quartzite brick manufactured from about one part of finely ground clay to two of crushed quartz, and containing 21–26% of Al_2O_3 . In the manufacture of lime-bond brick, the crushed rock is ground in mills with about 2% of good lime; the bricks are moulded, dried for 10–20 hours, and very carefully fired. The first stage of kilning, to drive off the moisture occupies three days with plenty of air, in the course of which the temperature rises to 300° F. (150° C.); the intermediate stage lasts for four days with gradually increasing temperature and less draught; the burning proper, with the formation of the clinker owing to the combination of the lime with the silica, lasts for three or four days, the temperature being forced up to 2800°–3000° F. (1540°–

1650° C.). In cooling, draughts of cold air must be avoided, and the operation extended over seven days. The composition of silica brick will be approximately as follows:— SiO_2 , 96.0%; Al_2O_3 , 0.90%; Fe_2O_3 , 0.70%; CaO , 1.75%; MgO , 0.14%; alkalis, 0.39%. It is an acid brick, used in metallurgical furnaces operating with acid slags to form a stable lining; it is very soluble in strong alkali solutions, easily attacked by metal oxides and flue dust. It is an ideal material for a high and constant temperature where the chemical action of the slag is not detrimental, but it possesses the drawback of "sprawling" or disintegrating if subjected to blasts of cold air or irregular cooling when hot; it is also essential to approach the working temperature slowly and evenly until the brick has become properly annealed. Compared with other refractories, silica brick possesses the important advantage of supporting pressures of 75 lb. per sq. in. well above 2800° F. (1510° C.) without deformation; the softening and melting points are almost identical at about 3400° F. (1870° C.). The bricks expand considerably in kilning owing partly to the conversion of the silica into tridymite, but show a relatively small expansion after the first burning. Silica brick is coming largely into use for the construction of the checkerwork of open-hearth furnaces, with the most satisfactory results. For boiler furnaces it is not so well adapted unless protection from draughts of cold air can be ensured. For the crowns of beehive coke ovens the advantage in structural properties imparted by the expansion properties of silica brick has established its supremacy under exceptionally adverse conditions of cooling. For the lining of lime-kilns, both vertical and rotary, and for cupolas in steel casting, the use of silica brick has resulted in prolonging the normal life of the refractory structures several times over. Similarly in by-product coke ovens and gas-retorts, the advantages derived from the superior properties of silica brick have enabled the industry to reach a stage of development not otherwise attainable, the expansion properties of the silica being particularly valuable in sectional retorts and long coking chambers.—J. F. B.

PATENTS.

Glass furnaces. C. F. Price, Birmingham. Eng. Pat. 101,136, Oct. 17, 1916. (Appl. No. 14,726 of 1916.)

THE furnace is an adaptation of that described in Eng. Pat. 100,819 of 1916 (this J., 1916, 930) and consists of a combustion chamber containing the glass pots or crucibles, mounted above a semi-producer, the sides of the latter being surrounded by flues which heat the air required for combustion. The gas and air are mixed and enter the base of the combustion chamber through an annular flue surrounding the top of the producer. Uniformity in the distribution of the hot air is secured by the use of several damper-controlled air inlets on each side of the producer. The waste gases are taken down flues which partially surround the combustion chamber and producer, and so act as heat insulators, before they proceed to the chimney.

—A. B. S.

Quartz glass: Process of producing articles of —. O. C. Trautmann, Assignor to Sidio Co. of America, Inc., New York. U.S. Pats. (A) 1,215,432 and (B) 1,215,433, Feb. 13, 1917. Date of appl., Aug. 10, 1916.

(A) THE quartz is packed around a resistance core constricted at its middle and heated in an electric resistance furnace until plastic. The core is then broken by twisting one end of it, and the two parts, together with the surrounding plastic quartz, are drawn apart until the latter forms a

tube. (B) An electric resistance furnace is shaped so as to form a mould, a resistance core is placed in it and surrounded by quartz which is then heated electrically until plastic. Any unfused quartz is removed, the core is broken as in (v), and the furnace is then transformed into an arc furnace whereby gases are generated which "blow" the plastic quartz and cause it to take the shape of the mould. —A. B. S.

Drying means of tender clay; Apparatus.

R. O. Perrott, Bucyrus, Ohio, Assignor to American Clay Machinery Co., Chicago, Ill. U.S. Pat. 1,215,819, Feb. 13, 1917. Date of appl., Aug. 11, 1913.

A MULTITUNNEL dryer is so arranged that one end of it is highly heated, whilst at the other end a "low primary curing heat" is applied to the goods by means of a transverse conduit with suitable openings. A forced draught is used throughout, the temperature and pressure of the air being controlled in each section of the dryer. —A. B. S.

Enamels for enamelling iron. R. Koepf and Co., Oestrich, Germany. Eng. Pat. 101,802, Feb. 18, 1916. (Appl. No. 11,121 of 1916.) Under Int. Conv., July 1, 1916.

NATURAL "borate of lime," e.g., borocalcite, colemanite, etc., may be used for the production of high-class enamels for iron if it has previously been melted with a relatively large quantity of boron-glass, lead-glass, or boron-lead-glass. The glass also lessens the injurious action of any chlorides or sulphates present. Two satisfactory mixtures are: (a) 10 parts of sand, 8 of felspar, 25 of ruby glass, 15 of borate of lime, 1 of saltpetre, 4 of soda, and 2 of fluorspar; (b) (for white enamel) 35 parts of glass, 25 of felspar, 15 of clay, 12 of borate of lime, 12 of sodium fluosilicate, 12 of soda, and 2 of saltpetre. Calcium compounds (other than borate) should be replaced by corresponding compounds of other metals. —A. B. S.

Refractory materials; Preventing disintegration of — M. Barrett, and The Leeds Fireclay Co., Leeds. Eng. Pat. 103,953, Aug. 18, 1916. (Appl. No. 11,751 of 1916.)

Blocks intended for use in coke-ovens, gas retorts, and the like, immediately they are made and whilst of a leather-like consistency, are polished on the surfaces to be treated, by soft leather, etc. They are then dried, and submitted, whilst in an incandescent state, to the hot vapour of an alkali chloride, such as sodium chloride, for about 30 mins. The parts not requiring protection may be coated with a wash of barium sulphate if desired or placed in close contact with each other. —J. E. C.

Centrifugal machines and the like. Eng. Pat. 102,107. See 1.

IX.—BUILDING MATERIALS.

Timber; Preservation of — from boring organisms. Engineering, 1917, 103, 171.

RESULTS are given of tests made in Australia on the Carbo-Teredo process for the preservation of timber from marine and land boring organisms (see Eng. Pat. 781 of 1915; this J., 1915, 1056). The timber is impregnated with a hydrocarbon and the surface is then charred by means of a high-pressure gas flame. If the continuity of this charred surface is broken in subsequent working, it must be restored by a further treatment before submerging. This treatment was very effective against *Sphaeroma gigantea* and other borers prevalent in Australian harbour works, and, on land, against the attack of white ants. —H. J. H.

Silica bricks and some new uses for them. Gray. See VIII.

Manufacture of polish (and cement) from felspar. See XVI.

PATENT.

Artificial stone slabs; Manufacture of — E. Iner-Schneider, Geneva, Switzerland. Eng. Pat. 101,151, Feb. 5, 1917. (Appl. No. 1824 of 1917.) Under Int. Conv., Feb. 16, 1916.

See Ger. Pat. 295,268 of 1916; this J., 1917, 219.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY

Committee on light alloys.

THE Advisory Committee for Aeronautics, Teddington, have appointed a light alloys sub-committee with a view to the co-ordination of the work which is now being done in connection with the use of light alloys in the construction of aircraft and aircraft engines. The functions of this sub-committee will be to advise Government departments on questions relating to light alloys, to institute research for the development and improvement of such alloys, and of the methods of working, and to assist in the removal of difficulties which may arise in practice in their production and use. The sub-committee will be in close touch with the experimental work on light alloys, and hope to be able to give advice and assistance to manufacturers undertaking the production of light alloys, and to founders engaged in the manufacture of engine parts, cylinders, pistons, crank cases, etc. They trust to have the co-operation of firms who have undertaken such work, and will be glad to receive suggestions and to give any help that may be possible in answer to inquiries. The members of the Committee are: Mr. Henry Fowler, Lieut.-Comm. C. F. Jenkin, R.N.V.R., Prof. F. C. Lea, Capt. H. P. Philpot, Mr. A. W. Johns, and Dr. W. Rosenhain, together with the Chairman of the Advisory Committee for Aeronautics, *ex officio*.

Basic lining; Reinforced — for Martin furnaces. H. Godfroid. Rev. Mét., 1916, 13, 359—360.

MAGNESITE or dolomite (100 parts) is well mixed with hot tar (15 parts) and steel turnings (23 parts). The mixture is applied in 4 in. layers which are compressed by means of red-hot tools; or a layer of the mixture of tar and refractory material (2—3 in.) may be made to alternate with a layer of one-fifth of its weight of steel turnings. —W. R. S.

Steel; Effect of annealing on overheated — S. Smolensky. Rev. Soc. russe Mét., 1916, 1, 31—37. Rev. Mét., 1916, 13, Extraits, 211—212.

THE effect of overheating steel is the more pronounced the higher the carbon and manganese content. Heating to 900° C. and allowing to cool in the furnace does not materially improve the structure of overheated steel. By keeping the articles at a temperature of 1000° C., cooling them slowly, and subjecting them to a second annealing process, a uniform structure and greatly improved mechanical properties are obtained. —W. R. S.

Carbon steels; Temperature of the reversible A1 transformation in — K. Honda. Sci. Reports, Tôhoku Imp. Univ., 1916, 5, 285—295.

TWELVE carbon steels, containing C 0.14—1.50, Si 0.05—0.31, Mn 0.30—0.67, P 0.01—0.051, S 0.014—0.044, Cu 0.05—0.13%, and one specially pure low-carbon steel containing C 0.29, Si 0.05, Mn 0.01, P 0.011, S 0.003%, were heated and cooled at normal and extremely slow rates, and the A1 transformation investigated magnetically. In every case the magnetic transformation of cementite was observed, the critical temperature being about 210° C.; the author proposes to designate this the A0 point. It is concluded that,

however slowly the heating and cooling processes are conducted, the A1 transformation cannot take place reversibly except in carbon steel free from impurities. For pure carbon steel the critical temperature is $727^{\circ}\text{C}.$ and the transformation is reversible, or nearly so, when the rate of heating is extremely slow. With impure carbon steel, whatever the rate of heating and cooling, the A1 point is much lower than the Acl point, the difference depending on the quantity of impurities, other than carbon, in the metal. The A1 point is independent of the maximum temperature previously attained by heating.—W. E. F. P.

Carbon in iron alloys; Rapid determination of —. S. Zinberg. Rev. Soc. russe Met., 1915, 1., 710—712. Rev. Mét., 1916, 13, Extraits, 193-194.

THE powdered alloy is heated with sodium peroxide in a test-tube, the bottom of which is covered with a thin layer of magnesia, until the mixture becomes incandescent and fuses. After cooling, the tube is dropped into 160 c.c. of sulphuric acid (sp.gr. 1.5), with or without 3 c.c. of chromic acid, and the assay finished according to Wiborg's method (this J., 1887, 748). A determination may be made in half an hour. The following mixtures are recommended: ferrochrome 0.2, peroxide 1.2, and magnesia 0.2 grm.; ferrotungsten 0.5, peroxide 1.2, and magnesia 0.1 grm.; ferromolybdenum 0.3, and peroxide 1.2 grm. A blank test must be made for each series of assays.—W. R. S.

Tin ores; Method for assaying —. G. M. Henderson. Eng. and Min. J., 1917, 103, 267. INSTEAD of using nickel crucibles, the fusion of tin ores with sodium peroxide may be carried out in small scorifiers in a muffle, with satisfactory results. The scorifier should not be left in the muffle too long after the mass is liquefied, or an incrustation will be formed which is insoluble in hydrochloric acid.—W. R. S.

Silica bricks and some new uses for them. Gray. See VII.

PATENTS.

Steel furnace; Electrically heated —. *Electric steel furnace.* J. L. Dixon, Detroit, Mich. U.S. Pats. (A) 1,214,763 and (B) 1,214,764, Feb. 6, 1917. Date of appl., Oct. 14, 1916.

(A) THE furnace is supplied with current from a two-phase transformer having two primary windings, and a pair of secondary windings for each primary, the secondary windings being interconnected so as to produce a delta connection expressed by a rectangular vector diagram. Four electrodes are arranged over a crucible, two of which are connected respectively with the right and left terminals of the left-hand member of one of the pairs of secondary windings, while the other two electrodes are similarly connected with the right-hand winding of the same pair. (B) The crucible, which forms no part of the circuit, is provided with two pairs of arcing electrodes, each pair being supplied with current from a primary and secondary of a two-phase transformer. The neutral points of the two secondaries are connected, and independent controlling devices of the ammeter type are connected in the respective leads to the electrodes.—B. N.

Ferrous metals [steel]; Process for deoxidising and refining —. E. H. Schwartz, Chicago, Ill. U.S. Pat. 1,215,065, Feb. 6, 1917. Date of appl., Jan. 6, 1916.

A DEOXIDISED and refined steel of relatively high carbon content is obtained by mixing carbon-steel scrap with spiegeleisen, and pig iron of high silicon content, adding limestone, and melting the charge in presence of carbonaceous material.—J. N. P.

Iron ores; Process of treating —. E. F. Goltra. St. Louis, Mo. U.S. Pat. 1,216,109, Feb. 13, 1917. Date of appl., Apr. 26, 1910.

IRON ore having a clayey gangue is calcined and tumbled in an inclined, rotary cylinder to expel moisture, etc., and loosen the gangue. The calcined material is then subjected to a strong blast by which the lighter particles are carried away; and the residual concentrate is smelted as usual.—W. E. F. P.

Precious metal alloy. W. J. Mellersh-Jackson. London. From G. H. Whiteley, jun., York, Pa., U.S.A. Eng. Pat. 101,025, Feb. 18, 1916. (Appl. No. 2459 of 1916.)

As substitutes for platinum and the platinum alloys employed hitherto for dental purposes, claim is made for alloys (of the general composition Pt 15—20, Pd 30—35, Au 45—55%) containing much less platinum than palladium or gold but sufficient for the melting point to be above that of gold or porcelain as required.

—W. E. F. P.

Aluminium or its light alloys; Method of protecting — *from corrosion by sea water and other liquids.* R. Seligman and P. Williams. London. Eng. Pat. 101,128, Sept. 28, 1916. (Appl. No. 13,831 of 1916.)

STRIPS or plates of an aluminium alloy (e.g., Al-Zn), which is electropositive to the metal or alloy to be protected, are placed in electrical contact with the latter.—W. E. F. P.

Aluminium, its alloys, and other lighter metals; Apparatus for and process of die-casting pure —. F. H. Borst, Artesian, S.D. U.S. Pat. 1,215,243, Feb. 6, 1917. Date of appl., June 22, 1916.

A BAR mounted so that it can be rotated, and having a stop at each end, carries on opposite sides a slide and a counterweight adapted to move outwards against the respective stops. Attached to the slide is a die with a crucible adjacent to its inner end. By the rotation of the bar, molten metal from the crucible is delivered by centrifugal force into the die, the air from the latter being discharged in a direction opposite to that of the flow of metal.—W. E. F. P.

Sulphur dioxide from metallurgical smoke and similar gases; Method of removing —. F. A. Eustis, Milton, Mass. U.S. Pat. 1,212,139, Jan. 16, 1917. Date of appl., May 14, 1915.

THE gases are caused to pass upwards through an absorption tower against a descending stream of water. By means of horizontal, perforated partitions, the tower is divided into superposed compartments, of which the lowest is empty, the next two nearly filled with broken coke, and the remainder charged with crushed dolomite. The quantity of water used is sufficient for physical solution of the sulphur dioxide.—W. E. F. P.

Sintering apparatus. F. A. Eustis, Milton, Mass. U.S. Pat. 1,212,333, Jan. 16, 1917. Date of appl., Aug. 18, 1915.

A SINTERING pan has a hinged cover to which an air-delivery pipe is attached; and the latter is connected with an air-supply pipe by means of a swivel joint. The space below the grate of the pan communicates with a stack, the arrangement being such that, when the pan is closed by the cover, air under pressure is caused to pass downwards through the charge on the grate.

—W. E. F. P.

Nickel ores: Treatment of —. F. A. Eustis, Milton, Mass., U.S. Pat. 1,212,331, Jan. 16, 1917. Date of appl. Aug. 21, 1915.

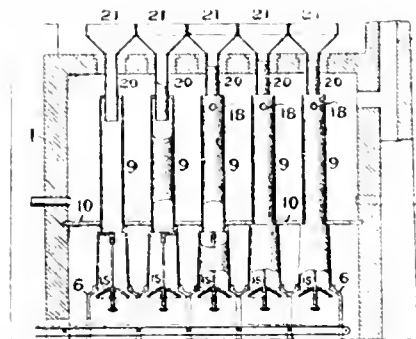
Oxidised nickel ore containing iron and alumina, is mixed with a small proportion of pyrites, and roasted at 400–500° C., whereby the nickel and alumina are converted largely into soluble sulphates, while the iron is not appreciably affected. —W. E. F. P.

Puddling furnace. E. L. Ford, Youngstown, Ohio, U.S. Pat. 1,212,929, Jan. 16, 1917. Date of appl. Sept. 22, 1915.

A CUP-SHAPED puddling furnace mounted so that it can be rotated and tipped on different axes, has its open end closed by a cover which is removed when the finished puddle ball is to be taken out of the furnace. Gaseous fuel is supplied to the interior of the furnace through a pipe, which projects into a hole formed in the centre of the cover, and the waste gases escape through the annular space between the pipe and the cover. —W. H. C.

Retort apparatus [for metals]. E. Fink, Milwaukee, Wis., Assignor to H. W. Seaman, Clinton, Iowa, U.S. Pats. (A) 1,213,316, and (B) 1,213,317, Jan. 23, 1917. Dates of appl. May 9, 1914, and June 10, 1915.

(A) A NUMBER of long, high, and narrow retorts are arranged in a combustion chamber so that



flues are formed between them. Each retort is provided with a vertical feed pipe at the top into which material is fed through a horizontal pipe by a conveyor, so that the retort is sealed from the air, and metallic vapour issuing from the retort is condensed. Vapour from the retort passes through a reduction chamber at one end and thence by a pipe to a condenser placed in a chamber adjacent to the combustion chamber and communicating with it, so that the condenser is heated by combustion products. (B) A series of retorts, 9, are supported on a partition, 10, in a combustion chamber, 1, and a zone of high temperature is maintained just above the partition. Material is fed from the hoppers, 21, through preheating tubes, 20, projecting into the top of each retort so as to leave a space free of material from which vapour is fed by a pipe, 18, to a condenser. The retorts are supported on members, 6, open at the bottom, and the material is retained by supports, 15, through each of which an agitator projects into the retort for breaking up crusts of material. —W. E. F. P.

Manganese: Method of improving the alloying qualities of — with brass and bronze. H. Goldschmidt and O. Weil, Essen, Germany, Assignors to Goldschmidt Thermite Co., New York, U.S. Pat. 1,211,539, Feb. 6, 1917. Date of appl. Dec. 5, 1914.

MANGANESE or ferromanganese is first alloyed with phosphorus and copper, and then added to the metal bath containing the other ingredients. —J. N. P.

Castings: Process of making tight —. R. B. Wolf, Berlin, N.H., U.S. Pat. 1,214,630, Feb. 6, 1917. Date of appl. Mar. 1, 1914.

THE casting is cleaned by treatment with a suitable acid, and a salt is then added which precipitates an insoluble sulphate or other compound in the pores and interstices. During the treatment the metal is subjected alternately to a vacuum and to pressure. —J. N. P.

Magnetic or inductive separation of substances. S. W. Osgood, Chicago, U.S. Pat. 1,214,817, Feb. 6, 1917. Date of appl. Sept. 18, 1914. Renewed June 30, 1916.

THE material is fed through a hopper on to an endless belt which travels horizontally around two supporting wheels. A direct-current electromagnet is suspended above the centre of the belt, in close proximity to the material. The magnet consists of a coil wound round a drum which is placed parallel to the belt. The ends of the drum are provided with extended circular flanges, to the lower ends of which are fixed flat metal plates serving as pole pieces. A shield of non-magnetic metal is interposed to prevent actual contact of particles with the poles. The magnetic field is applied intermittently by means of a revolving armature. Any magnetic substance in the material under treatment is thus raised from the main channel and deposited in an adjacent layer on the belt. —J. N. P.

Furnace: Electric — for fusing metals. Electric zinc distilling furnace and condenser for producing blue powder. J. Thomson, New York, Assignor to John Thomson Press Co., Jersey City, N.J., U.S. Pats. (A) 1,214,811 and (B) 1,214,812, Feb. 6, 1917. Date of appl. Jan. 28, 1916.

(A) THE sides and ends of the furnace are lined with refractory material, and a radiating carbon resistor is suspended in the chamber beneath a melting tank open at the top. The edges of the melting tank rest on the chamber walls, thus closing the chamber, and leaving a space between the tank and the walls, so that the tank is exposed to the heat emitted by the radiator and that reflected by the walls. The furnace is mounted on a rocker, and the tank is provided with a spout for pouring the metal. (B) The furnace is heated by a radiating resistor suspended above the bath, and the fumes pass through channels formed by two septum plates above, viz., through ports on the outside of the lower plate and a central port in the upper one, thus directing the fumes against the roof. The radiation of heat from the latter may be controlled, whereby the temperature of the hot fume is reduced before the gases enter the condenser. —J. N. P.

Zinc-bearing materials: Method of treating — and apparatus therefor. C. A. H. de Saulles, New York, U.S. Pats. (A) 1,215,006 and (B) 1,215,007, Feb. 6, 1917. Date of appl. June 19 and 28, 1915.

(A) MOLTEN zinc-bearing material is fed continuously into a retort heated to about 1350° C., part of the resulting zinc vapour being condensed to liquid metal and the remainder caused to expand rapidly at a relatively low temperature to form "blue powder." (B) The apparatus consists of a cylindrical retort, mounted in a furnace and sloping downwards towards the feed end, which is provided with an external charging funnel. The outlet of the retort communicates with a short, horizontal condenser (for the liquid metal) and the latter with a relatively large vertical pipe or chamber in which the blue powder is deposited. —W. E. F. P.

Reducing and metallising ores: Apparatus for —, H. N. Tracy, Los Angeles, Cal. U.S. Pat. 1,214,844, Feb. 6, 1917. Date of appl. Oct. 12, 1915.

A RESERVOIR for liquid metal is composed of a horizontal portion and a vertical arm at each end; a high vertical ore-reducing stack forms a continuation of one of the arms, whilst the other is provided with a means for discharging the spent ore. The horizontal portion is provided with a spiral conveyor, and the reservoir is adapted to hold liquid metal to a level above the horizontal part, so that the weight of the charge will force the ore beneath the level of the molten metal as it enters the horizontal portion.—B. N.

Brazing material. T. S. Fuller, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pat. 1,215,138, Feb. 6, 1917. Date of appl. Jan. 29, 1915.

COPPER parts are united by an intervening metallic film of a malleable tenacious alloy, containing 57 to 65 parts of silver, about 38 to 29 parts of cadmium, and some copper, the alloy having a melting point about 750° C.—B. N.

Metallic alloys [ferro-nickel]: Process of producing —, M. A. Robert, York, Pa. U.S. Pat. 1,215,857, Feb. 13, 1917. Date of appl. Apr. 8, 1914. Renewed May 23, 1916.

CALCIUM fluoride is melted in an electric furnace and electrolysed in the presence of nickel-bearing iron ore or a nickel compound and metallic iron.—W. E. F. P.

Metals and other materials: Method of treating — by heat. J. H. L. de Bats, Assignor to A. G. Zehner, Zehlendorf, and T. de Wolf, Pittsburgh, Pa. U.S. Pat. 1,216,086, Feb. 13, 1917. Date of appl. Mar. 19, 1914. Renewed July 11, 1916.

THE material is heated in a crucible or in direct contact with solid fuel in a closed chamber from which the gaseous products are withdrawn by suction while a limited quantity of air is admitted to the lower part of the fuel bed. The interior of the chamber is thus maintained under reduced pressure and the heat confined to the zone containing the material under treatment.—W. E. F. P.

[Crucible] furnace apparatus. W. W. Doolittle, Assignor to Crane Co., Chicago, Ill. U.S. Pat. 1,216,090, Feb. 13, 1917. Date of appl. Mar. 31, 1914.

IN a gas-fired crucible furnace, each crucible is contained in a separate heating chamber consisting of a lower section, which can be tilted, and above which the top of the crucible projects, and a removable upper section or cover. The lower section has an inclined pouring face opposite the crucible lip, and is adapted to seat a coping member by which the crucible is maintained in position, and the pouring facilitated, when the section is tilted.—W. E. F. P.

Electric furnace. H. de Nolly, St. Chamond, Assignor to Soc. Electro-Métallurgique de St. Bérón, Lyon, France. U.S. Pat. 1,216,961, Feb. 20, 1917. Date of appl. Jan. 31, 1914.

SEE Fr. Pat. 466,116 of 1913; this J., 1914, 599.

Apparatus for extracting values from bodies. U.S. Pat. 1,215,182. See 1.

Filtering medium for cleaning furnace-gases. U.S. Pat. 1,215,385. See 1.

XI.—ELECTRO-CHEMISTRY.

Silver voltmeter: Volume effect in the —, E. B. Rosa and G. W. Vinal. Bull. U.S. Bureau of Standards, 1916, 13, 447—457.

THE volume effect, consisting of the deposition of an excess weight in the large size voltmeters, in

the cases of the porous cup, Kohlrausch, siphon, and filter-paper forms, has been shown to be due to the presence of impurities in the electrolyte. Using the same cathodes, anodes, and porous cups, the volume effect may be made to appear and disappear according as the electrolyte is contaminated or not. Very high results have been obtained by contaminating the solutions with impurities, such as colloids. With the same cathode and solution, the volume effect may be increased by increasing the volume of electrolyte, i.e., increasing the amount of colloid present, as in the case of the siphon voltmeter.—B. N.

PATENTS.

Oxygen and hydrogen gases: Apparatus for the [electrolytic] production of —, W. Jones, New York. U.S. Pat. 1,212,229, Jan. 16, 1917. Date of appl. Oct. 16, 1913.

THE apparatus is provided with a number of electrodes, and a diaphragm between adjoining electrodes forming chambers for the separation of the evolved gases, with gas ducts leading from them and separate conduits connected with the gas ducts. The electrolyte is conveyed to the several chambers by supply ducts connected to a supply conduit, the various conduits being located beyond the electrodes, and so arranged as to be outside the path of the electric current through the apparatus.—B. N.

Electrolytic apparatus. W. E. Greenawalt, Denver, Colo. U.S. Pat. 1,211,775, Feb. 6, 1917. Date of appl. Aug. 18, 1913.

THE apparatus is provided with an electrode cell, the sides of which are formed from top and bottom pieces bolted together with a diaphragm between them, and the bolts in the bottom piece are protected from the corrosive action of the electrolyte. Means are provided in the bottom piece for the escape of the gases from the under side of the diaphragm. The cell contains a perforated electrode, with a hood over it, and with a liquid seal between the electrode and the hood. The perforated electrode on its outside edge is provided with a flange projecting in a downward direction, to collect the gases on the under side of the electrode and direct them through the perforations into the hood.—B. N.

Electrolytic gas-generator. I. H. Levin, New York. U.S. Pat. 1,211,934, Feb. 6, 1917. Date of appl. Dec. 20, 1915.

A CLOSED receptacle is formed from two similar dished casing members, the edges of which are placed adjacent to each other, and a partition is located in the upper portion of the receptacle, whereby the interior is divided into two gas chambers. A diaphragm projects downwards from the partition, with one electrode on each side. The receptacle is provided with means for filling and for conveying the gases from the gas chambers.—B. N.

Storage battery. W. Gardiner, Chicago, Ill. U.S. Pat. 1,213,182, Jan. 23, 1917. Date of appl. May 22, 1915.

THE electrolyte, of the consistency of jelly, is composed of sulphuric acid (sp. gr. 1.30) mixed with a "solution" of a half-pint of water, 2 oz. of sodium silicate, and 1 to 8 oz. of infusorial earth. This is covered with porous material and then with absorbent material.—B. N.

Impregnated [electrical] coil and method of making the same. L. H. Bakeland, Yonkers, N.Y., Assignor to General Bakelite Co., New York. U.S. Pat. 1,213,726, Jan. 23, 1917. Date of appl. Dec. 1, 1907.

THE windings of the coil are spaced apart, and are

provided with a fibrous covering, the interstices between the windings being filled, and the fibrous covering simultaneously impregnated, with a fluid and mobile phenolic condensation product, combined with a substance capable of increasing the flexibility of the final product. The product is transformed, whilst in position, into a solid, homogeneous, impervious, insoluble, and infusible body, serving both as a support and as an insulator for the windings.—B. N.

Method of liriciation of vegetable, animal, or mineral substances. Ger. Pat. 291,667. See I.

[Electrolytic] oxidation of cresols. Eng. Pat. 103,739. See III.

[Electrolytic] process of making cyanogen compounds. U.S. Pat. 1,214,770. See VII.

Process of producing articles of quartz glass. U.S. Pats. 1,215,132 and 1,215,133. See VIII.

Process of obtaining a hard fully-burnt, high-grade coke as by-product in the manufacture of lamp-black. Ger. Pat. 291,701. See XIII.

XII.—FATS; OILS; WAXES.

Lumbang and perilla oils. H. A. Gardner. Oil, Paint, and Drug Rep., Feb. 5, 1917, 91, 55.

Lumbang oil is obtained from the fruit kernels of *Alcurites moluccana*, which is indigenous to Polynesia and is now cultivated in many parts of Asia and in tropical islands. The oil is almost colourless and has a purgative action. It closely resembles tung oil in its characters, but has not the polymerising property of the latter. The pressed cake is prized by the natives as a fertiliser. A sample of the nuts contained 32.1% of kernels which on expression yielded 60.3% of oil with the following characters:—Sp. gr. 0.927; acid value, 1.3; saponif. value, 192.3; iodine value, 162.0; and refractive index, 1.475. The press-cake when freed from oil by extraction with petroleum spirit, and dried, had the following composition:—Nitrogen, 7.34; phosphoric acid (P_2O_5), 3.95; sodium oxide, 0.47; and potassium oxide, 1.42%. *Perilla oil*:—A sample of perilla seed from Yokohama yielded 33.73% of oil with the following characters:—Sp. gr. 0.937; acid value, 4.3; saponif. value, 193.4; iodine value, 193.3; and refractive index, 1.4870. The press-cake had the following composition after extraction of the residual oil:—Nitrogen, 5.28; phosphoric acid (P_2O_5), 2.58; sodium oxide, 0.56; and potassium oxide, 1.50%.—C. A. M.

Spinacene: a new hydrocarbon from certain fish liver oils. A. C. Chapman. Chem. Soc. Trans., 1917, 141, 56—69.

AS oil obtained from the livers of *Centrophorus granulosus* and *Seymouria licha*, both belonging to the *Spinacidae* or sharks, which are caught off the Moroccan coast, had the following characters:—Sp. gr. at 15°/15° C., 0.8666; saponification value, 22.5; iodine value (Wijs), 358; unsapon. matter, 89.1%; iodine value of unsapon. matter, 376.2; free fatty acid (as oleic acid), 0.12%; and bromine precipitate insoluble in ether, 76.5%. The unsaponifiable matter when distilled under a pressure of 10 mm. yielded a small amount of cholesterol, whilst the main fraction, distilling between 268° and 269° C., was a colourless mobile oil, with a faint odour suggestive of limonene (see also Mastbaum, this J., 1916, 316). It boiled at 280° C. under a pressure of 17 mm., and its elementary composition corresponded with the formula, $C_{30}H_{50}$. On the other hand, the depression of the freezing point gave a molecular

weight agreeing more closely with the formula $C_{27}H_{44}$ or $C_{28}H_{44}$. It was optically inactive, did not solidify at -20° C., had a sp. gr. of 0.8611 at 15°/15° C., and a refractive index, $n_D^{20} = 1.4987$. When exposed in a flat dish for two months to an atmosphere of oxygen it absorbed 23.8% of oxygen and became very viscid. Thin films of the hydrocarbon exposed to the air yielded hard skins similar to that given by linseed oil. Dry hydrogen chloride when passed into an ethereal solution of "spinacene" yielded a crystalline hexahydrochloride, $C_{30}H_{50}.6HCl$, beginning to melt at 110° C. and decomposing at 110° C. with the liberation of hydrogen chloride. After separation of the hexahydrochloride, a pale yellow viscous trihydrochloride, $C_{30}H_{50}.3HCl$, could be obtained from the filtrate. Bromine not only saturated the double bonds of the hydrocarbon, but also formed substitution derivatives. A dodecylbromide, $C_{30}H_{50}Br_{12}$ was obtained as a white crystalline product. Trinitroso- and hexanitrosochlorides were also prepared. Hydrogenation of spinacene, with platinum black as catalyst, reduced the iodine value to 18, and a hydrocarbon, $C_{30}H_{62}$, boiling at 271° to 275° C. (18 mm.) was obtained. This was a colourless odourless oil not solidifying at -20° C., and having a sp. gr. of 0.8172 at 20°/20° C. The unsaturated hydrocarbon "sequene" separated by Tsujimoto (this J., 1916, 609, 1121) from the livers of certain Japanese sharks, closely resembles spinacene and may be identical therewith.—C. A. M.

Soaps; Specifications for and methods of testing—. Circular No. 62, Dec. 16, 1916. Bureau of Standards, Dept. of Commerce, U.S.A., 1—25.

1. *Milled soaps.* The following are suggested as the maximum permissible limits:—Matter volatile at 105° C., 15% (in case of excess, deliveries to be rejected); free alkali as NaOH, 0.1%; alkali as alkaline salts (as Na_2CO_3), 0.3%, of which not more than half shall consist of sodium silicate; sulphate as Na_2SO_4 , 0.4%; chloride as NaCl, 0.3%; substances insoluble in water, 0.1%; unsaponified saponifiable matter, 0.1%. No rosin, sugar, or foreign matter is to be present. The mixed fatty acids must solidify (titertest) not below 37° C., and have a neutralisation value falling within the limits 203 and 212. Apart from moisture, the constituents are to be calculated on the basis of material containing 10% of volatile matter. A deduction of 2% from the weight of the soap delivered shall be made for each 1% of volatile matter in excess of 10%. 2. *White floating soap.* Matter volatile at 105° C., 34% (in case of excess, deliveries to be rejected); free alkali as NaOH, 0.1%; alkali as alkaline salts (as Na_2CO_3), 0.5%; chloride as NaCl, 1%; substances insoluble in water, 0.1%; no rosin, sugar, or foreign matter shall be present. The mixed fatty acids shall melt at not less than 35° C., and have a neutralisation value of not less than 212. The odour and character of the cake shall be as specified. Constituents other than moisture are to be calculated on the basis of material containing 28% of volatile matter, and a deduction of 2% from the weight of the soap to be paid for shall be made for each 1% of volatile matter in excess of 28%. 3. *Liquid soap.* This should consist of a clear solution of pure vegetable oil-potash (or potash and soda) soap, with or without alcohol or glycerol, suitably perfumed, and free from foreign matter. It must be free from objectionable odour, other than that of coconut oil, must lather readily, and contain not less than 20% of soap. Free alkali, as KOH, must not exceed 0.05%; alkali as alkaline salts (as K_2CO_3), 0.3%; chloride as KCl, 0.3%, whilst no sugar or sulphates must be present. 4. *Salt-water soap.* This must have been made exclusively from pure coconut oil, without removal

of glycerol. It should dissolve completely in both sea water and fresh water, lather well, and be free from filling materials. Matter volatile at 105° C. shall not exceed 55% (in case of excess, deliveries to be rejected); free alkali as NaOH, 0.5%; alkali as alkaline salts (as Na_2CO_3), not less than 2 nor more than 3%, of which not more than a quarter shall be sodium silicate; chloride as NaCl, not less than 2.5 nor more than 3.5%; mineral matter including sodium sulphate, substances insoluble in water, etc., 0.5%. No rosin, sugar, or foreign matter shall be present. The mixed fatty acids separated from the soap must have a neutralisation value of not less than 256. All non-volatile constituents are to be calculated on the basis of material containing 55% of volatile matter. In calculating the weight of soap to be paid for, $\frac{1}{2}$ lb. of matter not volatile at 105° C. shall be considered 1 lb. of soap. 5. *Special grade laundry soap.* This is intended to be used with soft water for cleaning and laundry purposes, where the presence of sodium silicate or carbonate may be objectionable. It should contain not more than 20% of water. Matter volatile at 105° C. must not exceed 34%; free alkali as NaOH, 0.2%; alkali as alkaline salts (as Na_2CO_3), 1%; chloride and sulphate, together, 1%; substances insoluble in water, 0.1%; and rosin, 15%. The mixed fatty and rosin acids shall solidify at not less than 35° C. Substances other than volatile matter are calculated on the basis of 28% of volatile matter. In calculating the weight to be paid for, $\frac{3}{8}$ lb. of matter not volatile at 105° C. shall be considered 1 lb. of soap, a deduction of 2% from the weight of the soap being made for each 1% of volatile matter in excess of 28% up to the limit of 34%. 6. *Ordinary grade laundry soap.* This soap is intended for use with moderately hard waters where there is no objection to the presence of rosin or sodium carbonate. It should contain not more than 20% of water. Matter volatile at 105° C. must not exceed 31%; free alkali as NaOH, 0.5%; alkali as alkaline salts (as Na_2CO_3), not less than 2%, nor more than 6%, and not more than half shall consist of sodium silicate; chloride as NaCl, 1%; sulphate as Na_2SO_4 , 1%; substances insoluble in water, 0.5%; rosin, 25%. The mixed fatty and rosin acids shall solidify at not less than 33° C. Constituents other than volatile matter are to be calculated on the basis of 28% of volatile matter. The weight of soap to be paid for is calculated in the same way as in the case of No. 5. 7. *Chip soap.* This must be suitable for use with soft water for high-grade laundry work. Matter volatile at 105° C. must not exceed 15%; free alkali as NaOH, 0.5%; alkali as alkaline salts (as Na_2CO_3), 0.5%; chloride as NaCl, 0.5%; and substances insoluble in water, 0.1%. Constituents other than volatile matter are to be calculated on the basis of material containing 10% of volatile matter. In calculating the weight, 9/10 lb. of matter not volatile at 105° C. shall be considered 1 lb. of soap, a deduction of 2% from the weight of soap being made for each 1% of volatile matter in excess of 10%, up to the limit of 15%. *Sampling deliveries.*—(a) *Cake soap.* One cake, weighing not less than 1 lb., is to be taken at random from each 1000 cakes. If the cake weighs less than 1 lb. additional cakes (not less than 3) to make up a sample of not less than 1 lb. shall be taken. The samples shall be placed in an air-tight container. (b) *Liquid soap.* After thorough admixture a sample of 1 qt. for each 100 galls. shall be taken and placed in a dry quart glass bottle. (c) *Chip soap.* Not less than 1 lb. shall be taken at random from each 1000 lb. or less of a shipment. This shall be placed in a dry air-tight container, which it must fill completely. *Preparation of laboratory sample.*—*Cake soap.* After reserving two cakes of medium weight in their air-

tight containers, a cake also of medium weight is divided diagonally and thin layers are cut from the fresh surfaces in such a way as to get a fair proportion of the inner and outer portions. *Liquid soap.* In cold weather the sample should be allowed to stand for at least 1 hour at 20° to 30° C., before taking samples for analysis. *Chip soaps.* The sample should be rapidly mixed before weighing the portions for analysis. *Methods of analysis.*—(a) *Matter volatile at 105° C.* Two grms. is spread evenly over the bottom of a porcelain dish 3 in. in diameter. After drying for 1 hour at 60° C., 50 c.c. of absolute alcohol is added, the liquid evaporated, and the residue dried for 1 hour at 60° C. and then for 2 hours at 105° C. (b) *Free alkali or acid (method for all except liquid soaps).* 5 grms. is dissolved in about 200 c.c. of freshly-boiled neutral 95% alcohol, with the aid of heat, the solution filtered through a weighed Gooch crucible, and any insoluble matter washed with hot freshly-boiled neutral alcohol. The filtrate and washings are cooled, and titrated with standard acid or alkali, with phenolphthalein as indicator. Free alkali is calculated as sodium hydroxide and free acid as oleic acid. (c) *Free alkali or acid (method for liquid soaps).* 10 grms. of the sample is dissolved in about 200 c.c. of freshly-boiled neutral absolute alcohol, the solution filtered, and the insoluble matter washed with freshly-boiled neutral alcohol. The filtrate and washings are titrated as described, free alkali being calculated as potassium hydroxide and free acid as oleic acid. (d) *Alkali as alkaline salts.* The residue insoluble in alcohol from (b) or (c) is extracted with hot water, and the solution is titrated with standard acid (HCl), with methyl orange as indicator. The result, which is calculated into sodium carbonate, includes carbonates, borates, and silicates. (e) *Silicate.* The solution which has been titrated for (d) is evaporated to dryness with excess of hydrochloric acid, and the silicate determined in the usual way, and calculated into the equivalent sodium carbonate. (f) *Sulphate.* The filtrate from (c) is treated with barium chloride. The barium sulphate is calculated into sodium sulphate except in the case of liquid soaps in which it is calculated into potassium sulphate. (g) *Substances insoluble in water.* The Gooch crucible containing the insoluble matter in (d) is dried for 2 hours at 105° C. and weighed. (h) *Unsaponified saponifiable matter.* 5 grms. of soap is dissolved in about 100 c.c. of 50% alcohol, any free fatty acids present being neutralised with standard alkali, and washed into a separating funnel with 50% alcohol. The solution is extracted with 100 c.c. of ether, the ethereal extract washed with water, and the unsaponified matter weighed. It is then boiled for an hour beneath a reflux condenser with 25 c.c. of alcoholic potassium or sodium hydroxide solution, the liquid evaporated to dryness, and the residue dissolved in water, and shaken with ether. The ether is washed free from alkali, and evaporated, and the residue of unsaponifiable matter dried and weighed. This is deducted from the unsaponified matter, and to the difference is added the amount of free fatty acids previously determined, the result giving the total unsaponified saponifiable matter. (i) *Preparation of total fatty acids (method for milled-toilet, white floating, or salt-water soaps).* 50 grms. of the soap is dissolved in 300 c.c. of hot water, and the solution transferred to a separating funnel, treated with 150 c.c. of about 2 N-sulphuric acid, and, after cooling, shaken with 120 c.c. of ether. The ethereal layer is washed until free from acid, with a strong solution of sodium chloride, and transferred to a flask, shaken with 20 to 30 grms. of anhydrous sodium sulphate, and allowed to stand until clear. It is then filtered and evaporated by means of a current of dry air at a temperature not exceeding 50° C. (j) *Fatty and rosin acids (method for*

laundry or chip soaps). About 50 grms. is dissolved in 500 c.c. of hot water, and the solution treated with 100 c.c. of 30% sulphuric acid and heated until a clear layer of fatty matter is obtained. This is washed with hot water, filtered through a hot-water funnel, and dried for 20 mins. at 100° C. (*b*) *Solidification point of fatty acids (ther test)*. About 25 c.c. of the fatty acids cooled to about 50° C., is introduced into a glass tube about 1 mm. thick, 25 mm. in diam., and 100 mm. in length. This is fitted by means of a cork into a bottle about 70 mm. in diam. and 150 mm. in height, and the fatty acids are slowly stirred with a thermometer until the mercury remains stationary for 30 secs., when the thermometer is suspended with its bulb in the centre of the mass, and the point to which the mercury rises is noted. (*c*) *Neutralisation value of fatty acids*. From 2 to 5 grms. of the fatty acids is heated with 50 c.c. of neutral alcohol (free from carbon dioxide), and the solution is titrated with standard alcoholic alkali, with phenolphthalein as indicator. (*m*) *Total alkali (method for all except liquid soaps)*. 5 grms. is dissolved in 100 to 150 c.c. of hot water, 40 c.c. of N/2 sulphuric acid added, and the mixture heated on the water bath until a clear layer of fatty acids is obtained. The beaker is cooled in cold water, the aqueous layer filtered, and the beaker, fatty acids, and filter washed with water. The united filtrate and washings are titrated with N/5 potassium hydroxide solution with methyl orange as indicator. The total alkali is calculated as sodium oxide. (*n*) *Total alkali (method for liquid soaps)*. The acid aqueous liquids obtained in the determination of total soap are heated to remove ether, and the excess of acid titrated as in (*m*). The result is calculated as potassium oxide. (*o*) *Chloride*. The neutral solution from the titration of the total alkali is titrated with N/10 silver nitrate solution, with potassium chromate solution as indicator. The chloride is calculated as sodium chloride (potassium chloride in the case of liquid soaps). (*p*) *Rosin*. As a qualitative test a small quantity of the fatty acids is heated with acetic anhydride, and a few drops of the liquid brought in contact with a drop of sulphuric acid (sp. gr. 1.83). A fugitive violet coloration indicates rosin. For a quantitative determination 5 grms. of the sample is dissolved in 100 to 200 c.c. of hot water, and the fatty acids separated by the addition of 40 c.c. of N/2 sulphuric acid, washed with ice-water, dried for an hour at 105° C., and dissolved in 20 c.c. of absolute alcohol. The solution is treated with 10 c.c. of a mixture of 1 vol. of strong sulphuric acid and 1 vols. of absolute alcohol, and boiled for 4 mins. beneath a reflux condenser. It is next treated with about 5 times its vol. of 7 to 10% sodium chloride solution, and extracted with ether. The aqueous layer is shaken two or three times with ether, and the united ethereal extracts are washed with sodium chloride solution until free from acid. The rosin acids are titrated with standard alcoholic sodium hydroxide solution (1 c.c. N/1 alkali = 0.346 gm. rosin). (*q*) *Total soap (method for liquid soaps)*. 10 grms. is dissolved in 100 c.c. of water, and the solution heated with 10 c.c. of N/2 sulphuric acid until a clear layer of fatty acids is obtained. The acid aqueous layer is twice shaken with 20 c.c. portions of ether, the fatty acids dissolved in the same ether, and the solution washed until no longer acid to methyl orange. The aqueous washings are united and shaken with 20 c.c. of ether. This ether is washed free from mineral acids and added to the other ethereal solutions, which are then evaporated at a temperature below 50° C. The residue is dissolved in neutral alcohol (free from carbon dioxide), the solution neutralised with standard alcoholic potassium hydroxide solution, and evaporated to dryness, and the residue of soap dried at 105° C. and

weighed. Any unsaponified or unsaponifiable matter is deducted from the result. (*r*) *Sugar*.—*Qualitative test*. A solution of the soap is heated on the water bath for 15 mins. with an excess of hydrochloric acid; and then cooled and filtered from fatty acids. The filtrate is boiled for 2 mins. with an equal volume of Fehling's solution.

—C. A. M.

Emulsification: Theory of — based on pharmaceutical practice. L. Roon and R. E. Oesper. J. Ind. Eng. Chem., 1917, 9, 156–161.

EXPERIMENTS are described in which gum arabic and soap solution were used as emulsifying agents for mixtures of water with cottonseed oil, mineral oil, oil of turpentine, benzene, chloroform, carbon tetrachloride, or hexane as internal phases. In the case of gum arabic the volumes of internal phase (10 c.c.) and water (7.5 c.c.) were kept constant, whilst the amount of gum arabic was varied to determine the minimum quantity required for emulsification. In the case of the soap solution 1 c.c. was used with 10 c.c. of the internal phase, and the minimum addition of water was determined. It was found that an excess of water produced much frothing, whilst insufficient water produced streaks on the sides of the tube due to incomplete emulsification. The critical point between these extremes could be determined within 0.1 c.c. of water. Systems containing a few tenths of a c.c. below the critical proportion formed emulsions if allowed to stand for 10 mins. before shaking. In general, the critical volume of water decreased relatively with the increase in the total volume of emulsion to be formed. The results obtained in the two series of experiments supported Fischer's theory (Science 1916, 43, 168), that the presence of a hydration compound is an essential in emulsification. The best results are obtained when this hydration compound is formed at the moment of dispersion of the internal phase, the globules produced by the shaking then becoming coated with the hydrated colloid. For example, better and more rapid emulsification is effected by adding all at once 7.5 c.c. of water to 10 c.c. of mineral oil and 5 grms. of gum arabic, than by the addition of 11.5 c.c. of water in successive small quantities. An excess of water (more than 7.5 c.c.) added all at once gives a less satisfactory emulsion than that obtained by diluting a previously prepared "nucleus" with the same excess of water. This is in accordance with the results of pharmaceutical practice. Slight variations from the critical proportions of the three constituents (water, internal phase, and emulsifier), or in the procedure lead to the formation of a less stable emulsion or of none at all. The critical proportions vary with the quantities and nature of the constituents. It was also found that "nuclei" of one system would tend to render stable incomplete emulsions of another system, and that a "nucleus" of one composition would act as an emulsifying agent for other internal phases.

—C. A. M.

The Shreveburg and Knapp process for the determination of coconut oil [in butter and margarine]. Elsdon and Bagshawe. See XIXA.

PATENTS.

Solutions containing oil, fat or wax: Distillation of solvents from — H. J. Pooley, and G. Scott and Son, Ltd., London. Eng. Pat. 103,682, Jan. 31, 1916. (Appl. No. 1466 of 1916.)

DISTILLATION is effected in a series of stills, the partially distilled contents of the top still passing at a regulated rate to the next lower one, and so successively to the bottom still, in which the heating is wholly or mainly effected, and thence to the discharge pipe. The vaporised solvent

(for solvent with steam, etc.) rises successively through the stills to the top one, whence it is conducted to a condenser. (Reference is directed, in pursuance of Sect. 7, Sub-sect. J, of the Patents and Designs Act, 1907, to Eng. Pats. 2900 of 1897 and 2847 of 1900; this J., 1897, 602; 1900, 437.)—C. A. M.

Oil-soaps; Process of making soft, transparent sodium —. J. W. Ryder, Assignor to Specification Soap and Oil Co., Inc., New York. U.S. Pat. 1,212,818, Jan. 16, 1917. Date of appl., July 12, 1915.

ABOUT 100 lb. of a vegetable oil is heated to 100 to 110° F. (38°—43° C.), about 3 lb. of denatured alcohol added, and the mixture saponified with about 50 lb. of caustic soda lye of 35° B. (sp. gr. 1.332) having a temperature of 60° to 90° F. (15.5°—32° C.). After the addition of 30 to 60% of water the mass is boiled until a transparent soap of the desired consistency is obtained.—C. A. M.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Resin of fir and pine. C. G. Schwalbe. Z. Forst- u. Jagdwesen, 1916, 92—103. Z. angew. Chem., 1916, 29, Ref. 186.

THE yield of resin from fir and pine, obtained by successive extractions with ether and alcohol, was considerably higher from new than from seasoned wood, especially with the former solvent. The ether extractive was yellow and oily and bitter to the taste, whilst alcohol yielded brown, almost brittle resins. The extractives contained a considerable proportion of unctuous fat, chiefly glycerol esters of oleic acid, and in smaller amounts esters of other unsaturated acids, such as linolic and linolenic acids; the pure resins were hard and brittle. From new wood resins were obtained with lower acid values and appreciably higher iodine values than from seasoned wood. The resins yielded no turpentine when distilled with steam, but turpentine was produced on heating either the fresh or extracted wood with caustic soda, under pressure, at 170° C.—F. SOBN.

Coumarone resin in the manufacture of lacquers. Krumhaar. Farben-Zeit., 1916, 21, 1086—1088. Z. angew. Chem., 1916, 29, Ref. 187.

COUMARONE resin is a neutral substance, indifferent towards saponifying agents. It is best dissolved in solvent naphtha I or II to which benzene may be added. Drying is due to volatilisation of the solvent, polymerisation of the paracoumarone, and autoxidation of the paraindene; the last is the most important factor, and good drying is chiefly dependent therefore on a high proportion of paraindene. The film of dried resin may exhibit a glossy or matt surface and for a time increases both in toughness and hardness, but ultimately it becomes brittle and develops cracks. When unsuitable, the consistency of the resin may be modified by the addition of solid resins or of linseed oil or linoxyn.—F. SOBN.

PATENTS.

Putty; Manufacture of —. E. Harkko, Kotka, Finland. Eng. Pats. (A) 15,248 and (B) 15,249, Oct. 28, 1915.

(A) PUTTY with a considerable degree of elasticity is obtained by using instead of ordinary oil, a mixture prepared by boiling rosin oil, 700 grms., until it ceases to froth and then stirring into it petroleum, 300 grms. (B) Animal glue, 50 grms., is dissolved and boiled in water, 200 grms. Bolted (rye) meal, 50 grms., is made into a paste with boiling water, 300 grms., and this paste is stirred into the glue solution; the whole is then mixed

hot with petroleum, 50 grms., and rosin oil, 350 grms., after which chalk or whiting may be added.

—E. W. L.

Paint and process of making same. A. G. Betts, Asheville, N.C. U.S. Pat. 1,213,330, Jan. 23, 1917. Date of appl., Apr. 27, 1915.

THE paint contains precipitated, dehydrated barium phosphate and a drying oil.—E. W. L.

Paint composition. G. C. Hicks, Chicago, Ill. U.S. Pat. 1,215,022, Feb. 6, 1917. Date of appl., Aug. 6, 1915.

A PIGMENT is incorporated with a mixture of glucose (less than 50%) and linseed oil (more than 50%), with or without filling material.—C. A. M.

Pigment powder and process of making the same. S. M. McMurray, Smyrna, and J. R. Parrish, Nashville, Tenn. U.S. Pat. 1,215,293, Feb. 6, 1917. Date of appl., Feb. 3, 1916.

A COMPOSITION intended to render inked impressions proof against the action of petroleum spirit, and to intensify such impressions, consists of a mixture of a saccharine substance (1 part of glucose) with a pigment (3 parts of lampblack), and an inert filling material (5 to 20% of starch). The glucose and lampblack may be mixed with water to render the mixture plastic, and then dried, powdered, and incorporated with the filling material.—C. A. M.

Water-glass paints which in use quickly become waterproof; Preparation of —. W. Gallenkamp, Grosshesselohe. Ger. Pat. 291,339, Apr. 1, 1916.

ORDINARY water-glass paints are mixed with an aqueous solution of an alkali bicarbonate or similar substance yielding carbon dioxide on heating, and the mixture is heated shortly before use. On heating, a uniform separation of very finely divided silicic acid takes place which renders the mixture more viscous without affecting its covering properties and renders the paint waterproof and weatherproof within twelve hours of its application.—F. SOBN.

Coke as a by-product in the manufacture of lamp-black; Process of obtaining a hard, fully-burnt high-grade —. A. Wegelin A.-G. für Russfabrikation u. Chem. Industrie, Cologne. Ger. Pat. 291,701, Mar. 27, 1915.

LIQUID fuel containing free carbon is submitted to distillation and imperfect combustion in a short cylindrical furnace which is kept in motion (preferably by rotation about a horizontal axis), in such manner that every part of the internal wall is moistened at intervals by the liquid charge and each successive film completely carbonised in turn by the heat of the flame. The coke produced yields very little ash and is suitable for making carbons for electrical work.—F. SOBN.

Gums or gum-resins; Preparation and purification of certain —. H. C. Miller, London, and H. A. Irlam, Mill Hill. Eng. Pat. 103,006, Jan. 11, 1916. (Appl. No. 639 of 1916.)

THE purification of gums or gum-resins, e.g., acaroid, grass tree, black boy, and Botany Bay gums—and their preparation in a granular or pulverulent form is effected by precipitating them from their solutions in alkali by means of an acid or acid salt. As alkalis, caustic soda, caustic potash, or ammonia may be used, and as acids, sulphuric, hydrochloric, or oxalic acid, or the acid salts of the first and last. Nitre cake may be used with good results. For example crude gum or gum-resin, 100, is dissolved in water, 500, containing in solution caustic soda (96—98% NaOH) 17 parts, at 80° C. The solution is filtered, and to the filtrate a mixture of sulphuric acid, 1, and water 10 parts is added, the temperature being main-

tained at 40°–60° C., preferably between 50° and 55° C. The precipitated gum is separated by filtration.—E. W. L.

Coaling composition; *Liquid* —, A. L. Brown, Wilkinsburg, Pa., Assigning to Westinghouse Electric and Manufacturing Co., U.S. Pat. 1,212,738, Jan. 16, 1917. Date of appl. Dec. 30, 1911.

THE composition contains a phenolic condensation product, a drying oil (Chinese wood oil), and a lead-manganese drier. The drying oil is present in greater proportion than the condensation product. — E. W. L.

[Resinous] *condensation product*, C. P. Steinmetz, Schenectady, N.Y., Assignor to General Electric Co., U.S. Pat. 1,215,072, Feb. 6, 1917. Date of appl. Jan. 2, 1915.

THE product described is a non-inflammable resin consisting of the condensation product of a halogenated phenol (monochlorophenol) and a substance containing an aldehyde group (formaldehyde).—E. W. L.

Condensation products from phenol, formaldehyde, and the like; *Manufacturing* —, K. Tarassoff, Moscow, Russia, U.S. Pat. 1,216,515, Feb. 20, 1917. Date of appl. Feb. 21, 1914.

SEE Eng. Pat. 528 of 1911; this J., 1911, 557.

Aldehydes and phenols; *Manufacture of hard compositions of matter from* —, K. Tarassoff, Moscow, Russia, U.S. Pat. 1,216,516, Feb. 20, 1917. Date of appl. May 7, 1911.

SEE Fr. Pat. 470,810 of 1911; this J., 1915, 187.

Condensation products; *Method of producing* — and *product thereof*, F. Pollak, Berlin, U.S. Pat. 1,216,728, Feb. 20, 1917. Date of appl. Sep. 11, 1910.

SEE Fr. Pat. 420,401 of 1910; this J., 1911, 373.

Manufacture of lead monoxide, Eng. Pat. 100,069. See VII.

Impregnated [electrical] coil and method of making the same, U.S. Pat. 1,213,726. See XI.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Vulcanisation; *Coefficient of* — and *state of cure*, P. Schidrowitz and H. A. Goldsbrough, India-rubber J., 1917, 53, 327–328.

THE authors point out that the figures referred to by Stevens (India-Rubber J., 1917, 53, 17–19) as given by them for combined sulphur do not necessarily represent their final opinion on the subject. It is quite possible that some of the rubbers referred to are exceptional. The question at issue is whether state of cure is to be judged by chemical or mechanical properties of the vulcanised article, that is by the amount of sulphur combined with the rubber, or by the stress-strain curve. The authors re-state the case for the latter, with reference to the papers by Spence (this J., 1917, 92), and de Vries (this J., 1917, 296).—E. W. L.

PATENTS.

Rubber waste; *Process for recovering* —, R. F. Kinsley, East Cleveland, J. D. Morron, Lakewood, and C. R. Haynes, Cleveland, Ohio, Assignors to Mechanical Rubber Co., U.S. Pat. 1,215,911, Feb. 13, 1917. Date of appl. Feb. 1, 1915.

RUBBER waste containing fibrous material is comminuted, and the fibrous material disintegrated by treatment with acid. Excess of an alkaline-earth base is then added and the mass worked

until homogeneous. The excess of alkali is subsequently neutralised by the addition of a saponifiable oil, with or without a separate devulcanising agent. The whole of the added ingredients and their products, except water, are allowed to remain in the mass thus obtained.—E. W. L.

Washing and disintegrating raw rubber and materials containing raw-rubber or the like; *Machine for* —, A. A. Thornton, London, From United Engineers, Ltd., Singapore, Eng. Pat. 104,210, Feb. 23, 1916. (Appl. No. 2716 of 1916.)

XV.—LEATHER; BONE; HORN; GLUE.

PATENTS.

Quebracho or other like tanning solutions; *Apparatus for the preparation of* —, G. van de Wyer, and Association Internationale d'Agences, Ltd., London, Eng. Pat. 104,115, Nov. 16, 1916. (Appl. No. 16,119 of 1916.)

A VAT in which liquid can be heated by means of a doubly-wound spiral steam-coil at the bottom, is provided with a central vertical shaft, carrying propeller-like stirrers at its lower end, and driven by bevel-wheel gearing at its upper end; a sleeve or hollow shaft fits over the central shaft, and is attached to a framework carrying four (or other number of) perforated baskets, the whole being capable of rotation by means of bevel-wheel gearing—in a direction opposite to that of the central shaft. The quebracho or other tanning material is placed in the baskets, and the vat is filled with liquid to near the top of the basket. When the apparatus is set in motion a current of heated liquid is driven upwards by means of the propeller-like stirrers through the baskets. At the same time liquid is forced up by the motion through bell-mouthed pipes, with swan-necks leading into the top of the baskets, good circulation of the extracting liquid through the tanning material being thus secured, and the process of extraction hastened.—E. W. L.

Tanning agents; *Producing soluble* —, O. Schmidt, Assignor to Badische Anilin u. Soda Fabrik, Ludwigshafen, Germany, U.S. Pat. 1,216,612, Feb. 20, 1917. Date of appl. July 2, 1914.

SEE Eng. Pat. 18,250 of 1913; this J., 1914, 877.

Leather; *Artificial* — and *composition used in the manufacture thereof*, L. Lilienfeld, Vienna, U.S. Pat. 1,217,123, Feb. 20, 1917. Date of appl. Dec. 11, 1912.

SEE Fr. Pat. 456,261 of 1913; this J., 1913, 953.

XVI.—SOILS; FERTILISERS.

Soil fertility; *Measurements of* —, W. H. Jordan, New York Agric. Exp. Station, Geneva, Bull. No. 121, 1916, 21 pages.

WITH the object of determining relationships between soil fertility and chemical composition, nine different soils from New York State were selected for investigation. They were put into wooden boxes, 15 in. square, with a layer of sand beneath, and sown with barley during two successive seasons, the grain, straw, and total dry matter being determined after each harvest. In the chemical investigation, the soils were analysed completely, and determinations were also made of the matter dissolved by hydrochloric acid (sp. gr. 1.115) during 10 hours at 100° C., of the substances rendered soluble by continuous leaching for 10 days with water, N/200 HCl, and N/25 HCl, and of the soluble matter obtained by shaking

with the same solvents for 5 hours. By no one of these methods was it found possible to correlate the crop-producing power of a soil with its content of nitrogen, phosphoric acid, and potash, either total or soluble. In some cases there appeared to be a connection between the fertility and the total soluble matter (particularly the organic) of a soil, e.g., two soils that gave a very low crop yield were also deficient in soluble matter, but on the other hand, yields of 11·1 and 96·8 grms. of dry matter were obtained from two of the boxes containing soils showing the same amount of soluble matter.—E. H. T.

Rice plant ; Study in the assimilation of nutrients by the —. J. N. Sen. Agric. Res. Inst., Pusa. Bull. No. 65, 1916. 13 pages.

A PLOT of non-calcareous clay rice-land (kewal) which had given uniform crop results in previous years was sown on May, 21, 1915, with seed ("kalamdan") which was regularly grown on this soil. The young plants were not transplanted, but the usual cultural operations were carried out, irrigation being performed only once—during an exceptionally dry August. Seedling samples were taken on June 30 and July 22nd; adult plants were gathered in the pre-flowering stage on Aug. 21, on Oct. 27 when flowering had begun, on Nov. 29, when the harvesting stage was reached, and on Jan. 7 (1916) when the plants were dead-ripe. Analyses of these samples showed that the nitrogen content steadily diminished from the first to the last period of growth, the greatest decrease taking place in the second period. In the roots there was a very slight gain during the last stages. The phosphoric acid content of the aerial parts remained constant except in the first stage and in the flowering period, when it was slightly higher. In the roots there was a continuous steady decline. The potash in the parts above ground increased up to the pre-flowering stage and then declined. In the roots it was the same during the first two stages after which it fell steadily. These three nutrients became concentrated in the grains as the ears formed and matured; their assimilation from the soil was practically finished by the flowering stage—hence the necessity of abundant plant-food during the early stages. No tendency was observed on the part of the absorbed nitrogen and potash to pass back into the soil. A yield of 900 lb. of dry grain involved a depletion in the soil of 29·33 lb. of nitrogen, 9·64 lb. of phosphoric acid, and 49·69 lb. of potash. An investigation of the feeding values of the parts of the plants at different stages, showed that the straw declined in value with the age of the plant; that leaves were more nutritious than stems of the same period, containing more oil and protein, slightly more carbohydrates, and less fibre. The food value of the leaves is greatest in the pre-flowering and the flowering stages. Dead-ripe plants are at least of equal nutritive value to the normally ripe samples.—E. H. T.

Stable manure ; Composition of army —. E. J. Russell. J. Board Agric., 1917. 23, 1053—1055.

ANALYTICAL data show that army stable manure compares very favourably with farmyard manure (Rothamsted). The former is very good both as regards condition and composition, being as rich in nitrogen, potash, and phosphoric acid, as the latter; it does not, however, equal cake-fed farmyard manure. It contains but very little litter; its moisture content is much lower, and its mineral content higher, than the farmyard product. Owing to the facts that the ammoniacal nitrogen content is low, and that the dumps are compacted by the running of carts over them, the loss on storage is relatively small. Army stable manure is a valuable source of potash,

one ton containing about 18 lb., equivalent to 144 lb. of kainite. At 1s. per load (1s. 1½d.—1s. 1d. per ton), it is extremely cheap; it is worth at least 5s. per ton on the farm.—E. H. T.

Potash [and cement] ; Manufacture of — from felspar. J. Board Agric., 1917. 23, 1087—1091.

A SUB-COMMITTEE of the Government Fertilisers Committee has tested Rhodin's process for converting felspar into a potash fertiliser (Eng. Pat. 18,338 of 1910; this J., 1911, 688), and utilising the residue for the manufacture of a white cement (Eng. Pat. 16,780 of 1899; this J., 1900, 633). Felspar from Loch Eriboll, Sutherlandshire, containing 8·6% of potash, yielded 60% of it in a soluble form; mineral from Derome, near Värberg, Sweden, containing 12·9%, gave 51% of the potash in soluble form; and Roche spar from Cornwall, with 10·8% potash, yielded 75% of it soluble in water. The white, or nearly white, hydraulic cement manufactured from the insoluble residue is suitable only for decorative purposes. As its yield is about 27 times that of the potash fertiliser and as the demand for it is limited, it would be necessary to sell it abroad, or to strengthen it and sell it at home. The Sub-Committee is satisfied with the process and recommends it for adoption on a large scale. It is calculated that 100 tons of Roche spar would yield 220 tons of white cement, and 8 tons of potash (K_2O), equivalent to 16 tons of 80% muriate.—E. H. T.

Fertilisers ; Plant-physiological study, preliminary to the chemical analysis of —. E. A. Mitscherlich. Landw. Jahrbücher, 1916, 49, 335—416. Z. angew. Chem., 1916, 29, Ref., 479—480.

THE sand-culture method which is regarded as the basis of manure analysis shows that when all the factors of growth, except one, are kept constant, the plant-yield (y) increases with this variable factor (x) in accordance with the law: $\log(A-y) = \log(A-a) - cx$. A comparison of the increase of yield obtained with different fertilisers containing similar plant nutriment gives an efficiency ratio for these fertilisers which, with similar manuring, is independent of all other factors of growth and of the species of plant. Excessive manuring causes plasmolytic abnormalities which render the law inapplicable. Since different plants take up different quantities of the various foodstuffs, it is thought that the value of the ratio is influenced by physical rather than chemical factors.—F. SOPN.

PATENTS.

Fertiliser composition, and process of making same. G. H. Earp-Thomas, Glen Ridge, Assignor to H. K. Hannah, Montclair, N.J. U.S. Pat. 1,212,196, Jan. 16, 1917. Date of appl., Nov. 10, 1914. Renewed Oct. 28, 1916.

THE fertiliser consists of a mixture of ground eel-grass, ground mineral phosphate, compounds of potassium and nitrogen, together with humus-forming material.—E. H. T.

Fish-scrap, kelp, etc. ; Apparatus for the reduction of —. G. H. Stillson, Port Townsend, Assignor to Pacific Products Co., Seattle, Wash. U.S. Pat. 1,212,416, Jan. 16, 1917. Date of appl., Dec. 21, 1915.

A CONVEYOR cylinder, containing a rotating conveyor screw, is surrounded by a jacketed chamber built in sections. A communicating shoot which can be closed automatically, and an air-duct, connect this cylinder with a drying cylinder furnished with a revolving paddle. From a hot-air chamber, fitted with steam coils, a blast of hot air is blown through an air-duct into and through the drying cylinder and the jacketed chamber. Separate sections of the latter are heated by the waste gases from a boiler furnace, by exhaust

steam from a steam pump and a steam engine, and by the waste steam from the coils in the hot air chamber. — E. H. T.

Fertiliser; Manufacture of — from Steffens waste water, etc. — E. Herzka, Arecibo, Porto Rico. U.S. Pat. 1,212,181, Jan. 16, 1917. Date of appl., Oct. 24, 1916.

STEFFENS waste water, osmosis water, or other waste liquor obtained in the extraction of sugar from beet molasses, is concentrated to 55 Brix., and treated with sulphuric acid in amount chemically equivalent to the total lime and alkali present. Calcium superphosphate, nitrogenous animal refuse, and sawdust are then added, and the mixture is dried. — E. H. T.

Fertilisers; Manufacture of — — D. Shields, Edgeworth, Pa. U.S. Pat. 1,212,573, Jan. 16, 1917. Date of appl., Nov. 23, 1916.

CARBONACEOUS matter, *e.g.*, that derived from comminuted coal, is mixed with finely divided clay, and treated with subterranean salt water at 212° F. (100° C.); or the carbonaceous substance is mixed with the salt water, heated to 212° F., and the clay then added. — E. H. T.

Fertilisers; (Continuous) process and apparatus for decomposing raw (phosphate) material for the manufacture of — — S. Barth, Düsseldorf, Ger. Pat. 291,575, Jan. 31, 1915.

THE mixture of raw material and acid, as it passes from the mixing vessel to the reaction chamber, is broken up by a current of compressed air, and the product is mechanically discharged from the chamber as a granular mass which is conveyed away for further treatment or for storage. — E. Sopn.

Fertiliser containing ammonium magnesium sulphate and ammonium chloride; Preparation of a — — H. Precht, Hanover. Ger. Pat. 291,857, Feb. 11, 1916.

AMMONIUM sulphate is allowed to react with magnesium chloride or material containing magnesium chloride, such as mother-liquors of the potash industry, and carnallite. The double salt obtained is non-hygroscopic and is much less soluble than ammonium sulphate. — E. Sopn.

XVII. SUGARS; STARCHES; GUMS.

Massecurite; Treatment of the — in the centrifugal (in Hawaii). — J. H. Pratt, Hawaiian Chemists' Assoc., Nov., 1916. Intern. Sugar J., 1917, 19, 89–90.

IN order to prevent the gradual destruction of the basket, when hastening drying by the aid of steam, it is suggested that the steam should be discharged between the curb wall and the basket, and caused to flow in the same direction as the revolving machine by a deflector fastened to the curb. When this procedure was adopted there was a saving of 10 per cent. in time, and the sugar showed an increased polarisation of 1°, while the purity of the molasses was practically unaffected. In carrying out the "hot molasses method," the machine is started empty, and when it has acquired sufficient speed to prevent swinging, the massecurite is run in slowly, hot molasses at 82° to 88° C. (180° to 190° F.) being introduced at the same time through a 3-in. pipe, three-quarters open or more. The outlet of this pipe is placed just above the drip-pan, almost touching and in front of the inflowing massecurite. Even when the molasses is not thinned by wash-waters, there may be a rise in the purity, but not enough to offset the great gain in the time of drying, which sometimes is

diminished by half, while the sugar may have a polarisation of 81°, as compared with 68° when hot molasses is not used. — J. P. O.

Sugar; Extraction of — from low-grade cane molasses by the Williams process. — J. N. S. Williams, Report to the Hawaiian Sugar Planters' Assoc., 1916. Intern. Sugar J., 1917, 19, 90–92. (See Eng. Pat. 16,799 of 1915; this J., 1916, 611.)

It is claimed by the author that if a final molasses be concentrated to a dry substance content of 99 Brix., practically the whole of its sucrose will crystallise, thus demonstrating, contrary to the theory of molasses formation held by Geerligns and others, that it is not the glucose, gums, or mineral matter which either singly or in combination prevent crystallisation, but solely the water present. In experiments made in Hawaii a quantity of "final molasses" was boiled to an almost complete absence of water, and run into small containers, in which sucrose separated in the form of a very fine grain. By using a centrifugal with a non-perforated bowl, operating at a very high speed of revolution, it was found that the very dense and practically solid mass could be separated into two parts, one containing a major portion of sucrose and a minor portion of impurities, and the other containing a minor portion of sucrose, but a major portion of glucose, gums, etc. It is claimed that over 45% of the sucrose present in the original "final molasses" (which had a purity of about 10%) was recovered in the form of a massecurite having a polarisation of 50° and a purity of 53°. In another experiment 644 lb. of dried molasses having a purity of 47° was diluted with 47 lb. of water, producing a massecurite, which was spun in a high-speed machine, when a massecurite weighing 365 lb. (53% of the original charge), and a polarisation of 57° and a purity of 60°, was obtained; while the molasses removed weighed 327 lb., and had a purity of 28.8°, and a polarisation of 25.6%. — J. P. O.

Risks in using commercial glucose in pharmaceutical preparations. — Cowie. See XX.

PATENTS.

Centrifugal machines and the like. — Eng. Pat. 102,107. See I.

Manufacture of fertiliser from Steffens waste water, etc. — U.S. Pat. 1,212,181. See XVI.

XVIII.—FERMENTATION INDUSTRIES.

Malt; Evidence of the existence in — of an enzyme hydrolysing the furfuroids of barley. — J. L. Baker and H. F. E. Hulton. Chem. Soc. Trans., 1917, 111, 121–130.

THE authors use the term "furfuroids" to denote substances which, like pentoses and pentosans, yield a considerable amount of furfural when distilled with hydrochloric acid under the usual conditions; for the determination of the furfural produced they employed Fehling's solution (see this J., 1916, 1127). The distribution of furfuroids in different parts of barley and malt corns is indicated by the following yields of furfural, referred to dry material in all cases:—entire barley corn, 5.9%; excised embryos before germination, 1.7%; young plumules germinated in the dark, 5.7%; rootlets (malt-culms), 9.1%; malt-husks (brewers' grains), 20.5%. During the conversion of barley into malt the amount of furfuroids present undergoes a small but distinct increase. Excised barley embryos, germinated on sand moistened with sucrose

solution, were found to increase in weight and furfuroid-content at the expense of the sugar. Under normal conditions of germination the furfuroids gained by the embryo are drawn from the endosperm, probably by the agency of an enzyme which renders them soluble. Experiments described indicate that such an enzyme occurs in extracts of green malt and is precipitable therefrom, like diastase, by alcohol. Digestion of green malt and barley *in vitro* showed that a portion of the insoluble furfuroids of barley is rendered soluble as the result of enzymic activity of the green malt. About 10% of the insoluble furfuroids of purified malt-husks was rendered soluble by the action of the precipitate produced by alcohol from an extract of green malt, at 30° C. An aqueous extract of green malt, allowed to act on brewers' grains, produced reducing sugars (pentose).—J. H. L.

Potato-starch as malt adjunct [in brewing]. V. Koudelka. *Allgem. Zeits. Bierbrau. u. Malzfabr.*, 1916, 44, 71. *Z. ges. Brauw.*, 1916, 39, 222.

IN Austria brewers are now permitted to replace 30% of their malt by sugar and to use potato-starch in addition. Very pure starch is necessary for this purpose. It must first be mashed-in with cold water to prevent the formation of lumps, and it may be saccharified either by itself in a subsidiary mash or after addition to the main mash; the former method is recommended for large breweries, the latter method requiring very efficient mash-tun rakes. According to Lintner the amounts of conversion products formed from 100 parts of potato-starch by the action of diastase at 50°, 55°, 60°, and 65° C. are 0.13, 5.03, 52.68, and 90.31 parts (dry substance) respectively. Since starch contributes no nitrogen to the wort, steps must be taken to utilise to the full the nitrogenous matters of the malt.—J. H. L.

Yeast maceration juice: Von Lebedeff's —. M. W. Beijerinck and J. J. van Nessel. *Folio Microbiologica, Holland. Beitr. ges. Microbiol.*, 1916, 4, No. 2. *Woch. Brau.*, 1916, 33, 176.

THE author modifies von Lebedeff's method of preparing yeast for maceration (this J., 1911, 1081) as follows:—Beer yeast which has not been pressed is allowed to ferment a 10% solution of sucrose. The yeast crop is pressed, passed through a hair sieve, and spread out on filter paper, in as fine a form as possible, to dry in a warm chamber. The dry material is again sifted, and only the floury portion is used, since this contains a larger proportion of ruptured cells and yields a much more active juice than the larger fragments. Auto-digestion liberates zymase only from previously ruptured cells, and the same is true of yeast catalase, which like zymase occurs as a suspension colloid in juice prepared by von Lebedeff's method. Both these enzymes are probably of greater molecular magnitude than diastase, tryptase, pepsin, and some classes of proteins.—J. H. L.

Titration [of brewing materials] in stages by means of two indicators. A. Reichard. *Z. ges. Brauw.*, 1916, 39, 313—315, 322—324, 329—331, 337—339, 345—347, 353—351.

IN the titration of barley and malt extracts, worts, and beers, with alkali, considerably lower results are obtained with litmus as indicator than with phenolphthalein. The development of acidity which accompanies the malting process cannot be directly determined by comparing the acidities of the barley and malt, as it is to some extent masked by a loss of acidity from the barley husk during steeping. The increase of acidity associated with the first stages of germination is due mainly

to the formation of very feebly acid substances which react acid towards phenolphthalein but not towards litmus. The acidity developed in wort during fermentation is due, on the other hand, mainly to substances which react acid towards litmus. The author considers that the stability of beer depends not so much upon the total acidity (determined with phenolphthalein), as upon a high acidity to litmus in proportion to the total acidity. Some experiments are described which show that in an electric field the aromatic substances of hops and malt migrate towards the anode and are therefore negatively charged. Under normal conditions they are probably adsorbed on positively charged colloidal particles in the beer.—J. H. L.

Amino-nitrogen in worts, extracts, etc.: Gasometric determination of —. R. Ensländer. *Z. ges. Brauw.*, 1916, 39, 265—267.

THE author has modified slightly the method described by Van Slyke (this J., 1911, 774). Octyl alcohol is used instead of amyl alcohol to overcome frothing; and the evolved gas mixture, before being transferred to the Hempel pipette for purification, is freed from most of its nitric oxide in the burette (P. *loc. cit.*) which is filled with concentrated ferrous sulphate solution instead of sulphuric acid. This avoids the frequent renewal of the alkaline permanganate solution in the Hempel pipette.—J. H. L.

Barley: Utilisation of the nutritive value of — in brewing. M. Busemann. *Z. ges. Brauw.*, 1916, 39, 331—332.

THE author adduces evidence to show that the nutritive value of barley is well utilised in brewing. According to Rubner, 70% of the nutritive value appears in the beer, and to this must be added the value of the spent grains and yeast as fodder. When barley is used directly for feeding pigs or other stock, only about 10% of the nutritive substances is eventually consumed by human beings, the remainder being destroyed within the animal.—J. H. L.

Adenine-uracil dinucleotide and the structure of yeast nucleic acid. Jones and Read. See XX.

Yeast nucleic acid: Mode of nucleotide linkage in —. Jones and Read. See XX.

PATENTS.

Yeast, mucorini, m-adds, bacilli, etc.: Pure-culture apparatus for —. J. H. P. Magné, Mexico. U.S. Pat. 1,212,656, Jan. 16, 1917. Date of appl., June 19, 1916.

THE apparatus comprises a small initial closed vat and a large secondary one, and means for transferring liquid from one to the other and for supplying them with steam and sterilised air under pressure. The mechanism for sterilising the air may include a sterilising or filtering medium so arranged as to be enveloped by steam in one of the vats (when these are steamed).—J. H. L.

Beverages: Process of preparing [alcoholic] —. G. Defren, Newton, Mass. U.S. Pat. 1,211,518, Feb. 6, 1917. Date of appl., June 29, 1911.

MATERIAL containing starch and protein is heated with acidulated water to produce a sufficient quantity of fermentable sugar. The conversion is then arrested, but the product is left somewhat acid to retain proteins in solution. After separation of undissolved matter, the liquid is boiled with hops and fermented. Before this boiling a portion of the liquid may be caramelised and again mixed with the bulk; and after the hop-boiling the product may be fined with casein.—J. H. L.

Beverages: Process of producing—. Extract having the flavour and aroma of malt and process of producing the same. M. and L. Wallerstein, New York, U.S. Pats. (A) 1,211,729 and (B) 1,211,730, Feb. 6, 1917. Date of appl. June 21, 1916.

(A) A SYNTHETIC extract containing the products formed by interaction between amino-compounds and sugars is dissolved in water, and the solution is boiled with hops and cooled. It may be filtered and carbonated, or fermented by yeast and then filtered and carbonated. (B) A synthetic extract having the flavour and aroma of malt is made from amino-compounds (proteolytic products) and sugars, e.g., by their interaction in a concentrated form at 90° C.—J. H. L.

Food product. U.S. Pat. 1,212,722. See XIXA.

Method of extracting and modifying proteins or albuminous matter [from yeast]. U.S. Pat. 1,213,515. See XIXA.

XIXA.—FOODS.

Milk powder: Analysis of—. Determination of moisture and fat. C. Porcher. Ann. Falsif., 1916, 9, 150—156.

THE quantity of moisture in milk powders is best determined by drying the sample over phosphorus pentoxide at 15° C. for 48 hours, or, if necessary, for 72 hours. Sulphuric acid is unsuitable as a drying agent owing to its marked vapour pressure at 15° C., and desiccation over calcium chloride is very slow. The ordinary method of drying in a steam-oven causes the milk powder to develop a brown colour and evidently alters the composition of some of the constituents; this discoloration is more pronounced in the case of milk powders prepared from milk which has been treated with sodium bicarbonate. The Röse-Gottlieb method is recommended for the determination of the fat; direct extraction of the powder with ether in a Soxhlet apparatus gives low results.—W. P. S.

Coconut oil [in butter and margarine]: The Shrewsbury and Knapp process for the determination of—. G. D. Elsdon and C. R. Bagshawe. Analyst, 1917, 42, 72—83. (See this J., 1910, 1128; 1912, 117.)

VARIOUS modifications in the working of this process were examined, the object being the prevention of error due to the different rates of separation of the insoluble acids from the alcoholic solution and also to ascertain the most suitable strength of alcohol to be used. The greatest difference between the values obtained for coconut oil and margarine, respectively, were obtained by using alcohol of sp. gr. 0.920 at 15.5° C. The details of the procedure recommended are as follows:—Five grams. of the fat is saponified by heating in a flask with 15 c.c. of glycerol-sodium hydroxide solution (a mixture of 700 c.c. of glycerol and 200 c.c. of a solution made by dissolving 1 lb. of sodium hydroxide in 1 litre of water), the soap is dissolved in 115 c.c. of boiling water, 10 c.c. of 10% (by vol.) sulphuric acid is added, the mixture is shaken, cooled, and the liquid filtered. The cake of fatty acids is shaken with 20 c.c. of boiling water, cooled, and the liquid filtered, the cake of fatty acids being broken up and rinsed on to the filter with 30 c.c. of cold water. The filter paper is opened and supported in the rim of the filter-stand and the flask is inverted over the filter paper, in which position both are allowed to drain and dry overnight. The flask is then heated in a water-oven for 5 minutes, while a current of air is blown into it, the filter paper is added, and the drying continued for a further 10

mins. One hundred c.c. of alcohol of sp. gr. 0.920 at 15.5° C. is then added, the flask is corked, its contents are heated until the fatty acids have dissolved completely, then cooled to 15.5° C., shaken, kept at this temperature for 30 mins., and the liquid filtered. Fifty c.c. of the filtrate is titrated with N/10 sodium hydroxide solution, using phenolphthalein as indicator. The value obtained for coconut oil, under these conditions, is 102, for butter 11, and for margarine 6.2. Tables are given showing the values obtained for various mixtures of coconut oil, butter, and margarine. —W. P. S.

Corn [maize] gluten: Relative value of certain proteins and protein concentrates as supplements to—. T. B. Osborne and L. B. Mendel. J. Biol. Chem., 1917, 29, 69—92.

THE products studied included casein, lactalbumin, edestin, cottonseed protein, cottonseed flour, soya bean flour, "milk-albumin," fish meal, maize oil cake, "vegetable albumin flour," brewers' grains, distillers' grains, pea meal, and earlham meal. The efficiency of these supplements to maize gluten presumably depends on their relative content of lysine and tryptophane, which substances are lacking in maize gluten. Lactalbumin proved to be the most efficient, and satisfactory growth was produced with smaller quantities of this protein than of any of the others; the least effective were brewers' grains, distillers' grains, and "vegetable albumin flour," probably because of their low lysine content. Small additions (one-eighth of the amount of maize gluten) of the more efficient proteins appeared actually to supplement the maize gluten, for equivalent amounts of these proteins alone, in a similar ration, were incapable of inducing a comparable degree of growth.—W. P. S.

Hydrocyanic acid [in plant tissues]: Determination of— and the probable form in which it occurs in *Sorghum vulgare*. J. J. Willaman. J. Biol. Chem., 1917, 29, 25—36.

METHODS in use for the determination of hydrocyanic acid in plant tissues are of doubtful accuracy owing to the difficulty of obtaining complete hydrolysis of the glucosides by means of acids, and because of the retention of the hydrocyanic acid by the tissues. Hydrolysis of the dhurrin in *Sorghum vulgare* is best attained by means of the glucosidase found in the same tissues (autolysis); it takes place rapidly at 45° C. Retention of hydrocyanic acid by the tissues during distillation cannot be prevented by the addition of tartaric acid nor can it be lessened appreciably by distilling under reduced pressure. Hydrocyanic acid occurs in *Sorghum vulgare* as a glucoside, dhurrin, and also in the form of a non-glucoside, the nature of which is as yet unknown; it is the latter portion of the cyanide of this plant which is probably responsible for the poisoning of cattle. The non-glucosidic cyanide can be distinguished from the glucosidic by macerating the leaves with 5% tartaric acid solution to prevent any enzyme action, and then distilling. —W. P. S.

Cyanogenetic compounds of Sorghum vulgare: Effect of anaesthetics and of frost on the—. J. J. Willaman. J. Biol. Chem., 1917, 29, 37—45.

THE leaves of *Sorghum vulgare* after exposure to the vapours of chloroform, ether, and alcohol, yield more hydrocyanic acid, both glucosidic and non-glucosidic, than do the normal leaves; the anaesthetics thus stimulate the hydrolytic and synthetic actions of the glucoside enzymes. Enzyme powder prepared from leaves which had been subjected to the action of chloroform was about twenty-five times as active towards amygdalin as was the powder prepared from

untreated leaves. Freezing also increases the quantity of hydrocyanic acid yielded by the leaves; this is due to the rupturing of the cells and to disturbed enzyme equilibrium.—W. P. S.

Cocoa; Alkalinity of —. Arpin. Ann. Falsif., 1917, 10, 10–11.

ACCORDING to French law, the alkalinity of the ash of pure cocoa should not exceed 2.75%, calculated as potassium carbonate and expressed in terms of the dry, fat-free substance; when this limit is exceeded, the cocoa must be sold as "alkalised" or "soluble cocoa," indicating that it has been treated with an alkali during manufacture. The author has examined certain samples lately which had an alkalinity corresponding with 3.1 to 3.5% of potassium carbonate and which the manufacturers guaranteed to be free from added alkali. Examination of cacao beans from various sources showed that the alkalinity sometimes exceeds the limit mentioned. *e.g.*, Madagascar beans had an alkalinity of 3.5%, Chuao beans, 3.59%. It is concluded, therefore, that slight excess of alkalinity in the three samples may have been due to natural causes.—W. P. S.

Coffee substitutes from malt, etc. L. Ronnet. Ann. Falsif., 1917, 10, 23–25.

To determine whether differences existed in the compositions of decoctions prepared from roasted barley, roasted green malt, roasted malt, etc., analyses were made of decoctions prepared under identical conditions from the various grains: 10 grms. of the sample was boiled for 5 mins. with 150 c.c. of water and, after standing for 18 hours, the solution was diluted to 250 c.c., and filtered. In all cases the total soluble substances amounted to about 38%, calculated on the dry substance; the reducing substances, expressed as maltose, varied from 5.3 to 8.5%, except in the case of malt which had been moistened and kept at 60 to 70° C. for three hours, the quantity of reducing substances then increasing to about 20% with a corresponding decrease in the amount of starch and dextrins. This reduction in the quantity of starch and dextrins was about 9%, *i.e.*, from about 29% to 20%.—W. P. S.

Study in the assimilation of nutrients by the rice plant. Sen. See XVI.

Utilisation of the nutrient value of barley in brewing. Busemann. See XVII.

PATENTS.

Egg-preserving compound. H. D. Bostock, Jacksonville, Fla. U.S. Pat. 1,212,445, Jan. 16, 1917. Date of appl., June 13, 1916.

THE compound consists of a solution of 1 lb. of *Desmodium tortuosum meibomia* in one gallon of water, in which the eggs are immersed.—J. H. J.

Curing meats; Art of —. G. F. Doran, Omaha, Nebr. U.S. Pat. 1,212,614, Jan. 16, 1917. Date of appl., Apr. 29, 1916.

THE meat is treated with a pickling liquor containing either sodium nitrite or a mixture of sodium chloride, an alkali nitrate, and an alkali nitrite.—J. H. J.

Food product. R. Wiles, Riverside, Ill. U.S. Pat. 1,212,722, Jan. 16, 1917. Date of appl., Dec. 26, 1914.

THE food consists of a powder composed of the solid constituents of fermented malt liquor, in the same relative proportions as in the liquor. The powder is soluble in water, and when the solution is carbonated, it has the original properties of the malt liquor without the alcohol content.—J. H. J.

Bread; Mineral water for use in the manufacture of leavened —. H. A. Kohman, Pittsburgh, C. Hoffman, New York, and T. M. Godfrey, Pittsburgh, Pa. U.S. Pat. 1,213,210, Jan. 23, 1917. Date of appl., June 8, 1916.

WATER containing ammonium chloride, calcium chloride, and potassium bromate is used as a yeast stimulant and dough ripener in making bread. (See also this J., 1916, 1030.)—W. P. S.

Dough; Composition for leavening —. A. M. Hamblet, Winchester, Mass. U.S. Pat. 1,213,357, Jan. 23, 1917. Date of appl., Dec. 10, 1914.

THE composition is a liquid containing lactic acid, lactic anhydride in amount not less than 15% of the lactic acid, and a solvent in amount not less than 20% of the total volume of the composition. The total acidity of the composition is greater than that of an N 4 acid solution.—J. H. J.

Bread; Process for the manufacture of whole-grain —. P. Gross, Charlottenburg, Assignor to Vollbrot Patent-Verwertungs Ges. m. b. H., Berlin. U.S. Pat. 1,213,627, Jan. 23, 1917. Date of appl., Dec. 5, 1916.

GRAIN is heated with water at about 60° C., the bran and suspended particles of starch are separated from the decorticated grain kernels, the latter are disintegrated while moist, and the product is worked into a dough for baking.—W. P. S.

Proteins or albuminous matter [from yeast]; Method of extracting and modifying —. C. C. Ringler and J. Beerhalter, Assignors to Pitzer Brewing Co., Duluth, Minn. U.S. Pat. 1,213,545, Jan. 23, 1917. Date of appl., Mar. 13, 1916.

BREWERS' yeast is freed from hop resins, heated under pressure with ammonia solution to dissolve the proteins, the excess of ammonia is then removed by evaporation, and the solution is separated from the sediment.—W. P. S.

Baking-powder. M. Vaygouny, Berkeley, Cal., Assignor to Royal Baking Powder Co. U.S. Pat. 1,214,726, Feb. 6, 1917. Date of appl., Feb. 1, 1912.

THE baking powder consists of a mixture of racemic acid, mesotartaric acid, and an alkali bicarbonate.—J. H. J.

Bread or the like; Manufacture and composition of —. E. S. Roworth, Assignor to G. Roworth and F. C. Lynn, Matlock. U.S. Pat. 1,215,995, Feb. 13, 1917. Date of appl., May 27, 1916.

SEE Eng. Pat. 100,295 of 1916; this J., 1917, 302.

Margarine; Manufacture of —. K. Erslev, Nijmegen, Netherlands. U.S. Pats. 1,216,671 and 1,216,675, Feb. 20, 1917. Date of appl., Nov. 13, 1916.

SEE Eng. Pats. 103,313 and 103,634 of 1916; this J., 1917, 302, 351.

XIXB.—WATER PURIFICATION; SANITATION.

PATENTS.

Softening water; Process of —. Oelwerke Stern-Sonneborn A.-G., Hamburg, Germany. Eng. Pat. 103,698, Feb. 9, 1916. (Appl. No. 1934 of 1916.) Addition to Eng. Pat. 22,362 of 1911 (this J., 1915, 977).

THE water is boiled for 5 mins. before being treated with commercial sodium phosphate.—J. H. J.

Purifying liquids; Composition for—A. H. Krieger, Assignor to Kieselguhr Co. of America, Los Angeles, Cal. U.S. Pat. 1,212,618, Jan. 16, 1917. Date of appl., Sep. 27, 1915.

The composition consists of a finely divided mixture of kieselguhr and hydrous aluminium silicate or colloidal clay in about equal quantities.—J. H. J.

Liquids [drinking water]; Method of purifying—Elekro-Gemose A.-G. (Graf Schwerin Ges.), Berlin. Ger. Pat. 291,751, June 11, 1915.

The liquid is treated with amorphous silicic acid which has been given a sufficient electropositive or negative charge by the action of acidic or basic substances to enable it to adsorb the impurities present. For example, silicic acid which has been positively charged by treatment with hydrochloric acid is employed to adsorb electro-negative impurities from drinking water.—F. SODX.

Centrifugal machines and the like, Eng. Pat. 102,407. See I.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Medicinal plants; Cultivation of—J. Board Agric., 1917, 23, 1103–1104.

Much has been done during the past two years to meet the demand for medicinal plants. According to a communication from the National Health Insurance Commission (England) to the Board of Agriculture, the quantities of belladonna, henbane, digitalis, and colchicum required for home consumption are approximately: belladonna, 50 tons of the dried leaves and 50 tons of the dried roots; henbane and digitalis, 20–25 tons of the dried leaves or each; colchicum, considerably less. The home demand for digitalis and colchicum could be met by collecting wild plants. The yields of belladonna and henbane could be improved in a similar way, but in these cases skilled cultivation is indispensable; the acreage under cultivation has considerably increased of late, and it is probable that the combined supply from both sources would now be sufficient to meet the home demand.—E. H. T.

Adenine-uracil dinucleotide and the structure of yeast nucleic acid, W. Jones and B. E. Read, J. Biol. Chem., 1917, 29, 111–122.

ADENINE-URACIL dinucleotide was prepared from yeast nucleic acid; on acid hydrolysis it yielded adenine and uracil but no adenosine or cytosine. When submitted to ammoniacal hydrolysis it gave adenosine and uridine but not guanosine or cytidine. It contained an equal number (one of each) of purine and pyrimidine groups and formed a tetrabasic salt. The latter fact indicates that the two mononucleotide groups are joined to one another through their carbohydrate groups. This mode of linkage must of course exist also in yeast nucleic acid so far as two of its nucleotide groups are concerned, and evidence is adduced that the same mode of linkage is maintained throughout the entire nucleic acid molecule (see following abstract).—W. P. S.

Yeast nucleic acid; Mode of nucleotide linkage in—W. Jones and B. E. Read, J. Biol. Chem., 1917, 29, 123–126.

YEAST nucleic acid is a tetranucleotide composed of groups of two purine nucleotides and two pyrimidine nucleotides; it has been shown (preceding abstract) that there is no direct phosphoric acid linkage in adenine-uracil dinucleotide and there is, therefore, no linkage at the corres-

ponding point in yeast nucleic acid. It must be concluded that the nucleotide groups of yeast nucleic acid are united to one another through their carbohydrate groups.—W. P. S.

Glucose in pharmaceutical preparations; Risks in using commercial—W. B. Cowie, Pharm. J., 1917, 98, 235–236.

THE suggestion to employ commercial glucose syrup as a substitute for sucrose in the preparation of pharmaceutical syrups is only feasible in the case of neutral syrups, as practically all commercial samples of glucose contain small quantities of sulphur dioxide. When used, for instance, for the preparation of the compound syrup of hypophosphites, containing free hypophosphorous acid, reduction of the sulphur dioxide gradually takes place with formation of free sulphur and hydrogen sulphide, accompanied by a change of colour and odour of the syrup. A useful test for the presence of sulphur compounds in sugar and glucose is as follows:—10 grms. of the substance is dissolved in water and made up to 50 c.c., 1 gm. of sodium hypophosphite and 10 c.c. of syrupy phosphoric acid (sp. gr. 1.5) are added, and the mixture set aside in a corked vessel in a warm place for a few hours, when hydrogen sulphide may be detected by its odour. Commercial glucose contains from 160 to 350 parts of SO_2 per million and even a sample which passes the B.P. test for sulphur dioxide will produce objectionable effects when used to the extent of 20% in the compound syrup of hypophosphites.—J. F. B.

NOTE.—Commercial glucose quite free from sulphur dioxide is already easily obtainable under the title of "neutral glucose."

Methyl compounds in ether; Note on the B.P. test for—D. B. Dott, Pharm. J., 1917, 98, 236.

SEVERAL difficulties have been noted in connection with the B.P. test for methyl compounds in ether by the fuchsin-sulphurous acid reaction. Many samples of fuchsin are not completely decolorised by sulphurous acid, and even when practically colourless the delicacy of the test is a matter of doubt, some samples even not reacting at all. A fair sample of fuchsin reagent will show a doubtful reaction with 0.1% of wood naphtha in pure ether and a distinct coloration with 0.2%. Even with a good sample of fuchsin the reagent may be spoiled if the solution be kept hot while the bisulphite and acid are added gradually. It is best to let the fuchsin solution cool to 60°C., then add the bisulphite and shake, next the acid, 2 c.c. at a time, shaking after each addition, cool, and dilute to 1 litre.—J. F. B.

Nitration of 2-acetylaminoo-3,4-dimethoxybenzoic acid and 3-acetylaminoveratrol, Gibson and others. See III.

Theory of emulsification based on pharmaceutical practice, Roon and Oesper. See XIII.

Determination of mercury in organic compounds, Marsh and Lye. See XXIII.

PATENTS.

Cephaeline iso-amyl ether and salts thereof; Process for producing—J. W. Menden, Indianapolis, U.S.A. Eng. Pat. 103,881, Feb. 21, 1916. (Appl. No. 2599 of 1916.)

THE iso-amyl ether of cephaeline, of the probable formula, $\text{C}_{25}\text{H}_{37}\text{O}_3\text{N}_{20}\text{C}_6\text{H}_{11}$, is produced by treating cephaeline with an alkali metal and an iso-amyl halide. *Example*, 46.6 grms. of cephaeline, 4.6 grms. of sodium, and 17 grms. of iso-amyl bromide are heated together under a reflux condenser for 2 hours. The alcohol is distilled off, the

residue dissolved in dilute hydrochloric acid, made alkaline with ammonia, and extracted with ether. Unchanged cephaline is extracted from the ethereal solution with excess of dilute caustic soda solution, and the ether is evaporated off on the water bath. The product may be purified by dissolving it in an acid, crystallising the salt, dissolving it in water, adding ammonia, extracting with ether, evaporating off the ether, and drying *in vacuo*. Cephaline *iso*-amyl ether is a varnish-like substance, easily soluble in alcohol, ether, and chloroform. It dissolves in acids to form salts, the hydrobromide crystallising in white needles. The ether and its salts are valuable medicinal products.—F. Sp.

Cholic acid - formaldehyde condensation product. E. Rietz, Elberfeld, Germany, Assignor to Synthetic Patents Co., New York. U.S. Pat. 1,213,261, Jan. 23, 1917. Date of appl. Dec. 29, 1911.

A COMPOUND of therapeutic value is produced by the combination of cholic acid and formaldehyde. It is a whitish powder soluble in alkali, alcohol, and glacial acetic acid, and melts at about 110° C.—F. Sp.

Acetaldehyde; Method of making—H. Hibbert and H. A. Morton, Pittsburgh, Pa., Assignors to Union Carbide Co., New York. U.S. Pat. (A) 1,213,486, and (B) 1,213,487. Jan. 23, 1917. Date of appl., Nov. 5, 1915.

(A) ACETALDEHYDE is produced by passing acetylene into dilute sulphuric acid containing a salt of mercury and a salt of a relatively weak acid which is not reduced under the working conditions, e.g., a borate. The acetaldehyde may be distilled off simultaneously. (B) Acetaldehyde is produced by passing acetylene into a solution containing a salt of mercury and an acid salt of a strong acid, e.g., a bisulphate, but practically no hydrogen ions. The solution may also contain a salt of a relatively weak acid, and the acetaldehyde may be distilled off simultaneously.—F. Sp.

Fusel oil or similar products; Manufacture of—from *petroleum*. H. Hibbert, H. Essex, and B. T. Brooks, Assignors to Gulf Refining Co., Pittsburgh, Pa. U.S. Pat. 1,214,919, Feb. 6, 1917. Date of appl., Apr. 8, 1915.

A PETROLEUM distillate boiling from 25 to 75° C., containing pentanes and hexanes, is treated with chlorine to produce chiefly mono-chloro derivatives, which are heated with an acetate at 170–250° C. and a pressure of 300 lb. per sq. in., to form pentyl and hexyl alcohols. The olefines formed at the same time may be treated with dilute sulphuric acid and hydrolysed to produce a further amount of pentyl and hexyl alcohols.—F. Sp.

Arsenobenzene derivatives containing nitrogen; Preparation of—Farbw. vorm. Meister, Lucius, u. Brünig. Ger. Pat. 294,276, Sept. 5, 1915.

3,5-DINITRO-4-DIALKYLAMINO BENZENE-1-ARSINIC acids are treated with reducing agents. The preparation of tetramethylhexa-aminoarsenobenzene, tetraethylhexa-aminoarsenobenzene, and dipiperidotetra-aminoarsenobenzene hydrochlorides is described. The products have a higher therapeutic value and a more pronounced action on certain parasites than the corresponding dialkyl compounds.—F. SODX.

Thiourac compounds of arsenic acid, its homologues and derivatives; Preparation of—H. Thoms, Berlin-Steglitz, Ger. Pat. 294,632, July 23, 1911.

ARSANILIC acid or a homologue or derivative is treated with allyl mustard oil, using methyl alcohol as solvent. The products have the combined therapeutic action of allyl and arsenic com-

pounds, without exhibiting the poisonous character of the latter. The compound of allyl mustard oil and arsanilic acid melts at 185° C., with decomposition; it is almost insoluble in water and alcohol, and is sparingly soluble in methyl alcohol. The corresponding compound of methylarsanilic acid darkens and intumesces at 170° C. without melting.—F. SODX.

Hydrogenisation and dehydrogenisation of carbon compounds. C. Bosch, A. Mittasch, and C. Schneider, Assignors to Badische Anilin u. Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,216,933, Feb. 20, 1917. Date of appl. June 1, 1914.

SEE Ger. Pat. 282,782 of 1913; this J., 1915, 723.

Liquid composition [for heating and refrigerating]. U.S. Pat. 1,213,368. See I.

[*Electrolytic*] *oxidation of cresols. [Preparation of salicylic acid.]* Eng. Pat. 103,739. See III.

Apparatus for organic chemical reactions. U.S. 1,213,113. See III.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

PATENTS.

Photographic images; Colouring or dyeing—H. Miller, New York, Assignor to Brewster Film Corporation, Newark, N.J. U.S. Pat. 1,214,940. Feb. 6, 1917. Date of appl., Feb. 26, 1915.

THE silver image is converted into an adsorbent halide by treatment with a halogen and a halogen salt, and is then coloured with a suitable dye.—B. V. S.

Screen for moving and other projected pictures. E. G. Meadway, Assignor to The British Patent Surbrite Co., Ltd., London. U.S. Pat. 1,216,151. Feb. 13, 1917. Date of appl., Mar. 1, 1915.

A SUITABLE support is coated with a mixture of a bright metallic powder, such as nickel, and a solution of rubber and some other substance, such as naphthalene, which crystallises out on evaporation of the solvent. The naphthalene is used in such proportion that it forms a reflective coating covering practically the whole of the surface.—B. V. S.

Film or the like for colour photography. Producing coloured photographic pictures. C. Raleigh, Jersey City, N.J., and W. V. D. Kelley, Brooklyn, N.Y., Assignors to Prizma, Inc. U.S. Pat. 1,216,493 and 1,217,125, Feb. 20, 1917. Dates of appl., Apr. 13, 1916, and Oct. 7, 1911.

SEE Eng. Pat. 11,225 of 1915; this J., 1916, 1189.

XXII.—EXPLOSIVES; MATCHES.

PATENTS.

Smokeless powders; Process for making—D. S. Kondratieff, Wilmington, Del., Assignor to B. Edelbartz, New York. U.S. Pat. 1,212,770. Jan. 16, 1917. Date of appl., Nov. 16, 1916.

NITROCELLULOSE, after washing, is centrifuged, and without further drying is gelatinised by a mixture of alcohol and ether.—J. N. P.

Explosives: Manufacture of —. Explosive and method of producing same. H. Hibbert, Pittsburgh, Pa. U.S. Pat. (A) 1,213,367 and (B) 1,213,369, Jan. 23, 1917. Dates of appl., Feb. 23, 1915, and Jan. 10, 1916.

STABLE explosives of a relatively non-volatile nature and low freezing point are composed of:—(A) A mixture of nitrated ethylene, propylene, and butylene-glycols with other explosive compounds; (B) a nitrated polyglycol or mixture of polyglycols, or a mixture of nitrated polyglycols and nitrated glycols; nitrocellulose may be dissolved in the nitrated polyglycol. J. N. P.

Explosive powder. J. L. Donner, Oregon City, Oreg., Assignor to J. Brosnan, jun., Washington, D.C. U.S. Pat. (A) 1,211,765 and (B) 1,211,766, Feb. 6, 1917. Date of appl., June 13, 1916.

(A) A heated aqueous solution of sugar is mixed successively with manganese dioxide, crude oil, and potassium chlorate, and the mixture is dried. The crude oil forms an envelope around the individual particles of chlorate and the quantity is adjusted so as to permit a quick and ready drying of the mixture. (B). The powder is prepared as in (A) but without manganese dioxide. J. N. P.

Matches: Process for the manufacture of —. T. T. Best, St. Helens, Lancs. Eng. Pat. 101,015, Feb. 15, 1916. (Appl. No. 2235 of 1916.)

SODIUM chlorate freed from hygroscopic impurities is used in place of potassium chlorate for match compositions. The chlorate is made by treating a solution of sodium carbonate with chlorine and separating the sodium chloride by crystallisation from a solution containing 1100 grms. NaClO₃ per litre. The chlorate is used in powdered form or in solution. A suitable composition is gum arabic 4 parts, sodium chloride 12 parts, potassium chromate 1.3 parts, sulphur 1.5 parts, glass powder or quartz 6.9 parts. The sodium chlorate may be partly replaced by potassium chlorate up to 50%.—W. F. F.

XXIII.—ANALYSIS.

Mercury in organic compounds: Determination of —. J. E. Marsh and O. G. Lye. Analyst, 1917, 42, 81.

To prevent the formation of a fatty or crystalline distillate in the method of determining mercury by combustion with calcium oxide, calcium sulphate is added to the mixture of calcium oxide and the mercury compound; the quantity of calcium sulphate necessary is about twice the weight of the portion of mercury compound taken for the determination. The mercury vapour remaining in the combustion tube at the end of the operation is expelled by carbon monoxide evolved on heating calcium oxalate placed at the closed end of the tube.—W. P. S.

Water content of coal, with some ideas on the genesis and nature of coal. Mack and Hulett. See IX.

Apparatus for determination of benzol and toluol in coal gas. Copp. See IX.

Rapid determination of carbon in iron alloys. Zinberg. See X.

Method for assaying tin ores. Henderson. See X.

Specifications for and methods of testing soaps. See XII.

Plant-physiological study, preliminary to the chemical analysis of fertilisers. Mitscherlich. See XVI.

Titration [of brewing materials] in stages by means of two indicators. Reichardt. See XVIII.

Gasometric determination of amino-nitrogen in worts, etc. Emslander. See XVIII.

Analysis of milk powder. Determination of moisture and fat. Porcher. See XIX.

The Shrewsbury and Knapp process for the determination of coconut oil [in butter and margarine]. Eldon and Bagshawe. See XIX.

Determination of hydrocyanic acid [in plant tissues] and the form in which it occurs in Sorghum vulgare. Willaman. See XIX.

Note on the B.P. test for methyl compounds in ether. Dott. See XX.

PATENTS.

Condenser for laboratory purposes. H. P. Clarke, Turlton, Lancs. Eng. Pat. 103,892, Mar. 2, 1916. (Appl. No. 3131 of 1916.)

A TANK through which the condensing fluid circulates is provided with short tubes or nipples projecting downward from the bottom, and corresponding clips at the top to receive condensing tubes which pass through from top to bottom. The joint between the condensing tube and the nipple may be formed by a piece of rubber tubing enclosing both, or by a rubber plug carried by the tube and fitting into the outlet of the nipple. —W. F. F.

Gas analysis apparatus. Aktiebolaget Ingeniörsfirma F. Egnell, Stockholm. Eng. Pat. 100,066, Jan. 25, 1916. (Appl. No. 1205 of 1916.) Under Int. Conv., Feb. 6, 1915.

SEE FR. Pat. 180,661 of 1916; this J., 1917, 106.

Trade Report.

Prohibited exports.

An Order of Council, dated 30th March, orders that the following headings in the list of prohibited exports* should be deleted:—(c) Citric acid; (c) Lead, white; (a) Chestnut extract; (a) Oakwood extract; (a) Valex; (a) Valonia; (b) Other extracts and substances for use in tanning; (c) Lead, oxides of; (b) Lead (except pig lead), alloys of lead, solder containing lead, and manufactures of lead or its alloys, not otherwise prohibited; (a) Lead, pig; (b) Quercitron bark extract.

The following headings are added:—(c) Aloes; (b) Barium peroxide; (c) Cascara sagrada; (b) Citric acid; (b) Hydrogen peroxide; (c) Jalap; (a) Lead compounds, and mixtures containing lead compounds; (c) Rhubarb (medicinal); (c) Senega; (a) Lead, lead alloys, and manufactures of lead or of lead alloys; (a) Tanning extracts and substances for use in tanning.

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Journal of the Society of Chemical Industry.

No. 8, Vol. XXXVI.

APRIL 30, 1917.

No. 8, Vol. XXXVI.

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 T. F. E. Rhead, D. F. Twiss, L. P. Wilson.

Canadian Section.

Chairman : T. H. Wardleworth.

Vice-Chairmen :

S. B. Chadsey, N. N. Evans, W. L. Goodwin.

Committee :

L. T. Acton.	J. A. De Cew.	Robt. Jol.
J. W. Bain.	J. R. Donald.	Otto G. Palma.
J. S. Bates.	C. F. Heebner.	W. H. Thorn.
D. G. Buchanan.	Milton L. Hersey.	

Hon. Treasurer : E. G. R. Ardagh.

Hon. Local Secretary :

Alfred Burton, 2-16, Liberty Street, Toronto.

Hon. Resident Secretary for Montreal :

Joel B. Saxe.

Acting Resident Secretary for Montreal.

J. R. Donald, 318, LaGauchetiere Street West, Montreal.

Edinburgh Section.

Chairman: James Walker.
Vice-Chairman: D. B. Dott.

Committee:
J. G. Annan, J. Rutherford Hill, Wilfrid A. Sim.
J. F. Briggs, Jas. C. Irvine, Allan Smith.
J. D. Brunton, D. S. Jordan, S. Stewart.
L. Dobbin, A. P. Laurie, H. E. Watt.

Hon. Local Secretary:

A. Lauder, 13, George Square, Edinburgh.

The following take office after the Annual General Meeting:—
Chairman: D. B. Dott; *Vice-Chairman:* J. S. Ford; *Committee:* J. Hendrick, B. D. W. Luff, B. D. Porritt, James Walker.

Glasgow Section.

Chairman: James Macleod.
Vice-Chairman: Quintin Moore.

Committee:
E. G. Beckett, Jas. Faill, J. McLarkue
A. R. Berry, Robert Hamilton, W. G. McKellar.
Thomas Cullen, T. H. P. Heriot, G. T. Purvis.
R. M. Clark, S. H. B. Langlands, James Reid.
W. H. Coleman, James Lawrence, James Robertson.
Cecil H. Desch.

Hon. Secretary and Treasurer:

G. S. Cruikshanks, Royal Technical College, Glasgow.

The following take office after the Annual General Meeting:—
T. Ewan, T. Gray, James Hope, D. A. MacCallum

Liverpool Section.

Chairman: John Gray.
Vice-Chairman: E. C. C. Baly.

Committee:
A. Carey, E. L. Peck, W. P. Thompson.
P. de G. Coghill, H. E. Potts, G. Carruthers.
J. Findlater, J. T. Smith, Thomson.
J. Hazen, Frank Tate, Stuart J. Willour.
R. D. Mason.

Hon. Treasurer:

Edwin Thompson, 25, Sefton Drive, Liverpool.

Hon. Local Secretary:

Alfred Holt, The University, Liverpool.

The following take office after the Annual General Meeting:—
Chairman: A. T. Smith; *Vice-Chairman:* John Gray; *Committee:* E. C. C. Baly, W. M. W. Fell, E. G. Jones, W. Mansbridge, J. W. Towers.

London Section.

Chairman: A. R. Ling
Vice-Chairman: H. E. Armstrong.

Committee:
Julian L. Baker, J. W. Hinchley, W. J. Leonard.
W. A. Bone, W. R. Hodgkinson, J. W. McDonald.
A. W. Crossley, E. Grant Hooper, Stephen Mall.
E. V. Evans, H. A. D. Jowett, R. Seligman.
J. T. Hewitt, C. A. Keane.

Hon. Local Secretary and Treasurer:

T. D. Morson, 14, Elm Street, Gray's Inn Road, W.C.

Manchester Section.

Chairman: J. H. Hoscason.
Vice-Chairman: W. Thomson.

Committee:
J. Allpass, L. Blundell, A. Lapworth.
E. Arden, Bertram Hart, E. F. Morris.
E. F. Armstrong, J. Huchner, A. Worthington.
J. Baddiley, A. C. Dunningham.

Hon. Local Secretary:

L. E. Vlies, Belmont, Gowan Road, Alexandra Park, Manchester.

The following take office after the Annual General Meeting:—
Chairman: W. Thomson; *Vice-Chairman:* (not elected); *Committee:* W. Andrews, A. C. Dunningham, W. B. Hart, J. D. Paton, L. G. Radcliffe, S. Smith.

Newcastle Section.

Chairman: H. Peile.
Vice-Chairman: T. W. Lovibond

Committee:
P. P. Bedson, J. T. Dinn, G. P. Lishman.
C. Bodde, F. C. Garrett, J. H. Patterson.
S. H. Collins, T. Hardie, H. D. Smith.
W. Diamond.

Hon. Local Secretary:

E. F. Hooper, Pilgrim House, Newcastle-on-Tyne.

New England Section.

Chairman: Robert W. Neff.
Vice-Chairman: Prof. L. A. Olney.

Committee:
E. L. Atteaux, C. L. Gagnebin, Hervey J. Skinner.
Eugene Barry, A. H. Gill, F. H. Thorpe.
R. L. Chase, Chester A. Howe, W. S. Willans.
W. C. Durfee, W. D. Livermore, S. W. Wilder.
Walter E. Piper.

Hon. Treasurer:

Frank W. Atwood, 216, Milk Street, Boston, Mass., U.S.A.

Hon. Local Secretary:

A. A. Clafin, 176, Federal Street, Boston, Mass., U.S.A.

New York Section.

Chairman: Jerome Alexander.
Vice-Chairman: C. E. Sholes.

Committee:
C. Baskerville, D. W. Jayne, Utley Wedge.
S. R. Church, A. C. Langmuir, M. C. Whitaker.
Carleton Ellis, H. S. Miner, H. Wigglesworth.
W. M. Grosvenor, Gilbert Rigg.
Martin H. Ittner.

Hon. Treasurer: Frank C. R. Hemingway, Bound Brook, N.J. U.S.A.

Hon. Local Secretary:

Allen Rogers, Pratt Institute, Brooklyn, New York, U.S.A.

Nottingham Section.

Chairman: R. M. Caven.
Vice-Chairmen: S. R. Trotman and John White.

Committee:
T. H. Adams, B. Collitt, C. E. B. Merriman.
L. Archbutt, R. Duncahe, A. Smith.
M. Barrowcliff, J. H. Dunford, J. T. Wood.
F. H. Carr, F. Stanley Kipping.

Hon. Treasurer:

S. J. Pentecost, Lenton Works, Nottingham.

Hon. Local Secretary:

J. M. Wilkie, 5, Balmoral Avenue, West Bridgford, Nottingham.

Sydney, N.S.W., Section.

Chairman: H. G. Smith.
Vice-Chairman: C. E. Fawsitt.

Committee:
R. W. Challinor, R. Greig-Smith, Loxley Meggitt.
F. A. Coombs, G. Barker, B. J. Smart.
J. B. Granger, A. B. Hector.

Hon. Local Secretary and Treasurer:

S. E. Sibley, c/o Messrs. Mauri Bros. & Thomson, Castlereagh Street, Sydney, N.S.W.

Yorkshire Section.

Chairman: J. W. Cobb.
Vice-Chairman: W. McD. Mackey.

Committee:
A. M. Aubin, J. Evans, C. H. Hardy.
James E. Bedford, C. P. Finn, F. W. Richardson.
B. A. Burrell, W. M. Gardner, J. T. Thompson.
S. H. Davies, A. G. Green, Geo. Ward.

Hon. Local Secretary and Treasurer:

T. Fairley, 17, East Parade, Leeds.

Official Notices.

ANNUAL GENERAL MEETING, 1917.

In accordance with the provisions of By-law 61, notice is hereby given that the Annual General Meeting will be held in The University Buildings, Edmund Street, Birmingham, at 10.30 a.m. on Wednesday, July 18th, 1917. A programme of the proceedings will be issued later.

In accordance with the provisions of By-law 21, those members whose names are printed in *italics* in the List of Council will retire from their respective offices at the forthcoming Annual Meeting.

Prof. Henry Louis has been nominated to the office of President under By-law 20; Dr. Charles Carpenter has been nominated Vice-President under By-law 20; Mr. John Gray, Mr. A. R. Ling, Prof. R. F. Ruttan, and Mr. J. T. Wood have been nominated Vice-Presidents under By-law 21.

Members are requested to nominate on or before May 23rd next, fit and proper persons to fill four vacancies among the ordinary Members of Council. Forms for this purpose can be obtained from the Secretary of the Society.

By-law 23:—An Ordinary Member of Council shall be nominated by ten or more members upon Form B in the Schedule, a copy of which form shall be furnished by the Secretary upon the written or verbal request of any member, but a member shall not be eligible to sign more than one such nomination form, and the member nominated shall sign the declaration set forth on the form. A nomination shall be declared invalid by the Council if:

a. The member thereon nominated is disqualified for election, or ineligible to be elected, as provided by the By-laws.

b. The nomination is not made on the authorised printed form or substantially not in the manner directed thereon.

c. The nomination form is signed by less than ten members not disqualified or not ineligible to nominate as provided by the By-laws.

d. The nomination form is not received before or upon the day appointed therefor.

e. The member nominated has not signed the declaration printed upon the form.

A member whose nomination aforesaid is declared to be invalid, shall receive notice thereof from the Secretary, and shall not be submitted for election.

J. P. LONGSTAFF,
Secretary.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY.

The first volume of these reports is now ready. As the issue is strictly limited, those who desire to obtain copies are advised to apply for them without delay. The price is 3s. to members and 5/6 to non-members, including postage.

REFRACTORY MATERIALS RESEARCH.

In the last issue of this Journal, page 370, reference was made to the appointment of a Committee on Refractory Materials Research, which is collecting data as to (A) the extent of such research work now in progress; (B) the facilities for research existing in this country;

(c) the facilities for collecting published information on refractory materials and making it generally available. This Society is represented on the Committee by Prof. J. W. Cobb, of the University, Leeds, who will be glad to receive particulars of problems in regard to refractory materials, especially in relation to the chemical industries, which call for immediate attention.

OUTPUT OF HIGH BOILING TAR ACIDS.

The Army Council have issued an Order, under date 11th April, requiring the occupiers of the factories and/or workshops specified in the Schedule hereunto annexed to place at the disposal of the Army Council the whole output of: (1) The high boiling tar acids capable of being produced at the said factories from such blast furnace creosote oil as may be supplied to them by or on behalf of the Director of Army Contracts between 16th April, 1917, and 15th July, 1917, and (2) such spent oil as may remain over from the manufacture of such high boiling tar acids; and to deliver such high boiling tar acids and spent oil in such manner as may be directed by or on behalf of the Director of Army Contracts; and to furnish to the Director of Army Contracts such information as to the cost of, and profit on, the production of the high boiling tar acids as he may cause to be required and to verify the information aforesaid in such manner as he may direct.

Schedule. W. Baird & Co., Ltd., 168, George Street, Glasgow. British Phenoloids Co., Ltd., Gables Road, Irvine, Carnbroe Chemical Co., Ltd., 14, St. Vincent Place, Glasgow. David Colville & Sons, Ltd., Glengarnock Steel Works, Glengarnock. W. Cooper & Nephews, Kelvindale Works, Lochburn, Maryhill, Glasgow. Killgerm Co., Ltd., Cleckheaton, Yorks. Langloan Iron and Chemical Co., Ltd., Coatbridge. National Tar Products, Ltd., Barhead, Newton, Chambers & Co., Ltd., Thorncliffe, near Sheffield. Quibell Bros., Ltd., Newark. Robert Young & Co., Ltd., 38, Elliott Street, Glasgow.

INTERESTS OF BRITISH AND ENEMY SUBJECTS IN PATENTS, TRADE MARKS, AND DESIGNS.

According to an announcement issued by the Foreign Trade Department of the Foreign Office, under date 13th April, every person, or body of persons, incorporated or unincorporated, resident, carrying on business or being in the United Kingdom, is granted full licence and authority to apply on behalf of any person, or body of persons, whose name now is, or shall hereafter be, placed on the Statutory List of persons with whom trading is forbidden by any Proclamation issued under the Trading with the Enemy (Extension of Powers) Act, 1915, for the grant, or for the renewal of the grant, of any letters patent, or for the registration, or for the renewal of the registration, of any trade mark or design in the United Kingdom, or in any part of His Majesty's Dominions outside the United Kingdom, where such applications are allowed by the Government of that part of His Majesty's Dominions to be made on behalf of persons, or bodies of persons, whose names are on the Statutory List, and for that purpose to transact all necessary business with regard to the application, and to all matters arising thereout with the person, or body of persons, on whose behalf the application is made, and generally to do all things necessary for carrying the application into effect, and in particular to pay any fees payable in the United

Kingdom, or in any such part of His Majesty's Dominions outside the United Kingdom as aforesaid (provided that no fees be paid to any person, or persons resident or carrying on business outside the United Kingdom, unless such person or persons is or are permitted by the Government of that part of His Majesty's Dominions in which he or they is or are resident or carrying on business, to pay fees on behalf of persons or bodies of persons whose names are on the Statutory List), and to pay and retain any charges or expenses incurred in relation to the matter aforesaid.

DEALINGS IN LEAD. MINISTRY OF MUNITIONS ORDER.

The Minister of Munitions has issued an Order as follows, dated April 6, 1917:—

1. No person shall until further notice purchase, sell, offer to purchase or sell, or, except for the purpose of carrying out a contract in writing existing prior to April 6th for the sale or purchase of white lead, lead oxides, lead manufacture, lead alloys or lead compounds of any kind, or a contract in writing existing prior to the 2nd February, 1917, for the sale or purchase of any other kind of lead, enter into any transaction or negotiation in relation to the sale or purchase of lead situated outside the United Kingdom except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions.

2. No person shall until further notice offer to purchase, purchase or take delivery of any lead situated in the United Kingdom except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions, or offer to sell, sell, supply or deliver any such lead to any person other than the holder of such a licence and in accordance with the terms thereof; provided that no such licence shall be required in the case of any offer to sell or purchase, sale, purchase or delivery of such lead:—

(A) For the purpose of a contract or order for the time being in existence certified to be within Classes "A" or "B" in the Order of the Minister of Munitions as to priority (see this J., 1917, 356).

(B) For the purpose of necessary repairs or renewals requiring immediate execution and involving the use of not exceeding 1 cwt. of lead and not exceeding 28 lb. of white lead, lead oxide or lead compound.

3. No purchase or sale of lead situated in the United Kingdom, or offer to purchase or sell any such lead, whether such purchase, sale or offer is or is not under any licence issued under the authority of the Minister of Munitions, shall in the case of any class of lead specified in the schedule hereto be at a price exceeding the price set opposite the same in the said schedule.

4. No person shall until further notice use any lead for the purpose of any manufacture or work except:—

(A) For the purpose of a contract or order for the time being in existence certified to be within Classes "A" or "B" in the Order of the Minister of Munitions as to priority.

(B) For the purpose of necessary repairs or renewals involving the use of not exceeding 1 cwt. of lead and not exceeding 28 lb. of white lead, lead oxide or lead compound.

(C) For the purpose of type casting from metal already in the form of type on the 2nd February, 1917, or from lead purchased for that purpose prior to that date.

(D) Under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions.

5. All persons shall within seven days from the

first day in each month send in to the Director of Materials (A.M.2. (E)), Hotel Victoria, Northumberland Avenue, London, W.C.2, monthly returns of:—

(A) All lead held by them in stock or otherwise under their control on the last day of the preceding month, the lead actually in stock to be shown separately.

(B) All lead purchased or sold by them for future delivery and not yet delivered on such last day.

(C) All lead delivered to them during the preceding month.

(D) All contracts or orders existing on the last day of, or entered into during, the preceding month requiring for their execution the use of lead for any purpose, specifying the amounts of lead required monthly for the purpose of such contracts or orders, and distinguishing between the amounts required for work certified to be within Classes "A" and "B" respectively in the said Order of the 8th March, 1917, and the amounts required for other purposes.

Notwithstanding the above, no return is required from any person whose total stock of lead in hand and on order for future delivery to him has not at any time during the preceding month exceeded 1 cwt.

6. For the purpose of this Order the expression lead shall mean pig lead, whether virgin or remelted, sheet lead, lead pipe, and old scrap lead, white lead, whether dry, in oil, or prepared for use, lead oxides, lead manufactures, lead alloys, and lead compounds of every kind, or any of them.

7. All applications for licences to purchase or use lead shall be made to the Director of Materials (A.M.2. (E.)), Hotel Victoria, Northumberland Avenue, London, W.C.2, and marked "Lead Licence."

8. The Order of the Minister of Munitions dated the 2nd February, 1917, relating to certain classes of lead is hereby cancelled, but such cancellation shall not affect the previous operation of that Order or the validity of any action taken thereunder, or the liability to any penalty or punishment in respect of any contravention or failure to comply with the same prior to its cancellation, or any proceeding or remedy in respect of such penalty or punishment.

Schedule of maximum prices.

Pig lead. Virgin pig lead, £29 per ton net ex ship, £30 per ton net ex store or ex refiners' works. Scrap lead or remelted scrap lead, £26 per ton net ex sellers' premises.

Manufactured lead. Sheet lead, £39 10s. per ton; lead pipe, £40 per ton, delivered United Kingdom, less 2½% monthly account; the usual trade extras and allowances to apply. The rate of exchange between chemical houses and manufacturers of chemical sheet lead, for the old lead in pig lead shape, to be £8 per ton net for sheet lead and £8 10s. per ton for lead pipe, the manufacturer paying cost of delivery of the old lead; the sheet lead or lead pipe to be delivered United Kingdom. The usual trade extras to apply.

Lead compounds. Dry white lead, £16 per ton, less 5% monthly account, delivered United Kingdom. The usual trade extras and allowances to apply.

White lead in oil, £53 per ton, less 5% monthly account for deliveries in packages of 5 cwt. and over; £55 per ton, less 5% monthly account, for lots of less than 5 cwt. White lead in packages less than 5 cwt. to be charged at the customary trade extra for packing.

These prices for white lead in oil are based on a price of £50 per ton as the spot price for raw linseed oil in barrels. If the average daily spot price of raw linseed oil during the preceding month rises or falls by multiples of £6 then the above maximum price of white lead in oil shall rise or fall

by 10s per ton for every £6 per ton rise or fall in the price of linseed oil.

Red lead and litharge. £42 per ton, less 2½% monthly account, in 5 cwt. casks delivered United Kingdom. The usual trade extras and allowances to apply.

Note.—Licences to purchase and take delivery of lead situated in the United Kingdom will usually be granted by the Minister of Munitions under the above Order for necessary repairs and renewals in the ordinary course of trade, and will also be granted for any other purposes which may be approved by the Minister of Munitions, including manufacture for the purposes of export trade.

Every applicant for a licence must state the amount of lead required by him per month and the use to which it will be put.

MANUFACTURERS' ADVISORY COMMITTEE.

A Manufacturers' Advisory Committee to the Ministry of Munitions has been formed. It consists of Mr. G. Mure-Ritchie and Mr. Douglas Vickers, who are connected with a number of mining, metallurgical, railway, and engineering enterprises; Mr. George Terrell, M.P. (nominated by the British Manufacturers' Association), representing the interests of the smaller manufacturers; Mr. R. G. Perry, of Messrs. Chance and Hunt, and Mr. H. G. McGowan, of Nobel's Explosives Co., representing the chemical and explosives industries; and Sir Frederick H. Smith, representing the textile industries.

MALT (RESTRICTION) No. 2 ORDER.

A further malt restriction Order, issued by the Food Controller under date 12th April, makes it illegal, except under licence, to manufacture any further malt, to sell or deliver any malt, or for anyone other than a brewer for sale to use malt for any purpose. The effect of this Order is to prevent home brewing, and it will apply also to the manufacture of any non-alcoholic liquors containing malt.

MANUFACTURE OF FLOUR AND BREAD ORDER.

By the Manufacture of Flour and Bread Order (No. 3), 1917, the Food Controller increases the percentage of flour from other cereals to be mixed with wheaten flour, from a maximum of 15% to a maximum of 25%, and from a minimum of 5% to a minimum of 10%.

FLOUR MILLS ORDER, 1917.

Acting on the powers conferred upon him by the Flour Mills Order, 1917, dated April 20th, the Food Controller takes over, as from April 30th, all flour mills in the United Kingdom which, on the date of the Order, used wheat in the making of flour, except those having an output capacity of less than five sacks of flour per hour.

The Food Controller has also issued an order forbidding the use, after April 28th, of any wheaten or rice flour, or of their products, except for human food; and any person who wastes, or permits to be wasted, any flour or article containing it will be guilty of an offence against the Defence of the Realm Regulations.

London Section.

Meeting held at Burlington House on Monday, April 2nd, 1917.

MR. A. E. LING IN THE CHAIR.

FURTHER NOTES ON THE ACTION OF ACETIC ACID ON ALUMINIUM.

BY RICHARD SELIGMAN, PH.D., AND P. WILLIAMS.

Introductory.

In an earlier paper (this Journal, 1916, 35, 88 *seq.*) the action of boiling concentrated acetic acid and some of its homologues upon aluminium was described, and reasons were given for the separate treatment of this section of the subject.

The present communication deals with the action of boiling acetic acid of lower concentrations, and also of acetic acid of all concentrations at ordinary temperatures. In addition the effect of the presence of small quantities of various substances in the acetic acid has been determined.

Action of boiling dilute acetic acid. The action of boiling acids of lower concentrations has been found to be analogous to that of the solutions containing between 100% and 50% acetic acid previously examined, and it has been found that the rate of dissolution of the aluminium rises continuously until the concentration of the acid falls to 1%. With acids of lower concentration than 1% it is not possible to obtain reliable figures owing to the fact that the metal becomes coated with a protective skin which interferes with the action of the acid. Even with solutions containing 5% acetic acid the numerical results become erratic owing to the same cause, but it is, nevertheless, possible to conclude definitely that where unprotected by a coating the aluminium dissolves at an ever-increasing rate.

The experiments made with boiling dilute acids had not proceeded far before it was found that the rate of dissolution was very much affected by the products of the interaction, and for this reason it became necessary to investigate the effect of fresh acid as well as that of acid already saturated with such products. It was found that this disturbance grew very rapidly with increasing dilution, so that in the case of acid of 1% concentration the rate of dissolution rose as the experiment proceeded to more than five times its initial value. It is not yet possible to assign a definite cause to this phenomenon and it is difficult to see which of the products of the interaction could account for so great an increase in the rate of dissolution. For a time the only possible explanation appeared to be that the acetate formed played some part, but it has since been found that acid which has become thus highly active with regard to aluminium can be distilled without change in its activity. Consequently, whatever it is that causes the rise in the rate of dissolution must be volatile, or else during the early course of the interaction some inhibiting substance or condition is eliminated.

This question is still under investigation, but it is obvious that a practical deduction can already be made from the facts observed. Where aluminium vessels are to be used in connection with dilute acids the greatest care must be taken in their design to avoid small recesses or pockets in which the circulation of the contents cannot take place freely, and in which, therefore, the products of the interaction can accumulate. Attention has been drawn to this fact in considering the effect of other acids on aluminium (this Journal, 1916,

35, 665 *seq.*), and the correctness of the view now expressed is fully borne out by experience in practice. The facts recorded here also explain why aluminium articles in contact with these acids invariably last much longer if subjected to frequent and rigorous cleansing operations than if left in contact with fouled contents.

During the experiments about to be described it has frequently been observed that at the very outset the rate of attack is rapid, but that the initial rate quickly falls and thereafter remains approximately constant until the accumulation of products of the interaction brings about the rise already referred to. As the main object of the experiments has been to reproduce practical conditions, the figures given in the tables for the initial rate of dissolution are those observed when the rate of attack had become constant, because in practice it is only necessary to consider repeated attack on the same metal by fresh acid and continuous attack by acid which is not frequently renewed and therefore becomes saturated with the products of the interaction. The case of fresh metal attacked by fresh acid need not be considered.

Solutions of acetic acid boiled in contact with aluminium become turbid after a period which is short or long according to the concentration of the acid, and the nature of the turbid solutions produced varies in different cases. Acids of concentration between 60% and 5% give rise to turbid solutions which clear on standing or on the addition of hydrochloric acid. The white precipitate which separates on standing dissolves readily in dilute hydrochloric acid. Little or no deposit is formed on the aluminium strip itself, and if any deposit be formed it is loosely attached and always readily removable. Such turbidity appears to be due to the separation of basic acetate or acetates of aluminium. In the case of acids of about 0.2% concentration the turbid solutions do not clear on standing, and the addition of dilute hydrochloric acid or caustic soda produces a flocculent precipitate which does not readily dissolve in boiling dilute hydrochloric acid. Such solutions give rise to a deposit which adheres firmly to the aluminium and is not removed readily either by chemical or mechanical means. It is considered that the turbidity in these cases may be due to the formation of a colloidal solution of aluminium hydroxide. Solutions containing between 5% and 0.2% of acetic acid give rise to turbid solutions of intermediate character. Thus, for instance, the solution produced by acid of 1% concentration falls into the second category with regard to the permanence of the turbidity, the formation of the precipitate by hydrochloric acid or caustic soda, and the insolubility of the precipitate, but the deposit is loose and does not adhere to the aluminium as in the case of more dilute solutions of acetic acid.

The amount of dissolved aluminium necessary to produce turbidity naturally varies with the concentration of the acid. It is found to increase as the concentration falls, and is at a maximum with acid of about 10% concentration.

In all cases where the action of boiling acetic acid of whatever concentration has been examined, the attack is uniform and no evidence of local action has been observed. The only exception is formed by anhydrous acetic acid as described in the previous communication (*loc. cit.*).

Cold acids. The rate of attack by cold acetic acid is in general small. As in the case of boiling acids, the rate of dissolution increases with increasing dilution of the acid, and the highest rate so far noted took place with a solution containing 0.02% acetic acid. The rate of dissolution is frequently high at first, but rapidly falls off and then remains approximately constant over prolonged periods. This phenomenon has not been

explained so far but does not appear to be of practical importance.

The attack is in most cases uniform, but between concentrations of 70% and 95% local action has frequently been observed, and where such local action takes place the rate of dissolution is also greater than would be expected from comparison with the figures given by acids of lower and higher concentrations. Local action has also been observed where the metal has been allowed to remain for prolonged periods in undisturbed contact with thin films of the dilute acid, which had thereby been subjected to intensive aeration. Indeed, the main factor determining local action appears to be the presence of oxygen, although there is evidence that some other factor plays a part. In the previous communication, cited above, the following statement was made: "It was considered at the outset of the experiments made to determine the conditions governing the rate of attack that the presence or absence of air might be the main factor, but this assumption was found to be erroneous although there was some evidence that in the absence of oxygen dissolution is more uniform than when oxygen is present."

In dealing with cold acetic acid it has been possible to show conclusively the effect of oxygen in promoting local action. Acids which normally cause local action of a serious kind can be made to act perfectly uniformly if the oxygen be entirely removed or if it be replaced by some inert gas. No doubt this accounts also for the fact that acids which in the cold or even at temperatures slightly below boiling point cause local action, nevertheless act perfectly uniformly at boiling temperatures when the oxygen is rapidly removed in the course of ebullition.

In the case of cold acids it has been found, moreover, that the actual rate of dissolution is increased by the presence of oxygen, and may be reduced to less than half its original magnitude if the oxygen be replaced by hydrogen.

Here again it may be well to point the practical moral of the observations made. Vessels used to contain solutions of these acids should not be allowed to remain wet for prolonged periods after being emptied and before cleaning. In such cases the metal is exposed to the action of thin films of acid subjected to intense aeration and, as practical experience has amply demonstrated, local attack frequently ensues. The metal should be purged as soon as possible of any remaining acid and, where practicable, left dry.

One of the original objects of this research was to find an explanation of the fact that in stills used for the distillation of acetic acid the still proper was often found to have a prolonged life whereas the condensers, notably in their lower part, were frequently subjected to rapid deterioration and to local perforation. It would appear that the effect of oxygen in promoting and localising such attack affords a sufficient explanation of this phenomenon, because it is precisely at the point where this attack has been observed in condensers that oxygen would have access to surfaces bathed in hot acids.

The question arises whether difficulties due to this cause could not be completely obviated by the introduction of some neutral gas at this point, or by preventing altogether access of oxygen to the condenser?

The effect of various foreign substances upon the rate at which aluminium dissolves in acetic acid has been referred to by many authors, but revision seemed desirable. It has been found that with dilute acids of about 10% concentration the addition of up to 1% of sodium chloride, potassium bromide, potassium iodide, or potassium nitrate has practically no effect in the case of boiling acid, whereas an equivalent amount of sodium sulphate raises the rate of dissolution appreciably. In cold

10% acetic acid, however, 1% of sodium chloride is sufficient to raise the rate of dissolution tenfold, whereas potassium bromide effects a much smaller increase in the rate of attack, and potassium iodide and potassium nitrate none at all. 0.5% of sulphuric acid in the form of sodium sulphate raises the rate of dissolution fourfold in the case of dilute acid at normal temperature.

Dealing with strong acids of about 80% concentration in the cold, 1% of sodium chloride was found to raise the rate of dissolution from 3.6 to 270 mgrms. of aluminium dissolved per hundred sq. cms. per 24 hours. The same amounts of potassium bromide and potassium iodide increase the rate of dissolution approximately tenfold, but 0.5% of sulphuric acid in the form of sodium sulphate cannot be said to have any effect on the rate of attack by 80% acid in the cold, and potassium nitrate reduces the rate of dissolution to one-fourth of its previous value. The most serious effect of the addition of the substances experimented with was noted in the case of 80% acid at boiling point. Here the rate of dissolution is raised by 1% of sodium chloride from 290 to 16,000. By 1% of potassium bromide the rate is only increased from 290 to 485, whilst potassium iodide and potassium nitrate may be said to have no effect; 0.5% of sulphuric acid in the form of sodium sulphate somewhat increases the rate of dissolution.

It will be seen throughout these experiments that the effect of the addition of chlorides to acetic acid is far greater than that of the addition of bromides or iodides. It was to be assumed that this was due to the fact that aqueous hydrochloric acid alone attacks aluminium much more readily than aqueous hydrobromic acid, and this was found to be the case, the rate of attack by half normal hydrochloric acid being at least tenfold that of the equivalent hydrobromic acid solution. It also appeared that the presence of potassium iodide had very little effect upon the rate of attack by hot acetic acid, but had considerable influence in the cold. This was found to be due to the fact that if acetic acid containing potassium iodide be allowed to stand, free iodine is rapidly produced, and in solutions containing free iodine the attack upon aluminium is considerable. If the free iodine be removed from cold acetic acid solutions in which it has been formed, the rate of attack falls to that of the acid alone.

The form of attack by acids to which the salts named had been added was such that acids which without addition attack aluminium in a uniform manner were not affected by the addition of these salts, except that where the rate of attack was raised considerably, etching of the surface could be observed.

Where, however, the acids alone caused local action, such local action was generally promoted by the presence of halogens, but retarded by the presence of small quantities of sulphuric acid and absolutely inhibited by as little as 0.1% nitric acid. It is hoped that there may be cases where this fact can be taken advantage of in practice.

Experimental.

The general arrangements adopted in the experiments about to be described followed closely the lines laid down in the previous communication (*loc. cit.*). The metal used was in the form of thin rolled strips 70 × 25 × 0.5 mm. thick. The composition of the metal was Si 0.45%, Fe 0.45%, Cu 0.00, Al (by diff.) 99.1%. Unless otherwise stated the metal was annealed before the experiments for 3 hours at 450°C. The surface of the aluminium was cleaned, first with caustic soda and then with dilute nitric acid immediately before each determination of the rate of dissolution.

As in the previous communication so here all numerical results are given as milligrammes of

aluminium dissolved per 100 sq. cm. per 24 hours and denoted thus (S.R.).

Series A. The experiments of this series were made with a view to determine the effect of boiling acids of lower concentration upon aluminium and thus to complete Table II. of the previous communication.

In view of the part played by the products of the interaction the bulk of acid used is naturally of importance. Throughout these experiments, except in the case of those conducted in sealed tubes, the quantity of acid used was either 1000 c.c. or 70 c.c. In the former case the experiments were conducted in a conical Jena flask fitted with a reflux condenser. In the latter a boiling tube served to contain the acid. In order to prevent evaporation the boiling tube was lightly stoppered by means of a narrower glass tube through which cold water was passed. The strips of metal were, in both cases, carried in a light frame made of glass.

Various samples of acid were used without marked differences in the rates of dissolution being observed except where the concentration was 5%, in which case the formation of a crust of acetate probably affected the figures.

The numerical results obtained are shown in Table I. With a view to facilitating comparison the figures given in Table II. of the previous communication are repeated here in brackets. In addition to the initial rates of dissolution, the rates when the acid had become saturated with the products of the interaction have been tabulated as well as the amount of aluminium dissolved when the solutions were first seen to be turbid.

TABLE I.

Concentration of acid.	Initial rate of dissolution.	Final rate of dissolution.	Grams. of Al dissolved per 100 c.c. which produce turbidity.
99.9%		S.R. = (7)	
98		(35)	
90		(165)	
80		(295)	
70		(330)	
60	S.R. = 390	(405) 410	0.11
50		(415) 420	
40	445	492	0.157
20	450	533	0.19
10	275	582	0.24
5	350	610	0.20
1	230	1200	0.058
0.2	60	770	

In the case of the 1% and 0.2% acids the results fluctuated considerably, due it is assumed to the formation of a protective crust. Therefore the figures given for the final rate of dissolution are the highest noted. In the case of the 0.2% acid no reliance is to be placed upon the figures. After a few hours solution ceased altogether, the coating formed entirely shielding the metal from contact with the acid.

An anomaly will be noted in the case of the 10% acid, the initial rate of dissolution found being lower than was to be expected. The experiment was, however, repeated several times with similar results, and it appears, therefore, that the figure given is substantially correct.

From this table the increase in the rate of dissolution as the experiments proceeded is clearly apparent, as well as the growth of this factor as dilution increased. In order to demonstrate the course of this change as well as the initial falling off in the rate of dissolution referred to above, one of several experiments with acid of 1% concentration is given in full, the numerical results obtained being shown in Table II. In this case the acid used was a sample purified by distillation over potassium permanganate, the strength, as determined by titration, being 1.07%, and the bulk 1000 c.c.

After the experiment had proceeded for four hours the saturation of the solution was expedited in the case under review by boiling for 1½ hours with some pure aluminium foil, the surface of which is, of course, very large.

TABLE II.

Time in hours from start.	Total weight of aluminium dissolved, grms.	S.R.	Remarks.
1	0.0066	440	Slight deposit on the aluminium
2	0.0094	187	
3	0.0138	295	
4	0.0173	240	
Acid boiled for	1½ hours with	aluminium foil.	Solution turbid.
1	0.5453	1179	
2	0.5628	615	
3	0.5720	659	
4	0.6023	700	
5	0.6192	1130	

The acid being now at its maximum activity was distilled. The distillate was found by titration to contain 1.08% acetic acid, and its concentration was, therefore, practically unchanged. On continuing the experiment the following results were obtained.

Time in hours from start.	Total weight of aluminium dissolved.	S.R.
1	0.0165	1100
2	0.0306	940
3	0.0453	980
4	0.0599	975
5	0.0737	925

With such dilute acids the results are irregular owing to the metal becoming coated, but it is nevertheless clear that the rate of dissolution rose from about 200 to over 1100. It is further clear that acid which attacks aluminium at the higher rate may be distilled without losing its enhanced power of dissolving aluminium. It may be added that the replacement of one sample of aluminium by another of the same composition did not materially affect the rate of dissolution by the same acid.

Series B. The experiments of this series were made to determine the action of cold acetic acid of varying concentration upon aluminium. The numerical results obtained are given in Table III.

TABLE III.

Concentration of acid.	Rate of dissolution.
99.2	0.00
98	0.01
95	0.15
90	0.26
85	0.57
80	0.58
75	0.61
70	0.60
65	0.62
60	0.60
55	0.61
50	0.56
25	0.65
15	0.85
10	0.90
5	0.80
2.5	0.85
1	1.10
0.5	1.4
0.25	1.7
0.1	2.8 (2.2)
0.02	(3.2)
0.004	(1.00)
0.000 (distilled water)	(0.00)

The acid used in the experiments detailed was prepared from a sample of glacial acetic acid purchased. The experiments with acids of from 99.2 to 0.1% concentration were conducted in stoppered bottles of 165 c.c. capacity about three parts full, maintained at a temperature of 20° C., in the thermostat described in a communication to this Society (this J., 1916, 35, 667.)

The experiments with lower concentrations could not be carried out in the thermostat because 1000 c.c. of solution was used in order that the acid might not become unduly neutralised during the course of the experiments. Consequently the temperature was not maintained above about 10–15° C., and the figures which are shown in brackets in Table III. are, therefore, somewhat low but strictly comparable among themselves. The period of exposure was from 5 to 9 weeks, weighings being made weekly.

It will be seen that from 85% concentration down to 25% the rate of dissolution was in this case practically constant, whilst in other experiments made under identical conditions but with different samples of acid the limits of constant rate of dissolution were raised or lowered somewhat. Except in the case of acids of between 70% and 95% concentration the attack, under the conditions of the experiment, was invariably uniform, but between 70% and 95% local action, varying in intensity with different samples of acid, was noted. When the action was markedly local the rate of dissolution was largely increased. Thus, for instance, one sample of acid which at a concentration of 80% caused serious local action dissolved aluminium at the rate of 1.8 mgrms. per 100 sq. cm. per 24 hours, which is three times as fast as the same sample of acid at 70% and 90% concentrations, in which cases the local action was much less pronounced.

Series C. The experiments of this series were designed to elucidate the conditions determining whether the action of acetic acid was general or local. Whilst it cannot be said that all the conditions have so far been determined it now appears certain that in the absence of oxygen no local attack takes place, whatever the other conditions may be.

From the previous paragraphs it will be seen that solutions of equal concentration prepared from various samples of acid differ as to the form of attack, so that although it has not yet been possible to determine what the impurities are, it must be concluded that foreign bodies present in some acids are responsible for local action.

The following experiments appear to be almost conclusive on this point. (1) A sample of commercial acid which was freed from copper and then redistilled was found to attack aluminium locally when at a concentration of 80% in the presence of air. A further quantity of this acid was purified by distillation over potassium permanganate, and then found to attack aluminium very much more uniformly than before treatment.

(2) A different sample of acid was found to cause local action at the outset of the experiment, but after a time no fresh evidence of local action was observed. Moreover after seven weeks contact with strips of aluminium, the latter were removed and replaced by fresh strips. In spite of frequent aeration no local action took place upon these fresh strips during five weeks, and it may, therefore, be concluded that whatever had caused the local action in the first case had been eliminated.

The effect of oxygen. (3) The acid used in Experiment (1) was found to attack aluminium locally, not only in the cold but even more markedly at temperatures slightly below the boiling point of the acid. However, when the acid was raised to the boiling point, whereby the air was eliminated, no further local action could be detected. On passing a current of oxygen through the boiling acid a

small amount of local action took place although as was to be expected, not to so marked an extent as with the acid below its boiling point.

(1) It was possible that during boiling some volatile constituent other than oxygen had been removed from the acid, and therefore further experiments were made to settle this point. Three tubes containing strips of aluminium and a quantity of the acid used in experiment (3) were freed from air by being boiled out and sealed. One of these tubes was opened in an atmosphere of oxygen and one in carbon dioxide, and both then resealed. In the tube containing oxygen local attack commenced within 24 hours and proceeded vigorously. Neither the sample of aluminium *in vacuo* nor that in an atmosphere of carbon dioxide showed any sign of local action during the 3 months for which the experiment was continued. Two further tubes prepared and sealed in the same manner, the one containing oxygen, the other free from oxygen, were heated to 100 C. in a water bath. The sample of aluminium in the tube containing oxygen showed marked local action within 30 minutes, the other remained free from any sign of local attack for over six hours. Oxygen was then admitted to this tube, which was resealed and heated again. Local action was observed within 30 minutes.

(5) A further experiment on this subject may be cited, because it shows the effect of oxygen, not only upon the form but also upon the rate of attack.

Samples of aluminium were sealed in four tubes containing respectively (a) 99% acetic acid *in vacuo*, (b) 99% acid and oxygen, (c) 90% acid *in vacuo*, (d) 90% acid and oxygen, the acid being derived from a different source from that used in the experiments so far described.

The tubes were maintained at room temperature for 130 days. After four days distinct evidence of local action was observed in tube *d*, but to the end of the experiment there was no sign of any but general dissolution in the other three cases.

The rates of dissolution were found to be (a) 0.02, (b) 0.04, (c) 0.08, (d) 0.48.

No weight can be attached to the very small figures obtained with acid of 99% concentration, but the effect of oxygen in promoting the attack and in localising it seems irrefutable in the case of acid of 90% concentration.

(6) Finally an experiment was made with very dilute acid in atmospheres of air, oxygen, and hydrogen respectively. The weighed samples were enclosed in glass bottles fitted with rubber stoppers which were furnished with inlet and outlet tubes by means of which the various gases could be admitted, and the bottles then sealed. The dissolved oxygen was removed by boiling before the introduction of the aluminium, and the acid was then allowed to cool in a current of hydrogen, air, or oxygen as the case might be. The bottles were sealed and allowed to stand at room temperature for 91 days, during which time three weighings were carried out. As in most similar cases the rates of dissolution were high at first but soon fell off, only to rise again towards the end of the experiment. Over a period of 63 days the numerical results obtained were: in air S. R. = 1.1, in oxygen 1.0, and in hydrogen 0.26. As in all cases under similar conditions, the attack was uniform.

Series D. The experiments of this series were designed to show the effect of the presence of small quantities of various inorganic acids upon the rate of dissolution of aluminium in acetic acid of varying concentration, both at 20° C. and at boiling temperature. The concentrations selected for the acetic acid were 80% and 10%, and the inorganic acids were added in the form of their salts, this being the most convenient method in view of the very small weights involved. Experiments

were made with hydrochloric, hydrobromic, hydriodic, sulphuric, and nitric acids. The experiments were carried out at various times over a prolonged period, and it was, therefore, not possible to use the same sample of acid for all the determinations. Consequently the rate of dissolution in the acetic acid without addition is given in each case so that a sufficiently accurate comparison of the effect of the addition of various acids may be arrived at.

The main results are shown in tabular form.

TABLE IV.
10% acetic acid boiling.

	Substances added.				
	NaCl	KBr	KI	SO ₄ (as Na ₂ SO ₄)	NO ₃ (as KNO ₃)
Acetic acid without addition	S.R.	S.R.	S.R.	S.R.	S.R.
" " with 0.1%	480	480	480	490	490
" " with 0.5%	500	—	—	690	485
" " with 1.0%	540	480	470	780	510

In all cases the attack was perfectly uniform. Only in the case of sulphuric acid can any appreciable effect upon the rate of dissolution be noted.

TABLE V.
10% acetic acid at 20° C.

	Substances added.				
	NaCl	KBr	KI	SO ₄ (as Na ₂ SO ₄)	NO ₃ (as KNO ₃)
Acetic acid without addition	S.R.	S.R.	S.R.	S.R.	S.R.
" " with 0.01%	0.65	0.9	0.9	0.7	0.7
" " with 0.1%	3.2	1.0	0.85	—	—
" " with 0.5%	4.2	1.5	0.80	2.5	0.8
" " with 1.0%	5.8	2.5	0.80	—	—

In all cases the attack was uniform, but the addition of sodium chloride and also of 0.1% and 1% of KBr gave rise to an etched appearance of the metal.

The solutions containing potassium iodide were faintly coloured by iodine. It will be seen that neither potassium iodide nor potassium nitrate affects the rate of dissolution, but that the latter is very much increased by the addition of sodium chloride and sulphate and potassium bromide.

TABLE VI.
80% acetic acid at 20° C.

	Substances added.				
	NaCl	KBr	KI	SO ₄ (as Na ₂ SO ₄)	NO ₃ (as KNO ₃)
Acetic acid without addition	S.R.	S.R.	S.R.	S.R.	S.R.
" " with 0.01%	3.6	1.2	1.2	2.0	2.0
" " with 0.1%	25	0.6	0.75	—	—
" " with 0.5%	65	1.8	1.5	2.0	0.4
" " with 1.0%	270	10.5	9.5	1.2	0.45

The sample of acid used when free from all added substances gave rise to local action in the course of a few days. The addition of sodium chloride promoted this form of attack in a very marked manner, 1% of this substance giving rise to rapid local disintegration of the metal. In the case of the other two halides no definite effect

upon the form of attack could be established, except that the acid containing 1% of potassium iodide appeared to promote local action to some extent and to a great extent if any free iodine were present. The addition of 0.1% of SO_3 in the form of sodium sulphate retarded the appearance of local action for several months, whilst with acid to which 0.5% of this substance had been added no local action was discernible at the end of four months. No local action could be seen on strips of aluminium exposed for 8 months to acid containing 0.1% of NO_3 in the form of potassium nitrate.

TABLE VII.
80% acetic acid boiling.

	Substances added.				
	NaCl	KBr	KI	SO_3 (as Na_2SO_4)	NO_3 (as KNO_3)
Acetic acid without addition	S.R.	S.R.	S.R.	S.R.	S.R.
" " with 0.01%	290	290	290	290	290
" " with 0.1%	340	—	—	—	—
" " with 0.5%	4400	270	—	336	280
" " with 1.0%	—	—	—	380	260
" " with 1.0%	16,000	485	217	—	—

It was noted that high rates of dissolution were only obtained with acids containing 0.1% and 0.01% of sodium chloride if the metal were boiled in acid containing these admixtures from the start. When the metal was boiled for 1 hour in acetic acid free from sodium chloride subsequent addition of up to 0.1% of this substance had no effect upon the rate of dissolution.

The addition of 1% of potassium iodide at first gave rise to erratic rates of dissolution, which were found to be due to the fact that after standing for a short time these solutions become coloured owing to the formation of free iodine. In the presence of free iodine aluminium was found to be attacked very rapidly, the interaction being accompanied by decolorisation of the solution.

The observation that small quantities of nitrates prevented local action and in some cases actually reduced the general rate of dissolution of aluminium in acetic acid suggested that nitrates might also neutralise the injurious effects of the presence of chlorides, and it was found that this may under some conditions be the case.

Experiment 8.

80% acetic acid at room temperature.

0.1% NaCl added. S.R. = 56.

0.1% NaCl + 0.5% HNO_3 in the form of KNO_3 added. S.R. = 9.0

Experiment 9.

80% acid at 90°–100° C.

0.1% NaCl added. S.R. = 2400.

0.1% NaCl + 0.5% HNO_3 in the form of KNO_3 added. S.R. = 187

Series E. In view of the marked difference shown by the results tabulated above between the effect of the addition of chlorides and bromides to acetic acid, it was naturally assumed that similar differences would obtain between the action of hydrochloric and hydrobromic acids without acetic acid, and as no data were available on this subject the two acids were compared with regard to the rate at which they dissolve aluminium.

At boiling point. Concentration of the acids N/2.

S.R. in HCl = 24,000.

S.R. in HBr = 2,500.

At 20° C. Concentration of the acids 0.686 N.

S.R. in HCl = 50.

S.R. in HBr = 14.5.

DISCUSSION.

The CHAIRMAN having complimented the authors on their valuable work,

Dr. C. A. KEANE pointed out that the character of the reactions due to concentrated and dilute acetic acid respectively must be essentially different and that it might be advantageous to differentiate them in discussing the chemical changes involved. In respect to the action of concentrated acetic acid, had they examined the acetic acid for any reduction products that might be formed? The generation of hydrogen might lead to the formation of acetaldehyde which by local re-oxidation might be concerned with the effects produced upon the aluminium, and it would accordingly be of interest to know whether the presence of acetaldehyde had actually been detected; the aluminium itself might act catalytically in this connection. In the case of dilute acetic acid such an effect was improbable, and in the corrosion by sea-water and tap-water other reactions must be concerned.

Mr. E. J. BOAKE thought, from the samples handed round, and from his experience of the practical employment of aluminium vessels, that the local corrosion of aluminium was due to impurities in the metal. He instanced a case coming under his own observation, where the mercury from a broken thermometer had been spilt in the still; very shortly afterwards the still bottom was found to be perforated, and upon examination there appeared relatively large cavities—many of them almost through the substance of the metal. He further suggested that it would be highly desirable if experiments could be conducted on aluminium of known purity, or failing this that the amount or nature of the impurities should be known, and results noted.

Mr. C. E. BAUS inquired whether the authors had made any experiments with aluminium of varying purity, and if so, was the corrosion increased by some impurities and decreased by others? The film of oxide formed by nitrates present in the acetic acid seemed to exert a retarding action. Had the authors ascertained whether treating an aluminium still with acetic acid containing nitrates prolonged the life of the vessel?

Mr. W. C. REYNOLDS asked whether the presence of traces of ammonium had any effect on the action of acetic acid on aluminium. He pointed out that it was a very common impurity in commercial acetic acid.

Mr. NICHOL said he thought from the appearance of the samples shown that the commercial metal had been used in the experiments, and that possibly chemically pure aluminium might yield different results. He suggested that the more rapid action of acids on aluminium, as the time of immersion increased, might possibly be due to the readiness with which gas might be evolved from a surface already acted upon?

Mr. E. T. BREWIS said that he had known cases of pitting of aluminium and could testify to the necessity of drying vessels after they had been used. Had the authors made any experiments as to the action of a fairly pure water, highly aerated, for example a condenser water which had been passed through cooling towers and become highly aerated?

Mr. FRYER asked whether the figures given for dilute acetic acid might safely be taken as applicable to butyric, propionic and the lower fatty acids generally?

Mr. W. C. HANCOCK considered that although the experiments described seemed to show that oxygen was the cause of the pitting, he agreed with a previous speaker that the action was more likely due to some impurity in the metal. If the corrosion was due to oxygen, how was it that the action was not more uniform over the whole surface? It was difficult to imagine that there were "pockets" of oxygen which localised the pits. He asked the authors if they had made any experiments with

the aluminium partly exposed to the air and partly immersed in the acid.

Mr. BREWIS inquired whether the authors had noticed any difference in the behaviour of aluminium treated in various ways, *e.g.*, cast, hammered, or rolled aluminium, and whether these various metallurgical treatments caused any variations in the resistance to corrosions.

Dr. SELIGMAN, in reply, said that with reference to the discussion which had arisen as to whether these experiments should have been conducted with chemically pure aluminium or aluminium of the purity in use in commerce, he had no doubt that experiments should if possible be carried out with both materials. It was true that experiments carried out with pure material would not be of much direct guidance when considering practical conditions, but on the other hand from experiments with material free from all impurities information would be gained which would be extremely valuable in estimating the effect of impurity, but unfortunately chemically pure aluminium was an unknown commodity. The purest sample of aluminium he had ever had through his hands contained 99.8% of aluminium, and a good many of the experiments which the authors had made with these acids had been done with material of this purity. The present series of experiments had, however, been done with a different metal, and the question of the bearing of the purity of the metal had never been overlooked. The authors were also alive to the possibility of the effects of certain additions to the aluminium not only in accelerating but in some cases in retarding corrosion, and information was gradually being accumulated on this subject. As an example he drew attention to the effect of as little as 0.5% of copper in stopping absolutely the action of mercury upon aluminium, to which Mr. Boake had referred. There were other cases in which the addition of small quantities of other metals had a beneficial effect upon aluminium, and it might ultimately be possible to make use of these facts. He could not agree with Mr. Boake's explanation of the fact that mercury attacked aluminium locally. Mr. Boake appeared to attribute this to the presence at the points attacked of small quantities of impurities, whereas the fact was that wherever aluminium became amalgamated attack developed, but amalgamation only took place under very definite physical conditions which did not prevail over the whole surface of the metal.

He quite agreed with various speakers that the appearance of a sample of aluminium which had been subjected to local attack at once suggested the presence at such points of impurities, and for a long time he had held the view that impurities in the metal were responsible for such occurrences. Gradually, however, he had forsaken this view, especially since almost every investigation made had shown that such impurities as were present in the aluminium were quite uniformly distributed throughout the metal. On the other hand he was now convinced that physical differences in the metal might under certain conditions account for the fact that the attack took place at one point in preference to another. Aluminium became amorphous under the effect of work, and amorphous aluminium was electro-positive to crystalline metal, and therefore it might occur that two adjacent points differed in polarity, and one of them would tend to corrode more rapidly than another. This also answered the question raised by Mr. Brewis as to whether different forms of aluminium showed differences with regard to corrosion. As to the other question raised by Mr. Brewis, the authors had not found that distilled water, even when aerated, caused any other than a general solution of aluminium, but they had not devoted special attention to excessive aeration of such water.

In reply to Mr. Barrs, he said that the effect of washing aluminium with dilute nitric acid prior to an attack by acetic acid had been examined. They had not been aware that, as Mr. Reynolds pointed out, acetic acid contained small quantities of ammonium acetate, and had, therefore, not so far investigated the effect of ammonia upon the rate of attack.

He could not agree with Mr. Nichol's suggestion that the increase in the rate of dissolution was due to the fact that as the surface of the metal became attacked the escape of gas from the surface was facilitated, because the authors had found that once an acid had increased in activity a fresh sample of aluminium immersed therein dissolved at the higher rate.

Mr. Hancock appeared to think that the authors attributed the localising effect of oxygen to the presence of "pockets" of oxygen in the acid, so that action only took place at the points where such pockets of oxygen occurred. The authors had no such idea. They merely stated that in the presence of oxygen the metal was attacked at certain points, but they were still far from being able to say in all cases why the metal broke down at those points and not at others. He wished to repeat that whilst many materials did not attack aluminium locally in the presence of oxygen, no materials which had so far been examined did attack it locally in the absence of oxygen. If aluminium was only partially immersed in acetic acid corrosion took place quickest at the water line, as Mr. Hancock anticipated.

In reply to Mr. Fryer's question, he said that they had examined the effect of a series of other acids and hoped to be able to bring the results forward later. Such figures as they had obtained indicated effects of the same order as those given for acetic acid.

The authors were very interested in Dr. Keane's suggestion that the formation of acetaldehyde might account for the accelerating effect of the products of the interaction upon the interaction. Acetaldehyde was undoubtedly formed during the dissolution of aluminium in acetic acid, but the authors' difficulty had been to explain how a product of the reduction of acetic acid could promote the attack. Dr. Keane's suggestion, as he understood it, was that they would have to look to the re-oxidation of the aldehyde for an explanation of the phenomenon. He could, of course, not say whether there was any substantiation for this view, but the matter would be investigated at once.

Manchester Section.

Meeting held at the Grand Hotel, on Friday, January 12th, 1917.

MR. J. H. ROSEASON IN THE CHAIR.

ESTIMATION OF PHOSPHORIC ACID AND PHOSPHATES BY ALKALIMETRIC METHODS.

BY JOHN H. SMITH, PH.D., F.R.C., A.R.C.S.I.

It is well known that the point of neutrality obtained by titrating phosphoric acid with an alkali differs according to the indicator taken, sodium dihydrogen phosphate, *e.g.*, being indicated as neutral when methyl orange is employed and disodium hydrogen phosphate when phenolphthalein is used. This difference in indication

suggested some useful applications for the special work I was engaged upon, but the results did not possess the accuracy aimed at; and the various and serious irregularities which may be introduced explain why such a method had not been suggested seriously for the estimation of phosphoric acids and phosphates in compounds, but has been confined to the estimation of the strength of solutions of pure phosphoric acid using phenolphthalein as indicator.

Foreseeing the possibility of eliminating the irregularities to a large extent, the author was led to investigate their cause more thoroughly in the hope that some reliable method might result for the analysis of mixtures of phosphates, and applicable to a large number of cases which would occur in ordinary practice, particularly that of the alkaline phosphates.

It was necessary first to find the exact point of neutrality with different indicators, to ascertain whether the end points are sufficiently definite and correspond sufficiently closely to the accepted ones. This necessitated the employment of pure phosphoric acid of known strength and a reliable standard solution of alkali. Caustic soda was selected as the alkali to be employed, but as this is difficult to obtain free from carbonate, a factor was introduced leading to the vitiation of the results. As an illustration of the amount of error which may be introduced from this source, 100 c.c. of strictly normal hydrochloric acid, accurately standardised against pure sodium carbonate dried at 250° C., and requiring 100 c.c. of the standard caustic soda solution in question to neutralise with methyl orange, required 100.6 c.c. with methyl red and 101.3 c.c. with phenolphthalein as indicator. Identical numbers were obtained with 100 c.c. of normal sulphuric acid. This would correspond to about 2.7% of the sodium being present in the form of carbonate.

Although phenolphthalein can hardly be recommended as an indicator for the estimation of carbonates in bulk, the results obtained in the cold, with such small quantities as would occur in the case of their presence as impurities, are satisfactory. For example, 100 c.c. of a *N*/20 solution of pure sodium carbonate required at normal temperature for neutralisation 99.85 c.c. of *N*/20 hydrochloric acid with methyl orange, 93.15 c.c. with methyl red, and 49.25 c.c. with phenolphthalein, but 49.60 c.c. with phenolphthalein when a few grammes of pure sodium chloride had been added to the solution. The end point with phenolphthalein corresponds approximately with the formation of sodium bicarbonate, and is fairly definite, in fact quite satisfactory, after the addition of sodium chloride.

The regularising action of sodium chloride and glycerin in titrations with phenolphthalein has been observed and their addition recommended by other workers. In the case of phosphoric acid and its salts the addition of sodium chloride is also extremely useful and generally preferable to glycerin.

In experiments of this delicate nature it is essential to be convinced with regard to the purity of all the reagents employed, and even the distilled water must be tested by blank experiment. One sample, although quite neutral to phenolphthalein, showed an alkalinity of 6.25 c.c. *N*/10 to methyl orange and 5.0 c.c. *N*/10 to methyl red per litre of water. This seemed to point to the presence of bicarbonates, but the alkalinity was considerably greater than that of the tap water in use.

It seemed interesting to determine what influence small amounts of ammonia and ammonium salts might have upon the results. 100 c.c. of a dilute solution of ammonia required: 100 c.c. of *N*/20 hydrochloric acid with methyl red, 102.8 c.c. with methyl orange, and 91.1 c.c. with phenolphthalein,

but 95.5 c.c. with phenolphthalein after the addition of sodium chloride. In this case again the addition of the salt renders the end point much more definite and brings it nearer to the theoretical 100 c.c. point of methyl red accepted as standard for ammonia.

With sodium carbonate and with ammonia the end points when using methyl orange and methyl red are quite definite and not influenced by addition of chloride.

Returning to the impurity contained in the standard sodium hydroxide solution, it might reasonably be inferred that this could be compensated for by making corresponding corrections in the calculations. This, however, is tedious, and not altogether satisfactory; hence the caustic soda was purified by addition of barium hydroxide. As it was essential that no barium salt should be left in the final solution on account of the precipitation of barium phosphate which would inevitably occur and vitiate the results in the analyses in view, it was necessary to add the barium hydroxide in just sufficient quantity to precipitate the whole of the carbonate present in the caustic solution. Even then a small quantity of the barium carbonate remained dissolved in the caustic soda, and although the barium could be removed by the addition of a sulphate the small proportion of carbonate could not be further eliminated. By this means, however, it was possible to reduce the amount of carbonate from about 2% as found in the best samples of caustic soda in lumps, as sold for analysis, to 0.2%. As only half of the carbonate is indicated by phenolphthalein this means an error of 0.1% when using this indicator, which is almost negligible.

As the barium hydroxide contains a large percentage of carbonate it is necessary to estimate its amount, which may be done volumetrically, using phenolphthalein and methyl orange as indicators; the barium carbonate remaining in the solution and the trace of excess hydroxide which it is advisable to add are precipitated by sulphuric acid after neutralising the solution, and the barium sulphate estimated gravimetrically. An amount of crystallised sodium sulphate equivalent to the barium left in the solution is then added to it. The solution should not be filtered from its precipitates of barium carbonate and sulphate respectively, but allowed to stand over night in closed bottles and decanted carefully. The sodium hydroxide solutions once standardised must naturally be protected from the action of atmospheric carbon dioxide by every possible means.

Titration of phosphoric acid.

A satisfactory sample of phosphoric acid was obtained and proved to be practically pure by ordinary qualitative tests. Ignited in a platinum crucible it gave a mere trace of residue. The specific gravity of the acid was 1.7421 at 17.5° C., which is equivalent to 88.3% H_3PO_4 according to Hager's table of specific gravity. From gravimetric analysis by the magnesia method a mean percentage of 88.605 H_3PO_4 was obtained, and as this is probably the more reliable result 88.6% was accepted as the correct strength.

The hygroscopic nature of phosphoric acid is well known, but the acid does not lose all its combined water when dried at 100° C.; even at 110° C. it was found that 3.25% H_2O remained combined, corresponding approximately to the formula $6\text{H}_3\text{PO}_4 \cdot \text{H}_2\text{O}$.

An amount of the phosphoric acid corresponding to 9.802 grms. of H_3PO_4 (0.1 mol.) required for neutralisation the following amounts of pure *N*/1 sodium hydroxide solution: 101.8 c.c. with methyl orange, 105.4 c.c. with methyl red, and

202.7 c.c. with phenolphthalein. The generally accepted points of neutrality with methyl orange and phenolphthalein are thus shown to be only approximately correct. The end points are, however, quite regular and fairly definite. This has been proved by a large number of comparative tests, so that it would be possible to make estimations of phosphoric acid and phosphates by multiplying the results obtained by the corresponding factors, viz.: 0.9823, 0.9488, and 0.9867 respectively, but the corrections make the work tedious and I have devised a method which makes it possible to dispense with such calculations.

While examining the effect of temperature of solution upon the end point I found that phosphoric acid is particularly sensitive to change of temperature as the following figures illustrate: 100 c.c. of a solution of phosphoric acid containing 32.68 grms. of H_3PO_4 per litre, required with methyl orange as indicator:—32.5 c.c. $N/1$ sodium hydroxide at 70°C ., 33.4 c.c. at 50°C ., 34.0 c.c. at 20°C ., and 34.2 c.c. at 5°C ., while with phenolphthalein the following amounts were required:—66.0 c.c. at 70°C ., 66.9 c.c. at 50°C ., 67.4 c.c. at 20°C ., and 67.6 c.c. at 5°C .. In the first case the theoretical point for NaH_2PO_4 is 33.33, and the second case 66.66 c.c. Curves plotted with these points taken to represent 100% in each case cross the 100% line about 55°C ., so that a mean temperature of 55°C ., may be taken as the best for conducting titrations of phosphoric acids and phosphates, without any necessity of making corrections in the results; this temperature has been adhered to in all further experiments.

Similar comparative experiments with other acids showed that temperature is without effect upon titrations with hydrochloric acid either with methyl orange or phenolphthalein. The same is the case for sulphuric acid, but only for phenolphthalein; with methyl orange accurate results are only obtained at very low temperatures; at high temperatures considerable deviations occur giving errors of more than 1%.

For acidimetric work hydrochloric acid possesses the great advantage over sulphuric acid that it is not affected by temperature, and this acid was usually employed in the subsequent titration of alkaline phosphates. As carbonates are constantly found in combination with the phosphates it was necessary to know how the presence of these affected the results, and a series of experiments on the titration of carbonates was made at various temperatures. Even with methyl orange the deviations are quite appreciable and point to a high temperature being preferable for the titration, unless the solution be boiled on approaching the end point. The results of the experiments indicated that the temperature chosen for titration, 55°C ., is suitable for all the acids with the exception, perhaps, of sulphuric acid with methyl orange.

Although I have shown in a second paper that there is reason to doubt the usually accepted constitution of some of the ordinary alkali phosphates under normal conditions, for convenience of calculation the results will be expressed in terms of NaH_2PO_4 , Na_2HPO_4 , and Na_3PO_4 . There are three definite points in the titrations which enable us to make analyses of a mixture of any three of these compounds, including the possible presence of free Na_2O .

Method of analysis.

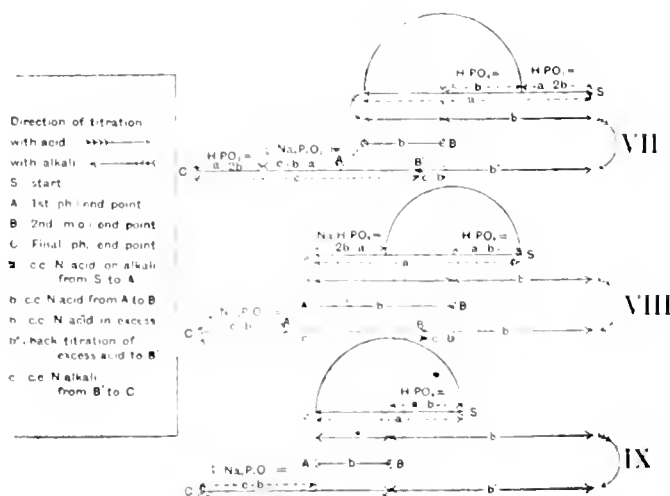
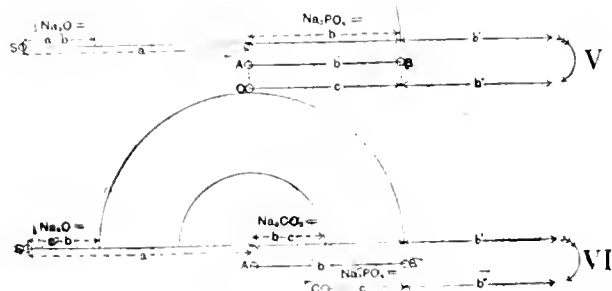
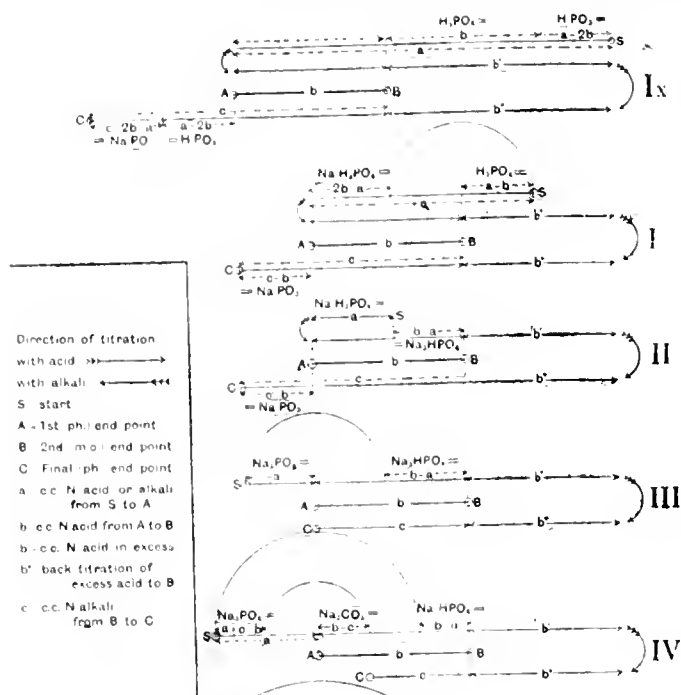
As the phosphates generally crystallise with a large proportion of water it is preferable to weigh out 5 to 6 grammes of the substance to be analysed, to ensure greater accuracy.

After dissolving in a minimum quantity of

distilled water, two drops of phenolphthalein solution are added; if the solution is not coloured pink the absence of Na_3PO_4 and Na_2CO_3 may be assumed. The solution is then heated to 55°C . and kept at this temperature during the whole of the titrations, being particularly careful to have the temperature correct when each end point is nearly reached. In the case under consideration the solution is first titrated with $N/1$ sodium hydroxide until a pink coloration is noticeable. It requires a certain amount of practice to determine the end points, and particularly this first one, with certainty, but once this practice has been attained there is no further difficulty, especially in presence of sodium chloride. One must not expect the same strong pink colour which is found when working with alkali and strong mineral acids; it is more of the nature of the pink coloration obtained with a drop of acid in excess when employing methyl orange as indicator.

This first end point will be called A and the number of c.c. of $N/1$ alkali required to reach this point is (a). The solution is now titrated back with $N/1$ hydrochloric acid with addition of a few drops of methyl orange solution, until the second end point (B) is reached, when the solution changes to a faint pink colour again. The number of c.c. of $N/1$ acid required between the A and B points will be denoted by (b). Now if we know that the solution contains only $\text{Na}_2\text{HPO}_4 + \text{NaH}_2\text{PO}_4$, or $\text{NaH}_2\text{PO}_4 + \text{H}_3\text{PO}_4$, or only one of these compounds, we have sufficient data, because if a is greater than b, $a-b$ represents the amount of H_3PO_4 and b the NaH_2PO_4 , whereas if b is greater than a, $b-a = \text{Na}_2\text{HPO}_4$, and $a = \text{NaH}_2\text{PO}_4$. If $a=b$ then each is equal to the NaH_2PO_4 present and if $a=2b$ only H_3PO_4 is present.

In order to make the method uniform I prefer to proceed further in every analysis and obtain a third end point, C, in the following manner. An amount of normal hydrochloric acid (b') approximately equal to b is added to the solution, which is then boiled vigorously for a quarter of an hour at least. By this boiling any metaphosphoric acid or metaphosphate is converted into the ortho form, while in the case of alkaline salts containing carbonates these will be destroyed and carbon dioxide evolved. After boiling, the solution is cooled again to 55°C . and titrated back with $N/1$ sodium hydroxide first to the B point again in which b'' c.c. of alkali is used and finally to the third end point C, where the phenolphthalein pink coloration is again reached and where the consumption of normal alkali is denoted by (c). In titrating back after boiling, the b' amount of alkali required to reach the methyl orange point where the pink coloration just disappears should always be exactly the same amount as the b' excess of acid added for boiling (except in the case of polyphosphates being present as referred to in my second paper), and in practice this is found to be the case, the difference seldom exceeding 0.05 c.c.; b'' may be less than b' by this quantity owing to a trace of the hydrochloric acid having evaporated, but if care is taken not to concentrate the solution too much no more serious error is likely to occur. In any case, however, it is preferable to consider the point reached after the addition of the b'' quantity of alkali as the identical point with B, so that b' and b'' are not used in the calculations but simply employed as a comparative check upon each other. If now the C point coincides with the A point, i.e., if $c=b$, the possibility of the presence of metaphosphoric acid and its salts, as well as of carbonates, in the original substance is excluded; if c is greater than b the presence of the former is indicated, while carbonates, which so frequently occur with the tribasic alkali phosphates, cause c to be less than b.



It is most convenient in working with normal solutions to consider each c.c. employed as equal to one molecule of NaH_2PO_4 , Na_2HPO_4 , Na_3PO_4 , H_3PO_4 , etc., in their transformation from one stage to another, i.e., in changing between the A and B points, the absolute weights being easily found by multiplying by $\frac{1000}{\text{m.w.}}$ of the respective molecular weights. Similarly the amounts of Na_2CO_3 and Na_2O present in the respective compounds are found by multiplying by $\frac{1000}{\text{m.w.}}$ of their respective molecular weights.

With the aid of the three fixed points A, B, and C, and the amounts of acid or alkali required to reach them, a, b, and c, it is possible to calculate the percentages of practically all the phosphoric acids and their salts which may exist together in a compound, including the carbonates and the free alkali which may be present with them, as shown in the accompanying chart.

In the titration of acid salts where a is greater than b, then $\text{H}_3\text{PO}_4 = a - b$, $\text{NaH}_2\text{PO}_4 = 2b - a$, and $\text{NaPO}_3 = c - b$ (generally nil).

If a were greater than 2b, then $a - 2b$ would be the measure of the metaphosphoric acid or of the foreign acid present.

When a is less than b, then $\text{NaH}_2\text{PO}_4 = a$, $\text{Na}_2\text{HPO}_4 = b - a$, and $\text{NaPO}_3 = c - b$ (usually nil).

With alkaline salts, C coincides with A, i.e., when no carbonate is present, and a is less than b, then $\text{Na}_3\text{PO}_4 = a$ and $\text{Na}_2\text{HPO}_4 = b - a$. Where c is less than b, i.e., where carbonate is present, and a is less than b, then $\text{Na}_3\text{PO}_4 = a + c - b$, $\text{Na}_2\text{HPO}_4 = b - a$, and $\text{Na}_2\text{CO}_3 = b - c$. Where no carbonate is present, and a is greater than b, then $\text{Na}_3\text{PO}_4 = b$ and $\text{Na}_2\text{O} = \frac{1}{2}(a - b)$. Where carbonate is present, and a is greater than b, then $\text{Na}_2\text{CO}_3 = b - c$, $\text{Na}_3\text{PO}_4 = c$, and $\text{Na}_2\text{O} = \frac{1}{2}(a - b)$.

These formulae have been proved to be correct by hundreds of experiments, and by mixtures of standard solutions of phosphoric acid and alkali in nearly every proportion. Comparative tests are concordant within the usual limits of experimental errors; in fact if every precaution is taken, results within 0.5% of accuracy are obtained which can hardly be excelled by other methods of phosphoric acid determination.

It is well, of course, to verify the results in some cases with qualitative tests, particularly in the case of the presence of the meta acid or its salts, and also of the pyro acid and its salts. When the pyro acid is present, point A is obscured and lies much nearer to B, but the correct A point is point C obtained after boiling with excess of acid.

When metaphosphate has been proved to be present it is advisable to repeat the titrations, employing normal sulphuric acid instead of hydrochloric acid, and evaporating to dryness after boiling, when the

last one or two per cent. of the acid is converted into the ortho form which is liable to escape conversion on merely boiling; otherwise, however, it is always preferable to adhere to hydrochloric acid.

On boiling pure acid phosphates in glass beakers or porcelain dishes a portion of alkali is almost invariably dissolved, but there is no difficulty in detecting this as *b''* in this case is less than *b'*. Under the conditions existing when the titrated solutions are boiled, this effect seems, however, hardly appreciable, which may be due to the considerable amount of sodium chloride present in the solution.

I have not been able to confirm the statement in the text books that sodium pyrophosphate is neutral to phenolphthalein, *i.e.*, to such an extent as to make the *c-b* amount quite reliable. In a test with fused sodium pyrophosphate it required 11.8% of the sodium hydroxide necessary to convert it into Na_2HPO_4 , but this may have been due to the partial conversion of the salt into NaH_2PO_4 on dissolving in water.

This method was applied to the examination of some commercial samples of phosphates. A specimen of ordinary sodium phosphate, $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$, was found to contain 38.92% Na_2HPO_4 , 2.41% Na_3PO_4 , and 59.57% H_2O ; theory requires 39.64% Na_2HPO_4 .

A sample of trisodium phosphate, dried at 110°C , contained $\text{Na}_3\text{PO}_4 + \text{H}_2\text{O}$, 26.70%, Na_2HPO_4 , 19.56%, and Na_2CO_3 , 23.95%. On examining the undried salt carefully it was found that the bulk of the crystals had become dried up so that decomposition of the salt from atmospheric influence seemed probable. A few fresh crystals still remained, however, and these contained Na_3PO_4 , 11.90%, Na_2O , 2.01%, Na_2CO_3 , 0.66%, H_2O , 55.43% ($\text{Na}_3\text{PO}_4 + 12\text{H}_2\text{O}$ requires Na_3PO_4 , 43.13%, H_2O , 56.87%). The original salt had probably a similar composition to these selected crystals and had been decomposed by atmospheric carbon dioxide. In my paper on the constitution of the alkali phosphates I shall show that Na_3PO_4 only crystallises with an excess of alkali, so that the above proportion of Na_2O is not to be looked upon as an impurity, and that it is a very unstable compound.

A specimen of sodium pyrophosphate contained $\text{Na}_2\text{P}_2\text{O}_7$, 92.62%, Na_2O , 6.50%, H_2O , 6.12%. In titrating both the pyrophosphate and the ordinary phosphate a small precipitate was found after boiling with the acid and subsequently neutralising with sodium hydroxide.

A compound was examined which was labelled "glacial" phosphoric acid. It was rather soft and lumpy, and seemed to have been dried at a high temperature and afterwards to have absorbed moisture from the atmosphere. It had a strong acid reaction and gave a strong sodium flame reaction. Analysis showed it to contain NaH_2PO_4 , 60.35%, H_3PO_4 , 35.30%, water (by diff.) 4.35%. It is remarkable that this substance with no trace of metaphosphoric acid should have come to be sold as "glacial" phosphoric acid. I presume, however, that it had been produced by heating ortho acid at an insufficiently high temperature, the sodium present being accounted for by the action of the acid on the vessels.

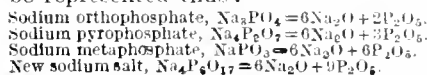
ON A NEW ACID SODIUM PHOSPHATE AND ITS ACTION UPON GLASS, PORCELAIN, SILICA, PLATINUM, AND NICKEL VESSELS.

BY JOHN H. SMITH, PH.D., F.I.C., A.R.C.S.I.

In the course of the experiments described in the foregoing paper relating to the estimation of phosphoric acids and phosphates, I discovered that phosphoric acid is capable of combining with

sodium oxide in a much higher proportion than is represented by sodium dihydrogen phosphate or the metaphosphate.

The composition of the three known forms of ignited sodium phosphates and of the new salt may be represented thus:—



The new salt is easily prepared in an impure state by evaporating mixtures of caustic soda or sodium carbonate and phosphoric acid with a sufficient proportion of the latter and igniting the residue. Any excess of acid is volatilised during the ignition, so that this proportion of acid is evidently the highest with which Na_2O is capable of combining and resisting the high temperature employed. The ignition was finished in a muffle furnace at a bright red heat.

The salt is a fused glassy mass which dissolves slowly in cold, but more readily in warm water, and is nearly neutral to both methyl orange and phenolphthalein.

That the fused residue is a distinct chemical compound is shown by the fact that the substance is stable at a bright red heat, thus excluding the presence of either free orthophosphoric acid or the meta acid, while its neutrality to methyl orange precludes the possibility of its having the composition of $2\text{NaPO}_3 + \text{HPO}_3$ even after solution in cold water. In an actual test it was found that only 8% of the amount of free acid shown in the above formula was indicated by methyl orange.

There is evidence, however, that the new acid salt on prolonged boiling with water is converted into sodium metaphosphate and free orthophosphoric acid, not the meta acid. The sodium metaphosphate does not seem to become converted into sodium dihydrogen phosphate by further boiling with water under these conditions, but if it is boiled with excess of mineral acid, only the ortho acid is found in the solution and no meta acid. To ensure complete conversion it is necessary to evaporate the solution to dryness, and of course sulphuric acid must be employed for quantitative work.

I have never found either sodium metaphosphate or the new salt, which I shall call sodium polyphosphate, to be quite neutral to phenolphthalein, but this is no doubt due to the impossibility of dissolving them even in cold water without a partial change. The figures varied from 12% to 15% of the acidity represented by the salts after conversion into the ortho form, and in the case of $\text{Na}_4\text{P}_2\text{O}_7$ this would not even suffice to bring the excess of P_2O_5 over the meta form up to that condition. It would require one molecule of Na_2O to bring the formula to 6NaPO_3 and another $3\text{Na}_2\text{O}$ to bring this again to $6\text{Na}_2\text{HPO}_4$ after converting to the ortho state, *i.e.*, 25% of the total alkali required is necessary to neutralise the excess of acid.

A remarkable property of sodium polyphosphate is its exceedingly energetic corrosive action upon glass, porcelain, and even platinum and silica vessels. The action was naturally most energetic at the high temperature of fusion, the glaze of porcelain dishes being eaten into, and leaving generally after dissolving out the salt a deposit of granular silica. Silica vessels were also sensibly attacked and silica entered into the composition of the resulting salt. A platinum dish was strongly attacked and became brittle wherever it had been in contact with the fused salt, being torn right across afterwards as easily as a piece of paper. A nickel vessel was attacked until the residue consisted entirely of sodium and nickel pyrophosphates. The corrosive action of the metaphosphate is appreciable, but nothing like that of the polyphosphate. This suggests

a use for the salts in the preparation of phosphates which cannot be obtained under usual low temperature conditions.

This corrosive action rendered it almost impossible to obtain the salt in a pure condition and to determine its exact composition.

By taking a mean of all the experiments a fair approximation to the real composition could be obtained, and I think I am justified in giving the salt the formula I have quoted until some more satisfactory method for obtaining and analysing the pure substance is found.

No reliable quantitative results could be obtained from the experiment in the platinum dish as there was a loss of substance from the holes which were formed in the bottom of the dish by the fused salt. It was exceedingly difficult to get the last traces of salt separated from the platinum; only after separate treatment with boiling hydrochloric and nitric acids and ammonia was this approximately possible, the excess weight of the platinum dish being reduced in this way from 0.075 gram. to 0.010 gram. After the platinum dish had been ignited again in the muffle furnace for one hour at a bright red heat, the metal had regained its original properties but had lost not only the 0.010 gram. excess weight but 0.030 gram. of its own weight.

Several experiments were made in porcelain dishes, which were strongly attacked, the alkali being extracted from the fusible glaze and silica remaining on the bottom of the dish. Concordant results could not be expected under such circumstances, since the action must depend to a large extent upon the conditions of the reaction, and again it is not only the polyphosphate which acts upon the porcelain but the excess of acid, as was proved by an independent experiment.

A pure sample of phosphoric acid which left a mere trace of residue when ignited at a low temperature in a platinum vessel, left 3.15% residue in a porcelain dish, i.e., this proportion of acid had been fixed by alkali abstracted from the dish. As this reaction would be taking place simultaneously with the volatilisation of the excess of acid, it is not necessary to assume that the polyphosphate enters into the reaction until all excess of free acid has been volatilised. In one experiment 6.9 c.c. of *N*/1 caustic soda, together with some water, was added to 1.5 grms. of pure phosphoric acid of 88.6% strength in a porcelain dish and the solution evaporated to dryness. Dried in an air bath at 110° C. the weight of the residue was 1.59 grms.; ignited over a weak Bunsen flame until no more fumes were given off the residue weighed 1.19 grms., while after one hour's fusion in a muffle furnace at a bright red heat the weight of residue was 1.11 grms. After dissolving the salt in hot water the dish had lost 0.015 gram.

If the porcelain glaze was a pure feldspathic one the 0.045 gram. abstracted from the dish would be K_2O . Potassium was present in the solution but its amount was not determined. In the calculations I have considered the 0.015 gram. both as (a) Na_2O and (b) K_2O .

The salt would have the following percentage composition after ignition in the muffle furnace:—

	a.	b.	$Na_4P_6O_{17}$	$NaPO_3$	$Na_2O + 2P_2O_5$	$4Na_2O + 7P_2O_5$
P_2O_5	77.57	78.73	77.45	69.61	82.08	80.0
Na_2O	22.43	21.27*	22.55	30.39	17.92	20.0

* Calculated from K_2O .

The (a) composition is thus exceedingly close to that of the calculated percentage composition of $Na_4P_6O_{17}$ or $2Na_2O \cdot 3P_2O_5$.

The (b) calculation gives 1.3% P_2O_5 in excess which would only be a comparatively small deviation. In any case it seems certain that the proportion of P_2O_5 given in the formula $Na_4P_6O_{17}$ is the least that can be assumed. The next formula of a simple nature which we could consider would be that of $Na_2O + 2P_2O_5$, containing 100% more P_2O_5 than the metaphosphate of sodium. But its percentage of P_2O_5 (82%) is much too high again. If we take the composition of the salt just after ignition over a weak Bunsen flame we find that about 80% P_2O_5 is then present, and this is the highest proportion which could be assigned to the salt. This proportion would correspond to the formula $4Na_2O + 7P_2O_5$. There may be a salt with a higher proportion of P_2O_5 stable at intermediate temperatures but probably not at bright red heat.

A confirmation of the formula $Na_4P_6O_{17}$ was obtained from an experiment in a fused silica dish. Normal caustic soda solution and water were added to 88.0% phosphoric acid and the solution evaporated to dryness in a silica dish, dried first at 110° C., then at 210° C. on the sand bath, and finally ignited for 35 minutes in a muffle furnace at a bright red heat. The portions of the residue soluble in cold water, boiling water, and sulphuric acid, and the insoluble portion were examined by the method described in the preceding paper, and the silica estimated gravimetrically.

With the exception of the acid extract, which had a greater proportion of phosphoric anhydride than necessary to combine with the silica present, all the results approached remarkably closely to the theoretical formula, $2Na_4P_6O_{17} + SiO_2 \cdot P_2O_5$. Whether this is a chemical compound and explains the difficult solubility, or is simply a mixture has not been investigated.

The silica was afterwards examined for associated P_2O_5 but with a negative result.

As far as the sodium salt is concerned I think the results prove satisfactorily that $Na_4P_6O_{17}$ is the formula of the salt formed, the excess of P_2O_5 found being only about 2%.

The action of the salt on nickel is the same as the action when phosphoric acid is boiled down in a nickel vessel, and the residue ignited, only it is much more energetic. In one case where 3 grms. of phosphoric acid was boiled down and the residue ignited, the loss of weight of the dish was 0.068 gram., whereas with 0.7 gram. of $Na_4P_6O_{17}$ after ignition 0.33 gram. of the weight of the nickel dish had been lost, the nickel having been quantitatively converted into pyrophosphate, while at the same time the salt had been reduced to the form of sodium pyrophosphate.

Sodium polyphosphate probably could be employed with advantage in many cases where exceedingly energetic chemical reactions are necessary, e.g., for the disintegration of complex minerals, silicates, etc.

ON THE CONSTITUTION OF THE ALKALI PHOSPHATES, AND SOME NEW DOUBLE PHOSPHATES.

BY JOHN H. SMITH, PH.D., F.I.C., A.R.C.S.I.

While applying the titrimetric method I have advocated for the estimation of phosphoric acids and phosphates (see p. 415) to the analysis of various commercial samples of phosphates, I was struck by the deviations which occurred in their composition as compared with the generally accepted formulae of the salts in question, such deviations being generally in a well-defined direction.

To take the most conspicuous case of the ordinary disodium hydrogen phosphate, it has long been known and remarked upon that this

salt, which theoretically should be neutral to phenolphthalein, is invariably alkaline. It seemed hardly likely that this result could be due in every case to the presence of free alkali or alkali carbonate as an impurity, and as my new method seemed particularly well adapted to elucidate the question, this salt was studied in the first instance.

Disodium hydrogen phosphate.

A particularly pure sample of phosphoric acid was secured which, ignited in a platinum crucible, left the merest trace of residue. The specific gravity was 1.7424 at 17.5° C., corresponding with 88.3% H_3PO_4 in Hager's table. Gravimetric estimation by the magnesia method gave a mean strength of 88.605%, so that 88.6% was accepted as the correct strength. Pure caustic soda in normal solution was employed as alkali.

A standard solution of the phosphoric acid was prepared containing 32.68 grms. of H_3PO_4 per litre; 100 c.c. of this solution is equal to 33.33 c.c., 66.66 c.c., and 100 c.c. of the pure normal alkali solution for the preparation of the theoretical salts NaH_2PO_4 , Na_2HPO_4 , and Na_3PO_4 respectively. From 50 to 100 c.c. of the H_3PO_4 was employed in order to obtain accurate results.

It might be assumed naturally that on adding the solutions in the exact proportions to form Na_2HPO_4 and evaporating there would be no difficulty in obtaining the pure crystallised salt. This was found, however, not to be the case. In the first instance an attempt was made keeping the H_3PO_4 in 2% excess. It was possible to evaporate this solution to 50% content of the dry salt without crystallisation occurring, or at any of the various intermediate concentrations at which attempts were made to crystallise. The solution was then diluted, and the 2% missing alkali added to it. The solution would not crystallise, however, until 0.05 gm. of commercial Na_2HPO_4 crystals, equal to about $\frac{1}{2}\%$ of the total salt, had been added. The crystals were rinsed with water and after dissolving in water were titrated by the method referred to. Neglecting the water of crystallisation they possessed the relative composition:—

93.93 mols. $\text{Na}_2\text{HPO}_4 + 6.07$ mols. Na_3PO_4 .
The mother liquor was also titrated and the missing H_3PO_4 was found quantitatively in it as NaH_2PO_4 .

As the commercial phosphate is made from sodium carbonate instead of caustic soda, a comparative experiment was made by using exactly equivalent quantities of acid and carbonate. The solution crystallised with difficulty and the crystals possessed the relative composition:

100 mols. $\text{Na}_2\text{HPO}_4 + 2.76$ mols. Na_2CO_3 .
The missing acid was again found quantitatively in the mother liquor.

As no carbonate was found in the commercial phosphate another experiment was made and the crystals dried at 110°C. The salt was then found to be quite free from carbonate, and of the composition, 94.48 mols. $\text{Na}_2\text{HPO}_4 + 5.52$ mols. Na_3PO_4 . Commercial phosphate had the composition, 94.6 mols. $\text{Na}_2\text{HPO}_4 + 5.4$ mols. Na_3PO_4 , neglecting the slight foreign impurities it contained.

If these results are reduced to a simpler denomination we obtain one molecule of Na_3PO_4 combined with 15.4 to 17.5 of Na_2HPO_4 . In order to obtain a greater degree of accuracy to find if there is any real difference between the results obtained by employing sodium carbonate instead of the caustic solution another experiment was made with sodium hydroxide solution, adding it to the phosphoric acid in the exact proportion to form $\text{Na}_3\text{PO}_4 + 16\text{Na}_2\text{HPO}_4$. The crystals possessed the composition 1:16.6 while the mother liquor contained the equivalent larger proportion of H_3PO_4 or NaH_2PO_4 . This shows that the results with caustic alkali and carbonate are identical

and that we may accept the proportion of the two salts in the purest form of disodium hydrogen phosphate to be: $17\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{PO}_4$. This seems at least to be the nearest approach to the theoretical formula Na_2HPO_4 which it is possible to obtain under usual conditions.

From the manufacturer's point of view two points are brought out:—

(1) Sodium carbonate may replace caustic soda for the preparation of the salt.

(2) The carbonate should be added in the exact excess represented by the formula, viz., 2.8% reckoned on the pure chemical.

Crystals may be obtained containing a higher proportion of Na_3PO_4 . There seem to be quite a number of these double salts of $\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{PO}_4$ which form well defined crystals. On employing 6% excess of alkali, crystals were obtained having the composition:— $8\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{PO}_4$. The crystals were in lanceolate or lamellar forms and generally arranged themselves in radiating groups producing a feathery appearance. The laminae were thin and belonged apparently to the mono or triclinic systems.

Other double phosphates were also obtained in definite crystals and possessing the following approximate composition:—

$6\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{PO}_4$, in fine rhombic tables with angles of 66°.

$3\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{PO}_4$, in rhombic pyramids with basal planes in parallel grouping forming radiating spires—vitreous lustre.

$3\text{Na}_2\text{HPO}_4 + 2\text{Na}_3\text{PO}_4$, crystallising in very fine needles.

Both the crystals and mother liquors were titrated in order to check the analysis, but the crystals were not always recrystallised and purified.

The water of crystallisation, which was always very considerable, was not estimated.

Sodium pyrophosphate.

It would be expected that this salt would have exactly the same relative composition as the disodium hydrogen phosphate as far as the $\text{Na}_4\text{P}_2\text{O}_7$ and Na_3PO_4 are concerned, and this would no doubt be the case if the pyro salt were prepared by ignition of the disodium hydrogen phosphate and there were no action on the vessels at the high temperature of ignition.

I have not been able to go into this question fully from an examination of self-prepared samples, but I have found commercial samples with less excess alkali than that represented by the formula I have given. It does not follow because the disodium hydrogen phosphate invariably requires the excess of alkali to crystallise which I have stated, that the pyro salt has the same relative composition. It is quite probable that the excess of alkali on ignition is converted into the active form of Na_2O which would be free to act on the vessels employed.

From the manufacturer's standpoint it seems to me it would be much preferable to manufacture the salt not from the crystals, but using exact equivalents of the acid and carbonate, evaporating to dryness and igniting. In this way the theoretical salt $\text{Na}_4\text{P}_2\text{O}_7$ should be obtainable. If it were found necessary to crystallise the Na_2HPO_4 first to eliminate impurities, then an amount of acid equivalent to the excess of alkali could be added before the ignition.

Sodium dihydrogen phosphate.

Phosphoric acid and sodium hydroxide solutions were added in the exact proportions to form this salt, the solution evaporated to a small bulk and crystallised. The crystals were then dissolved and titrated and found to correspond exceedingly well with the theoretical salt NaH_2PO_4 , while the water of crystallisation, which was only roughly

estimated, was slightly in excess of the formula $\text{NaH}_2\text{PO}_4 + \text{H}_2\text{O}$. The salt was practically neutral to methyl orange, if anything slightly acid. The crystals were very clear, needle shaped, and many were joined at right angles, forming crosses with arms.

The mother liquor had abstracted a considerable amount of alkali from the beaker after standing a week.

Sodium metaphosphate.

This was formed by adding the acid and alkali in the exact proportion for NaH_2PO_4 , evaporating to dryness and igniting in a muffle furnace. The residue weighed 0.3% more than that represented by NaPO_3 , but as this is within the limits of the errors of experiment it may be neglected. It is difficult to find direct evidence of the constitution of this salt, but as NaH_2PO_4 is unquestionably a uniform substance there is no reason to doubt that the metaphosphate has the formula NaPO_3 or one of the multiples of this formula found in the text books.

Sodium polyphosphate.

This new acid phosphate which I have described fully in a separate paper (see ante, p. 419) contains 50% more acid than the meta salt, and although it could not be obtained in a pure state on account of its strong corrosive action, by fair deduction its simplest molecular constitution may be written as $\text{Na}_4\text{P}_4\text{O}_{17}$ or $2\text{Na}_2\text{O} \cdot 3\text{P}_2\text{O}_5$. The salt was a fused glassy mass, slightly soluble in cold, more readily in hot water, almost neutral to methyl orange and only slightly acid to phenolphthalein. After prolonged boiling with water it decomposes into orthophosphoric acid and sodium metaphosphate so that attempts to crystallise a corresponding hydrated salt proved fruitless.

Trisodium phosphate.

To find the constitution of this salt was exceedingly difficult, first on account of its extreme solubility and secondly on account of the rapid rate at which it took up carbon dioxide from the atmosphere. Commencing with a 2% excess of phosphoric acid over the theoretical quantities, it was found impossible to obtain crystallisation until a point was reached where on cooling the mass suddenly solidified into a block of solid, feathery crystals. A few drops of water sufficed to dissolve the crystals on heating and these would not crystallise again. As the water content was bordering upon that of the crystals of Na_3PO_4 themselves it can be concluded that this slight acid addition renders the crystals soluble in their own water of crystallisation at a slightly elevated temperature, as compared with the solubility of Na_3PO_4 crystals in the proportion of 28.3 to 100 water at 15° C.

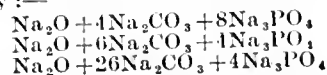
An experiment with the theoretical proportions of acid and caustic alkali proved more successful, although it was here also necessary to evaporate to a high degree of concentration before crystals could be obtained. A crop of crystals was obtained containing about one quarter of the total phosphoric acid and these had the approximate composition: $-2\text{Na}_3\text{PO}_4 + \text{Na}_2\text{HPO}_4$. The mother liquor which on slightly further concentrating crystallised to a solid mass in feathery crystals, possessed the composition: $-18\text{Na}_3\text{PO}_4 + \text{Na}_2\text{O}$.

Here again it seems, just as in the case of the ordinary phosphate, that the orthophosphate cannot be obtained in crystalline form from its components, or else it does not exist under normal conditions. The excess of alkali necessary for crystallisation, as indicating the nearest approach to purity obtainable, is double in the case of the Na_3PO_4 salt than of the Na_2HPO_4 salt for equivalent molecules, but in the proportion of 4 : 3 when

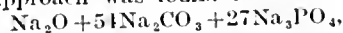
the total alkali in the composition of the salts is considered.

In order to obtain a mere exact proportion, if possible, an experiment was made using 4% excess caustic soda over the theoretical proportion. The crystals, which represented then about 75% of the total phosphoric acid, had now the composition, $17\frac{1}{2}\text{Na}_3\text{PO}_4 + \text{Na}_2\text{O}$, while the mother liquor had the approximate proportion (not formula) $4\text{Na}_3\text{PO}_4 + \text{Na}_2\text{HPO}_4 + \text{Na}_2\text{CO}_3$. The crystals were in long fine needles.

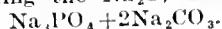
Whether the proportion of $17\frac{1}{2} : 1$ or $18 : 1$ is taken as being the correct one is not a matter of great importance. I am inclined to think the simpler formula $18\text{Na}_3\text{PO}_4 + \text{Na}_2\text{O}$ is more likely to be the correct one. The sodium carbonate found in the mother liquor was repeatedly observed in later experiments, particularly where the proportion of alkali was further increased. It was due of course to the action of atmospheric carbon dioxide. This action is exceedingly energetic, in fact the Na_3PO_4 and the excess Na_2O seem both to be attacked and quite to the same degree as free hydroxide. In crystallising there was always a tendency for the first crop of crystals to contain no carbonate, this remaining in the mother liquor and crystallising with the remaining phosphate later. The amount of carbonate included in the crystals varies exceedingly and no definite ratios could be detected. The following typical examples will illustrate this apparent irregularity:—



A large number of crystallisations were made but no useful purpose will be served in bringing the results forward until some system has been found to exist. No crystals were found with $\text{Na}_3\text{PO}_4 + \text{Na}_2\text{CO}_3$ as sole ingredients, although a near approach was found in

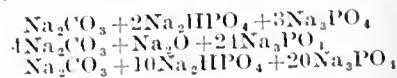


which, neglecting the Na_2O , becomes



A remarkable fact regarding some of the crystals was the impossibility of recrystallising them without alteration. They seem to form and crystallise under the "equilibrium," so to speak, of the mother liquor surrounding them. When freed from these surroundings, dissolved in water, and the solution again crystallised, they split up into two new forms which balance again, one crystallising and the other remaining in the mother liquor. This also accounted for the fact that the crystals could not always be obtained by mixing their components in solution and crystallising.

Towards strong (95%) alcohol the crystals were mostly stable but with dilute alcohol they were generally decomposed, especially on heating, when part of the crystals dissolved and another part melted, forming an oily layer at the bottom of the test tube. This oily portion always contained carbonate but varied much in composition, e.g.:—



When carbonate is present an almost endless number of combinations seem possible, the carbonate evidently entering into the molecular constitution of the salt, even in large proportion.

In order to find whether it would be possible from the manufacturer's point of view to obtain under definite conditions a certain yield of Na_3PO_4 from the use of phosphoric acid and sodium carbonate only, the following experiments were made.

Phosphoric acid and sodium carbonate solutions

were employed in the proportion of 50% excess of the latter over the amount necessary to form Na_2HPO_4 theoretically.

(1) The carbonate was added all at once, 32.4% of the acid had been converted into Na_3PO_4 while 23% of the carbonate remained with a portion of the Na_3PO_4 , the remaining Na_3PO_4 crystallising out with the whole of the Na_2HPO_4 approximately in the proportion of $3\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{PO}_4$.

(2) The carbonate was added first in the proportion to form Na_2HPO_4 and the other 50% later, after all evolution of carbon dioxide had ceased, the solution being kept at the boil. In this case only 10.2% of the acid had become converted into Na_3PO_4 while 30.4% of undecomposed carbonate remained in the mother liquor with a part of the Na_2HPO_4 ; this time the remaining Na_2HPO_4 crystallised out with the Na_3PO_4 in the approximate proportion of $6\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{PO}_4$.

(3) 4% more sodium carbonate was added than in the two former cases, and the phosphoric acid was added to the carbonate solution at the boil, very slowly, almost drop by drop. It was hoped that a higher yield of Na_3PO_4 might be obtained but the reverse was the case. Not only was no Na_3PO_4 formed but both NaH_2PO_4 and NaHCO_3 were present, the former both in the crystals and the mother liquor, the latter only in the mother liquor. It seems then that by the slow addition of the acid, stable compounds are already formed before the acid addition is completed, so that the last quantities can only be effective in the formation of sodium bicarbonate and dihydrogen sodium phosphate. This is again evidence that the sodium carbonate enters into the chemical composition of the compound. I shall show later that there is strong evidence that Na_3PO_4 combines very energetically with Na_2CO_3 up to a proportion of one molecule of the former to 2 of the latter. Now if we assume that such a compound is first formed it is evident that the later portions of acid would be employed in decomposing this body first, probably by bringing the Na_3PO_4 to Na_2HPO_4 , and further, this again to NaH_2PO_4 , while the carbonate would be simultaneously attacked. The mother liquor had the approximate composition $\text{NaHCO}_3 + 3\text{NaH}_2\text{PO}_4 + 7\text{Na}_2\text{CO}_3$.

The crystals (containing the bulk of the original acid) had the approximate composition $\text{NaH}_2\text{PO}_4 + 4\text{Na}_2\text{CO}_3 + 8\text{Na}_2\text{HPO}_4$ which after recrystallisation was altered approximately to $\text{NaH}_2\text{PO}_4 + 3\text{Na}_2\text{CO}_3 + 8\text{Na}_2\text{HPO}_4$.

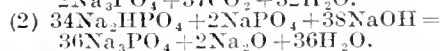
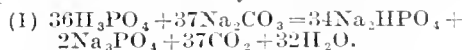
The sodium carbonate (including bicarbonate) remaining was equivalent to 42.3% of the original amount.

(4) The same proportion (104%) of caustic soda solution was used, the solution being added all at once as in experiment 1. The salt, however, was evaporated to dryness and dried at 110°C . re-dissolved and then allowed to crystallise. Instead of the high temperature and greater concentration assisting the further action of the Na_2HPO_4 in decomposing the carbonate the reverse was the case. 20.4% of the phosphoric acid had been converted into Na_3PO_4 while 31.5% of the carbonate remained behind. The whole of the Na_3PO_4 had crystallised out in the same form as in experiment 1, viz.:— $3\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{PO}_4$, while in the mother liquor both Na_2HPO_4 and NaH_2PO_4 were found with the whole of the carbonate in the approximate proportion of:— $3\text{NaH}_2\text{PO}_4 + 4\text{Na}_2\text{HPO}_4 + 17\text{Na}_2\text{CO}_3$.

We see from these experiments that the conditions of experiment 1 are by far the best, and that the yield of Na_3PO_4 which was obtained, 32.4%, is probably nearly the maximum which it is possible to attain. This corresponds closely

to the formula:— $\text{Na}_3\text{PO}_4 + 2\text{Na}_2\text{HPO}_4$, neglecting the carbonate, and this is possibly the highest form of alkaline phosphate which can be considered as a really stable compound: a greater proportion of Na_3PO_4 being easily attacked and decomposed by atmospheric carbon dioxide, as we know the Na_3PO_4 is attacked with re-formation of Na_2HPO_4 . I have not yet found definite crystals with this proportion of Na_2HPO_4 and Na_3PO_4 , the nearest approach I have found being $3\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{PO}_4$ in well defined crystals, already referred to.

Trisodium phosphate is not a satisfactory product for the manufacturer as it is so exceedingly unstable, but the best method seems to be to use sodium carbonate for the first stage and caustic soda for the second stage, employing the exact proportions I have already indicated, viz.:—



As this proportion of caustic soda (commercial) would contain probably one molecule of Na_2CO_3 we should expect this in the commercial Na_3PO_4 and this I have found to be the case, the carefully selected crystals from one sample having the approximate composition $\text{Na}_3\text{PO}_4 + 5\text{Na}_2\text{O} + \text{Na}_2\text{CO}_3$ and water of crystallisation. This is more than double the excess of alkali it need have had, but we must not assume that the whole of the salt originally consisted of exactly the same crystals when the salt was freshly manufactured. These selected crystals might only have represented a fraction of the original substance. We have in any case a check upon the state of the original substance in an analysis from the bulk of the salt in its present condition, and by tracing this back *quantitatively* we can determine the average composition the salt must have had when freshly manufactured, neglecting the water of crystallisation.

The carbonate found now in the bulk must have been originally Na_2O , with the exception of the 1.48% now in the selected crystals. The Na_2HPO_4 now found in the bulk must have been in the form of Na_3PO_4 as the Na_2O then existing was in excess of that necessary to effect this transformation.

The following table shows the present and the original composition of the salt, working back in this way, neglecting water of crystallisation:—

Commercial salt.				
	Purest attainable $18\text{Na}_3\text{PO}_4 + \text{Na}_2\text{O}$.	Selected crystals.	From bulk.	Original state.
Na_3PO_4	97.9	94.01	26.01	95.88
Na_2O	2.1	4.51	—	2.64
Na_2CO_3	—	1.48	23.92	1.48
Na_2HPO_4	—	—	50.07	—

The quantity of alkali in the original state was thus still more than that necessary to obtain the purest form of salt, at the same time 2% less than that in the selected crystals. The Na_2O would naturally only suffice for a limited quantity of crystals in the form of those selected, and I am inclined to think that one of the other forms of crystals I have referred to, possibly the $2\text{Na}_3\text{PO}_4 + \text{Na}_2\text{HPO}_4$, had separated before the "selected" ones and that the salt had originally contained a heterogeneous mass of crystals. It was hardly possible to find this out from a careful examination of the salt in its present state as it was in such a crumbly condition.

Whether the manufacturer has well-founded reasons for supplying the salt in this form or

whether it is from ignorance on his part I cannot tell, but the customer should have a salt at any rate the nearest approach to the theoretical which can be produced and not something differing to such a degree. It is regrettable that the salt even in its nearest approach to purity is so impermanent.

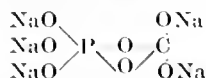
It seems that $\text{Na}_3\text{P}_2\text{O}_7$ is capable of combining with still higher proportions of caustic alkali although the union is a much weaker one and the compounds are easily broken up by the action of atmospheric carbon dioxide. $\text{Na}_2\text{O} + 6\text{Na}_3\text{P}_2\text{O}_7$ was obtained in the crystalline form, but the Na_2O was rapidly replaced by carbonate.

Proportions of alkali up to that represented by $\text{Na}_3\text{P}_2\text{O}_7 + 2\text{NaOH}$ seemed to be held in a state of semi-combination; although they could not be obtained as definite crystallisation products, the excess of sodium hydroxide which clung to the actual crystals ($6\text{Na}_3\text{P}_2\text{O}_7 + \text{Na}_2\text{O}$) was not abstracted by 95% alcohol. On drying on a porous tile, however, this excess was eliminated.

The sodium carbonate which is soon formed in all cases where $\text{Na}_3\text{P}_2\text{O}_7$ with Na_2O exist, does not seem to be simply a by-product, but is a very active agent and an intimate constituent of the resulting body. $\text{Na}_3\text{P}_2\text{O}_7$ or its nearest approach is exceedingly soluble, much more so than Na_2CO_3 , but mixtures of these, at any rate up to those having a greater molecular proportion of the Na_2CO_3 , are still more soluble than $\text{Na}_3\text{P}_2\text{O}_7$.

$\text{Na}_3\text{P}_2\text{O}_7 + 2\text{Na}_2\text{CO}_3$ with a trace of Na_2O has been obtained crystallised in clusters of fine, hair-like crystals of silky lustre in radiating tufts. If the Na_2CO_3 did not enter into chemical combination it would have settled out and crystallised long before the concentration at which these mixtures crystallise.

Without entering into theoretical speculations, it may be suggested that there is a possibility that phosphorus becomes actively pentavalent in such conditions of extreme alkalinity, *e.g.*, as might be represented by the formula:—



The presence or absence of carbonate in the solution seems to determine, in many cases at least, the nature of the crystallisation which occurs, *e.g.*, the salt $3\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{P}_2\text{O}_7$, which had been obtained in fine rhombic pyramids from sodium carbonate solution, did not crystallise from the same constituents in aqueous solution, but the ordinary salt, $17\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{P}_2\text{O}_7$.

The work described in this and the two foregoing papers was done in the photographic laboratories of the Manchester School of Technology. I have to thank Professor Knecht and Mr. Peachey for valuable suggestions, and Mr. Rhead for assistance in describing the crystals.

DISCUSSION.

MR. J. H. ROSEASON thought Dr. Smith was to be congratulated on applying a purely chemico-physical method so as to place it on a practical footing in the laboratory for analytical work. There was always difficulty, more or less, in examining alkali phosphates volumetrically and one was forced in determining the phosphoric acid to do so gravimetrically. Had Dr. Smith applied his process to the ammonium phosphates, and if not, what modification of his process would he suggest? Was the process applicable to the examination of arsenates? An interesting application of the paper on polyphosphates would be the decomposition of mineral phosphates for commercial purposes.

MR. L. G. RADCLIFFE said that he had had occasion to prepare ethylene on quite a large scale for laboratory purposes, making many kilos. of

ethylene dibromide. The first method used was to run alcohol on to hot syrupy phosphoric acid. Glass vessels had proved unsatisfactory as they were rapidly corroded. Subsequently a thick porcelain chlorine still had been used and worked well for some three weeks at eight or ten hours a day continuously, when it had become worn out owing to the action of the phosphoric acid, and probably the formation of the salt $\text{Na}_4\text{P}_2\text{O}_7$ which Dr. Smith mentioned had such a drastic effect.

MR. L. E. VILES inquired whether gravimetric estimations had been made of the sodium and phosphorus in the polyphosphates to support the evidence he had obtained by volumetric methods of the existence of the new phosphate.

MR. J. BARNES inquired whether the corrosive action was noticeable in the case of gold. Was it possible to obtain further information by precipitating with silver nitrate and titrating any acid set free?

MR. F. W. ATTACK noticed that the author had mentioned heating sodium bicarbonate to 250°C . before using it for standardising purposes. A paper in the *Zeitsch. f. Phys. Chem.* (1908), by Johnson, had shown that if the temperature was taken much higher than 200°C . for any considerable period appreciable amounts of carbon dioxide were lost. Had Dr. Smith any experience in regard to this point?

DR. SMITH, in reply, stated he had not made any tests either with ammonium phosphates or arsenates, but thought such analyses were quite possible. He was not quite certain with regard to the methyl orange, but probably the process could be employed by using methyl red, and ascertaining the point at which 100% of phosphate was indicated. As far as phenolphthalein was concerned the point with ammonia was sufficiently exact to make the process workable. The new salt might be employed with advantage for the disintegration of mineral phosphates. He had not made any gravimetric estimations of the $\text{Na}_4\text{P}_2\text{O}_7$ as he was working with chemically pure alkali and phosphoric acid. He had no experience of the action of phosphoric acid on gold. He had not tried to precipitate the new salt by means of silver nitrate. The form of $2\text{Na}_2\text{HPO}_4 + \text{Na}_3\text{P}_2\text{O}_7$ seemed to be the largest proportion of $\text{Na}_3\text{P}_2\text{O}_7$ in a salt which would not be liable to the action of the carbonic acid of the atmosphere. He understood from the text books that a temperature of 250°C . was quite admissible for heating sodium bicarbonate, although of course a strong ignition over a Bunsen flame was not admissible.

Meeting held at Grand Hotel on Friday, February 2nd, 1917.

MR. J. H. ROSEASON IN THE CHAIR.

CATALYTIC ACCELERATION OF THE VULCANISING PROCESS.

BY S. J. PEACHEY, M.Sc.TECH.

The history of the rubber industry dates back to the year 1825, when Charles Macintosh established in Manchester the first factory for the manufacture of waterproof garments. The successful development of the industry dates, however, from the year 1839, when, as the result of a laborious investigation, Goodyear discovered the process of vulcanisation. Goodyear's process consisted in intimately mixing the rubber with a suitable proportion of sulphur and subjecting the mass to a temperature of $135^\circ\text{--}140^\circ\text{C}$. for a period of time varying with the amount of sulphur employed. Shortly

afterwards Hancock introduced a modification of the process, in which the formed articles of rubber were immersed in a bath of molten sulphur and kept at a temperature of about 135° C. until the raw rubber had become modified in properties to the desired extent. In 1846 Parkes introduced what is known as the cold-cure process whereby a superficial vulcanisation may be effected by immersing the rubber in a weak solution of sulphur chloride in carbon bisulphide.

Of the three processes the original one is by far the most widely employed in the industry, Hancock's method being applied to the manufacture of a few specialities only, and Parkes' cold cure being mainly used in the proofing of fabrics.

The changes in the nature of the rubber which are brought about by vulcanisation according to Goodyear's process may be summarised as follows :

(1) The strength, the durability, and the elasticity (or more correctly the distensibility) of the rubber are increased,

(2) The sensitiveness of the rubber to changes of temperature is diminished,

(3) The rubber loses its adhesiveness,

(4) The rubber becomes insoluble in the ordinary solvents for raw rubber and therefore resistant to the action of these,

(5) Rubber which has been softened and denatured by mechanical working recovers its valuable characteristics completely on vulcanisation, a property which enables the manufacturer to soften the raw material by mastication in order to work in the sulphur and any desired filling agents, to mould the mixing while in the plastic condition, and subsequently to produce the finished article by merely heating the mould to the vulcanising temperature for the requisite time.

The main drawback to Goodyear's process is the rather lengthy period of heating required to effect complete vulcanisation. This depends upon the amount of sulphur present and for average mixings may vary from about one to three hours, or, in the case of vulcanites, may be six hours or more. In the case of soft rubbers the speed of vulcanisation may be increased by the use of larger amounts of sulphur, but there are other considerations which make it desirable to keep the sulphur content within certain limits.

It has been known to manufacturers for a long time past that certain metallic oxides, when added to a mixing in moderate quantities, possess the property of accelerating vulcanisation, such substances being commonly termed sulphur-carriers. The best known of these are the oxides of lead, magnesium, and calcium; the addition of any of these substances to a mixing in appreciable quantities (say 5%, and upward, or somewhat less in the case of lime) will reduce quite considerably the time needed for complete vulcanisation.

The use of these mineral accelerators is, however, restricted to the manufacture of medium and low-grade goods owing to the fact that they produce other effects which are undesirable. Litharge, for example, can be employed in black or in dark-coloured mixings only, because it yields a certain amount of lead sulphide during vulcanisation; moreover its high density tends seriously to affect the specific gravity of the finished rubber. Lime, if used in any but very small quantities, tends to produce hardness especially on storing the rubber, and magnesia suffers from the same drawback, though to a less degree.

The idea that accelerators might be discovered amongst organic substances appears to have originated in the old observation that the presence of a little aniline in a rubber mixing facilitates to a slight extent the subsequent vulcanisation.

It was not until 1912, however, that a really powerful organic accelerator was found, the discovery being due to Messrs. Bayer und Co. of Elberfeld, who patented the use of piperidine for the purpose

(Ger. Pat. 265,221, 1912). They showed that the addition of as little as 0.5% of piperidine to a mixing consisting of 100 parts of rubber and 10 parts of sulphur brought about a very substantial reduction in the time needed for vulcanisation. A little later the same firm prepared a solid derivative of piperidine which possessed similar properties, and this substance appeared on the English market a few months prior to the commencement of the war. More recently Messrs. Bayer & Co. have taken out a patent in which they claim accelerating properties for all organic bases possessing a dissociation constant greater than 1×10^{-8} (Ger. Pat. 280,198, 1914). This unusually wide patent would include amongst other substances the primary, secondary, and tertiary aliphatic amines, the benzylamines, benzenediazonium hydroxide and the bromobenzenediazonium hydroxides, and a number of the well-known alkaloids. The dissociation constants of a few of the compounds referred to are given below.

Substance.	Dissociation constant.	Temp.
		° C.
Methylamine	5.0×10^{-4}	25
Ethylamine	5.6×10^{-4}	25
Propylamine	4.7×10^{-4}	25
Dimethylamine	7.4×10^{-4}	25
Diethylamine	1.3×10^{-3}	25
Dipropylamine	1.0×10^{-3}	25
Trimethylamine	7.4×10^{-5}	25
Triethylamine	6.4×10^{-4}	25
Tripropylamine	5.5×10^{-4}	25
Ethylene diamine	8.5×10^{-5}	25
Benzylamine	2.4×10^{-6}	25
Diethylbenzylamine	3.6×10^{-8}	25
Benzenediazonium hydroxide	1.23×10^{-8}	0
Bromobenzenediazonium hydroxide	1.5×10^{-4}	0
Brucine	7.2×10^{-4}	15
Strychnine	1.4×10^{-7}	15
Quinine	2.2×10^{-7}	15
Quinidine	2.4×10^{-7}	15
Cinchonine	1.6×10^{-7}	15
Cinchonidine	3.7×10^{-7}	15
Cocaine	4.0×10^{-7}	25
Emetine	2.0×10^{-8}	15
Cofline	1.3×10^{-8}	25
Piperidine	1.6×10^{-8}	25

The majority of these compounds, however, are far too costly to be available to the industry as activators.

For comparison the dissociation constants of some of the weaker bases are given below.

Substance.	Dissociation constant.	Temp.
		° C.
Urea	6.7×10^{-14}	16—31
Creatine	1.9×10^{-11}	40
Semicarbazide	2.7×10^{-11}	40
Aniline	3.2×10^{-10}	15
Methylaniline	7.4×10^{-9}	60
Dimethylaniline	2.4×10^{-10}	18
<i>o</i> -Phenylenediamine	3.3×10^{-10}	25
<i>α</i> -Naphthylamine	9.9×10^{-11}	11
<i>β</i> -Naphthylamine	5.0×10^{-10}	11
Quinoline	1.6×10^{-9}	15
Pyridine	2.3×10^{-9}	25

During the early part of 1914 the author was engaged in the problem of accelerating vulcanisation and in the course of numerous experiments with various types of organic compounds discovered that the nitroso-derivatives of certain bases such as dimethylaniline, methylaniline, and diphenylamine are capable of acting as powerful accelerators of the vulcanising process (Eng. Pat. 4263, 1914). A mixing consisting of 100 parts of rubber and 10 parts of sulphur which normally requires to be heated to 140° C. (40 lb. steam pressure) for one hour if a soft cure is desired, or for a longer period in the case of a harder cure, may be completely vulcanised

in from 20 to 25 minutes by incorporating 0.3 to 0.5% of *p*-nitrosodimethylaniline with the mixing, prior to heating. Similarly a vulcanite mixing consisting of 100 parts rubber and 10 parts sulphur, which normally requires to be heated for 6 hours at 140° C. may be completely cured in about 2 hours by the addition of 0.75% of the nitroso-base.

These examples illustrate the effect of the nitroso-base on pure mixings of rubber and sulphur, but the result is almost equally good with any high or medium grade quality of mixing. Thus, for example, the well-known SA mixing, which in addition to rubber and sulphur contains a moderate proportion of zinc oxide, normally requires to be heated for 3 hours to 140° C. for complete vulcanisation; by incorporating 0.5% of nitroso-base with the mixing perfect vulcanisation may be brought about by heating for 1 hour at the same temperature.

In fact, generally speaking, the addition of 0.3 to 0.5% of nitroso-base to any mixing of good quality is sufficient to reduce the time of vulcanisation to from one-quarter to one-third of that normally required. The value to the manufacturer of an accelerator such as this is fairly obvious, for at a comparatively small cost he should be able at least to treble the output of his existing vulcanising plant. The nitroso-base is now being employed successfully by a considerable number of important rubber firms under the trade name of "Accelerene."

p-Nitrosodimethylaniline is a green crystalline powder of melting point 85° C. It is usually marketed in a moist condition (about 30% water), this adding considerably to its stability and rendering it safer to store in bulk. Before use it may conveniently be dried by exposure to warm air or preferably in a vacuum dryer. It should be incorporated with the rubber towards the end of the mixing operation, as there is otherwise some danger of a partial vulcanisation taking place on the rolls, especially if these are fairly hot. The material shows some tendency to cake on the back roll of the mixer, but this is readily avoided by wrapping the weighed quantity of the accelerator in a portion of the sheeted rubber and then working this in with the remainder. Alternatively the roughly dried nitroso-base may, prior to use, be mixed with about 20% by weight of kieselguhr, which effectively overcomes the tendency to adhere to the rolls and in the small quantities employed is quite unobjectionable as an addition to the mixing.

The time required for curing the mixing may be roughly calculated on the assumption that the use of 0.5% (on the weight of the mixing) of nitroso-base reduces the time of cure to one-third of the normal. In the case of red mixings containing antimony sulphide as the vulcanising agent and no added sulphur the accelerator fails to develop its full effect. In such cases it becomes necessary to introduce a certain quantity of sulphur and to employ the sulphide mainly as a pigment. The presence of litharge in any quantity tends to diminish the effectiveness of the organic accelerator. On the other hand the presence of a small quantity of magnesia augments very considerably the accelerating power of the nitroso-base, and by using the two substances in suitable proportions it is possible to prepare high-class mixings which will vulcanise perfectly in about one-eighth of the normal time, that is to say, in ten minutes or thereabouts. This combination of accelerators is especially useful in connection with mixings for quick repair work.

It is to be noted that the maximum accelerating power of *p*-nitrosodimethylaniline is only fully manifested when new rubber is used; with reclaimed rubber or rubber waste the results obtained are not very satisfactory.

One of the most valuable applications of the new accelerator is in the manufacture of vulcanite. As

previously stated, a pure vulcanite mixing consisting of 100 parts of rubber and 40 parts sulphur, which normally requires about six hours' heating, may by the addition of 0.6 to 0.75% of nitroso-base be perfectly cured in two hours. Similar results are obtainable with any vulcanite mixing of good quality. Another point of interest to manufacturers may be briefly referred to, viz., the prevention of "blooming," or "sulphuring-up." The amount of sulphur employed in a mixing is invariably greater than that required to combine with the rubber and to produce the desired degree of vulcanisation. The result is that manufactured rubbers nearly always contain a considerable percentage of free sulphur; this appears to be present in the freshly vulcanised rubber in the form of minute globules, that is to say, in the superfluid condition, but on standing for a time the globules gradually crystallise in the form of small needles which penetrate the surface of the rubber and produce the effect known as sulphuring-up. By reducing the amount of sulphur in the mixing to something approaching the theoretical amount required for vulcanisation, adding a small proportion of nitroso-base (about 0.75%) and then heating for the normal period required for vulcanisation, it is possible to obtain a well-cured rubber containing practically no free sulphur and one which will remain quite free from bloom even on prolonged keeping. In such case there is naturally little or no reduction in the time of vulcanisation owing to the diminished proportion of sulphur present, the power of the catalyst being expended in bringing about practically complete combination between the molecules of the rubber and the sulphur.

The chemistry of the vulcanisation process is even at the present time not fully understood, and it may therefore appear rather premature to attempt any explanation of the action of accelerators and so-called sulphur carriers.

The majority of rubber chemists agree, however, that the vulcanisation of rubber must be regarded mainly as a chemical effect, whatever physical changes may simultaneously be concerned in the process. Thus it is fairly generally accepted that vulcanisation by Goodyear's process involves the following changes:—

- (1) Depolymerisation by heat of the complex rubber molecule.
- (2) Adsorption of sulphur by the rubber colloid.
- (3) Combination of the depolymerised rubber with sulphur.
- (4) Repolymerisation to complex molecules as a result of (3).

The final product, that is the vulcanised rubber, is regarded as being a solid (or semi-solid) solution of the compound of rubber and sulphur in unchanged rubber.

In seeking to explain the action of accelerators and of sulphur carriers one must therefore treat the process of vulcanisation as a chemical reaction and study the factors which are known to be operative in promoting chemical change.

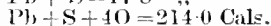
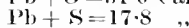
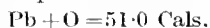
Seidl (Gummi-Zeitung, 1911, 10, 748), Esch, and others attribute the accelerating effect of litharge and magnesia to the generation of heat in the interior of the mixing consequent upon reaction taking place between these oxides and a portion of the sulphur present in the following sense:—



in which M represents an atom of lead, magnesium, or calcium; or alternatively upon reaction occurring between the oxide and small quantities of hydrogen sulphide produced by the decomposition of the resins, which are invariably present, by a portion of the sulphur. In support of this theory Seidl quotes a series of experiments in which he claims to have detected and measured this thermal effect. Satisfactory methods for

making such determinations are exceedingly difficult to devise and to carry out on account of the low conductivity for heat of rubber. The author has made a considerable number of such experiments (the details of which will be published later) and has so far failed entirely to confirm Seidl's observations. In regard to the reaction between sulphur and the oxides of lead and magnesium which is stated by Esch to take place during vulcanisation, it may be remarked that the author has prepared a number of mixings containing different proportions of magnesia (5 to 50%) and normal amounts of sulphur and has vulcanised these in the usual manner. The vulcanised rubbers were subsequently finely ground and extracted for ten hours with boiling water. An examination of the extract for the presence of magnesium sulphate gave negative results in every case, from which it may be concluded that in the case of magnesia at any rate the theory supported by Esch cannot hold good. In the case of litharge there is no question that a certain amount of lead sulphide is formed, but whether this takes place in accordance with the equation given is open to doubt.

The heats of formation of the substances involved in this equation are as follows:—



and the reaction should be exothermic to the extent of 63.4 calories.

In the case of a mixing containing 5% of litharge this would correspond with the development of an amount of heat sufficient to raise the internal temperature of the rubber very considerably, but the author has not succeeded in detecting any such rise.

The newly discovered organic accelerators differ from the so-called sulphur carriers in that an exceedingly small quantity of material is effective in bringing about a very powerful acceleration. The obvious conclusion to be drawn from this fact is that their action is of a catalytic nature, that is to say, that these substances act by their mere presence and do not themselves undergo any permanent chemical change during the process. The main characteristics of catalytic action are that the catalyst is usually present in relatively small concentration and that it does not start a reaction, but only accelerates a change which can proceed by itself (though perhaps extremely slowly). Taking *p*-nitrosodimethylaniline as an example, a quantity of the accelerator having one two-hundredth of the mass of the reacting substances is sufficient to treble the speed of the reaction. The internal heat theory cannot possibly apply here, and indeed the only reasonable supposition is that the nitroso-base acts purely as a catalyst.

In this connection it should be stated that whilst the nitroso-derivatives of such bases as methylaniline, ethylaniline, diphenylamine, and others are powerful accelerators, the isomeric nitrosoamines produce no similar effect. The difference between the isomerides is one of constitution only. It would therefore appear that the accelerating effect of these nitroso-bases is in some manner bound up with the presence of a nitroso-group directly linked up with the nucleus.

It is important to note that the catalytic action of *p*-nitrosodimethylaniline appears to differ entirely in mechanism from that of piperidine and of the other bases covered by Bayer's patents. The latter appear to act by virtue of their powerful basic character, for the patentees specify as accelerators only those bases having a dissociation constant lying above 1×10^{-8} . *p*-Nitrosodimethylaniline is a very feeble base with a dissociation constant of 1.9×10^{-10} , a figure lying far

below that quoted in Bayer's patent. Further it has been found that certain nitroso-compounds which are quite destitute of basic properties, for example, nitrosophenol and nitrosonaphthol, possess marked accelerating power. The accelerators discovered by the author constitute in fact a new class and appear to owe their accelerating power entirely to the presence of the nitroso group. Experiments are now in progress to determine whether these compounds can function as catalysts in other reactions which involve the addition of sulphur to an unsaturated molecule.

The discovery of the accelerating effect produced by the nitroso-derivatives of aromatic bases rendered it important to study other classes of organic compounds in order to ascertain whether the property is peculiar to this type of compound or is shared by other types. Owing to the difficulty in arriving at any theoretical explanation of the mechanism of the supposedly catalytic action of the nitroso-compounds it was not possible to obtain any guidance as to which of the very numerous classes of organic compounds were likely to produce a similar effect. It was soon found, however, that members of another group of compounds were capable of bringing about a similar, although considerably less powerful, accelerating effect on vulcanisation. The group referred to comprises the condensation compounds formed by the interaction of aldehydes and amines, for example, benzyldene-ethylamine, benzyldene-aniline, and hydrobenzamide (Eng. Pat. 7370, 1914). These substances, even when used in small quantities, produce a well-marked effect in accelerating the combination of rubber and sulphur but they are considerably less effective than the nitroso compounds.

An interesting observation made in the course of these vulcanisation experiments is worth placing on record. It was found that certain organic compounds possess the property of retarding vulcanisation, that is to say, they appear to act as anti-catalysts. Phenylhydrazine is an example of such a compound. In spite of its well-marked basic properties, the presence of even a small quantity in a rubber mixing, is sufficient to hinder quite appreciably the process of vulcanisation. Other substances behave similarly, notably glucose and methylene blue. It is conceivable that these anticatalysts may find useful applications in certain branches of rubber manufacture when their behaviour has been studied more fully.

DISCUSSION.

Mr. H. L. TERRY understood that the discovery of catalytic acceleration resulted from research work in connection with synthetic rubber which would not vulcanise properly, owing doubtless to the absence of certain nitrogenous matters. There appeared to be about 35 different substances that had already been used with success as accelerators. The author had referred to the importance of the process in connection with the mixing known as 8A. The difficulty had always been to effect the vulcanisation within the amount of sulphur allowed by the Government, and from this point of view the shortening of the vulcanisation process was of advantage so far as the subsequent quality of the goods produced was concerned. It would be interesting to learn whether the use of piperidine, etc., was recognised by the experts at Woolwich. The author had raised a point with regard to the formation of inorganic sulphates during vulcanisation. He (Mr. Terry) had also found that magnesium sulphate was not formed, but calcium sulphate was easily produced during the period of vulcanisation. This fact had at times led to recrimination in the trade owing to the presence of gypsum being proved when the manufacturer said he had not used any. There had been a rather sweeping statement made with regard to reclaimed rubber and low-grade

mixings. He could quite understand that the sulphur was fully combined as far as the reclaimed rubber was concerned and that the "accelerene" and the piperidine only affected the unvulcanised rubber. At the same time if free sulphur were added it might be possible to reduce the quantity of that free sulphur by using piperidine. When reference was made to reclaimed rubber something should be said as to its quality. There was a great difference between high-grade alkali reclaimed and low-grade oil reclaimed rubber.

Mr. W. THOMSON inquired whether vulcanisation involved solely the combination of the rubber with the sulphur? Was it not possible that whilst some combination between the sulphur and rubber took place a certain amount of the rubber underwent polymerisation and that the rôle which the sulphur played was not entirely a direct combination. It was hardly conceivable that 1.5% nitroso-base would cause a piece of rubber to become perfectly black which otherwise would be white, unless there was a change in the molecules of the rubber of the nature of polymerisation. It would be interesting to learn whether nitroso bases had any oxidising effect on the rubber or an effect which did not involve the use of sulphur. Had the author tried vulcanising rubber with the nitroso base without sulphur? By placing in the steam bath a piece of copper upon a piece of sheet indiarubber for about 24 hours the rubber became hard under the copper through the sheet, proving that there was catalytic action between the copper and the rubber. If cloth containing even a trace of copper were coated with rubber, the rubber would speedily perish. So-called vulcanisation might possibly prove to be to some extent an oxidising action. A curious oxidising effect he had observed was that by passing ozone over a piece of stretched rubber thread, the stretched thread was destroyed within a few minutes whilst the unstretched part was apparently uninjured.

Mr. W. C. SMITH said that credit ought to be given to Ostronski who had endeavoured to vulcanise rubber without the aid of sulphur. A very serious problem in connection with the use of accelerene was the fact that it induced dermatitis, and that people who perspired freely should not be allowed to handle it. Did the use of an accelerator tend to overcome variability in the vulcanisation of plantation rubbers? What effect had the accelerene with regard to the porosity of the rubber and particularly so with regard to ebonite? What stability had the vulcanised article when accelerene had been used? He did not consider there was any danger of the material sticking to the back roller so long as the nitroso product was what it was claimed to be. Regarding the necessity for complying with the Government specification, the point was whether there was anything left after vulcanisation from the 0.5% which would injure the rubber or which could be found by chemical analysis. Personally he did not think there was. With regard to Mr. Thomson's comment, *re* the action of ozone upon rubber, he pointed out that the effect of ozone upon rubber was exactly the same as that which was noticed when high pressure cables broke down.

Mr. CHEETHAM inquired whether the first Bayer patent was English or German, whether publication preceded the second and whether the second really covered matter claimed by the first.

Mr. D. CARDWELL inquired whether it had been possible to determine any relationship between the catalytic effect of the bases mentioned and the readiness with which they themselves combined with sulphur. Aniline combined with sulphur to form thioaniline with elimination of hydrogen sulphide and most probably other bases acted in a similar manner. In what way did nitrosodimethylaniline react with sulphur? The fact that no catalytic effect had been observed when antimony

sulphide was used instead of sulphur, supported the view that the interaction of the catalyst with free sulphur played some part in bringing about the desired result. Could Mr. Peachey state whether any experiments had been made as to the effect of vulcanising agents on the unpolymerised hydrocarbons of which rubber consisted? Whether, in fact, polymerisation and vulcanisation had been carried out at the same time.

Mr. A. PORRER had found that indigo in the proportion of 0.25% gave quite a good blue colour to a vulcanised rubber. Contrary to expectation, Thioindigo Red or Scarlet in the same proportion gave at the most a pale strawberry colour. It would be interesting to know whether these dye-stuffs possessed any accelerating action in the vulcanising process. The compound of piperidylurea marketed by Bayer in 1913 was in the form of a fine yellow powder, something like sulphur, and it acted quite well both with raw rubber and with high-grade reclaimed rubber. It was interesting to learn that aniline had a slight effect in accelerating the vulcanisation process. This was rather surprising, because there was at least one process in use in which aniline, in conjunction with strong caustic soda, was claimed as a reclaiming agent, the patentees claiming that not only free sulphur but combined sulphur could be removed. He thought he was right in saying that it was upon the work of Stevens in connection with proteins that the use of accelerators was based. Stevens had found that rubber recovered from benzene solution gave quite different results on vulcanisation from the natural raw rubber, owing to the presence of the natural proteins in the latter. Certain American workers had carried the work still further by using other albuminoid bodies. Had Mr. Peachey tried the effect of accelerene on such a recovered rubber, and if so what was the quantity required to yield the same effect as the natural proteins?

Mr. F. J. THOMP drew attention to the fact that no satisfactory method had as yet been found for determining the true dissociation constants of bases. The constants usually given were too small, a consideration which might explain the anomalous behaviour of such a weak base as *p*-nitrosodimethylaniline in aiding vulcanisation.

Mr. PEACHEY in reply, said he had not made much progress as regards the possibility of detecting the nitroso-base in the vulcanised rubber, but he had found that the acetone extract of such a rubber was always so highly coloured that, in the absence of anything else which would yield a dark colour, he thought that alone would suggest the use of the accelerator. He intended to make further tests. His opinion was that a portion at least of the nitroso-base remained as such in the vulcanised rubber. Possibly it had been noticed by those who had already used the nitroso-base that the vulcanised articles tended to stain paper with which they came in contact. He considered that at least half of the substances alluded to by Mr. Terry had practically no accelerating effect. As regards reclaimed rubber he had only experimented on medium qualities. He could quite imagine that the new accelerator would produce a moderate effect with a high class reclaimed rubber. He thought it was now practically accepted that the process of vulcanisation was of a chemical nature and involved a certain degree of combination between the rubber and the sulphur. *p*-Nitrosodimethylaniline possessed high tinctorial power which tended appreciably to darken the vulcanised rubber. The rather strong green colour of the mixing, however, faded to a light drab on vulcanisation, provided only a small quantity of the accelerator was used. He would not like to state definitely as yet that it would be practicable to use the accelerator for very light-coloured goods.

If rubber were heated with nitroso-base a tarry

mass was formed; there was no evidence of vulcanisation. He thought it was now well established that the presence of copper accelerated oxidation. There was of course a very close parallel between the addition of sulphur to rubber and the addition of oxygen. Copper apparently acted as a catalyst, and activated oxidation. Ostromyslenski's work was intended to show that vulcanisation could be effected by means of such substances as nitrobenzene and a number of other comparatively simple organic compounds in the absence of sulphur. He felt considerable difficulty in accepting all that was stated in the abstract of the paper which had appeared. He was convinced that when Ostromyslenski spoke of rubber being vulcanised by nitrobenzene he did not attach quite the same meaning to the term as other chemists. With regard to the prejudicial effect of *p*-nitrosodimethylaniline upon the health of workers using it, he thought it was largely a question of the impurities originally present in the nitroso-base and that the pure material was not so objectionable as the crude. Whether the evil resulted from the presence of a little unaltered dimethylaniline in the base was a question worth investigating. He was not in a position as yet to answer the question with regard to the variability of different plantation rubbers. He had not carried out as many experiments with the steam cure as with the press cure, but so far the results had been equally good in both cases. Although the samples shown that evening were thin, some of them were remarkably solid, and showed no sign of porosity.

He was of the opinion that equally good results could be obtained with thicker rubber. Regarding the stability of vulcanised rubber he could speak with some confidence as he possessed samples which had been kept for two years or more. Except the case of a few which were not more than 0.1 mm. thick there had been no deterioration. The strength tests carried out with material vulcanised in conjunction with the accelerator gave better results than those obtained with material normally vulcanised as nearly as possible in the correct time to give the same cure. There appeared to be a uniform slight increase in strength as the result of using the accelerator, but too much confidence must not as yet be placed in these experiments as they would have to be repeated on a very large number of samples. Bayer's first patent (1912) covered the use of piperidine. The second patent covered the use of non-volatile aliphatic amines or non-volatile derivatives of volatile aliphatic amines, and a third covered the use of a solid derivative of piperidine, namely, piperidylurea or the carbon bisulphide addition compound. The fourth patent covered all bases having certain dissociation constants, and in regard to this he could not yet express an opinion as to validity. It appeared to him to be of an unusually wide character in that it covered substances known and unknown. He had experimented with all the nitroso compounds including nitrosodimethylanilines, but the effect of the latter was not so marked as that of *p*-nitrosodimethylaniline. He had already referred to the remarkable fact that nitrosophenol and nitrosonaphthol also had a marked accelerating effect notwithstanding the absence of basic properties. Mr. Tromp had questioned the accuracy of the dissociation constants as published in the literature, and had suggested the possibility of *p*-nitrosodimethylaniline falling under Bayer's patent. He did not think there was any fear of this. It was quite evident that the nitroso group was responsible for the accelerating power of the substance. Nitrosophenol exerted a marked accelerating action, although acidic substances generally either had no action or were actually retarding agents. The effect of the nitroso group appeared to outweigh the acidic property in the case of nitrosophenol.

A point had been raised as to whether a compound was first formed between the nitroso-base and sulphur, but as to this he had as yet no really reliable information to impart. Another question related to mixings containing antimony sulphide failing to respond to the action of the accelerator. This was especially curious because antimony sulphide invariably contained free sulphur. He had made no experiments with depolymerisation products or lower polymerisation products. He had not examined the effect of indigo on a mixing but he was aware there was a considerable bleaching effect in the case of ultramarine. Thioindigo red had been put on the market in Germany in the form of a lake for the special purpose of colouring rubber and he was rather surprised to learn that it gave only a strawberry colour. He had understood it to be a dyestuff that was fairly stable to sulphur at vulcanising temperature, but he could not say whether it produced any acceleration. The only observation he had made in connection with dyestuffs was that methylene blue had a distinct retarding action. At present he had no information to offer with respect to the effect of nitroso-base on de-resinated rubber except that as the result of his own experiments he did not agree with the conclusions published by Weber regarding the impossibility of vulcanising de-resinated rubber.

Newcastle Section.

Meeting held at Bolbec Hall on Wednesday, March 21st, 1917.

MR. HENRY PEILE IN THE CHAIR.

THE INFLUENCE OF ARSENIC IN BRASS.

BY OLIVER SMALLEY.

The influence of arsenic in copper has received much attention from various sources, and, where once it was regarded with great suspicion and looked upon as an undesirable impurity, it is now actually employed to increase the tenacity and hardness, yet displaying little effect on the ductility. It is valuable in neutralising the deleterious influence of bismuth, antimony, oxygen, etc., and it is used, in small amounts, for making copper more resistant to the action of reducing gases when hot. But this latter use is based on a more or less doubtful hypothesis, for the question of "gassing" is one that is based solely on the oxygen content.

As regards copper castings it is certainly beneficial in conferring soundness, even though inferior to silicon, manganese, or boron, so that arsenic is of real value in copper.

This information, though in itself definite, does not remove the feeling of scepticism that exists as to the value of arsenic in brass; and published information to date does no more than suggest that arsenic might be either beneficial or detrimental, depending upon the conditions under consideration. It is therefore with a view to the determination of the actual value, or otherwise, of arsenic in brass that this work has been undertaken.

Furthermore, it is common knowledge that there is a considerable exhaustion in the world's stocks of copper, as may be noted in the present prohibitive price and in the difficulty in obtaining current supplies. It is essential, then, that we utilise whatever copper we do possess or can obtain to the best possible advantage whatever its quality.

At the present moment a considerable amount of arsenical copper is obtainable in the form of scrap.

shell driving bands, turnings, swarf, etc. The arsenic content of these driving bands is between 0.25 and 0.45%, this being the range permitted in specifications. To use this copper for the manufacture of brass would give an arsenic content not generally met with, so that an early suggestion was to attempt the removal of arsenic by melting the copper in conjunction with suitable fluxing. This, of course, necessitated the erection of a new plant and an immediate expenditure such as could not be entertained. The first valuable outlet found was its use in the manufacture of tin bronzes where the arsenic introduced by the copper was found to be beneficial in the production of sound casts and in the obtaining of a slightly increased elastic limit.

The next outlet tried was in the making of Class "C" extruded bar, $2\frac{1}{8}$ in. diameter. An 80 lb. cast was made of the intended composition—Cu, 58.00%; Zn, 40.25%; Pb, 1.75%. The copper used in its manufacture was two-thirds electrolytic and one-third balled arsenical swarf. The tensile tests expected from such an extruded bar, together with those obtained, were as follows:—

	Yield point Tons sq. in.	Maximum stress. Tons sq. in.	Elongation % on 2".
Expected	10.0	22.0	28.0
Obtained	10.4	22.7	11.0

These clearly demonstrated the deleterious influence of small percentages of arsenic on extruded brass.

It may be said that the work so far carried out shows that small quantities of arsenic are beneficial to copper-tin alloys but detrimental to hot-working copper-zinc alloys.

From our present knowledge of the microstruc-

ture of the copper-zinc series of alloys we are able to divide commercial brass into three groups, each having its own specific value.

Group 1 possesses a simple microstructure consisting of allotrimorphic crystals of an isomorphous mixture of copper and zinc, and the brasses coming into this group are known as α -phase brasses. They may contain as much as 37% zinc, though 30% zinc is the true limit in which perfect mixed crystals exist at all temperatures in the solid state, and such material can only be worked cold. Brasses coming within this range are well known for their combined strength, ductility, and malleability, and so provide us with a simple, but valuable, range of alloys.

Groups 2 and 3. Between 30—37% zinc we have a series of alloys which are polymorphic and can be worked both hot and cold—their hot-working properties increasing with an increasing zinc content. Above 37% zinc we have a new constituent appearing at ordinary temperatures which is generally termed the β -constituent. It is stronger and harder than the α -constituent, but it is less ductile, and the percentage of β -constituent, which increases directly as the zinc content, determines the physical properties of the brass, everything else being equal.

The ease with which such an alloy lends itself to hot work classifies it purely as a hot-working alloy, for owing to the difference in the physical properties of the two micro-constituents present in such brasses, one soft and the other hard, this does not readily permit the application of cold work.

Thus we have two types of brass, each having its own sphere of usefulness, possibilities and necessary treatment; and attention is limited in this paper to the determination of the influence of arsenic on the two alloys most representative of their groups, namely, the 70/30 mixture and the 59/41 mixture.

Manufacture.

In all, nine alloys were made, five of the 70/30 mixture and four of the 59/41 mixture, the arsenic content varying from nil to 1.0% as shown in the following tables, where both intended and actual compositions obtained are given:—

Series No. 1.

Mark.	Intended composition.			Actual composition.			
	Copper.	Zinc.	Arsenic.	Copper.	Zinc.	Arsenic.	Iron.
	%	%	%	%	%	%	%
A.C. 8	70.0	30.0	Nil	70.10	29.90	Nil	Trace.
A.C. 7	70.0	29.92	0.08	70.45	29.55	0.09	0.10
A.C. 4*	70.0	30.0	?	69.57	30.00	0.18	0.25
A.C. 5	70.0	29.5	0.50	70.10	29.41	0.40	Trace.
A.C. 6	69.5	29.5	1.00	69.16	29.87	0.97	Trace.

* Copper driving bands.

Series No. 2.

Mark.	Intended composition.			Actual composition.			
	Copper.	Zinc.	Arsenic.	Copper.	Zinc.	Arsenic.	Iron.
	%	%	%	%	%	%	%
A.C. 0	59.0	41.0	Nil.	58.96	41.04	Nil.	Nil.
A.C. 1*	59.0	41.0	?	58.58	41.08	0.14	0.20
A.C. 2	59.0	40.5	0.50	58.91	40.54	0.48	0.07
A.C. 3	58.5	40.5	1.00	58.77	40.28	0.95	Trace.

* Copper driving bands.

In order that complete physical and chemical investigations might be completed and that the tests obtained should bear direct application to works' practice, in the "as cast," "worked," or "heat-treated" conditions, the whole series of alloys were made entirely under works' conditions.

Melting was done in an ordinary forced blast

Melting was done in an ordinary forced blast

coke furnace, 25 lb. ingots being made. The Series 1 set of alloys were cast into slabs 1.95 in. thick by 4 in. broad, and those of Series 2 were cast into ingots 3 in. square.

No perceptible objections or peculiarities arose through the presence of the arsenic. The alloys A.C.8 and A.C.0 were made from high grade electrolytic copper and "Crescent" brand spelter; each of these alloys represented a standard to the series, for comparative purposes only. The same brand of spelter was used for all the alloys: whilst

as the casting temperatures were all carefully controlled.

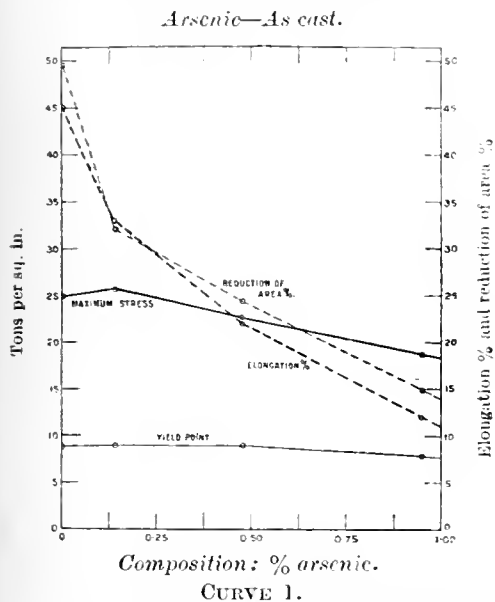
Mechanical treatment.

The upper half of each ingot was used for the necessary physical tests in the cast state. In Series 1 the lower half was treated exactly as an ordinary 18 pdr. cartridge case slab before attempting to cup for drawing purposes, such treatment being as follows:—cold roll in three passes to 0.55 in.; anneal at 600° C., reduce in two passes to 0.451 in.; and re-anneal.

In Series 2, the lower half of each ingot was forged hot from 3 in. sq. to 1½ in. sq., allowed to cool, re-heated and hot rolled to 1½ in. thick in three successive passes. Forging was commenced at 650° C., and finished at 590° C. Rolling was carried out at 630° C.

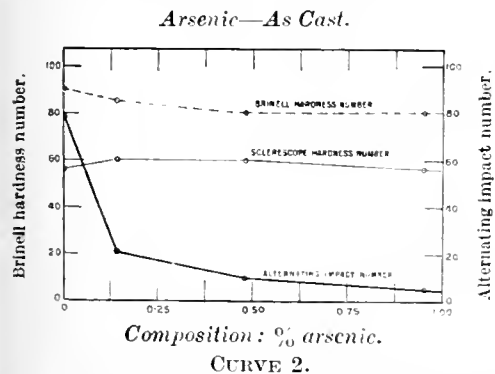
Physical tests.

Static tests were taken from each alloy in the cast condition. Alloys of Series 1 were tested after the third pass, first anneal, second finishing pass,



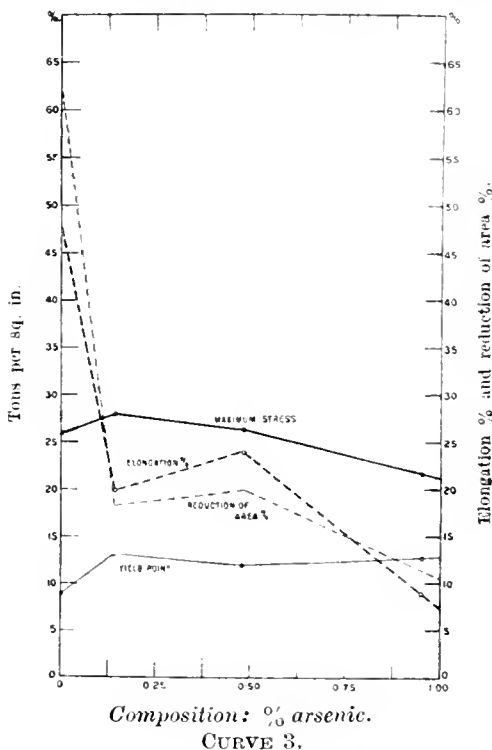
the only difference between alloy A.C.1, Series 1, and alloy A.C.1, Series 2, and the standard alloys A.C.8 and A.C.0, is that in the former mentioned pair of alloys scrap shell driving bands containing 0.28% arsenic were used in the place of electrolytic copper.

Alloy A.C.7, Series 1, was made from 50% scrap shell driving bands and 50% electrolytic copper by adding the requisite copper content; while the rest of the alloys were made from electrolytic copper, the desired arsenic content being obtained by suitable additions of a 5% arsenic-copper alloy.



On breaking a small fragment from the croppings of each alloy a strongly marked arborescent pattern was displayed by all the arsenical brasses, but with alloys A.C.8 and A.C.1, which are free from arsenic, this was not shown; thus indicating that the initial casting temperature of the arsenical alloys was too high. But this was not the case,

Arsenic—As forged.



and final anneal. Alloys of Series 2 were only tested after hot rolling to 1½ in. thick slabs.

As far as possible all test-pieces were cut from a similar position in each slab, all operations being performed under like conditions.

The Brinell hardness test was made with a 10 mm. diameter ball under a load of 1000 kilogrammes for 30 seconds.

Dynamic stress tests. For this purpose an alternating impact testing machine was used, the test-piece being 4 in. × ½ in. × ½ in. with a ⅛ in. radius groove milled in the centre of one face at right angles to the principle axis. A steel tup having a total weight of 10 lb. is allowed to fall untrammelled from a height of 18½ inches on the test-piece, the first blow being given on the face opposite the groove, and for every succeeding blow the test-piece is rotated through an angle of 180°. The

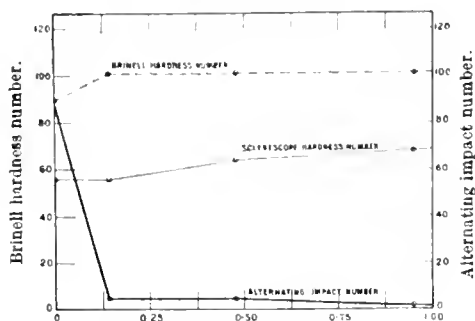
blows are given at a regular rate of 25 per minute and the number of blows received by the test-piece before fracture is taken as the alternating impact number.

Where considered necessary an Izod test was made. This figure is stated in foot-pounds absorbed in fracture.

The influence of arsenic on the mechanical properties of 59/41 brass.

The results of the tests made on this series of alloys are tabulated on Test Sheet No. 3, and shown graphically by Curves Nos. 1, 2, 3, and 4.

Arsenic—As forged.



Composition: % arsenic.

CURVE 4.

From these it may be seen at a glance that in every instance, with reference to the ductility, there is a serious drop in both the cast and hot-worked conditions as the arsenic content rises. In the cast state the presence of 0.14% arsenic reduces the elongation some 27% without appreciably affecting the yield point or ultimate stress; whilst the shock-resisting properties are seriously impaired, the impact test number, for instance, being only one quarter that obtained from the standard non-arsenical sample. As the arsenic content increases a further lowering of the shock-resisting properties is effected; whilst both the yield point and ultimate stress are somewhat reduced, this being marked in alloy A.C. 2, which contains 0.5% arsenic.

In the 1% arsenic alloy we have a material that is hopelessly brittle and in which the shock-resisting properties are practically reduced to zero, though the ductility, as measured by the elongation percentage from the tensile test, does not reveal this so clearly. In fact, it is here shown that the value of the elongation percentage, adopted as a measure of the ductility and a safeguard against brittleness, is of very little practical value unless accompanied by some suitable form of dynamic stress test.

The effect of hot-work. The effect of hot-working the non-arsenical brass, included in this series, is shown to have been distinctly beneficial to the physical properties in general; and, as anticipated, both the ductility and impact number are raised, while the tenacity is unaffected. But with the arsenical series there is the reverse effect. Here, the yield point and ultimate stress are increased, but only so slightly that they in no way compensate for the low ductility produced.

The elongation percentage of alloy A.C.2 does not seem to support this last remark; yet the decided fall in the impact number makes it an outstanding example of the conclusion just previously stated of the ambiguity of the elongation percentage as a reliable measure of ductility.

Fractures. A most noticeable feature of the

presence of arsenic in the cast series is the complete removal of the fine yellow-coloured granular fracture that always accompanies Muntz metal free from arsenic, it being replaced by a coarsely laminated crystalline fracture of a dull mossy brown appearance—the coarseness of the crystals and depth of colour increasing with a rising arsenic content until at 1% arsenic it takes an almost bluish hue.

The fractures of the forged specimens bear a close relationship to the "cast" with regard to colour, but all traces of the coarse laminated crystals are removed, the fracture taking in every instance the form of an exceedingly shallow cup and cone (See Notes, Test Sheet No. 3).

The elongation, not being confined to the vicinity of fracture, gives a reduction of area percentage the same at any position along the length of the parallel of the test piece, and this peculiarity seems common to all arsenical brasses.

In both the cast and forged specimens the presence of incipient signs of fracture throughout the 2 in. parallel of the test piece is apparent in this series, the cracks becoming more pronounced as the arsenic content increases.

Microstructure.

The microscope affords us a ready means with which to study the embrittling effect of the arsenic in the cast or hot-worked specimens.

In 1910 Bengough and Hill published an interesting research on the influence of arsenic in copper and the probable constitution of the copper-arsenic thermal equilibrium diagram, in which they showed the formation of two compounds, namely, Cu_3As and Cu_5As_2 , in confirmation of Friedrich's report of 1905. They also showed that the solubility of these two intermetallic compounds in the main copper-rich α -phase metal was dependant upon the rate at which the alloy was cooled, etc.

This latter feature, whilst not so important in this series of alloys, plays a great part in the 70/30 series and will be referred to later.

Photomicrographs No. 1 and 2, which represent the standard alloy in the "ascast" and "worked" conditions, do not call for special comment, their structural formation being that expected and are here reproduced for the purposes of comparison.

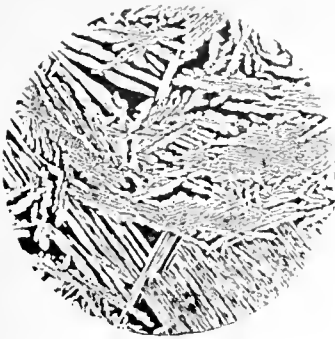
The presence of 0.14% arsenic is revealed microscopically in the formation of numerous minute granules of arsenide distributed mainly amongst the β -constituent and not easily shown photographically.

As the arsenic content increases the presence of these granules becomes more pronounced and can readily be shown at lower magnifications (see photomicrographs Nos. 3 and 4). Here, with such lowering of the magnification, the photographic rendering does not do justice to the distinctness with which these granules appear under the microscope.

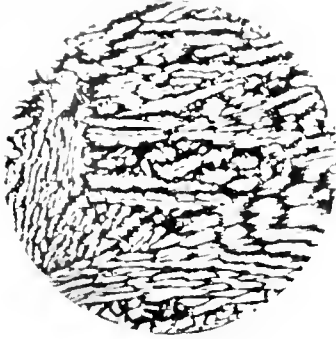
Photomicrographs Nos. 5 and 6 show the microstructures of alloys A.C.3 and 3.R, which are very similar to the lower arsenic alloys structurally except for the presence of larger quantities of free arsenide.

That the embrittling effect of arsenic may be more clearly understood, an analogy may be drawn from the influence of tin on such brass.

Ordinary Muntz metal is capable of retaining in solution approximately 1.2% tin, and when this amount is exceeded, a third constituent, which may be termed " γ ", makes its appearance. With the advent of this constituent, which is hard and brittle and has, in general, the same physical properties as the arsenide formed in the arsenical series, we consequently have a similar reduction in the ductility of the brass; with 3% tin the effect of this " γ " constituent is such that the brass is commercially useless, giving the following tests:



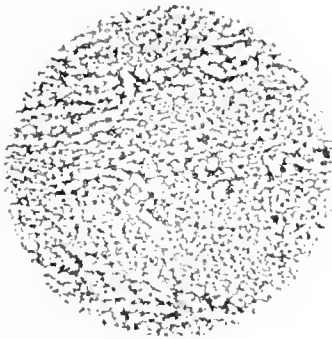
1.



2.



3.



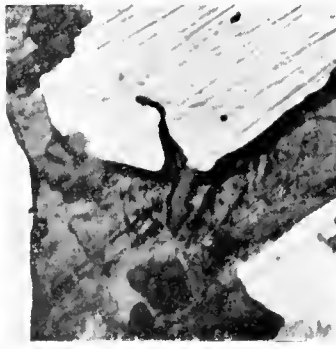
4.



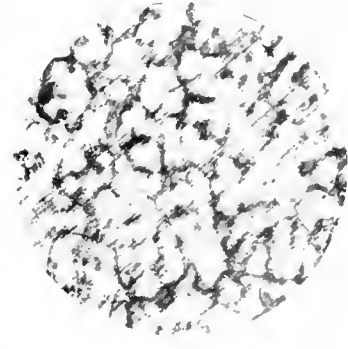
5.



6.



7. (mag. $\times 1350$.)



8.



9.



10.



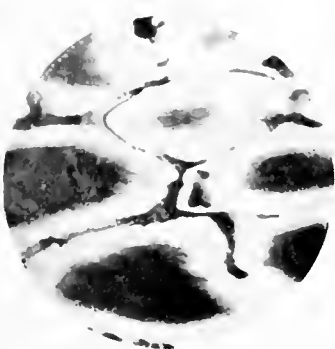
11.



12.



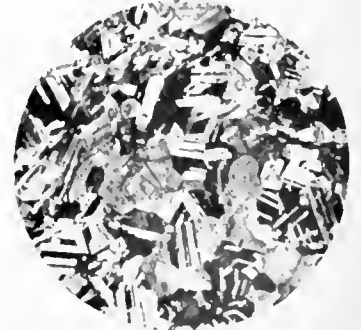
13.



14. (mag. $\times 630$.)



15.



16.

Yield point.	Maximum stress.	Elongation	Reduction of area %.	Alternating impact no.
Tons sq. in. 16.5	Tons sq. in. 21.25	1.5	3.2	1

These results are somewhat similar to those obtained in the test with alloy A.C.3 which contains 1% arsenic.

From this comparison the deleterious influence of small percentages of arsenic on hot-working brass is clearly understood, but it must be borne in mind that though the action of tin and small quantities of arsenic is very similar on the physical properties, through the introduction of a third micro-constituent, the formation of this third micro-constituent originates very differently.

In the arsenical series the arsenic exists as free arsenide; this arsenide incites a slight nucleus action on the two phase " β " constituent but does not tend to dissociate it in any way; this is clearly demonstrated by photomicrograph No. 7

which was taken from alloy A.C.3 in the cast condition, the groups of arsenide granules being shown gathered in a chain-like formation mainly in the " β " constituent; this latter-mentioned constituent in is no way resolved by the arsenide and even at the high magnification at which the photograph was taken only a slight internal lamellar structure can be revealed. Tin, however, exercises a different effect in promoting a dissociation of the two-phase " β " constituent.

Conclusions.

(1) The inherent brittleness of arsenical $\alpha\beta$ brass is due to the formation of a third micro-constituent which exists in a chain-like fashion mainly in the β -constituent.

(2) That hot work is detrimental to their physical properties is due to the arsenide, which forms or tends to form at the crystal junctions, being enveloped in the β -constituent; this separates each crystal grain from its neighbours by a weak, brittle compound; hence the typical intercrystalline fracture of forged arsenical Muntz metal.

TEST SHEET No. 3.

Weight of materials pnt in pot.				Intended composition.			Actual composition.				
Series No.	Copper.	Zinc.	Copper arsenic.	Copper.	Zinc.	Arsenic.	Copper.	Zinc.	Arsenic.	Iron.	Lead.
	lb. oz.	lb. oz.	lb.	%	%	%	%	%	%	%	%
A.C.0	14 12	10 4	—	59.0	41.0	Nil.	58.96	41.04	Nil.	Trace.	Nil.
A.C.1	14 12	10 4	—	59.0	41.0	Nil.	58.58	41.08	0.14	0.2	Trace.
A.C.2	11 14	10 2½	3	59.0	40.5	0.5	58.91	40.54	0.48	0.07	Trace.
A.C.3	8 12	10 ½	6	59.0	40.0	1.0	58.77	40.28	0.95	Trace.	Trace.

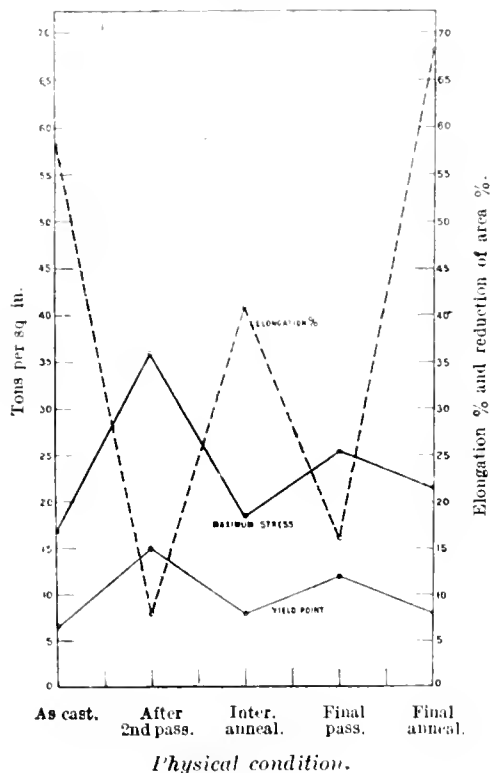
Physical tests.

Series No.	Yield pt. Tons per sq. in.	Maximum stress. Tons per sq. in.	Elongation % on 2".	Reduction of area %.	Fracture.	Alternating impact No.	Fracture.	Brinell hardness no.	Scleroscope hardness no.
A.C.0	8.8	24.0	45.0	49.7	Fine, stony, semi-cup and cone.	79	Fine granular silky edges.	90	14
A.C.1	9.0	25.6	33.0	32.0	Fine, stony with coarse crystals running along the length of the fracture as in the presence of a high tin content, and of a light yellowish colour. The 2-in. parallel much undulated but no trace of intercrystallinity exhibited.	21	Coarse laminated crystals.	85	15
A.C.2	9.0	22.6	22.0	24.5	As A.C. 1, but the crystals are more pronounced and the colour of fracture is of a brownish mossy appearance.	11	Intermediate between A.C. 1. and 3.	80	15
A.C.3	7.9	18.7	12.0	15.0	As alloy A.C.1 and A.C. 2, but of a deeper brown colour than A.C. 2. Presence of fissures along the 2 in. parallel.	5	As A.C.1, except that colour is of a deep dead brown appearance.	80	14
A.C.0R	9.0	26.0	47.5	62.0	Fine, stony, silky edges.	87	Fine granular, silky edges.	90	14
A.C.1R	13.2	28.0	20.0	18.3	Fine, stony, shallow cup and cone.	5	Fine, stony, short.	101	14
A.C.2R	12.0	26.0	24.0	29.0	Fine, stony, of a brown colour, shallow cup and cone.	5	Intermediate between A.C.1 and 3.	101	16
A.C.3R	12.5 12.7	21.9 21.6	6.0 9.0	5.0 10.0	Fine, stony, mossy brown colour, very shallow cup and cone.	2 2	Fine, crystalline, short. Deep brown colour	101	17

Series 1.

In directing our attention to this series of alloys, it is necessary to bear in mind that α -brasses owe their high commercial value to the great ease with which they can be cold worked, and to the ready recovery of their ductility after a simple heat-treatment.

As nil.



CURVE 5.

An idea of the plastic flow of alloy A.C.8—which is the standard non-arsenic alloy—can be gained from the fact that a chill cast slab 6 ft. \times 1 ft. may be cold rolled from 1.05 in. thick to a strip 0.18 in. thick, in six passes, without exhibiting any traces of overwork; this treatment raises the Brinell hardness from 57 to 171. Thus in an α -brass, not only have we a metal which readily lends itself to plastic deformation, but one possessing a good range of physical properties easily controlled by suitable mechanical work and heat-treatment. An idea of the range of physical properties obtainable from the effect of cold-work and heat-treatment can be gained from the physical tests obtained during the working-down of an 18 pdr. cartridge case blank, these tests being as shown in test-sheet No. 4, after each subsequent operation. The figures are displayed graphically in Curve No. 5.

This treatment having long been standardised, and the nature of the accompanying physico-chemical changes having received considerable attention from various investigators, it was regarded as an ideal treatment to adopt for the present investigation, as one yielding complete information in the cast, worked, and heat-treated conditions, and so demonstrating in a practical manner the influence of varying amounts of arsenic in all possible physical conditions; while it also shows actually to what extent arsenic may be present in cartridge case brass without detriment.

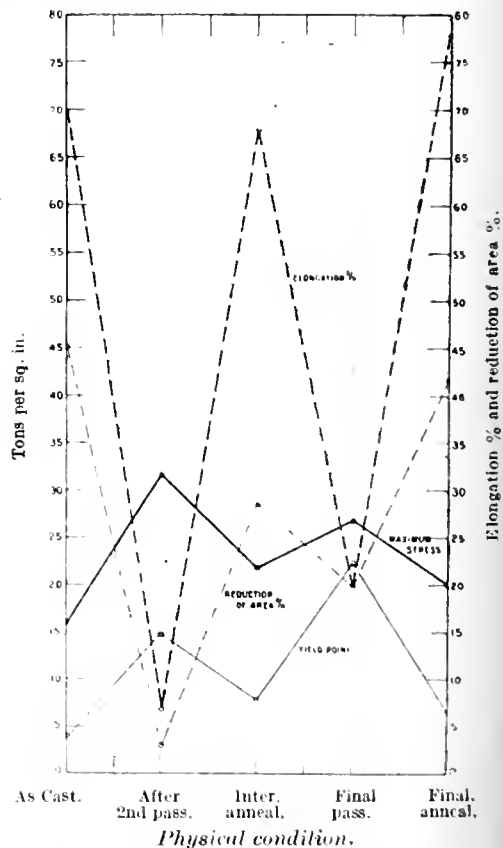
Complete details of these tests are tabulated alongside the tests obtained from the standard non-arsenic alloy in Test Sheet No. 4, and shown in a lucid manner by Curves 6, 7, 8, and 9.

Before discussing these results, it must be pointed out that the tensile test from each alloy in the "as cast" condition was made in accordance with the specification of the Engineering Standards Committee, 0.564 in. \times 2 in. length parallel, all subsequent tests being 0.309 in. \times 1 in., this latter size test-piece being procurable from all strips after each subsequent operation.

The effects wrought by arsenic on the cast samples are somewhat striking, alloy A.C.7 containing 0.09% arsenic displaying an all-round superiority over the standard non-arsenic alloy. A further increase in the arsenic content now produces a reversal effect, 0.12% arsenic reducing the elongation from 58% to 50%, while the shock-resisting properties are reduced 58%.

The presence of 0.18% arsenic is sufficient to reduce the ductility to a figure of very low order, and at the same time is responsible for a slight drop in the tenacity.

As 0.09%.



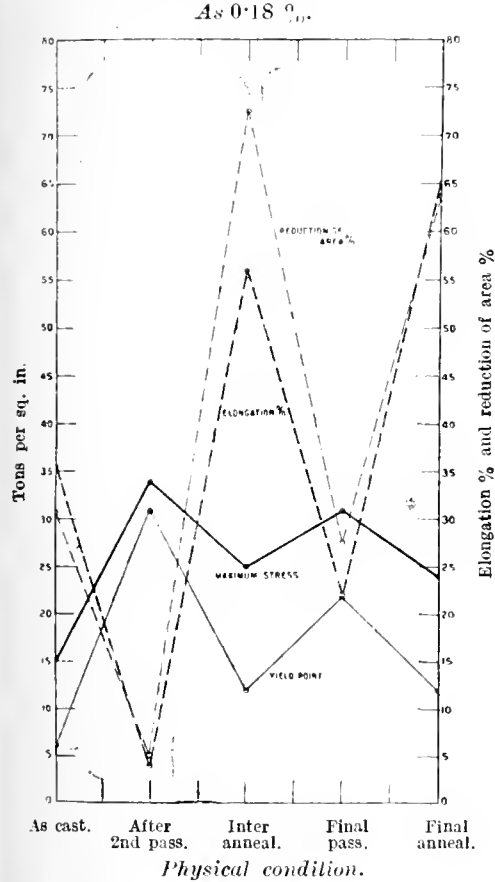
CURVE 6.

Accompanying further increases in the arsenic content, both the tenacity and ductility suffer, till in the presence of 0.5% arsenic, the general physical properties render the alloy of little value in the "cast" condition; whilst 1% arsenic results in the chill cast slab being hopelessly weak and brittle and the shock-resisting properties reduced almost to zero.

In spite of such embrittlement of the arsenic in the chill cast slabs, all the alloys were cold-rolled with equal ease, alloy A.C.7 displaying no superiority over alloy A.C.6.

These unexpected results introduced the question to what extent did arsenic affect the cold flow of the metal? It was decided to determine this, and details of the results obtained will be dealt with in a later part of the paper.

The influence of arsenic as displayed on these alloys after such combined cold work and heat-treatment is most striking, not only resulting in an all-round improvement of the physical properties, but raising them so that a decided superiority is revealed of alloys A.C.4 and 5 over alloy A.C.8; this is most interesting when we consider the physical properties obtained in the "as cast" condition, particularly in regard to alloy A.C.5, which contains 0.5 % arsenic.



CURVE 7.

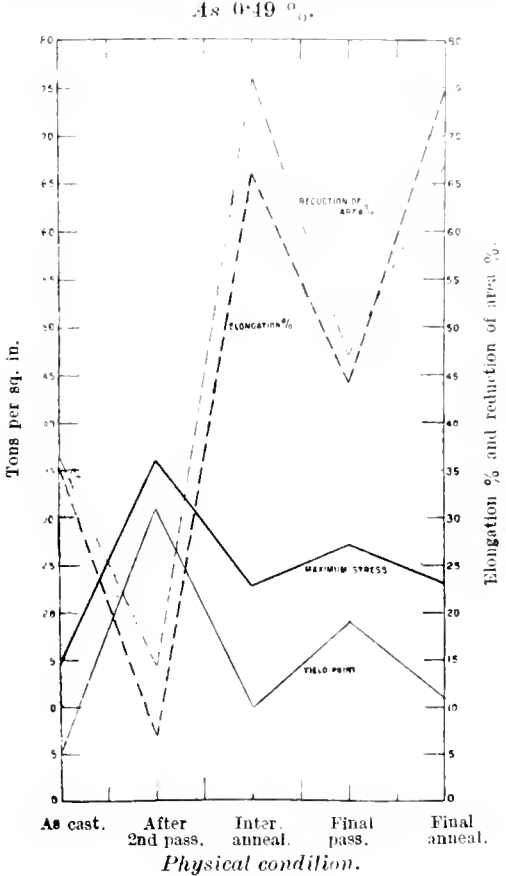
The physical tests after the final treatment of alloy A.C.6, which contains 1% arsenic, are more or less as expected. Its elongation is slightly improved from the cast state; whilst the percentage reduction of area is somewhat reduced.

In all, the ductility and shock-resisting properties are little affected, while the tenacity is improved six tons per square inch, but even this does not attain the value recorded by any of the other alloys, after the same physical treatment.

Structural changes due to the presence of arsenic.

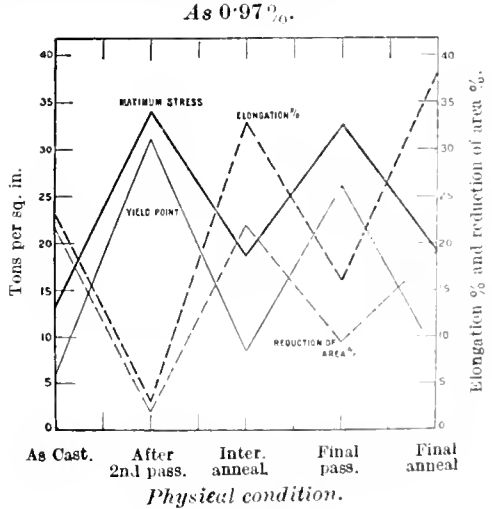
Having detailed the changes that accompany the presence of small quantities of arsenic on the physical properties, it becomes necessary to explain these results *a priori*; and the microscope has again been used as affording a ready means whereby the structural changes due to arsenic can be followed in all the respective physical conditions.

The technique of the preparation of the micro-sections does not call for special mention, but the following method of etching is necessary: after preparing the specimen in the ordinary way, the



CURVE 8.

surface is completely freed from any trace of dirt or grease and immersed in a solution consisting of potassium bichromate 40 grms., sulphuric acid (sp.gr. 1.81) 1 c.c., water 100 c.c., until a slight attack is observed to the naked eye.



CURVE 9.

The specimen is rinsed in water and immersed in a dilute solution of acid ferric chloride until a faintly coloured film is seen to cover the specimen. It is then at once withdrawn and washed in water, a little absolute alcohol being used to assist in drying rapidly.

The formation of a peculiar brownish coloured deposit in all the arsenical series (the intensity of which increases with an increasing arsenic content), makes it almost impossible to etch, by the use of a single reagent, with any measure of success; the specimen is either spoilt or rendered extremely dull and difficult to decipher. But by the double attack aforementioned the trouble is completely overcome. Alloy A.C.8 was etched in this manner for the purposes of comparison only.

A magnification of 63 diameters has been found convenient for revealing the general microstructure together with some detail and was used for all the original photomicrographs unless otherwise stated. The illustrations shown here, however, are on a somewhat smaller scale, viz., $\times 34$.

Photomicrograph No. 8, which illustrates the microstructure of alloy A.C.8 (arsenic *nil*) in the chill cast condition, does not demand special mention. It is a typical example of the shadowy, indefinite ghost-like structure of all " α " brasses that display "coring" when chill cast from high temperatures; the cores taking their formation from a copper-rich centre to zinc-rich envelope at the outer edge in each primary crystal.

The presence of small amounts of arsenic, however, exercises quite a marked effect on this indefinite cored-like structure. Their arborescent formation becomes more conspicuous while the "coring" of the copper-zinc solid solution is not so clearly revealed, but a new type of coring or heterogeneity makes its appearance.

Alloy A.C.4 "as cast" shows clearly both types of coring:—

(1) The coring due to the heterogeneity of the copper-zinc solid solution, and

(2) The coring due to the formation of free arsenide granules, the depth of diffusion of the arsenide into the surrounding material being clearly marked.

As the arsenic content increases this duplex structure becomes more marked by the formation of more free arsenide (see photomicrographs Nos. 10 and 13).

The last-mentioned photograph displays an almost perfect cellular structure, consisting of dark-coloured cells surrounded by thick light-coloured cell walls, and all the photographs show not only the value of the mode of attack used for revealing the microstructure, but the value of the reagent in clearly revealing the most minute traces of arsenic in brass, with its consequent structural effects.

By carefully examining photomicrographs Nos. 10 and 13, with the aid of a hand glass, the formation of small specks of free arsenide can be traced in alloy A.C.4, which gradually become clearly and definitely marked in alloy A.C.5; while in alloy A.C.6 they are shown to be continuous and completely surrounding the crystal grain.

The continuity of the films of free arsenide is best displayed in photomicrograph No. 14, taken at a higher magnification.

From these we see that free arsenide develops exactly as in the 59/41 series, and that these films become continuous at 1.0% As, forming practically complete envelopes to the crystal grains, whence the gradual embrittling effect accompanying a rising arsenic content in α -brass.

That this is not so severe in this series of alloys as in the $\alpha\beta$ series is self-explanatory when it is borne in mind that the arsenide in the $\alpha\beta$ -brass exists mainly in the β -material, which is a

hard, tenacious micro-constituent possessing little ductility, while in the series under consideration it can only exist in the α -material, which is a soft, ductile micro-constituent.

Hard-rolled structures.

As the metal is deformed by the cold rolling of alloys A.C. 8, 7, 4, 5, and 6, each of the crystal grains elongates, the orientation from one point to another of the same grain remaining identical, so that after the second pass through the rolls the arsenide granules become broken up into more or less continuous fine threads surrounded by attenuated arsenide cores, until eventually the structure appears to be made up of alternating layers of the dark-coloured arsenide-free zone with the light etching arsenide cores. Photomicrographs 11 and 15 illustrate this and represent the alloys A.C.5 and 6 respectively.

The physical tests from all these alloys at this stage is as anticipated from the microstructure. Their high tenacity and low ductility is due to the cold work applied which removes the crystalline structure and replaces it with an amorphous one in which are shown numerous slip-bands (see photomicrographs 11 and 15).

The presence of these slip-bands is always indicative of plastic deformation; they owe their formation to the cold work causing plastic strain in each crystal grain due to the slipping of one layer of crystals on its adjacent partners.

The surface steps so formed by this slipping are shown on etching in the form of black lines in a striated and cross-like fashion through several systems of planes, and at all these internal surfaces of movement the material becomes decrystallised. These amorphous layers are harder than the crystalline substance from which they are formed, the intensity of their formation determining the hardness figure and tenacity. Hence the similarity in the physical tests obtained from both the non-arsenical alloy and the arsenical alloys after the second pass through the rolls.

Annealed structure.

Photomicrograph No. 9 illustrates the microstructure of alloy A.C.8 after the first anneal, the worked cored structure being replaced by a homogeneous structure consisting of polygonal twin crystals, this structure being typical of all worked α -brasses after annealing.

In the arsenical series, however, the first anneal does not effect such complete removal of the cored structure, in consequence of which we have formed a complex microstructure consisting of a ghost-like pattern of the original cast and worked "core-banded" structure overlain by the polygonal twin structure obtained in alloy A.C.8. This double structure is more marked as the arsenic content increases.

In this condition the alloy A.C.4 exhibits very slight traces of free arsenide, while alloys A.C.5 and A.C.6 exhibit free arsenide, but in much less quantities than those shown in the original cast samples, and it is the presence of this remaining free arsenide that is responsible for the reproduction of the original cored cast structure *in situ*. So we see that while cold work, followed by annealing, rectifies the heterogeneity of the copper-zinc cores it does not effect complete interdiffusion of the arsenide cores.

With the aid of further work, followed by a second annealing, however, homogeneity is obtained, for it is possible to detect only a few very minute specks of free arsenide even in alloy A.C.6, which contains 1% arsenic.

Hence the microstructure now consists of homogeneous polygonal twin crystals, illustrated by photomicrograph No. 9 (see photomicrographs

Nos. 12 and 16, which show the microstructures of alloys A.C.5 and 6 respectively).

It is, therefore, because of the complete removal of this free arsenide and the homogeneity obtained that such a marked improvement is exhibited in both the tenacity and ductility, which goes to prove that arsenic in solution confers increased ductility on brass. But the quantity permissible is very limited, as may be determined by the tests obtained from alloys A.C.5 and A.C.6 after the second anneal, the latter alloy being hopelessly intercrystalline. This intercrystallinity is due to the ternary intermetallic compound acting, when present in sufficient quantities—as do all intermetallic compounds—by conferring on the alloy in which present their own inherent poor physical properties.

The cold-working properties of arsenical α -brass.

To ascertain to what extent arsenic affects the cold-working properties of α -brass, sections (3 in. by 1 in. by 1.05 in.) were cut from alloys A.C.8, 7, 4, 5, and 6, and each cold rolled in successive passes of $\frac{1}{8}$ in. reduction per pass until incipient cracking commenced through overwork.

Complete data obtained are tabulated in Test Sheet No. 5.

These results show that:—

(1) Arsenic in quantities not exceeding 0.20% is beneficial to the cold-working properties, for alloys A.C.7 and 4, containing 0.09% and 0.18% arsenic respectively, permit a greater reduction by cold rolling than is possible with the standard non-arsenical brass A.C.8, without displaying any traces of over work.

(2) Between 0.20% and 0.50% arsenic no material effect is noticed, for alloy A.C.5, containing 0.49% arsenic, withstands the same reduction as alloy A.C.8.

(3) In the presence of an arsenic content exceeding 0.50%, the cold rolling properties are somewhat deteriorated, alloy A.C.6 breaking down at a thickness of 0.20 in.

This reversal effect which occurs with an increasing arsenic content is similar to that shown to have occurred in the tensile tests (see Test Sheet No. 4) although the changes are not so drastic. It is possible to cold roll alloy A.C.6 almost to the same extent as alloy A.C.8, while the superiority of alloys A.C.7 and A.C.4 over alloy A.C.8 is very small.

That it should be possible to cold roll alloy A.C.6 to such an extent is not altogether unexpected in spite of its inherent brittleness, when we bear in mind the almost liquid-like flow of α -brass; also that metals which are completely shattered by rapidly-applied stress may readily be made to extend slowly under a comparatively low stress.

Thus, when the arsenide is present in sufficient quantities to separate the crystal grains by more or less continuous envelopes, its action is to promote or tend to promote rupture at the crystal junctions when the cleavage slip in the crystal grains has been sufficient to render the amorphous material formed less mobile than the material at the crystal junctions.

Hence the type of defect subsequently determining an overworked arsenical brass of this nature presents itself in the form of fissures at the crystal junctions.

When the free arsenide does not predominate, but exists as in brasses containing under 0.5% arsenic, the limit of overwork is determined very differently.

After each pass slipping will occur which counterbalances the new stress by an increased area across which the internal forces can act. Thus the material stiffens until its limit of accommodation of these stresses is reached, when the severe com-

pound internal stresses—tensional in the cores and compressive in the superficial layers—give rise to longitudinal rupture. The fracture takes a cup and cone formation.

The Brinell and Scleroscope hardness numbers obtained after each reduction through the rolls bear out the comments previously made on the hardness being a direct measure of the extent that crystalline metal is replaced by amorphous metal.

The annealing of arsenical brass.

The numerous operations through which α -brasses pass during the working up into a desired form, whether as rod, strip, tube, or cartridge case, etc., necessitate numerous annealings between successive operations, or a combination of successive operations, depending upon the intensity of the cold work applied per operation, the annealing being such that a maximum ductility is obtained at the lowest temperature in the shortest possible time, so reducing to a minimum any possibility of dezincification or scaling which so readily occurs owing to the large surface generally exposed of objects made from α -brass.

Recrystallisation accompanied by a complete restoration of the ductility of non-arsenical 70/30 brass is obtained at a temperature of 650° C., when the period of heating does not exceed 10 minutes. In general works' practice a slightly lower temperature than this is used, the period of annealing being longer, and such that the same results are obtained.

In the presence of arsenic the temperature was found to be somewhat raised, so the following experiment was conducted:—Sections were taken from the original strips of each alloy after cold rolling to a thickness of 0.55 in., when the Brinell hardness number in every case was in the proximity of 155. Two specimens from each alloy were annealed at 600°, 650°, 700°, 750°, and 800° C. for ten minutes. One sample was cooled in air, the other quenched rapidly in water. Brinell hardness tests were then made on each specimen, with the results given on page 439.

That the annealing temperature is raised is undoubtedly shown by these results, while the temperature at which complete annealing occurs is that at which the arsenide just passes into complete solution in the brass; this goes to prove that it is the presence of free arsenide which retards the rate of crystal growth.

From experiments at present in hand on the crystal growth of arsenical brasses which are micro-chemically homogeneous, no differences can be discerned from that of "non-arsenical" brass in the same physical condition, and as far as these experiments have been conducted, they substantiate the forementioned conclusions.

General conclusions.

1. Arsenic embrittles all copper-zinc alloys, commercially known as "brass," when it is present as free arsenide, which arsenide is a weak, brittle constituent, and if present in sufficient quantities, completely envelopes each crystal grain, resulting in a crystalline mass, the grains of which are stronger than the junctions, so acting as do antimony, bismuth, and other metals which form definite intermetallic compounds the presence of which produces "intercrystallinity."

2. These films of arsenide do not affect the cold-working properties of α -brasses to any appreciable extent owing to the ready accommodation of this class of brasses to plastic deformation without rupture.

3. Small quantities of arsenic—under 0.10%—are beneficial to α -brasses, no matter what their physical condition, due to the arsenic

Mark.	Physical conditions.	Thickness.	Total reduction.	Brinell hardness no.	Scleroscope hardness no.	Comments on condition of plate.
A.C.8 As nil	As cast. 8th pass.	1.05 0.100	Nil. 0.945	55 193	12 42	— Incipient cracking.
A.C.7 As 0.09%	As cast. 5th pass. 8th pass.	1.05 0.370 0.078	Nil. Nil. Nil.	52 171 200	12 38 54	— Split at one end.
A.C.4 As 0.18%	As cast. 1st levelling pass. 1st pass. 2nd pass. 3rd pass. 4th pass. 5th pass. 6th pass. 7th pass. 8th pass. 9th pass.	1.05 0.85 0.68 0.55 0.50 0.44 0.36 0.28 0.19 0.12 0.08	Nil. 0.20 0.37 0.50 0.55 0.61 0.69 0.77 0.86 0.93 0.97	51 101 138 154 154 159 165 178 185 185 200	10 18 27 29 30 32 34 36 38 38 50	— Condition good. " " " " " " " " " " " " " " " " Split.
A.C.5 As 0.49%	As cast. 1st levelling pass. 1st pass. 2nd pass. 3rd pass. 4th pass. 5th pass. 6th pass. 7th pass.	1.05 0.85 0.68 0.55 0.40 0.36 0.27 0.19 0.12	Nil. 0.20 0.37 0.50 0.65 0.69 0.78 0.86 0.93	58 101 138 154 165 171 178 185 193	10 20 28 30 30 36 37 40 43	— Condition good. " " " " " " " " " " " " Incipient cracking.
A.C.6 As 0.972%	As cast. 1st levelling pass. 1st pass. 2nd pass. 3rd pass. 4th pass. 5th pass. 6th pass. 7th pass. 8th pass.	1.05 0.85 0.68 0.55 0.50 0.44 0.37 0.28 0.20 0.14	Nil. 0.20 0.37 0.50 0.55 0.61 0.68 0.77 0.85 0.91	52 101 148 159 165 171 171 185 200 200	10 20 28 30 33 36 36 42 46 48	— Condition good. " " " " " " " " " " " " " " Incipient cracking at edges.

Mark.	Mode of cooling.	Annealing temperatures.				
		600° C.	650° C.	700° C.	750° C.	800° C.
		Brinell hardness numbers.				
A.C.8 (As nil)	Air. Water.	62 62	52 52	48 48	— —	— —
A.C.7. (As 0.08%)	Air. Water.	62 62	62 62	52 52	— —	— —
A.C.4 (As 0.18%)	Air. Water.	80 80	72.4 74	59 59	52 52	52
A.C.5 (As 0.49%)	Air. Water.	85 85	72.4 72.4	59 59	52 52	52 52
A.C.6 (As 0.97%)	Air. Water.	90 —	74.3 74.3	59 59	52 52	52 52

entering mainly into solid solution, the amount remaining as free arsenide being negligible when considered as a mechanical enclosure.

4. A complete recovery of the ductility of all essentially cold-working arsenical brasses, containing under 0.5% arsenic, is effected by cold-working and subsequent annealing, this treatment bringing about a complete solution of arsenide which is beneficial to the quality of the brass when present in quantities not exceeding 0.20%; exceeding 0.20% and up to 0.50% As, the brass possesses the same physical properties as non-arsenical brass.

Exceeding 0.50% arsenic, the brass becomes intercrystalline no matter the physical condition of the arsenide, going to prove that the physical properties of arsenical α -brasses containing under 0.50% arsenic are governed by the physical condition of the brass; when exceeding that amount the percentage of arsenic governs the physical properties no matter what be the physical condition of the alloy.

5. The temperature at which α -phase brasses containing free arsenide will anneal is 30°–50° C. higher than that of pure non-arsenical brass, data not yet being to hand concerning the influence of arsenic on re-crystallisation when present in perfect solid solution in the copper-zinc as a perfectly homogeneous alloy.

6. Arsenic when present even in the most minute quantities is detrimental to the physical properties of hot-worked brass, although it in no way affects the hot-working properties.

7. Arsenic does not assist in any structural inversion of the " β "-constituent, when cooled under normal conditions.

In closing I wish to express my thanks to the Directors of Messrs. Sir W. G. Armstrong, Whitworth & Co., Ltd., for their permission to publish these data, and also to recognise the valuable assistance rendered by Messrs. J. W. Craggs, R. N. Richardson, and R. L. Granville-Johnston.

Industrial Notes.

RESEARCH AND THE COTTON INDUSTRY.

At the end of July of last year, at the instance of the Advisory Council of the Committee of the Privy Council for Scientific and Industrial Research, a meeting of representatives of some of the larger firms engaged in the various branches of the cotton trade and others interested in textile research was called by the Lord Mayor of Manchester to consider the possibility of establishing a scheme for the scientific investigation of the various problems presented by the cotton-using industries, and it was agreed that there is great need for research bearing on the cultivation and manufacture of cotton, and in the dyeing, printing, bleaching, and other finishing processes. It was also thought that efforts should be made to increase and to improve the system of textile education. At an adjourned meeting it was decided that some practical steps should be taken to organise a complete scheme for these two purposes. A Provisional Committee was appointed and this, in due course, was constituted a Committee of the Advisory Council of the recently formed Government Department of Scientific and Industrial Research.

This Committee is largely representative of the various interests concerned. Its function is to formulate a preliminary scheme of a comprehensive character and to report to the Advisory Council and then to lay before the trade, for its consideration, definite proposals for the establishment of a Research Association, eligible for recognition by the Government Department and consequently for monetary grants from the National Exchequer.

The Provisional Committee consists at present of the following members:—Mr. J. W. McConnoil (Fine Cotton Spinners' Association, Ltd.), Chairman; Mr. H. R. Armitage (Bradford Dyers' Association, Ltd.); Dr. W. Lawrence Balls (late of the Khedivial Agricultural Society of Egypt and the Egyptian Ministry of Agriculture); Messrs. T. D. Barlow (Messrs. Barlow & Jones, Ltd.), P. W. Barwick (Manchester Chamber of Commerce Testing House), Stanley Bourne (cotton doubler, representing the Nottingham Chamber of Commerce), Lindsay Cropper (Messrs. J. & P. Coats, Ltd.), Henry P. Greg (Messrs. R. Greg & Co.), J. C. M. Garnett (Manchester School of Technology and the University of Manchester), A. E. Hawley (dyer, representing the Leicester Chamber of Commerce), Forrest Hewit (Calico Printers' Association, Ltd.), E. L. Hoyle (Messrs. Joshua Hoyle & Sons, Ltd.), Alfred J. King (Bleachers' Association, Ltd.), Kenneth Lee (Messrs. Tootal Broadhurst Lee Co., Ltd.), J. H. Lester (late of the Manchester Chamber of Commerce Testing House), James Prestwich (Federation of Master Cotton Spinners' Association), Fred. J. Smith (British Cotton and Wool Dyers' Association, Ltd.), and Charles H. Turner (Cotton Spinners' and Manufacturers' Association). Mr. A. Abbott, H.M. Inspector of Technical Schools, has been appointed by the Advisory Council, with the concurrence of the Board of Education, to act as Secretary *pro tem*.

The Provisional Committee are holding fortnightly meetings.

They have to consider the place for research in each branch of the cotton industry, whether in the cultivation of cotton, in spinning, doubling, manufacturing, knitting, lace-making, bleaching, dyeing, printing, finishing, or in the technology of cellulose. They have also to ascertain what facilities now exist for the education of boy

entering any of these branches, and what opportunities are likely to be offered by the trade for the employment of highly-trained men. They will also have to formulate a scheme both for an Institute to undertake research work in collaboration so far as practicable with existing bodies, and for an Association of firms and individuals willing to make donations and subscribe regularly for a period of years to promote research and improve technical training.

The terms and limitations under which the Association can obtain its share of the million pounds granted by the Treasury to promote scientific and industrial research will be ascertained by the Provisional Committee.

Any suggestions relating to the researches to be undertaken or to any other matters coming within the scope of the proposed Association will be welcomed by the Committee, and should be sent to the Secretary, Provisional Committee on Cotton Research, 108, Deansgate, Manchester.

SOCIETY OF DYERS AND COLOURISTS.

At the annual meeting of the Society of Dyers and Colourists, at Manchester, on March 30th, Dr. Alfred Rée was re-elected President, and dealt in his presidential address with the subject of patent law reform.

Dr. Rée said the number of well-trained chemists in this country was only one-fortieth of the number in Germany and one-fiftieth of the number in Switzerland in proportion to the population. It was high time that the old prejudice against the study of chemistry should be overcome. Much could be done by improving the remuneration of the well-trained chemist, though that was enormously better than it was a few years ago. The conception of the training necessary for a "chemist" and a "pharmacist" required to be legally defined. Without in any way decrying the latter, a well-trained chemist required a far longer and more thorough training and education, and some means should be found whereby the difference between them should be definitely established, as it was in other countries. With regard to the work of German chemists, Dr. Rée was assured by well-informed authorities that many of the most brilliant discoveries connected with the coal-tar colour industry were not made even in Germany so much by Teutons as by people of French, Alsatian, or Swiss origin, or of Polish and even Anglo-Saxon origin. Some of the most clever and expert German industrial chemists had spent years in England and benefited by a close study of English ways and methods before attempting to accomplish their great work in their own country. It was also to be pointed out that some of the greatest discoveries were made and rendered valuable to industry by relatively untrained men. Some of the first works in the world to produce aniline colours were situated near London.

Our patent laws, Dr. Rée said, had been a serious deterrent to the development of the chemical industry. He had no hesitation in saying that their influence for evil had been far greater than could be realised except on a rather exhaustive examination of the whole question. He even went so far as to assert that had we had no patent laws at all with regard to chemical processes and products our progress in the British colour and allied industries would have been quite satisfactory in the last 40 years. To the bad effect on industry of the patent laws generally

there was the further one with regard to the compulsory working of patents in this country, especially foreign ones. Proposals for the compulsory working of patents in this country, granted to persons who might afterwards work or manufacture the articles outside the United Kingdom, had emanated from the Manchester Chamber of Commerce, and had been fought for by the late Mr. Ivan Levinstein with a great degree of skill and perseverance. Had the warnings of the Chamber been heeded years ago our position to-day and since the outbreak of the war would have been very different. Not only would the aniline colour industry have been established on a firm and adequate scale, but the same statement would have applied to a number of other chemical industries with which high explosives were so intimately associated. It was, indeed, deplorable to what a serious extent the interests of the British chemical industry had been mishandled from a legislative point of view before the war. When the war was over we must not re-establish wealthy German firms in the privileges they had possessed and render their position more secure and lasting than before. He hoped we had learned our lesson, and would not fall into that kind of trap. The newly-formed Association of British Chemical Manufacturers, acting as a united body, would, he trusted, be able to prevent in the future a perpetuation of such an evil.

The President, at the close of his address, presented to Professor Arthur G. Green, F.R.S., the Perkin Gold Medal of the Society in recognition of his valuable researches in dyestuff chemistry, and particularly for his discovery of primuline in 1887. This was the fourth award of the medal, which was instituted by the Society in commemoration of the late Sir William Perkin, and is awarded triennially for investigations and inventions of high scientific or industrial importance. Professor Green is the first Englishman to receive the honour.

THE CANADIAN COBALT INDUSTRY.

A report of the special Committee on Metal Industries to the Canadian Mining Institute contains the following particulars of the cobalt industry:—

Almost the entire cobalt supply of the world is drawn from the mines of Ontario. This metal was formerly largely a German product, and for two or three hundred years that country controlled the supply, but prior to the discovery of the Canadian product the ores of New Caledonia had become the main source of supply. These mines, however, were forced to close when brought into competition with the cheaper supply from Ontario. The ore and concentrates produced in the Temiskaming district of Ontario contain from 4 to 10% cobalt, 2 to 8% nickel, 15 to 40% arsenic, and from 500 to 5000 oz. of silver per ton.

During the early days of mining in the Cobalt district much ore was exported to the United States and treated for its silver contents, the cobalt being slagged and lost. Now, only a small amount of the rich cobalt ores is exported to that country, but a considerable tonnage of low-grade concentrates, low in silver, nickel, and cobalt, still goes to the American smelters and is treated for its silver contents only. Two or three of the mining companies at Cobalt have erected plants for desilverizing their high-grade ores and concentrates, leaving the cobalt, nickel, and arsenic in residues for shipment to cobalt smelters.

Germany received some of this product before the war. A small quantity is now sold in England, while the larger portion is handled by southern Ontario smelters. During the past years the smelting industry of Ontario has been steadily developing and handling a larger percentage of the ores and concentrates from the Temiskaming district. Cobalt is largely sold as cobalt oxide, but also in the metallic form and to a limited extent in salts. The output is largely controlled by the demand for cobalt, as production could readily be increased if circumstances warranted it. A few years ago practically the only market for cobalt was in the ceramic industry, where it was employed for whitening the body of china and in the production of blue colour. It is employed in the enamelling trade, the manufacture of blue-coloured signs, the colouring of glass, and to a small extent in the manufacture of pigments such as cobalt blue. These industries could consume only three or four hundred tons of cobalt per year. In the last few years, however, new uses have been found for the metal, and there has been an increase in the consumption of cobalt salts for such purposes as the manufacture of cobalt driers for paints.

The use of cobalt in the metallic form is increasing. It has been found that it has several advantages over nickel for electroplating, a smaller quantity having a greater resistance to abrasion, and with use of a proper bath it can be deposited much more rapidly. In the manufacture of high-speed steels, cobalt has been used as an alloy to considerable advantage, as for instance in the manufacture of the so-called Becker steel, which became of some little commercial importance in Germany just before the war. Other brands of cobalt steel are also on the market. A new cutting metal called "stellite," composed of cobalt, chromium, and tungsten, without iron, has proved to be superior to high-speed steel for many operations. It is claimed that this metal is to high-speed steel what high-speed steel is to ordinary carbon steel; that is, it will allow of increasing the rate of cutting on the lathe from 20% to 50% and minimizes the time consumed in sharpening tools. The development of the cobalt industry in Ontario has been greatly assisted through the action of the Ontario Government in granting, some years ago, a bounty of 6c. per lb. for all cobalt and nickel refined in that province. The Dominion Government, also through the Department of Mines, assisted in the attempts to develop new uses for this metal by a vote for research work conducted in the metallurgical laboratories of Queen's University. It was here that cobalt plating was developed (see this J., 1915, 619).

MINERAL PRODUCTION OF CANADA FOR 1916.

The preliminary report on the mineral production of Canada, during 1916, prepared by John McLeish, chief of the division of Mineral Resources and Statistics, has been issued by the Canadian Department of Mines. The table on page 442 summarises the statistics given.

The war had a most pronounced effect in stimulating the production of nickel, copper, and zinc, iron and steel, molybdenum, etc., used so extensively for war purposes, and also in increasing the production of other products, such as chromite and magnesite. The general industrial activity in metallurgical operations and in the manufacture generally of munitions of all kinds, including the freight movements required, increased the demand

for fuel, which was met in Western Canada at least by large increases in coal production.

Considerable progress was made during the year in establishing and increasing smelting and refining capacities, of which the installation of electrolytic zinc and copper refineries at Trail and the beginning of construction of a nickel refinery at Port Colborne, Ont., are conspicuous examples. In addition, mention is made of the production of metallic magnesium at Shawinigan Falls, of ferromolybdenum at Orillia and Belleville, of metallic arsenic at Thorold, and of stellite, the cobalt alloy for high-speed tool-metal, at Deloro, and of the increased capacity for the production of steel.

The mining output was restricted and the efficiency of operation considerably reduced by the withdrawal for war service of such a large proportion of the more experienced labour and engineering

smelteries and reduction plants in Canada and 3,466,665 oz. estimated as recovered from ores exported to the United States smelteries.

The production of copper has shown large increases during the last three years. In 1916 the total copper contents of smelter products credited to Canadian ores and estimated recoveries from ores exported amounted to 119,770,814 lb.; production in 1915 was 100,785,150 lb. Of the total 1916 production 92,763,603 lb. was contained in blister copper and in matte, and 27,007,211 lb. estimated as recovered from ores exported. In addition to the recoveries from domestic ores there was also recovered by British Columbia smelters 5,551,166 lb. of copper from imported ores. An electrolytic copper refinery, installed at Trail, began active operations about Nov. 1 with a capacity of 10 tons of refined copper per day. Exports of copper according to Customs records were: Copper fine in ore, matte, regulus, etc., 124,942,400 lb.; in pigs, bars, sheets, etc., 2,430,400 lb. There were also exports of old and scrap copper amounting to 5,846,600 lb.

The production of nickel in 1916 was, as usual, derived from the ores of the Sudbury district supplemented by the recovery of a small quantity of metallic nickel, nickel oxide and other nickel salts as by-products in the treatment of ores from the silver-cobalt-nickel ores of the Cobalt district. The total production was 82,958,564 lb., as against 68,308,657 lb. in 1915. The total production of matte in 1916 was 80,010 tons containing 44,859,321 lb. of copper and 82,596,862 lb. of nickel. The tonnage of ore smelted (part being previously roasted) was 1,521,689 tons.

Nickel was recovered as a by-product in smelteries at Deloro, Thorold, and Welland, from the silver-cobalt-nickel ores of the Cobalt district, the total nickel contents of nickel oxide, nickel sulphate, and metallic nickel produced being 361,701 lb. The products recovered included 79,360 lb. of metallic nickel, 323,418 lb. of nickel oxide, and 232,450 lb. of nickel sulphate.

The demand for molybdenite resulted in considerable exploration of known occurrences and the development of several properties of considerable promise. The total MoS_2 contents of concentrates produced and shipped during the year was about 159,000 lb., for which the official price paid was 105s. per unit of MoS_2 at Liverpool. A portion of the concentrates was used in the manufacture of molybdic acid, and ferromolybdenum at Orillia, Ont. Ferromolybdenum is also now being made at Belleville, Ont.

The total production of pig iron in 1916, not including the output of ferro-alloys, was, according to complete returns now received, 1,169,257 short tons. The production of ferro-alloys in Canada in 1916, chiefly ferrosilicon, but including also ferrophosphorus and ferromolybdenum, all made in electric furnaces, was 28,628 tons.

The asbestos industry was particularly active during 1916, the value of the production having been the highest on record, though the quantity was slightly exceeded in 1913. The total quantity of asbestos rock sent to mills during the year was 1,822,461 tons, from which was obtained 112,832 tons of fibre, or an average recovery of 6.20%.

Product.	Quantity.
Metallic:—	
Antimony ore (exports), tons*	794
Cobalt, metallic and contained in oxide, etc., lb.	841,850
Copper, lb.	119,770,814
Gold, oz.	926,963
Iron, pig iron Canadian ore, tons	115,691
Iron, ore sold for export, tons	140,608
Lead, lb.	41,593,680
Molybdenite, MoS_2 contents, lb.	159,000
Nickel, lb.	82,958,564
Platinum, oz.	15
Silver, oz.	25,669,172
Zinc, lb.	23,515,030
Non-metallic:—	
Actinolite, tons	250
Arsenic, white, tons	2186
Asbestos, tons	136,016
Asbestic, tons	18,500
Chromite, crude ore,† tons	27,030
Coal, tons	14,461,678
Corundum, tons	67
Felspar, tons	19,166
Fluorspar, tons	1284
Graphite, tons	3971
Gritstones, tons	3328
Gypsum, tons	341,618
Magnesite, tons	55,413
Manganese, tons	979
Mica, tons	914
Mineral pigments:—	
Barytes, tons	1368
Oxides, tons	8811
Mineral water	—
Natural gas, Million cu. ft.	25,238,568
Peat, tons	300
Petroleum, barrels	198,123
Phosphate, tons	203
Pyrites, tons	309,411
Pyrites, tons	135,893
Quartz, tons	124,033
Salt, tons	19,651
Talc, tons	620
Tripollite, tons	620

* Tons of 2000 lb.

† Ore and concentrates finally marketed estimated as 13,834 tons.

supervision. Higher costs offset advantages derived from higher prices of output and in the case of gold mining were a distinct burden.

There was an increased production of nearly all metals with the exception of lead and silver.

The total production of gold in placer and mill bullion and in smelting production in 1916 is estimated at 926,963 fine oz., valued at \$19,162,025, as compared with 918,056 fine oz. valued at \$18,977,901 in 1915. Of the total production in 1916, 26% was derived from placer and alluvial mining, 54% from bullion and refined gold, and 20% contained in matte, blister copper, residues and ores exported.

The production of silver in 1916 was 25,669,172 fine oz., as against 26,625,960 fine oz. in 1915. The production from the ores of Cobalt and adjoining silver camps was 21,885,057 oz., including 18,418,392 oz. in bullion recovered in

PLASTIC CEMENTS.

Some useful information is given by J. B. Barnitt in the February issue of the General Chemical Bulletin on plastic cements, i.e., adhesives used to secure joints and connections between like or unlike material and which are more or less perma-

nent. Physically speaking, plastic cements consist of a vehicle in which are suspended or dissolved solids of such nature that they are resistant to the gases and liquids coming in contact with them. In some cases the constituents of the cement react with each other or with the surfaces to which they are applied, thus forming a more strongly adhering mass.

The general methods of application of plastic cement are varied to suit special cases as follows: (A) Heating the composition to make it plastic until firmly fixed in place. (B) Heating the surface to be cemented. (C) Application of the cement with water or a volatile solvent, depending upon the evaporation of the solvent for drying or setting. (D) Moistening the surfaces to be cemented with water, oil, etc. (the vehicle of the cement itself). (E) Application of the cement in workable condition, setting taking place by chemical reaction, hydration, or oxidation.

Plaster of Paris. Plaster of Paris is often used alone as a paste for joints on gas and wood distillation retorts and similar places where rapidity of setting is a requisite. In order to impart strength, a fibrous material such as asbestos is often mixed with it. Shavings, straw, hair, and cloth are frequently used as binders, when a high temperature is not required, while stone, glass, and various mineral substances are used as fillers. The following cements are particularly suitable for oil vapours and hydrocarbon gases: (A) Plaster and water. (B) Wet plaster and asbestos. (C) Wet plaster and straw. (D) Wet plaster and plush trimmings. (E) Wet plaster and hair. (F) Wet plaster and broken stone.

Hydraulic cement. Cement is used either alone or with sand, asbestos etc., and is especially resistant to nitric acid. When used with rosin or sulphur it is employed as a filler rather than for any powers of setting by hydration.

Clay frequently enters into the composition of plastic cement as a filler. The finely divided condition of the material gives body to a liquid such as linseed oil which, unless stiffened, would be pervious to a gas, the clay being inert. (A) Clay and linseed oil is suitable for steam. (B) Clay, linseed oil, and fire clay for chlorine gas. (C) Clay and molasses for oil vapours.

Lime. Caustic lime and linseed oil mixtures are used as a putty. Chalk or china clay frequently replace part of the lime, but enough lime should remain to maintain the caustic property necessary to the formation of a certain amount of lime soap. Silicate and casein compositions also contain lime.

Asphalt and pitch are used interchangeably in plastic cements, pitch making the stronger binder. Tar is of less value on account of the light oils and water contained in it. Asphalt in benzol is useful as an adhesive for uniting glass for photographic and microscopical uses, also for coating wood, concrete, brick work, steel, etc., where the melted asphalt would be too thick to apply readily. Benzol is the cheapest and most satisfactory solvent. For waterproofing, melted asphalt with a small amount of paraffin added, and in particular cases boiled oil is used.

(A) Refined lake asphalt. (B) Asphalt, 4 parts; paraffin, 1 part. (C) Asphalt, 10 parts; paraffin, 2 parts; boiled oil, 1 part. Any of these may be thinned with hot benzol or toluol. (D) Pitch, 8 parts; rosin, 6 parts; wax, 1 part; plaster, $\frac{1}{4}$ to $\frac{1}{2}$ part. (E) Pitch, 8 parts; rosin, 7 parts; sulphur, 2 parts; stone powder, 1 part. Compositions (D) and (E) are used to unite slate slabs and stoneware for engineering and chemical purposes. Various rosin and pitch mixtures are also used, the proportions determined by the consistency desired. Sulphur prevents chemically

the formation of cracks, while stonepowder acts in like manner mechanically. If acid vapours or corrosive gases come in contact with the cement, limestone should not be the powder used, otherwise it is best. Wax prevents the composition from becoming brittle.

Plastic cements for caulking must be both tough and elastic and have the added property of expanding and contracting with the joint to which they are applied: (F) Pitch, 3 parts; shellac, 2 parts; pure raw rubber, 1 part. (G) Pitch, 1 part; shellac, 1 part; rubber substitute, 1 part. (F) and (G) are mixed by melting over a burner.

Rosin, shellac, and wax. A strong stone cement having little body and applied in layers. (A) Rosin, 8 parts; wax, 1 part; turpentine, 1 part.

For nitric and hydrochloric acid vapours. (B) Rosin, 1 part; sulphur, 1 part; fire-clay, 2 parts.

Sulphur gives great hardness and permanency in rosin cements. Good waterproofing cements are: (C) Rosin, 1 part; wax, 1 part; powdered stone, 2 parts. (D) Shellac, 5 parts; wax, 1 part; turpentine, 1 part; chalk, 8 to 10 parts. For a soft airtight paste for ground glass surfaces: (E) Wax, 1 part; vaseline, 1 part. A strong cement without body for metals (not copper), porcelain, and glass is (F) Powdered shellac, 1 part; ammonia water, 10 parts. Allow to stand until solution is effected.

Rubber. As a leather cement: (A) Asphalt, 1 part; rosin, 1 part; gutta-percha, 4 parts, carbon bisulphide, 20 parts. As a resistant to acid vapours: (B) Rubber, 1 part; linseed oil, 2 parts; fireclay, 3 parts. A plain rubber cement is made by dissolving crude rubber in carbon bisulphide or benzol.

Linseed oil. Linseed oil is one of the most generally useful materials for cementing purposes. For aqueous vapours: (A) China clay and linseed oil. (B) Lime and linseed oil, forming the well-known putty. (C) Red or white lead and linseed oil. The above mixtures become very strong when set and are best diluted with powdered glass, clay, or graphite. (D) Oxide of iron and linseed oil.

Casein, albumin, and glue. Cements of this nature, if properly made, become very tough and tenacious, are resistant to moderate heat and oil vapours but not to acid fumes. (A) Finely powdered casein, 12 parts; fresh slaked lime, 50 parts; fine sand, 50 parts, and enough water to make a thick mass. A strong cement for ground unions standing a moderate heat: (B) Casein in fine powder, 1 part; rubbed with silicate of soda, 3 parts. (C) White of egg made into a paste with slaked lime. This should be used immediately after being made up. A composition for soaking corks, wood packing, etc., to render impervious to oil vapours: (D) Gelatin, 2 parts; glycerin, 1 part; water, 6 parts.

Silicate and oxychloride cements for oil vapours standing highest temperature. (A) Paste of sodium silicate and asbestos. For gaskets for super-heated steam retorts, furnaces, etc.: (B) Sodium silicate and glass. (C) Sodium silicate, 50 parts; asbestos, 15 parts; slaked lime, 10 parts. Metal cement: (D) Sodium silicate, 1 part; oxides of zinc, lead, or iron, singly or mixed, 1 part. (E) Zinc oxide, 2 parts; zinc chloride, 1 part; water, to make a paste. (F) Magnesium oxide, 2 parts; magnesium chloride, 1 part; water to make a paste.

Flour and starch. (A) Flaxseed makes a very tough cement but does not withstand water. (B) Flour and molasses to a stiff paste. A permanent cement for ordinary temperatures impervious but attacked by condensing steam and nitric vapours. (C) Stiff flour paste and concentrated zinc chloride solution. As a core compound: (D) Dextrin and fine sand.

Miscellaneous. For insertion of glass tubes in brass or iron: Litharge and glycerin mixed to a stiff paste. For high temperatures:—Alumina, 1 part; sand, 4 parts; slaked lime, 1 part; borax, $\frac{1}{2}$ part; water. Core compounds: (A) Dextrin, 1 part; sand, 10 parts; water to form a thick paste. (B) Anthracite coal powdered with molasses added to thick paste. (C) Rosin, partly saponified by soda lye, 1 part; flour, 2 parts; sand, 4 parts; with water as a diluent. (D) Powdered ghte, 1 part; flour, 4 parts; sand, 6 parts; water. As a coating for glassware to protect from injury by direct flame: A mixture of fire clay and plumbeago made into a paste with water. For retorts: Fine flour and lime, 1 part; potter's earth, $\frac{1}{2}$ part; make a moist paste with white of egg well beaten with a little water. For melting pots: (A) sift brick dust and mix with equal quantity of red lead; rub together with boiled linseed oil, which has been mixed with sand to a stiffness of cement. In covering dishes apply the paste first then apply sand and heat. (B) Add freshly slaked lime to concentrated solution of borax, apply with a stiff brush and allow to dry. Upon heating a fused glaze is obtained. For large pots: Litharge, 6 parts; fresh burnt lime, 1 part; white bole, 2 parts; and mix with cold linseed oil.

MINERAL PRODUCTION OF THE UNITED KINGDOM IN 1916.

The following tables, showing the output of coal and certain other minerals in the United Kingdom at mines worked under the Coal and Metalliferous Mines Acts (the returns from quarries under the Quarries Act are not yet available) during the year 1916, with comparative figures for the preceding year, are extracted from an advance proof (subject to correction) of tables prepared for the Mines and Quarries General Report and Statistics for 1916.

Output of minerals under the Coal Mines Act.

	1915.	1916.
	Tons.	Tons.
Barium (compounds)	7477	8973
Coal	253,179,446	256,348,351
Clay and shale, other than fire-clay and oil shale	236,506	177,719
Fire-clay	1,839,746	1,712,281
Igneous rocks	79	108
Iron pyrites	9255	9496
Ironstone	6,080,218	5,648,602
Limestone	4464	2477
Oil shale	2,998,652	2,994,386
Sandstone (including "ganister") ..	141,420	160,513

* The quantity of ganister obtained was 128,938 tons in 1915, and 159,769 tons in 1916.

Output of certain minerals under the Metalliferous Mines Regulation Act.

	1915.	1916.
	Tons.	Tons.
Arsenic	2496	2534
Barium (compounds)	53,324	60,468
Bauxite	11,723	10,329
Chert, flint, etc.	3033	3202
Clay and shale	86,202	84,168
Copper ore and copper precipitate ..	746	937
Fluorspar	25,577	34,517
Gold ore	5086	1338
Gypsum	204,574	188,801
Igneous rocks	43,010	23,875
Iron ore	1,795,887	1,751,437
Iron pyrites	1280	985
Lead ore	20,698	17,084
Limestone*	283,216	235,983
Manganese ore	4640	5140
Ochre, amber, etc.	4030	4570
Rock salt	131,348	129,030
Sandstone†	57,626	32,174
Slate	48,893	46,184
Tin ore, dressed‡	6427	6161
Zinc ore	12,057	8476

* Including 271 tons of calc spar in 1915 and 67 tons in 1916.

† Including 4297 tons of ganister in 1915, and 8497 tons in 1916.

‡ In addition, 385 tons of undressed tin ore was obtained in 1915.

The above figures do not in all cases represent the total production of the minerals for the year. Large quantities of several important minerals, such as iron ore, limestone, sandstone, slate, clay, etc., are obtained from quarries under the Quarries Act, and from other open workings, the returns from which are not yet available. The totals for coal and for the ores of copper, lead, and zinc are, however, substantially complete.

Correspondence.

Berkeley, Cal., U.S.A.

24th March, 1917.

VARIABILITY OF PLANTATION PARA RUBBER.

DEAR SIR,

I write to correct a misstatement which my friends Messrs. Eaton and Grantham make in their communication (this J., 1916, 35, 1046) "Variability of Plantation Para Rubber with Different Technical Mixings." They state that the vulcanisation tests dealt with in the paper of mine to which they refer were carried out by Schidrowitz. This is not so. I was working in Schidrowitz's laboratory at the time that the vulcanisation tests were made and I pursued his methods, but the experiments, both in the East and in Europe, were conducted by myself.

Yours faithfully,

G. STAFFORD WHITBY.

To the Editor of the
JOURNAL OF THE SOCIETY OF CHEMICAL INDUSTRY.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each, to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.

United States.—1s. each, to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—Patent number, date, name of patentee, and title of invention.

French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56 Rue Ferou 8 Paris (Se.). Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

PATENTS.

Refrigerating apparatus; Absorption.—H. E. Willsie, Cranford, N.J. U.S.A. Eng. Pat. 102,080, Feb. 10, 1916. (Appl. No. 2027 of 1916.)

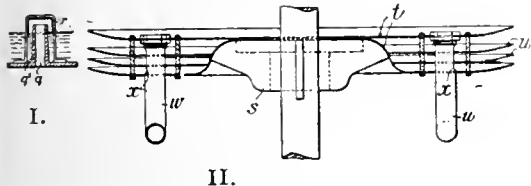
THE still-absorber and the condenser are con-

nected together through the evaporator, so that the refrigerating fluid passes through the evaporator as it leaves and returns to the condenser. The refrigerating fluid also passes through a chamber which serves as a moisture-trap and which seals off one set of pipes during the absorption period. The still-absorber is mounted

on a pivot and is flexibly connected with the rest of the apparatus so that the alteration in its weight operates the supply of gas to the heating arrangement. The warm water from the condenser may be used as a supply for a warm water circulating system.—W. H. C.

Liquids and gases; Apparatus for effecting the intimate contact of —. Kirkham, Hulett, and Chandler, Ltd., and S. Hersey, London. Eng. Pat. 104,261, Apr. 28, 1916. (Appl. No. 6120 of 1916.)

IN apparatus of the type described in Eng. Pat. 18,129 of 1908 (this J., 1909, 873), each of the superposed chambers is provided with several spraying devices, one central and the others arranged in a concentric circle and mounted on



separate parallel vertical driving shafts; or each chamber may be provided with two sprayers arranged symmetrically in relation to the centre of the chamber, and rotating in opposite directions. The floor of each chamber is provided with openings having upstanding flanges through which the driving shafts of the spraying devices extend, and additional openings, *q* (see Fig. I.), with upstanding flanges, *q'*, covered by serrated hoods, *r*, are provided for the upward passage of gas. When dense liquids such as heavy oils are used, the sprayer preferably comprises a collar, *s* (see Fig. II.), carrying top and bottom plates, *t*, between which intermediate annular dish-shaped plates, *u*, are fixed. The tubes, *v*, for picking up the liquid are supported by the top plate, and are provided with extended openings, *x*, for the discharge of liquid on to the plates, *t*, *u*.—W. F. F.

Boilers and the like; Production of means for preventing fur from depositing in —. O. L. K. Andersen, Struer, Denmark. Eng. Pat. 104,294, July 12, 1916. (Appl. No. 9815 of 1916.)

A SUBSTANCE for preventing boiler incrustation is produced by heating a mixture of catechu, 50–75%, sodium hydroxide 25–12.5%, and raw, ground, or grated potatoes or potato liquor, 25–12.5%, until the greater part of the catechu is dissolved. The mixture is used in the proportion of 0.5 to 1 part per 1000 of water.—W. F. F.

Drying apparatus; Air shafts for —. H. P. Dinesen, Herlev, Denmark. Eng. Pat. 104,327, Jan. 25, 1917. (Appl. No. 1248 of 1917.)

HAY, straw, or like fibrous material is stored with a number of vertical perforated tubes embedded in it, through which air is forced into or withdrawn from the material. The perforations are more numerous toward the bottom of the tubes, and sliding plates are provided on the tubes to guide the air current horizontally.—W. F. F.

Drying grain; Apparatus for —. G. Staunton, Muskegon, Mich. U.S. Pat. 1,212,275, Jan. 26, 1917. Date of appl., Aug. 4, 1913. Renewed June 12, 1916.

THE grain is placed in the upper compartment of a closed cylindrical chamber, and air is injected tangentially into a lower compartment which is provided with a heating coil of inverted conical shape and is separated from the upper chamber by a perforated partition.—W. H. C.

Drying machine. J. F. Sullenberger, Columbus, Ga. U.S. Pat. 1,216,880, Feb. 20, 1917. Date of appl., May, 6, 1916.

A VERTICAL cylindrical casing is built up of rings flanged internally and externally and separated by distance members bolted to the external flanges. A shallow pan is supported on each internal flange, the pans being provided with central and peripheral openings alternately. Each pan is heated by a coiled heating tube beneath it, and the material to be dried is moved across the surface to the opening by a rotating feeding member having depending spiral ribs. All the feeding members are mounted on a common central rotating shaft.—W. F. F.

Dryer [; Centrifugal —]. C. A. Wendell, Joliet, Ill. U.S. Pat. 1,218,024, Mar. 6, 1917. Date of appl., June 9, 1916.

A CENTRIFUGAL dryer comprises two horizontal, rotary, differentially geared members, one in the form of a delivery spout, the other acting as a projecting agent for the material. In the latter a screen is mounted at an angle to the vertical, water expelled by centrifugal action passing through the screen, and the dried material being deflected by the angle of the screen through discharge ways opened intermittently by the relative rotation of the two members.—J. E. C.

Carbon; Revivification of used finely powdered decolorising —. A. Wijnberg, Amsterdam. Eng. Pat. 104,456, July 18, 1916. (Appl. No. 10,092 of 1916.) Under Int. Conv., Feb. 25, 1916.

THE material is conveyed in alternately opposite directions through heated cylinders, the heavier particles being deposited in a collecting receptacle at the end of the course. The finer particles are drawn off along with the escaping vapours and passed to a precipitator, where separation of the vapour and solid particles takes place. Steam or water may be injected to increase the separating effect.—J. E. C.

Gaseous fluids; Apparatus for removing suspended matter from —. H. L. Doherty, New York. U.S. Pat. 1,212,193, Jan. 16, 1917. Date of appl., Apr. 4, 1912.

THE gases are passed through two or more spiral passages having their sides practically parallel and enclosed in a chamber provided with inlet and outlet ports. The free area of the spiral passages can be varied to suit variations in the quantity of gas to be passed, by raising or lowering the level of a liquid in the chamber.—W. H. C.

Fillering air; Apparatus for —. S. Cooper, Assignor to F. Offermann, Evansville, Ind. U.S. Pat. 1,214,760, Feb. 6, 1917. Date of appl., Oct. 26, 1915.

THE air is passed through a conduit across which two aprons moistened with water are stretched. The aprons are wound round two drums, one of which is perforated and serves to supply the water. The aprons are shifted simultaneously in the direction of their length by rotating the drums.—W. H. C.

Furnaces; Process of operating [producer-] gas-fired —. H. L. Doherty, New York. U.S. Pat. 1,211,520, Feb. 6, 1917. Date of appl., Mar. 31, 1909.

THE products of combustion are withdrawn from the combustion chamber through ports spaced at intervals along each side, so that approximately equal proportions are withdrawn through each port. The hot products of combustion withdrawn from one side of the furnace

are utilised to preheat the primary air, which after being saturated with water vapour is introduced into the gas producer. The products of combustion from the other side of the furnace chamber are used to preheat the secondary air.

—W. H. C.

Distillation; Method of and apparatus for fractional —. W. E. Lammus, Lynn, Mass. U.S. Pat. 1,216,331, Feb. 20, 1917. Date of appl. Apr. 6, 1916.

IN a distilling apparatus of the column type, the vapours are passed successively through a series of reflux condensing chambers. A cooling or condensing medium is circulated through the latter, the cross-sectional area and the length of path and rate of flow of the stream of cooling medium being so regulated that there is a relatively constant difference between the temperature of the medium and that of the vapours, the rate of flow of the vapours into the chambers being also regulated.—W. P. S.

Condensing and vacuum draught mechanism for furnaces. F. L. McGahan, Los Angeles, Cal. U.S. Pat. 1,217,100, Feb. 20, 1917. Date of appl. Apr. 9, 1914.

FURNACE gases enter a receiving chamber at the top of a vertical casing having in its lower part a condensing chamber provided with a rotating water-spreading device. This device consists of a vertical tubular member open at the ends and carrying helical vanes upon its exterior surface, against which water impinges to rotate the device, which is mounted on a vertical shaft. The shaft also carries a fan in the gas-receiving chamber and a centrifugal governor for regulating the water supply. The heavier elements are thus separated from the gas and treated with water, and the purified gas passes down through the spreader tube to the bottom of the casing, which is divided by a partition into a "water chamber" and a "vacuum chamber," which communicate with each other, and to the latter of which suction is applied.—W. F. F.

Filling process. A. L. Genter, Salt Lake City, Utah. U.S. Pat. 1,218,511, Mar. 6, 1917. Date of appl. Jan. 1, 1915.

SEE GER. Pat. 287,318 of 1914; this J., 1916, 243.

Solvents; Process of recovering —. T. Baker, Assignor to E. I. du Pont de Nemours Powder Co., Wilmington, Del. U.S. Pat. 1,218,616, Mar. 13, 1917. Date of appl. Mar. 26, 1915.

SEE ENG. Pat. 10,351 of 1914; this J., 1915, 601.

Apparatus for separating and liquefying gases. U.S. Pat. 1,215,957. See under VII.

II.A.—FUEL; GAS; MINERAL OILS AND WAXES.

Coal carbonisation at atmospheric pressure; Effect of temperature and duration of reaction on the formation of light oils in —. M. C. Whitaker and W. R. Crowell. J. Ind. Eng. Chem., 1917, 9, 261—269.

CARBONISATION of coal at low temperatures promotes the formation of the total light and heavy oil and tar acids, whilst an increase of temperature reduces the yields of light oil and tar acids, but increases the yield of heavy oil. The oils obtained at low temperatures contain a high percentage of paraffins and unsaturated compounds and a low percentage of aromatic compounds. The maximum formation of aromatic compounds is accompanied by a decrease in the proportion of unsaturated compounds. In the case of the coal used in the investigation there was apparently a definite

relationship between the temperature and the rate of formation of benzene, toluene, and xylene. Xylene and toluene appeared to form between 400° and 900°C., and benzene between 500° and 900°C. The points of maximum formation were:—Benzene, 800°C., toluene, 700°C., and xylene, 600°C. These results agree closely with those obtained in the "cracking" of petroleum oils, and apparently the course of the reactions in the formation of benzene, toluene, and xylene is the same in both cases. It would therefore seem probable that the primary products of the decomposition of coal consist largely of paraffins of high molecular weight, which are decomposed successively into olefins, and the decomposition products (naphthenes, polycyclic compounds, etc.) which yield benzene and its homologues. The so-called "recirculation" process, in which the non-condensable distillation gases are circulated repeatedly through the retort, reduces the duration of the carbonisation reactions, and tends to increase the actual yields of heavy and light oils, as well as of the benzene, toluene, and xylene fractions. It also tends to increase the percentage yield of paraffins and to decrease the percentage yield of aromatic and unsaturated compounds in the neutral oil distilling below 170°C. Increasing the duration of the carbonisation by non-circulation gives higher percentage yields of benzene, toluene, and xylene in the light oil distilling up to 210°C., but in the zones of maximum formation of aromatic compounds (usually 700° to 900°C.) the actual yields are increased by recirculation. Both the actual and percentage yields of tar acids in the light oil show a tendency to be increased by recirculation, which supports the view that tar acids are primary products of the decomposition of coal. These results indicate the necessity for control of the temperature in the carbonisation process. For obtaining the best yields of benzene, toluene, and xylene, the temperature should not be much below 700° or much above 800°C. Good yields obtained in the gasworks at higher temperatures are attributed to the protection afforded by the cooler central core of coal which does not reach the cracking temperature, and to the dilution of the hotter gases by the cooler gases from the centre of the charge. By shortening the carbonisation process it should be possible to increase the yield of paraffin oils at low temperatures and that of aromatic compounds at higher temperatures. It is suggested that it might be possible to treat the tars obtained by carbonisation at a low temperature by the cracking processes used with petroleum oils.—C. A. M.

Coke dust or other low-grade fuel; Producer-gas, and the utilisation of —. W. Chaney, Midland Assoc. Gas Eng. and Managers, Mar. 22, 1917. Gas J., 1917, 137, 607—608.

COKE dust, passing a $\frac{1}{8}$ -in. riddle, is gasified under ammonia-recovery conditions in the Birmingham City Gasworks, and the producer gas obtained is used to heat coke-ovens, the gas from which is used wholly for town lighting, etc. The calorific value of the dust is approximately 10,000 B.T.U. per lb. and nitrogen content 1%. It is capable of yielding 45—50 lb. of ammonium sulphate per ton and 95,000 cu. ft. of gas of calorific value 111 B.T.U. per cu. ft. In practice it is found preferable to mix 40% of the dust with 60% of a producer slack, when a gas of calorific value 130 B.T.U. per cu. ft. can be obtained and the rate of gasification much increased. The thermal efficiency of retort heating with an outside producer is less than that of the normal built-in producer, but other economic advantages are claimed. The dust fuel used, which represents 3 to 4% of the coal carbonised, is usually regarded as valueless and it liberates for sale the larger

coke generally used. At the same time a fair yield of ammonium sulphate is obtained. Other advantages are the flexibility, when ovens or retorts are shut off, the uniform quality of the gas, and the absence of flue dust or clinkering troubles in the retort settings.—H. J. H.

Inflammability of carbonaceous dusts. Brown.
See XIXB.

Simple apparatus for the washing of gases. Gray.
See XXIII.

PATENTS.

Drying peat, and apparatus therefor. F. G. Lea, London. Eng. Pat. 103,729, Mar. 20, 1916. (Appl. No. 4117 of 1916.)

THE difficulties of drying peat which has been compressed are avoided by alternately compressing and breaking up the peat, which is at the same time heated. The disintegrated air-dried peat is fed upon an endless band which carries it through a series of hot pressing rollers; between the pressing rollers a heating apparatus is fixed below the band and a disintegrating roller above the band.—H. J. H.

Gas producer. The Hampden Cloncurry Copper Mines, Ltd., Melbourne, Australia. Eng. Pat. 100,634, Feb. 24, 1916. (Appl. No. 2790 of 1916.) Under Int. Conv., June 8, 1915.

A GAS producer is divided into an upper and a lower section by a constriction. Air is supplied through tuyères in the region of the constriction and below the grate of the lower portion. Gas is conducted from the lower half by means of an inverted U-shaped bridge and side outlet, and passing through a vaporiser generates steam which is admitted at the top and bottom of the producer.—J. E. C.

Gas; Apparatus for manufacture of —. H. Begemann, Portland, Me., Assignor to W. J. Gindele, Pawtucket, R.I. U.S. Pat. 1,217,554, Feb. 27, 1917. Date of appl., June 25, 1914.

AN apparatus for the manufacture of gas consists of an externally heated vertical retort with a cylindrical upper portion, a lateral coal inlet, and a gas outlet, the latter below the coal inlet. A close-fitting plunger in the cylindrical portion forces the coal through the retort.—J. E. C.

Gas generation; Process of —. H. E. Rider, Brooklyn, N.Y., Assignor to L. Leven, New York. U.S. Pat. 1,218,470, Mar. 6, 1917. Date of appl., Dec. 26, 1914.

THE suction of an engine is utilised to atomise oil by means of air currents through jets connected to an oil supply. The mixture of air and oil vapour is ignited and the flame smothered by passing the partly consumed gas through a restricted passage. The gas is thoroughly mixed and caused to impinge against a static body of oil. The gas, enriched by evaporation of some of the oil, passes through screens of fine mesh to break up individual currents. Air may be admitted to vary the richness of the mixture.—J. E. C.

Oil-gas producer. C. O. Nordensson, Chicago, Ill. U.S. Pat. 1,218,575, Mar. 6, 1917. Date of appl., Jan. 2, 1913.

AN oil-gas producer is provided with means for supplying a preheated mixture of air and vapour (steam) to the generator, and means controlled by the heat of the vapour-producing medium for supplying preheated oil to the generator and for mixing it with the mixture of air and vapour.—J. E. C.

Gas-washers and like apparatus. G. K. Davis, Manchester. Eng. Pat. 104,465, Aug. 23, 1916. (Appl. No. 11,964 of 1916.) (See also Eng. Pat. 17,005 of 1914; this J., 1915, 897.)

To prevent leakage in gas washers and the like, a disc is secured to the fanner shaft, causing the liquid to be thrown off at the largest diameter. The disc encircles part of a boss projecting within the body of the washer and furnished with a peripheral groove.—J. E. C.

Liquid fuel; Apparatus in which — is vaporated. D. La Cour and C. V. Schou, Copenhagen. Eng. Pat. 104,604, June 19, 1916. (Appl. No. 8640 of 1916.)

IN apparatus in which liquid fuel is to be vaporised, a piece of metal which is a good conductor of heat is heated externally to the apparatus by means of solid or liquid products of combustion of a heating cartridge, and conducts heat to the region of vaporisation.—J. E. C.

Hydrocarbon vapours; Apparatus for generating and burning —. J. I. Leary, Assignor to E. H. Doud and G. L. Hogan, Chicago, Ill. U.S. Pat. 1,216,578, Feb. 20, 1917. Date of appl., July 3, 1916.

A VAPORISING device for hydrocarbons contains passages having walls of aluminium arranged so that the liquid and vapour passing through the retort come in contact with the aluminium. The aluminium is reinforced by a wall of conducting material so that it cannot sag when heated. A fuel reservoir is provided with an outlet in its lower portion which communicates with the vaporiser. A vertical tube within the reservoir has its upper end above the fuel level and its lower end directly over the fuel outlet; an intervening screen is placed between the lower end of the tube and the outlet. Means are provided for supplying a "hydro-oxygen cleaning solution" to the vaporiser.—J. F. B.

[Petroleum] oils; Treating —. C. Ellis, Montclair, N.J. U.S. Pat. 1,216,971, Feb. 20, 1917. Date of appl., June 3, 1913.

AN oil heavier than gasoline, such as kerosene, is heated to a decomposing temperature. Liquid products are removed by condensation from the gas, which is then compressed to remove a further quantity of liquefiable products. A portion of the gas is added to the raw material entering the zone of heat decomposition.—J. E. C.

Briquettes of coal, coke, peat, ores, and the like; Process and apparatus for introducing and mixing the binding medium in making —. E. Kleinschmidt, Frankfort, Germany. Eng. Pat. 100,158, Mar. 10, 1916. Under Int. Conv., Mar. 10, 1915. (Appl. No. 3558 of 1916.)

SEE U.S. Pat. 1,207,180 of 1916; this J., 1917, 76. Other forms of apparatus for introducing the binding medium in a direction at right angles to the stream of material to be briquetted are described.

Lignite and the like; Treatment [drying] of —. T. Rigby, Dumfries, and N. Testrup, London. U.S. Pat. 1,219,155, Mar. 13, 1917. Date of appl., Jan. 11, 1913.

SEE Eng. Pat. 969 of 1912; this J., 1913, 353.

Fuel and fire-lighter; Composition —. E. H. Smirk, St. Annes-on-the-Sea. U.S. Pat. 1,219,178, Mar. 13, 1917. Date of appl., June 19, 1916.

SEE Eng. Pat. 101,813 of 1916; this J., 1916, 1210

Coking plants; Processes and means for controlling combustion in —. W. J. Mellersh-Jackson. London. From H. Koppers Co., Pittsburgh, Pa., U.S.A. Eng. Pats. 104,368 and 104,369, Feb. 26, 1916. (Appl. Nos. 2909 and 2912 of 1916.)

SEE U.S. Pats. 1,176,066 and 1,176,067 of 1916; this J., 1916, 527.

Apparatus for removing suspended matter from gaseous fluids. U.S. Pat. 1,212,193. See I.

Process of operating [producer-] gas-fired furnaces. U.S. Pat. 1,214,520. See I.

Gas analysing plant. Eng. Pat. 103,107. See XXIII.

11B.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

Method of producing crude wood creosote from hardwood tar. Judd and Acree. See III.

Commercial beechwood creosote. Smith and Acree. See III.

PATENTS.

Vacuum apparatus [X-ray tubes]. The British Thomson-Houston Co., Ltd., London. From General Electric Co., Schenectady, U.S.A. Eng. Pat. 104,230, Mar. 7, 1916. (Appl. No. 3391 of 1916.)

THE high vacuum, in an X-ray or other electron discharge tube, is maintained by automatically and electrically disintegrating a metal within the container, in response to incipient positive ionisation of the gas evolved from parts of the apparatus during working, thus fixing the gas.—B. N.

X-ray tube. F. A. Wiggin. Lawrence, Mass. U.S. Pat. 1,218,026, Mar. 6, 1917. Date of appl., Oct. 5, 1916.

AN X-ray target comprises a face plate of tungsten alloy, a backing metal of relatively high heat conductivity, and an intermediate metal or alloy having a coefficient of expansion intermediate between that of the backing and of the tungsten alloy.—J. E. C.

Electric arc candle; Self-igniting —. J. Billiter, Vienna. U.S. Pat. 1,216,401, Feb. 20, 1917. Date of appl., Jan. 28, 1914.

ELECTRODES, placed adjacent to each other, are arranged with an intermediate layer of 20 to 60% of titanium oxide, 20 to 80% of fluorspar, 20 to 50% of titanium oxalate as binding material, and 2 to 20% of graphite.—B. N.

Revivification of used, finely powdered decolorising carbon. Eng. Pat. 104,456. See I.

III.—TAR AND TAR PRODUCTS.

Crude wood creosote from hardwood tar; Method of producing —. R. C. Judd and F. S. Acree. J. Ind. Eng. Chem., 1917, 9, 276—277.

DISTILLATION of the tar with steam is slow, consumes a large amount of steam, and gives small yields of creosote. The best method is to distil the tar by direct heat until the distillate comes over as a homogeneous liquid at a temperature well above 100° C. The temperature is then raised, and a jet of steam is introduced to stir the tar, the distillate being then separately collected, and the distillation continued until paraffin wax comes over. The heavy oil fraction should then contain not more than 1% of acid, whilst the residue of pitch can be removed without fear of coking.—C. A. M.

Beechwood creosote; Commercial —. H. K. Smith and S. F. Acree. J. Ind. Eng. Chem., 1917, 9, 275—277.

A SAMPLE of beechwood creosote containing tar and pitch distilled between 200° and 285° C., leaving 21.6% of a black solid residue. Above 300° C. the pitch decomposed and became friable when cold. The fraction distilling between 215° and 230° C. was extracted with an excess of 10% sodium hydroxide solution to remove phenolic compounds, and yielded about 40% of a neutral oil and 56% of acid oil, both of which distilled without material decomposition and without the formation of pitch. Redistillation of the acid oil yielded about 65% of a guaiacol fraction boiling between 190° and 225° C.—C. A. M.

Paradiazoinobenzene; Acyl derivatives of —. G. T. Morgan and A. W. H. Upton. Chem. Soc. Trans., 1917, 111, 187—196.

FORMYL- and acetyl-*p*-phenylenediamines on diazotising in aqueous solution in absence of strong acids, yield ill-defined diazoamines, whilst benzoyl-*p*-phenylenediamine yields benzoyl-*p*-aminobenzene-diazonium nitrite and the corresponding hydrogen carbonate. If, however, these substituted *p*-phenylenediamines are diazotised with liquid nitrous anhydride, free from nitrogen peroxide, in dry acetone, they yield formyl-, acetyl-, and benzoyl-*p*-phenylenediazoimides as pale yellow crystalline substances decomposing explosively at 125°—128° C., 127° C., and 139° C., respectively, whilst benzoyl-1,4-naphthylenediamine similarly diazotised yields benzoyl-1,4-naphthylene diazoimide, decomposing at 123° C. without explosion. Formyl- and acetyl-*p*-phenylenediazoimides are unstable at ordinary temperatures, losing nitrogen and being converted into ill-defined resinous materials, whilst benzoyl-*p*-phenylenediazoimide and benzoyl-1,4-naphthylenediazoimide are quite stable in air at the ordinary temperature. These diazoimides readily combine additively with phenols and naphthols and with bases such as the naphthylamines and *m*-phenylenediamine and its homologues, yielding azo derivatives.—T. C.

Output of high-boiling tar acids. See page 407.

Direct iodation of hydrocarbons by means of iodine and nitric acid. Datta and Chatterjee. See XX.

Iodation by means of nitrogen iodide or by means of iodine in presence of ammonia. Datta and Prosad. See XX.

Improvements in calorimetric combustion, and the heat of combustion of toluene. Richards and Davies. See XXIII.

IV.—COLOURING MATTERS AND DYES.

Indigo plants; Extraction of the colouring principle of Formosan —. T. Katayama and H. Matsumoto. Kōgyō - Kwagaku Zasshi (J. Chem. Ind. Tokyo, Japan), 1917, 19, 1151—1162.

THE Formosan indigo plants (*Indigofera anil* and *Strobilanthes flaccidifolius*) belong to the indican-containing variety. The optimum temperature for the hydrolysis of the indican is 50° C., no indigo being produced at 80° C. The frothing up during the steeping does not concern the formation of indigo, being the result of rotting of vegetable matters. The colouring principle was dissolved out completely in 3 hrs. at 50° C. to give a liquid which was not contaminated with indifferent organic matters, as was the case with the ordinary

cold steeping method, and hence gave a better cake indigo. The Indigo Red content is greater if the steeping is carried out at 69°–70° C. than at 40°–50° C.—F. W. A.

Acyl derivatives of paradiazoiminobenzene. Morgan and Upton. See III.

PATENTS.

Triphenylmethane series; Dyes of the — and process of making same. A. Stock and O. Nicodenus. Assignors to Farb. vorm. Meister, Lucius, und Brüning, Höchst, Germany. U.S. Pat. 1,217,238, Feb. 27, 1916. Date of appl. June 22, 1915.

SEE Ger. Pat. 290,065 of 1914; this J., 1916, 531. Special claim is made for the dyestuff produced by heating with *p*-phenetidine the dyestuff obtained by condensing 4-chloro-2'-methyl-4'-dimethylaminobenzophenone with *N*-ethyl- α -phenylindole, and then sulphonating the product. It is a dark powder giving a reddish-blue solution in water and an orange-yellow solution in concentrated sulphuric acid, and dyes wool reddish-blue shades of great fastness to light.

Triphenylmethane dye; Blue —. M. Weiler, Elberfeld, Germany. Assignor to Synthetic Patents Co., New York. U.S. Pat. 1,218,232, Mar. 6, 1917. Date of appl., Mar. 27, 1915.

SEE Ger. Pat. 287,003 of 1914; this J., 1916, 171.

Ortho[hydr]oxymonoazo dyes. R. Kirchhoff, J. Dedichen, and W. Lange. Assignors to Act.-Ges. f. Anilinfabr., Berlin. U.S. Pat. 1,219,951, Mar. 20, 1917. Date of appl., Nov. 27, 1915.

SEE Eng. Pat. 16,592 of 1915; this J., 1916, 686.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Paper; Mould fungi causing deterioration of —. P. Sée. Comptes rend., 1917, 164, 230–232.

PAPER is very susceptible, in a damp atmosphere, to attack by mould fungi, many of which secrete pigment and produce specks of various colours. Examination of a stain due to mildew shows that it is made up of two portions: a central portion, generally rather dark in colour, composed of mycelium, and a peripheral zone, almost circular, paler, coloured by the secretions of the fungus, and frequently visible, owing to the diffusion of the pigment, on both sides of the paper. The germs of infection are not necessarily conveyed to the paper during storage but probably pre-exist in the material from which the paper is made. The number of species of mould fungi found in paper is strictly limited and the same forms occur in spite of the great variety of materials employed and of experimental conditions. The stains may be reproduced by infection on strips of sterilised paper without the addition of other nutritive media. Certain species are characterised by the appearance of the stain, others by the colour. Several species give a blackish stain of green, grey, brown, or maroon shade, others are characterised by specific colours: ochreous, pink, cherry-red, apple-green, brownish-yellow, pale brown, or maroon.—J. F. B.

Paper; Influence of humidity on the physical constants of —. O. Kress and P. Silverstein. J. Ind. Eng. Chem., 1917, 9, 277–282.

The sheets of paper used in the tests were suspended for 3 hours over strings in a double-walled chamber provided with a constant temperature and constant humidity apparatus, including an air pump, steam pipe, water sprays, compressor,

and fan. The humidity regulator was controlled by a silk thread which expanded or contracted with the degree of moisture in the chamber, so as to admit steam to the heating coils or compressed air into the room. The extreme ranges of humidity which could be maintained were 41 to 82 %. The series of papers included: (1) papers containing 30 % of mechanical wood and 70 % of sulphite pulp; (2) sulphite papers; (3) "kraft," 20, 30, 40 and 50 lb. papers; and (4) "kraft" 30, 40, and 60 lb. papers. It was found that an exposure of 2½ hours was sufficient to bring the papers to the required moisture content. In measuring the constants the room weight was taken on the 500 basis, sheets 24 in. by 36 in. The resistance to bursting was measured by the Mullen tester, the strength in lb. required to burst 1 sq. in. being termed the "points per lb.," whilst the "strength factor" or "points per 0.001 in." represented the results of the Mullen tester divided by the number of thousandths of an inch thickness of the paper. The tensile strength in kilos, and the % strength of the paper were determined by means of the Schopper tensile strength machine, and the resistance to folding by the Schopper folder. The average results of 5 or, in divergent cases, of 10 tests were taken. The following conclusions were drawn from the results:—(1) The value of "points per lb." increases with the decrease in relative humidity. The increase between 40 and 65 % of moisture is fairly regular, but above 70 % a large reduction in strength occurs. For example, in the case of Series I., taking the strength at 65 % humidity as the standard, there was an average variation of 8 % in strength on increasing the humidity from 41 to 65 %, whilst from 65 to 82 % the strength decreased by 21.5 %. (2) Similar results were obtained in the breaking length tests, the strength falling more rapidly above 70 to 75 % relative humidity than between 40 and 75 %. (3) The stretching capacity increases with the increase in relative humidity, the variation being more regular than in (1) and (2). In the case of the papers of Series I., the increase was 17 % on increasing the relative humidity from 41 to 65 %, and 31 % for an increase from 65 to 82 % of humidity. (4) The folding properties are more affected by the humidity than the other constants. In papers of Series I. and II., a great resistance to folding was observed between 55 and 77 % of relative humidity, but a further increase in the moisture content caused a sharp break in the folding strength. With the "kraft" papers, however, the folding strength increased with the humidity, and at 82 % of humidity they showed greater folding strength than at 77 %. It is pointed out that when papers are bought and sold on strength specifications more uniform results would be obtained if the relative humidity during the tests were also specified.—C. A. M.

[Paper testing.] *Colour; Numerical expression for — as given by the Ives tint photometer.* O. Kress and G. C. McNaughton. J. Ind. Eng. Chem., 1916, 8, 711–714; 1917, 9, 282–284.

THE Ives tint photometer consists essentially of a form of telescope into which light is admitted from two sources by means of a mirror and is focussed by a special lens into two semi-circular fields. The amount of light reflected is controlled by a shutter moved by a lever which passes over a graduated scale. The base of the eye-piece tube has a sliding carrier in which are mounted red, green, and blue colour screens, and one of colourless glass. The light is first reflected from two magnesia blocks, the shutter set at 100, and the other aperture adjusted by a thumb-screw until the two halves of the field appear of uniform intensity. The right magnesia block is then replaced by the object (*e.g.*, paper) to be tested.

Each of the colour screens is used successively, the light entering the left aperture being reduced until it is of the same intensity as that entering the right aperture reflected from the paper. The position of the lever on the scale when this equal intensity is obtained with each screen gives numerically the proportions in which red, green, and blue light are reflected by the paper. For example, an undyed sulphite paper gave readings of 77 parts of red, 71 parts of green, and 67 parts of blue. The sum of the three colours in the case of the white standard was 300, so that there was a darkening effect of 85 "parts black" in 300. Duplicate determinations can be made within one division with this instrument. In tests with papers made from specially prepared pulps tinted with various amounts of Diamond Green GN, Rhodamine B extra, Crystal Violet, and Jet Black 2 R, uniform readings were readily obtained in "parts red, green, and blue" and "parts black." A paper of brown shade dyed with Vesuvine BPX, Auramine, and Safranin T Extra Conc. was accurately matched to the eye by natural and artificial light by a paper dyed with Auramine, Safranin, and Victoria Green, and gave identical readings in the photometer. In determining the effect of calendering upon the colour, the "glare" was measured by means of Ingersoll's "glarimeter," which determines the percentage of "specularly" reflected light (*i.e.*, light reflected where the angle of incidence equals the angle of reflection) in comparison with the total reflected light. The results showed that whilst the glarimeter might be of value in determining the degree of finish of white papers, it is not suitable for coloured papers of different hues and intensity.—C. A. M.

PATENTS.

Carbonising sheep's wool; Process for —. 1. Teller, Vienna. Eng. Pat. 16,087, Nov. 15, 1915. Under Int. Conv., Jan. 22, 1915.

SEE Ger. Pat. 293,884 of 1915; this J., 1916, 1106. After treatment with the solution of zinc chloride in hydrochloric acid, the wool may be centrifuged, treated with a solution (about 15%) of sodium bisulphite, and then washed with cold water until the washings are no longer acid. (Reference is directed, in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pats. 2505 of 1876 and 8795 of 1885.)

Animal hair [wool]; Process of cleaning — and producing fertiliser. H. Y. McBride, Artesia, N. Mex. U.S. Pat. 1,218,573, Mar. 6, 1917. Date of appl., Oct. 6, 1915.

RAW wool is treated with a comminuted grease-absorbing, earthy material, *e.g.*, gypsum, which is subsequently removed, together with the absorbed grease and other extraneous matter, including "manure, humus, and the like." The wool is afterwards treated with pulverised sodium bicarbonate.

Fibrous materials; Process of fireproofing —. R. E. Prince, Madison, Wis., Assignor to the Government and People of the United States. U.S. Pat. 1,216,729, Feb. 20, 1917. Date of appl., Nov. 25, 1916. (Dedicated to the public.)

FIBROUS material is saturated with a solution of a compound of borie oxide, dried, and saturated with a soluble salt of lead.—J. F. B.

Fabric for power transmission belts; Method of treating the —. E. L. Burrell, Chicago, Ill. U.S. Pat. 1,218,052, Mar. 6, 1917. Date of appl., Feb. 13, 1915.

THE material is subjected to the action of tannic acid and the latter is fixed by means of a mordant,

e.g., tartar emetic; the treated fabric is then impregnated with a heated waterproofing compound, *e.g.*, one comprising 66% of wax tailings, 19% of paraffin, and 15% of lubricating oil, and is finally faced with an asbestine dressing containing a pigment.—J. F. B.

Fabrics; Method of impregnating —. L. Petersen-Hviid, Copenhagen, Denmark. U.S. Pat. 1,219,319, Mar. 13, 1917. Date of appl., Apr. 21, 1916.

THE fabric is treated with a mixture of rubber and sulphonated castor oil to which sulphur has been added, then dried and vulcanised.—J. F. B.

Acetylcellulose plastics; Process of making —. W. G. Lindsay, Caldwell, N.J., Assignor to The Celluloid Co., New York. U.S. Pat. 1,216,581, Feb. 20, 1917. Date of appl., Nov. 27, 1911.

ACETONE-SOLUBLE acetylcellulose is incorporated with less than half its weight of a chlorinated alkylacetanilide, *e.g.*, tetrachloro-ethylacetanilide, together with a small proportion of ethyl alcohol (1—1.5 times the weight of the acetanilide derivative) and heated. The acetanilide ingredient, when melted, is a solvent for acetylcellulose, but at the ordinary temperature, in presence of ethyl alcohol, is a non-solvent.—J. F. B.

Cellulose; Process of dissolving —. Z. Ostenberg, San Francisco, Cal., Assignor to International Cellulose Co., Reno, Nev. U.S. Pat. 1,218,954, Mar. 13, 1917. Date of appl., Jan. 31, 1916.

CELLULOSE is dissolved in a mixture of highly concentrated hydrochloric acid and a concentrated inorganic acid, *e.g.*, phosphoric acid, which does not react with the hydrochloric acid, at a temperature below 50° C., not less than 25% of hydrogen chloride being present in the mixture. —J. F. B.

Esparto or the like; Removing — from stationary digesters used in papermaking and the like. W. M. Wallace, T. Marshall, and A. Brown, Denny, Stirling, and Bertrams, Ltd., Edinburgh. Eng. Pat. 104,578, Apr. 18, 1916. (Appl. No. 5650 of 1916.)

THE digested material in the digester is broken up and removed through a discharge pipe connected with the discharge-door, by directing streams of water under pressure against the material from nozzles suitably arranged within the digester or within the discharge orifice. Alternatively, nozzles may be fitted in the feed orifice at the top of the digester and the stream of water directed against a conical member on the floor. Various means for disconnecting the discharging apparatus from the digester are described.—J. F. B.

Paper; Safety —. E. E. Schmidt, Covington, Ky. U.S. Pat. 1,217,076, Feb. 20, 1917. Date of appl., Jan. 26, 1916.

PAPER is impregnated with ox-gall and a ferrocyanide and/or magnesium sulphate.—J. F. B.

Paper stock; Means and process for refining —. P. R. Thom, Appleton, Wis. U.S. Pat. 1,217,528, Feb. 27, 1917. Date of appl., Feb. 4, 1915.

THE refiner consists of a conical casing and a conical core, rotating in the casing and slightly spaced therefrom to form a passage annular in cross-section. Unrefined stock is fed under pressure into the large end of the passage, and by reason of the relative rotation of the core and casing, the centrifugal action is caused to exert a counter-pressure on the stock effective throughout the length of the passage. The small end of the conical passage communicates with a

discharge conduit, the feeding pressure being sufficient to cause the stock to travel from the large to the small end of the passage.—J. F. B.

Paper and fabric. A. Eichler, New York. U.S. Pat. 1,218,599, Mar. 6, 1917. Date of appl., June 28, 1916.

A FLEXIBLE sheet of absorbent material or fabric is treated with a mixture containing a vegetable oil, e.g., Chinese wood oil, and polymerisation products of the coumarone and indene groups.—J. F. B.

Cork and leather substitute and process of making the same. A. L. Clapp, Braintree, Mass. U.S. Pat. 1,218,982, Mar. 13, 1917. Date of appl., July 16, 1914.

PAPER-FELT material, composed of associated wood fibres puffed or increased in diameter, with a surface-texture resembling felt, is waterproofed by the application of a rubber-like solution capable of uniting with the fibres to render them substantially waterproof, while acting as a preservative and maintaining the resiliency of the paper-felt.—J. F. B.

Waste sulphite [pulp] liquor; Process for the utilisation of—. A. D. Fest, Chicago, Ill. U.S. Pat. 1,218,638, Mar. 13, 1917. Date of appl., Oct. 30, 1915.

WASTE sulphite liquor is concentrated and treated by fermentation for the recovery of alcohol, and solid substances are precipitated from the residual solution. The precipitate is calcined and the gases produced in calcination are passed in contact with a medium capable of extracting sulphur dioxide for the production of calcium bisulphite, a suitable medium consisting of the ashes of calcination in presence of water.—J. F. B.

Impregnating woven belts and conveying-bands; Method of—. H. W. Andersen, Odense, Denmark. U.S. Pat. 1,218,350, Mar. 6, 1917. Date of appl., Oct. 29, 1914.

SEE Ger. Pat. 285,049 of 1913; this J., 1915, 1139.

Cellulose acetates; Process of treating—to alter the solubilities thereof, and products of said process. H. Dreyfus, Basle, Switzerland. U.S. Pat. 1,217,722, Feb. 27, 1917. Date of appl., Aug. 1, 1913.

SEE Addition of July 7, 1911, to Fr. Pat. 432,046 of 1911; this J., 1912, 225.

Manufacture of artificial leather, felt products, paper products, or the like. Eng. Pat. 101,536. See XV.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Achroodextrinase. Effront. See XVIII.

PATENTS.

Pectic matter from vegetable fibres; Process of removing—. B. Leech, Macclesfield. Eng. Pat. 104,202, Feb. 22, 1916. (Appl. No. 2657 of 1916.)

RAW cotton, yarn, or fabric is treated at or near the boil with aqueous hydrochloric acid of suitable strength (ascertained by experiment) to remove pectic matter as pectic acid and soluble chlorides of the bases with which the pectic acid was combined, but not sufficiently concentrated to produce a serious loss of tensile strength.—F. W. A.

Conveying of cotton, cotton waste, wool, and like textile or fibrous substances in the washing, bleaching, and like treatment thereof. T. Taylor, N. Beswick, and E. Jenkins, Hadfield. Eng. Pat. 104,214, Feb. 25, 1916. (Appl. No. 2843 of 1916.)

A CLOSED or open pipe or trough or the like is

adapted to be tilted to elevate either of its ends according to the direction in which the substance is to be conveyed, and means are provided for causing a stream of water or other liquid to flow through the pipe in either direction and for feeding to the pipe the textile or fibrous substance. The pipe may be provided with a number of discharge outlets, and with gates, which can be arranged to direct the discharge through any outlet.—F. W. A.

Cotton waste; Conveying of—in the washing, bleaching, and like treatment thereof. T. Taylor, N. Beswick, and E. Jenkins, Manchester. Eng. Pat. 104,524, Feb. 25, 1916. (Appl. No. 2842 of 1916.)

COTTON waste in process of treatment is conveyed from the washers to the bleaching or steeping boxes by feeding it into inclined closed or open pipes or troughs through which water or other liquid is caused to flow and carry the waste along with it. The pipes or troughs may be mounted on pivots so as to be capable of inclination in either direction, and may be provided with gates for discharge at any desired point. (Reference is directed in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pats. 13,626 of 1889, 5560 of 1891, and 11,929 of 1899; this J., 1890, 856; 1900, 689.)—J. F. B.

White woollen goods; Process for producing—. A. E. Garrett, St. Albans. U.S. Pat. 1,217,744, Feb. 27, 1917. Date of appl., Aug. 30, 1916.

SEE Eng. Pat. 13,215 of 1915; this J., 1916, 687.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Nitrogen; Fixation of—. J. E. Bucher. Amer. Inst. Chem. Eng., Jan., 1917. J. Ind. Eng. Chem., 1917, 9, 233—253.

IN 1839 Thompson described a method of preparing cyanide by the action of atmospheric nitrogen on potash and carbon heated in a crucible in the presence of iron turnings, which he stated to be essential. In many of the later attempts (e.g., Castner's Eng. Pat. 12,218 of 1894 and Acker's U.S. Pat. 1,019,002 of 1912; this J., 1895, 572; 1912, 334) the necessity for the presence of iron was not recognised, and the industry therefore developed on the lines of electrical fixation methods. *Magnesium nitride process.* An electrolytic process was tried with the view of improving the ammonia-soda process. Magnesium chloride could be electrolysed, and the resulting magnesium burned in the nitrogen from the towers to form magnesium nitride, which could be heated with ammonium chloride from the mother liquors to produce ammonia and regenerate magnesium chloride. *Nitrogen fixation with alkali metals.*—On heating a mixture of ignited lampblack, powdered "alcoholised" iron, and metallic sodium in an iron tube through which a current of nitrogen was passed, the absorption of the gas was practically instantaneous, and only a small quantity of argon left the tube, whilst about 94% of the sodium was converted into cyanide. The reaction takes place in accordance with the equation— $2\text{Na} + 2\text{C} + 2\text{N} = 2\text{NaCN}$ —the iron acting as catalyst. This method affords a convenient means of separating nitrogen from gases of the argon group in gas analysis. *Purification of iron.*—By means of this reaction carbon, sulphur, oxygen, and phosphorus can be rapidly removed from iron, leaving it quite soft; or, if desired, the surface of the iron may be quickly purified, leaving an interior of steel. *Preparation of metallic sodium.*—The reaction is reversible, and by heating sodium cyanide with pure iron

powder in an iron tube a layer of metallic sodium is deposited in the cooler part of the tube. *Nitrogen fixation with alkali carbonates.*—When sodium carbonate is heated with carbon (powdered graphite) and powdered iron at moderate temperatures (860 to 980° C.) reaction takes place in accordance with the equation— $\text{Na}_2\text{CO}_3 + 4\text{C} + 2\text{N} = 2\text{NaCN} + 3\text{CO}$. The best results were obtained in iron tubes 10 ft. long and 2 in. in diameter. In some of the experiments the solutions extracted from the products and evaporated to dryness left residues containing over 95% of sodium cyanide. *Use of briquettes.* To obviate the disadvantages of using powders on a large scale, briquettes were made by mixing the charge of coke, soda-ash, and iron with water as near to the temperature 101–75° C. as possible, by means of a steam-jacketed kneading machine, and the hot dough-like mass was mechanically cut into briquettes 2 in. long by 2 in. broad, and 1 in. in diameter, and rapidly dried, e.g., by means of hot waste gases. The powder was prepared on an industrial scale by grinding iron scale (magnetite, hematite, etc.) to a 100-mesh powder, adding an equal weight of coke ground to the same degree of fineness, continuing the grinding for an hour, then adding the soda ash and grinding for 5 mins. Briquettes thus prepared gave products containing up to 28% of sodium cyanide, showing that iron oxides may take the place of metallic iron in the mixture. If the briquettes do not completely fill a horizontal pipe, so that an upper channel is left for the passage of the nitrogen, the yield of cyanide may fall as low as 1–4%. This may be obviated by using a vertical pipe. In one experiment the briquettes were heated in a rapid current of nitrogen in a vertical pipe, 6 ft. long by 6 in. diameter, for 1 hour 10 mins. at 1000° to 1090° C., and, on cooling, the top of the charge contained 24%, and the bottom 20%, the average being 22% of sodium cyanide. Experiments at different temperatures showed that it is possible to obtain over 30% of cyanide of 87% purity in a batch furnace below 920° within 30 mins., and that even below 820° C. considerable quantities of nitrogen are fixed within a few minutes. At mines it would be possible to fixivate the cyanide, and to mix the moist filter cake with soda ash to form new briquettes. *Continuous furnaces.*—The briquettes were introduced into the top of a vertical tube 14 ft. long, which was heated by oil burner flames. This tube opened at the base into a wider portion, beneath which was a screw conveyor to remove the hardened briquettes in which the cyanide had been formed. *Electric furnace.*—A cylindrical furnace which gave good results had a basic lining and a perforated bottom, like a Bessemer converter. It contained molten iron in which graphite fragments were deeply embedded. Sodium vapour and nitrogen were blown into the bottom of the furnace, and cyanide distilled at the top. The heat was produced by the resistance of a graphite column, which also served to keep the iron saturated with dissolved carbon. *Rate of heat penetration.*—With external heating a long time is required to heat a 6 or 8 in. column of briquettes to a uniform temperature, and with a large charge the heating would take some hours. When the briquettes were heated internally by electricity, their heat conductivity increased with the temperature and an abundant yield of cyanide was obtained from a charge of many lb. in a few minutes. *Use of air instead of nitrogen.*—Air passed through heated coke before being admitted to the tube of briquettes gave results practically identical with those obtained with nitrogen. Producer gas, flue gas, or gases from the combustion chamber of the furnace could also be used in the cyanising tubes. *Production of nitrogen.*—Pure nitrogen is readily obtained in quantity by passing air

through a vertical iron pipe 10 in. in diameter and 6 ft. long, filled with copper turnings supported on iron crosses to prevent sagging. The tube is heated in a furnace with two flues, one for the burner flame and the other for the tube, to a temperature not exceeding 450° C. When exhausted the copper is reduced with hydrogen. *Distillation of cyanide.*—Instead of fixivating the briquettes, the cyanide may be distilled from them either *in vacuo* or in a current of nitrogen. Cyanised briquettes were completely freed from cyanide by distillation in a copper tube at 1000° C. and at a pressure of about 2 mm. *Ashless carbon.*—By passing carbon monoxide over ground coke, heated in a glass tube containing finely divided iron as catalyst, an abundant deposit of carbon was obtained in accordance with the equation— $2\text{CO} \rightleftharpoons \text{C} + \text{CO}_2 + 38080$ cals. The equilibrium for this equation gives almost pure carbon monoxide at 1050° C., whilst at 500° C. the reverse action takes place. As soon as the concentration of the carbon dioxide reaches a certain point the iron becomes oxidised and loses its catalytic activity, and the course of the reaction is changed. Nickel can take the place of iron as catalyst, and does not form oxides so readily. The advantage of this process would be that a mixture of finely-divided lampblack with iron would be obtained, thus obviating the necessity of mixing and grinding, and providing internal heat in the briquettes themselves. *Oxidation of iron pipes.*—This is avoided in electrically heated furnaces, and may also be prevented in fuel-heated furnaces by regulating the proportion of carbon dioxide in accordance with the temperature. For this purpose a concentration-temperature diagram is given. For example, if the iron pipe is heated to 950° C. it would be possible to have 25% of carbon dioxide present without oxidation taking place. The carbon could be burned in accordance with the equation— $\text{C} + 2.5\text{O}_2 = 3\text{CO} + \text{CO}_2 + 181,830$ cals. without the possibility of oxidising the tube, and the remaining 203,010 cals. could be obtained by admitting sufficient air in the pre-heating zone to burn the 3CO, where the lower temperature would prevent oxidation taking place. A copper sheathing to the iron tubes might also prove a safeguard. *Destructive effect of carbon monoxide.*—In using producer gas it is essential to stop the current before the briquettes begin to cool, otherwise the cyanide formed is destroyed again, probably through the action of the carbon dioxide produced by the catalytic action of the iron in causing the formation of ashless carbon— $2\text{CO} \rightleftharpoons \text{C} + \text{CO}_2$. *Sodium ferrocyanide.*—On making the cyanide briquettes into a stiff paste with hot water, and agitating the mass, reaction takes place readily in accordance with the equation— $6\text{NaCN} + \text{Fe} + 2\text{H}_2\text{O} = \text{Na}_4\text{Fe}(\text{CN})_6 + 2\text{NaOH} + \text{H}_2$. After several hours the liquid is filtered, and deposits the ferrocyanide on cooling and concentration. In fixivating the briquettes to separate cyanide, the temperature should be kept a little above 35° C., and the operation completed as rapidly as possible to prevent the formation of ferrocyanide. At temperatures below 35° C., the mass will take up water of crystallisation to form $\text{NaCN} \cdot 2\text{H}_2\text{O}$, and will set like plaster of Paris. *Ammonia and sodium formate.*—By boiling sodium cyanide solution, to which caustic soda has been added, ammonia and sodium formate are produced— $\text{NaCN} + 2\text{H}_2\text{O} = \text{HCO}_2\text{Na} + \text{NH}_3$; the caustic soda prevents hydrolytic dissociation to form hydrocyanic acid, and “salts out” the sodium formate, which may either be returned to the cyanising process or may be heated *in vacuo* to convert it into sodium oxalate. *Urea, ammonia, and nitrogen.*—By heating the cyanide to just above its melting point in an iron pot through which is passed a current of air, sodium cyanate is formed— $\text{NaCN} + \text{O} + 2\text{N}_2 = \text{NaCNO} + 2\text{N}_2$ —the

nitrogen from which reaction is turned into the cyanising furnaces. One-half of the cyanate is heated with water, which converts it into ammonia— $\text{NaCNO} + 2\text{H}_2\text{O} = \text{NaHCO}_3 + \text{NH}_3$ —whilst the other half of the cyanate is mixed with water and the ammonia introduced. Then, by the admission of carbon dioxide from the cyanising furnace, urea is produced— $\text{NaCNO} + \text{NH}_3 + \text{H}_2\text{O} +$

The sodium chloride begins to deposit when the sea water reaches a density of 25° B. (sp. gr. 1.21) and at 27° B. (sp. gr. 1.23) about 43.5% of the total quantity separates. The salt obtained by concentrating (1) the mixture of sea water with the mother liquors and (2) the sea water alone to 32.4° B. (sp. gr. 1.29) had the following percentage composition:—

	Calcium sulphate.	Sodium chloride.	Magnesium sulphate.	Magnesium chloride.	Sodium bromide.	Potassium chloride.
1. Mixture of sea water and mother liquors ...	0.924	89.275	3.462	4.586	1.043	0.710
2. Sea water alone	0.640	96.950	0.542	0.653	1.215	—

$\text{CO}_2 = \text{NaHCO}_3 + \text{NH}_4\text{CNO}$, and $\text{NH}_4\text{CNO} = \text{CO}(\text{NH}_2)_2$. The bicarbonate is returned to the cyanising process. In this way urea is inexpensively obtained. It has been found to give results in culture experiments equal to those obtained with potassium nitrate. *Oxamide, oxalic and formic acids.*—By electrolysis the cyanide pure sodium and cyanogen are readily obtained. The cyanogen may be rapidly absorbed by 44% hydrochloric acid, which acts as a catalyst and converts it into oxamide: $(\text{CN})_2 + 2\text{H}_2\text{O} = (\text{CONH}_2)_2$. This oxamide should be of especial value as a fertiliser. By heating it with concentrated hydrochloric acid and adding water, it is converted into oxalic acid— $(\text{CONH}_2)_2 + 4\text{H}_2\text{O} + 2\text{HCl} = (\text{COOH})_2 \cdot 2\text{H}_2\text{O} + 2\text{NH}_4\text{Cl}$, and this is converted into formic acid by heating with glycerol.—C. A. M.

Potassium salts; Utilisation of the mother liquors of marine salt works as a source of— E. Manzella. *Annali Chim. Appl.*, 1917, 7, 1—27.

In the salt works at Trapani (Sicily) sea water of 3.5° B. (sp. gr. 1.025) is concentrated in the primary evaporating pans to a density of about 6° B. (sp. gr. 1.043); in the secondary pans to about 18° B. (sp. gr. 1.143); and in the tertiary pans to about 25° B. (sp. gr. 1.21). At this stage it has deposited the small amounts of iron and calcium carbonate, and about five-sixths of the calcium sulphate originally present, and is ready for feeding the salt pans (*Caselle*), in which it is concentrated to about 28.5° B. (sp. gr. 1.246), and deposits a small quantity of calcium sulphate, magnesium sulphate, magnesium chloride, and about two-thirds of its sodium chloride. In some of the works the concentration is carried to about 32° to 33° B. (sp. gr. 1.285—1.296); this, however, increases not only the yield of sodium chloride, but also the amount of other salts in the deposit. It is also a common practice to add the mother liquors to the liquid in the tertiary pans to accelerate the deposition of the salt. The following table shows the effect of concentration on the composition (in parts per 1000 of original water) of the deposits and mother liquors:—

Apart from the addition of mother liquor to the sea water in the tertiary pans, the concentration of the water to a little above 28° B. (sp. gr. 1.241) has the effect of yielding an impure sodium chloride. The bulk of the Sicilian salt is exported to Norway and America, where it is used for salting fish, and since the flavour is preferred to that of the salt from other European salt works the presence of the other salts appears to be an advantage. It is calculated that each ton of sodium chloride deposited at 32.4° B. (sp. gr. 1.29) will leave a volume of about 0.97 cub. metre of mother liquor, of which about 0.87 cub. m. would be available for the extraction of the salts. It is estimated that in the Sicilian salt works alone about 167,600 cub. m. of mother liquors would be available for the extraction of bromine and potassium salts.—C. A. M.

Carbonates; Studies of the —. Part II. Hydrolysis of sodium carbonate and bicarbonate and the ionisation constants of carbonic acid. C. A. Seyler and P. V. Lloyd. *Chem. Soc. Trans.*, 1917, 114, 138—158.

PREVIOUS attempts to determine the second ionisation constant $k_3 = \frac{[\text{H}][\text{CO}_3]}{[\text{HCO}_3]}$ of carbonic acid and the hydrolysis constant of sodium carbonate have led to results which vary greatly with the dilution of the solution. The authors show that this is due to the ionisation of sodium carbonate and bicarbonate in the solutions used. They have determined the amounts of carbonate and bicarbonate in solution in equilibrium with air containing a known amount of carbonic acid and from this they deduce the ratio between the two ionisation constants $\frac{k_2}{k_3}$ to be 7120 at 25° C.

This gives $k_3 = 4.91 \times 10^{-11}$. Values for the ionisation of sodium carbonate and bicarbonate are deduced and it is shown that the ionisation of sodium carbonate takes place in two stages, namely, $\text{Na}_2\text{CO}_3 = \text{Na} + \text{NaCO}_3$, and $\text{NaCO}_3 = \text{Na} + \text{CO}_3$, the constant for the second stage, $\frac{[\text{Na}][\text{CO}_3]}{[\text{NaCO}_3]}$, being smaller than that for the first.

—W. H. P.

° B.	Vol.	Iron.	Calcium carbonate.	Calcium sulphate.		Sodium chloride.		Magnesium sulphate.		Magnesium chloride.		Sodium bromide.		Potassium chloride.	
				De-posit.	Dis-solved.	De-posit.	Dis-solved.	De-posit.	Dis-solved.	De-posit.	Dis-solved.	De-posit.	Dis-solved.	De-posit.	Dis-solved.
3.5	1	0.003	0.117	—	1.749	—	29.696	—	2.479	—	3.317	—	0.552	—	0.534
25	0.112	—	—	1.466	0.283	—	29.696	—	2.479	—	3.317	—	0.552	—	0.534
28.5	0.039	—	—	1.734	0.015	20.807	8.889	0.043	2.136	0.087	3.230	0.073	0.179	—	0.534
32.4	0.023	—	—	1.749	—	25.703	3.993	0.086	2.293	0.126	3.191	0.160	0.392	—	0.534

Line: Effect of exposure on commercial—. J. C. Whetzel. J. Ind. Eng. Chem., 1917, 9, 287—290.

THE line used in the tests was selected by hand so as to obtain average samples, and these were exposed in boxes 6 in. \times 6 in. \times 6 in., and in barrels, for periods up to 60 days. Under actual conditions of commercial shipments, the air would have less access to the line than in the experimental tests. In the case of one sample of high-calcium lump line, the available calcium oxide had fallen from 97.2 to 83.6%, whilst the water had increased from 1.6 to 22.7%, and the carbon dioxide from 0.2 to 3.1% in 60 days in the boxes, whilst in the barrels the corresponding figures were 90.8, 1.8, and 19.4%. In the case of magnesian lines the carbon dioxide was absorbed more rapidly at the beginning than in the case of the high-calcium lines, whilst the absorption of water was less. There was little difference in the rates of absorption of carbon dioxide by ground line and hydrated line. Comparative tests indicated that carbonic acid will not be absorbed to a greater depth than 3 in. by bulk ground line in 20 days in summer weather. There is not much difference between the amounts of carbon dioxide absorbed in summer and in winter, although much more water is absorbed in summer. The absorption of carbon dioxide by hydrated line is also relatively small, a thin layer protecting the remainder from carbonation.

—C. A. M.

Nitrites: Cadmium and zinc—. P. C. Rây. Chem. Soc. Trans., 1917, 111, 159—162.

AT a dilution of 10 litres the equivalent conductivity of cadmium chloride is 53 compared with 134 for potassium chloride; a stable cadmium nitrite should therefore exist to accord with the hypothesis that a metal, the halide of which shows comparatively poor conductivity in aqueous solution, may be expected to yield a corresponding normal nitrite, since as a rule, the nitrite is also feebly ionised. Cadmium chloride on triturating with silver nitrite, with gradual addition of water, and then filtering, gives a solution which on evaporation in a vacuum over sulphuric acid yields bright, pale yellow crystals of cadmium nitrite, $\text{Cd}(\text{NO}_2)_2$. On heating gradually these decompose, giving nitric oxide as the chief gaseous product, and leave a residue of cadmium nitrate and oxide. Zinc nitrite, prepared by the interaction of zinc sulphate and barium nitrite, can only exist in dilute aqueous solution. On concentrating the solution nitric oxide is continuously evolved, leaving ultimately a residue of basic zinc nitrate.—T. C.

Boric anhydride and its hydrates. J. E. Myers. Chem. Soc. Trans., 1917, 111, 172—179.

THE velocity of hydration of boron trioxide was determined by exposure to a moist atmosphere with periodical weighings. The results indicate that there are at least two stages, the first yielding metaboric acid and on further hydration orthoboric acid. The hydration to metaboric acid is a unimolecular reaction and much faster than the further reaction. Dehydration of orthoboric acid at 100° C. proceeds as a unimolecular reaction to form metaboric acid. At a higher temperature the reaction becomes more complicated, probably on account of the formation of molecular complexes of metaboric acid.—W. H. P.

Dissociation pressure of sulphides: Method for the determination of— and its application to covellite (CuS) and pyrite (FeS_2). E. T. Allen and R. H. Lombard. Amer. J. Sci., 1917, 43, 175—195.

THE method consists in balancing the dissociation

pressure of the sulphide by a known vapour pressure of heated liquid sulphur. An evacuated glass tube, having a small bulb at each end, is used, one containing the sulphide and the other the liquid sulphur. The two bulbs can be independently heated by electrical tube furnaces placed end to end. While the sulphide is held at a chosen temperature, that of the sulphur is varied until its vapour pressure equals the dissociation pressure of the sulphide. In practice it is necessary to find two temperatures for the sulphur, thus fixing two pressures, at one of which the sulphide loses sulphur, at the other of which its dissociation product gains weight. The dissociation pressure of the sulphide lies between these limits. The method was applied to covellite (CuS) over the range 400—490° C. and pyrite (FeS_2) over the range 575—680° C. The results are expressed by the equation $\log p = -\frac{A}{T} + B \log T + C$.

For CuS , $A = -96397.514$, $B = 356.43227$ and $C = -1150.98605$. For FeS_2 , $A = 191912.61$, $B = -431.195975$, $C = -1197.56707$. The method is perhaps capable of wider application in cases where mercury pressure gauges cannot be used but where the dissociation product does not attack glass or silica. One advantage is the fact that equilibrium is approached from both sides.—H. J. H.

Sulphur dioxide and the sulphites: Iodometric determination of—. J. B. Ferguson. J. Amer. Chem. Soc., 1917, 39, 364—373.

THE principal cause of error in the analysis of sulphites and of gases containing sulphur dioxide is the oxidation which takes place in moist air or in solution containing dissolved oxygen. Rubber connections are also a source of error. For accurate determinations the gaseous mixture, preserved from all previous contact with moisture, is passed into a solution containing excess of iodine. In the case of sulphites the solid salt should be dissolved directly in an excess of iodine solution containing sufficient hydrochloric acid. When carbon dioxide and sulphur dioxide are to be determined together, absorption in potash followed by addition of the potash to an iodine solution containing an excess of hydrochloric acid is recommended, but the results are always low. If the proportion of sulphur dioxide is below 3 or 4% a correction factor may be employed, but with higher concentrations the uncertainty increases. In all cases the author recommends the performance of blank determinations to correct for the amount of iodine required to give the standard (pink) colour (Washburn, J. Amer. Chem. Soc., 1908, 30, 42) with the starch solution used.—W. H. P.

Chromium phosphate. [Volatility of platinum.] A. E. Joseph and W. N. Rae. Chem. Soc. Trans., 1917, 111, 196—202.

ON mixing cold solutions of chrome alum and disodium hydrogen phosphate, an amorphous violet precipitate of hexahydrated chromium phosphate is produced. If allowed to stand for two days in contact with the solution, the precipitate becomes crystalline without change in colour or composition. On longer standing it becomes green and again amorphous, forming the tetrahydrate. The violet crystals on boiling with water for about half an hour, form a green crystalline tetrahydrate, and on boiling with acetic anhydride a green crystalline dihydrate. Either of these at a low red heat gives a black anhydrous phosphate and at a red heat a green basic phosphate. Either the amorphous or the crystalline hexahydrate on being exposed to air slowly loses water and becomes green, retaining its amorphous or crystalline structure. The process is incomplete after two years but is pre-

sumably due to the formation of tetrahydrate. The anhydrous compound obtained by heating the amorphous green tetrahydrate is brown rather than black. The hydrated phosphates dissolve in sulphuric and hydrochloric acids, the dihydrate reacting rather slowly with hydrochloric acid. The anhydrous compound is attacked by sulphuric acid only when the acid is nearly boiling. The hydrated forms dissolve in alkalis but the anhydrous form requires strong heating with lime to bring it into an alkaline solution. Sodium carbonate solution immediately converts the hexahydrate into a green basic compound retaining alkali which is not removed by washing with water. *Volatility of platinum.*—The fact that platinum readily volatilises when heated in air is illustrated by the fact that the authors' crucible, weighing 40 grms., lost over 1 gm. during two heatings totalling 48 hours at 1100° C. in a gas furnace with a good draught (see Crookes, this J., 1912, 540).—W. H. P.

Neodymium as the cause of the red-violet colour in certain minerals. E. T. Wherry. J. Wash. Acad. Sci., 1917, 7, 143—146.

THE red-violet colour of some samples of calcite and apatite has been attributed to the presence of manganese, though both permanganates, which are too unstable to be permanent, and manganic salts, which may develop in minerals under mildly oxidising conditions, have characteristic absorption spectra which have hitherto not been observed with calcite or apatite. The presence of ferrous iron in these minerals moreover precludes the possibility of a manganic salt. Violet and red-violet specimens of apatite which are free from any underlying green colour due to ferrous iron, have recently been discovered in California, and give the characteristic absorption spectrum of neodymium.—J. N. P.

Carbon; The Penfield test for —. W. G. Mixer and F. L. Haigh. J. Amer. Chem. Soc., 1917, 39, 374—375.

THE delicacy of the Penfield test for carbon in minerals, which consists in fusing with lead chromate and observing the effect of the gases evolved on a drop of barium hydroxide solution in the same hard glass tube, has been tested by the authors. The source of carbon was a mixture of silicon carbide and alumina which could be freed from dust and other carbonaceous impurities by heating in oxygen. It was found that positive results could be obtained with a quantity of carbide containing 0.003 mgrm. of carbon.—W. H. P.

Volatilisation of potassium salts from cement materials. Anderson and Nestell. See IX.

Volumetric method for determining the strength of hypochlorite solutions. Analysis of hydrogen peroxide. Bury. See XIXb.

PATENTS.

Polish; Process for obtaining — from polish-rocks. F. C. Gillen. Assignor to W. A. Krasselt, Milwaukee, Wis. U.S. Pat. 1,215,517, Feb. 13, 1917. Date of appl., Apr. 19, 1915.

THE ground mineral is heated under pressure with an aqueous solution of sodium hydroxide or carbonate, whereby sodium silicate and potassium aluminate are formed. After adding borax to prevent the formation of a double sodium aluminium silicate, carbon dioxide is admitted to the solution and brings about the separation of alumina and silica and the formation of potassium and sodium carbonates, from which the potassium salt may be separated.—J. N. P.

Felspar and other polish-bearing silicious minerals; Decomposing —. W. H. Gillen, Milwaukee, Wis. U.S. Pat. 1,215,518, Feb. 13, 1917. Date of appl., Feb. 21, 1916.

THE ground mineral is mixed with borax, added to an excess of an aqueous solution of sodium hydroxide, and heated under pressure, whereby sodium and aluminium silicates are formed. Carbon dioxide is then admitted, and aluminium silicate and silica are precipitated and removed, while potassium carbonate remains in solution.—J. N. P.

Potassium compounds; Process of producing soluble —. H. P. Bassett, Catonsville, Md., Assignor to The Spar Chemical Co., Baltimore, Md. U.S. Pat. 1,217,388, Feb. 27, 1917. Date of appl., Mar. 8, 1915.

A MIXTURE of an insoluble silicate containing potassium with an alkali acid sulphate, and another salt capable of absorbing sulphur trioxide, is heated progressively to the decomposition temperature of the acid sulphate. The sulphur trioxide gas liberated by the reaction is led back and brought into contact with the mass at the commencement of the heating, when it is again absorbed and brought into action.—J. B. C. K.

Potassium-containing silicates and phosphate rock; Process of treating —. H. P. Bassett, Catonsville, Assignor to The Spar Chemical Co., Baltimore, Md. U.S. Pat. 1,217,389, Feb. 27, 1917. Date of appl., July 15, 1915.

A MIXTURE of ten parts by weight of an insoluble silicate containing potassium, and one to two parts of phosphate rock, is heated to 900° to 1200° F. (about 480°—650° C.) with 6—8 parts of sulphuric acid, an equal weight of water, and 0.5 part of carbon. At this temperature the carbon or other carbonaceous material acts as a reducing agent, and the sulphuric acid decomposes the phosphate rock, with the result that the potassium is brought into soluble form.—J. B. C. K.

Potassium salts; Process of producing —. H. P. Bassett, Catonsville, Md., Assignor to The Spar Chemical Co., Baltimore, Md. U.S. Pat. 1,217,390, Feb. 27, 1917. Date of appl., July 15, 1915.

IN order to produce soluble potassium salts, an insoluble silicate containing potassium is heated to a reacting temperature with calcium sulphate, sulphuric acid, water, and a reducing agent. As an example of the quantities used, the following are given: Green sand marl, 10 parts by weight, calcium sulphate, 1—2, sulphuric acid, 4, water, 6—8, and carbon, 0.5 parts.—J. B. C. K.

Potash and alumina; Process for extracting — from alunite. P. J. Fox, Washington, D.C. U.S. Pat. 1,217,432, Feb. 27, 1917. Date of appl., May 5, 1916. (Dedicated to the public.)

ALUNITE and a fluoride are ground together and the finely-powdered mixture is heated until the aluminium is converted into aluminium fluoride. The potash is leached out of the fused mass with water, and the residue is then treated for recovery of the aluminium by means of fluxing agents and electrolysis.—J. B. C. K.

Alkaline deposits; Process of recovering constituents of value from —. Process of recovering potassium chloride from alkaline deposits. Process of recovering borax from alkaline deposits. L. C. Jones and F. L. Grover, Syracuse, N.Y., Assignors to The Solvay Process Co., Solvay, N.Y. U.S. Pats. (A) 1,215,543, (B) 1,215,544, and (C) 1,215,545, Feb. 13, 1917. Date of appl., Aug. 30, 1916.

(A) BRINES containing sodium carbonate and potassium salts and borates are treated with carbon dioxide, and the sodium bicarbonate

precipitated is removed. Sodium carbonate, which is recovered later, is then added in sufficient quantity to prevent the precipitation of potassium salts. The solution is concentrated at a high temperature, when sodium carbonate, chloride, and sulphate are precipitated and boric acid and its less soluble salts are converted into the more soluble sodium metaborate. On cooling, potassium chloride is precipitated. The operation may be modified by treating a portion only of the brine with carbon dioxide, removing the bicarbonate, and adding the remaining treated solution to the original untreated portion, then concentrating at a high temperature to precipitate sodium carbonate, chloride, and sulphate, and finally cooling to precipitate potassium chloride. (i) The brine is concentrated at a high temperature, when boric acid salts are converted into more soluble sodium metaborate and the less soluble sodium salts are precipitated. The concentration is continued until the solution is saturated with potassium chloride at the temperature employed. The potassium chloride is then precipitated by cooling, and removed. The mother liquor containing sodium metaborate is returned to each succeeding batch of brine until the solution is saturated with this salt, when it is precipitated as borax, and the remaining solution is added to the next portion of brine to be treated. (c) Alkaline brines containing sodium carbonate are heated to convert boric acid and its less soluble salts into the more soluble sodium metaborate. The solution is concentrated at a high temperature to precipitate sodium carbonate, sulphate, and chloride, and then cooled to precipitate potassium chloride. The solution is then treated with carbon dioxide to convert the sodium metaborate into borax, which is precipitated.—J. N. P.

Potassium and magnesium chlorides; Process of recovering—from natural deposits. L. C. Jones, F. L. Grover, and J. L. Silsbee, Syracuse, N.Y., Assignors to The Solvay Process Co., Solvay, N.Y. U.S. Pat. 1,215,546, Feb. 13, 1917. Date of appl., Oct. 23, 1916.

THE brine is evaporated at a relatively low temperature until nearly saturated with respect to potassium chloride. The sodium chloride, which is precipitated during the concentration, is removed, and the evaporation of the liquor is continued at a high temperature, with further separation of sodium chloride, until, at the temperature employed, it is saturated with potassium chloride but not with magnesium chloride. The liquor is cooled to precipitate potassium chloride, which is removed, and is then evaporated at a high temperature, with further precipitation of sodium chloride, until again saturated with potassium chloride, and cooled to give a second crop of this salt. To recover the magnesium chloride which remains in solution, the final mother liquor is evaporated at a high temperature, and the carnallite which precipitates is removed, until a fused product remains containing about 48% $MgCl_2$ and 52% water. Solid potassium chloride is removed from the carnallite by dissolving away the magnesium chloride in a liquor saturated with potassium chloride but unsaturated with magnesium chloride.—J. N. P.

(A) (B) *Alkaline deposits; Process of recovering constituents of value from natural —.* (C) *Process of separating mixed potassium chloride and borax.* J. D. Pennock, L. C. Jones, and F. L. Grover, Syracuse, N.Y., Assignors to The Solvay Process Co., Solvay, N.Y. U.S. Pats. (A) 1,215,574, (B) 1,215,575, and (C) 1,215,576, Feb. 13, 1917. Dates of appl., Dec. 16, 1915, Jan. 14, 1916, and Sept. 12, 1916.

(A) The sodium carbonate present in the solution

of the material is converted into bicarbonate and removed. The solution is then evaporated, when sodium chloride and sulphate are deposited and potassium salts retained. Calcium chloride and milk of lime are added to convert sulphate, borate, and carbonate compounds into insoluble calcium salts. The product is filtered and the solution is subjected to alternate hot and cold crystallisation to recover separately the remaining sodium and potassium chlorides. (B) The solution is treated with carbon dioxide to convert sodium carbonate into bicarbonate, which is precipitated and removed. Potassium sulphate and sodium chloride, which are obtained at a later stage of a previous operation, are added to the solution in such quantity that upon concentration by evaporation at a high temperature, all the sulphate will be precipitated and the solution will be left with double the potassium content of the original lake water. During this evaporation, sodium sulphate and chloride are first precipitated and removed, then potassium sulphate and sodium chloride are precipitated. The potassium chloride remains in solution and is precipitated by cooling. (C) A solution containing approximately 23.6% potassium chloride, 8.6% borax, and 67.8% water is concentrated at a high temperature until saturated with potassium chloride while remaining unsaturated with borax. The mixed salts are added to the solution until it is saturated with borax, and while still hot, the undissolved potassium chloride is removed. Water, equivalent in amount to that removed by the evaporation, is then added to the solution, which is cooled and the borax removed by crystallisation.—J. N. P.

Salts; Process of recovering—from mixtures in solution. E. N. Trump, Syracuse, N.Y., Assignor to Solvay Process Co., Solvay, N.Y. U.S. Pat. 1,216,187, Feb. 13, 1917. Date of appl., Mar. 24, 1916.

THE solution is subjected to fractional crystallisation in a series of evaporating vessels which are maintained at progressively increasing temperatures. During the concentration, the solution circulates from the vessel at the highest temperature to the one at the lowest, and the salt precipitated in each vessel is transferred to the adjacent one at a higher temperature, whereby the more soluble salt is dissolved. The final products of the separation are removed from the vessels at each end of the series.—J. N. P.

Aluminium chloride; Manufacture of —. A. McD. McAfee, Port Arthur, Assignor to Gulf Refining Co., Pittsburgh, Pa. U.S. Pat. 1,217,471, Feb. 27, 1917. Date of appl., Sept. 29, 1916.

FINELY-DIVIDED hydrated alumina, or undried bauxite, is mixed with finely-divided coking coal, with or without a temporary binder, the mixture is coked, and is then submitted to the action of chlorine gas, or of a gas containing chlorine.

—J. B. C. K.

Aluminium chloride; Art of producing —. M. Barnett and L. Burgess, New York, Assignors to Alchior Chemical Co. U.S. Pat. 1,218,588, Mar. 6, 1917. Date of appl., Aug. 14, 1916.

ALUMINIUM carbide is treated with hydrochloric acid gas in the presence of heat, and the aluminium chloride produced by the reaction is volatilised and condensed. The other gases evolved during the reaction are employed for heating the retort. The apparatus used consists of a furnace, a retort within the furnace, a condenser, a charging-hopper, and gas-burners for heating the furnace with the evolved gases.—J. B. C. K.

Liquefying and separating gases [air]; Apparatus for —. R. Mewes, Berlin. U.S. Pat. 1,215,957, Feb. 13, 1917. Date of appl., Oct. 7, 1915.

Air at low pressure is cooled by a counter-current device and fed to a coil within a separating chamber and opening into it. The air passes from the separating chamber to an expansion chamber and thence to a second coil in the separating chamber. Air rich in oxygen is forced at high pressure by a cooled compressor through a third coil in the separating chamber, in counter current to the expanded air, to a throttle valve, from which it issues into the separating chamber. Air rich in nitrogen is similarly compressed and passed through a fourth coil in the separating chamber to a throttle valve, from which it also issues into the separating chamber.—W. F. F.

Sulphuric acid; Apparatus for the continuous concentration of —. S. Dreyfus, Denton, Lancs. U.S. Pat. 1,217,577, Feb. 27, 1917. Date of appl., Jan. 10, 1917.

SEE Eng. Pat. 101,642 of 1916; this J., 1916, 1155.

Sulphuric acid; Process of producing —. P. Farup, Gløshaugen, Assignor to Det Norske Aktieselskab for Elektrokemisk Industri, Christiania, Norway. U.S. Pat. 1,219,277, Mar. 13, 1917. Date of appl., Feb. 25, 1913.

SEE Fr. Pat. 454,893 of 1913; this J., 1913, 867.

Sodium thiosulphate; Process for the manufacture of —. T. W. S. Hutchins, L. Hargreaves, and A. C. Dunningham, Middlewich. U.S. Pat. 1,219,819, Mar. 20, 1917. Date of appl. Aug. 18, 1916.

SEE Eng. Pat. 12,599 of 1915; this J., 1916, 1059.

Process of producing cement and recovering potassium compounds. U.S. Pat. 1,219,315. See IX.

VIII.—GLASS; CERAMICS.

PATENTS.

Plate glass; Manufacture of —. R. S. Pease. Assignor to Pittsburgh Plate Glass Co., Pittsburgh, Pa. U.S. Pat. 1,217,340, Feb. 27, 1917. Date of appl., June 5, 1915.

A SHALLOW pot is partially filled by dipping it into molten unrefined glass contained in a tank. The pot is then allowed to float on the surface of the molten glass and is moved forward and exposed to a refining heat. When the glass in the pot is sufficiently refined, the pot is allowed to cool slightly and is then removed from the tank and the glass poured into another vessel.

—A. B. S.

Pots for the manufacture of plate glass, and method of making same. C. H. Kerr, Tarentum, Pa., Assignor to Pittsburgh Plate Glass Co., Pittsburgh, Pa. U.S. Pat. 1,217,956, Mar. 6, 1917. Date of appl., May 8, 1914. Renewed Nov. 18, 1916.

POTS for melting plate glass are made of ordinary glass-house pot clay mixed with finely divided silica or sand, so that the mixture contains 8 to 30% of the silica. The sand is of such fineness that the major portion consists of grains less than 0.05 in. diameter.—A. B. S.

Glassware; Process of producing decorative colour effects on —. H. Northwood, Wheeling, W. Va. U.S. Pat. 1,217,490, Feb. 27, 1917. Date of appl., Sep. 28, 1916.

The ware is stained with copper sulphate solution (with or without a binder such as ferruginous clay), fired at 900° F. (480° C.), cooled, and the binder removed. It is then coated with a solution of a silver salt (with or without a binder) and re-fired at the same temperature.—A. B. S.

Carborundum articles. G. A. Balz, Rahway, N.J., U.S.A. Eng. Pat. 103,818, Dec. 19, 1916. (Appl. No. 18,199 of 1916.) Under Int. Conv., Jan. 28, 1916.

POWDERED or granulated carborundum (firesand) is mixed with about 2% of slaked lime or other alkaline-earth hydroxide and sufficient water to make the mass plastic. Articles are made by pressing or moulding and then burning at 1400° C. or somewhat higher so as to flux or frit the material. Bricks, etc., made in this way are extremely refractory and may be used under conditions for which neither aluminous nor silicious materials are satisfactory.—A. B. S.

Kiln construction. C. H. Zwernmann, Kalamazoo, Mich. U.S. Pat. 1,216,590, Feb. 20, 1917. Date of appl., Dec. 4, 1916.

THE goods to be burned are supported in the centre of the kiln, and are separated from the combustion chambers at each side by partitions. A series of lateral and upright tubular flues is connected to each combustion chamber. The inner and outer walls of the kiln are insulated from each other.—A. B. S.

Glass; Production of articles of — and apparatus therefor. J. Connolly, Manchester, and J. A. Temple, Richmond. Eng. Pat. 104,555, Mar. 15, 1916. (Appl. No. 3818 of 1916.)

Glass; Method of and apparatus for conveying molten —. Art of feeding molten glass. W. J. Mellersh-Jackson, London. From Hartford-Fairmont Co., Canajoharie, N.Y., U.S.A. Eng. Pats. 104,605 and 104,606, June 19, 1916. (Appl. Nos. 8648 and 8653 of 1916.)

Cutting, cleaning, or polishing material [abrasive]; Manufacture of a —. Naaml. Vennootschap West Borneo Cultuur Maatschappij, The Hague. Eng. Pat. 100,140, Mar. 4, 1916. Under Int. Conv., Mar. 4, 1915. (Appl. No. 3290 of 1916.)

SEE Fr. Pat. 481,099 of 1916; this J., 1917, 139.

Carborundum article and process of making it. G. A. Balz, Rahway, N.J. U.S. Pat. 1,217,683, Feb. 27, 1917. Date of appl., Jan. 28, 1916.

SEE Eng. Pat. 103,818 of 1916; preceding.

IX.—BUILDING MATERIALS.

Wood; Chemistry of the decay of —. R. E. Rose and M. W. Lisse. J. Ind. Eng. Chem., 1917, 9, 284—287.

SAMPLES of sound, partially decayed, and completely rotten wood from Douglas firs were analysed with the following average percentage results:—

	Soluble in cold water.	Soluble in hot water.	Alkali-soluble.	Cellulose.	Acid hydrolysis.	Pentosans.	Methyl-pentosans.	Methoxy group.	Moisture (40-mesh).	Moisture (sawdust).	Ether extract.	Ash.
Sound heart wood	4.03	2.23	10.61	58.9	0.71	7.16	2.64	3.94	9.81	10.22	2.71	0.15
Partially decayed	1.79	4.19	38.10	41.66	0.28	6.79	3.56	5.16	10.63	9.09	2.05	0.15
Completely rotten	1.16	7.77	65.31	8.47	0.17	2.96	6.06	7.80	9.09	8.97	2.72	0.65

The cellulose was determined by Cross and Bevan's method on the sawdust, and the other constituents on powder passing through a 40-mesh sieve. Pentosans and methylpentosans were determined by Tollens' method, and the methoxy group by Zeisel's method. For the acid hydrolysis 2 grms. was boiled for 3 hours with 2.5% sulphuric acid, and the volatile acids distilled, titrated, and calculated as acetic acid. The alkali-soluble substances were determined by heating 2 grms. on the water-bath with 100 c.c. of 1% sodium hydroxide solution, and deducting from the loss in weight the percentage removed by the hot and cold water and ether extractions and the acid hydrolysis. The results indicate that the alkali-soluble material is formed at the expense of the cellulose, the determination of which might serve to detect incipient decay. The lignin is more resistant to decay than the cellulose, and does not appear to decay uniformly, the portion first attacked being that which yields acetic acid and furfural on hydrolysis. The more resistant portion appears to be that which yields methylfurfural on treatment with strong hydrochloric acid, and methyl iodide when heated with strong hydriodic acid.—C. A. M.

Polash [potassium] salts; Volatilisation of— from cement materials. E. Anderson and R. J. Nestell. J. Ind. Eng. Chem., 1917, 9, 253—261.

EXPERIMENTS described in detail show that the potassium oxide in any cement material can be completely volatilised, the velocity and extent of the volatilisation depending upon the temperature, length of exposure, and the volume of gas present, whilst in the kiln the size of the clinkers has also an influence. The potassium oxide is expelled more readily from some materials than from others. Volatilisation begins at about 1100° C. and at 1200° to 1300° C. most of the potassium oxide can be expelled from any cement material. The velocity of volatilisation increases rapidly with the temperature, and at 1100° C. nearly the whole of the potassium oxide can be expelled in a very short time. The presence of chlorides, and especially of calcium chloride, increases the speed of volatilisation, whilst sulphates have a retarding influence. It is therefore an advantage to add chlorides to the material. The presence of sulphur dioxide in the furnace gases decreases the rate of volatilisation, owing to the formation of sulphates. Sodium oxide is volatilised nearly as readily as potassium oxide. The most suitable means of obtaining the maximum volatilisation of potassium oxide is to burn the material at a high temperature in kilns so constructed that the material is kept as long as possible in the hot zone and in contact with the hot stream of gas.—C. A. M.

PATENTS.

Roads; Method of and material for surfacing— R. E. Phillips, London. From J. N. Honeyman, Middlesbrough, and P. H. Watson, Hartlepool. Eng. Pat. 101,472, Sep. 27, 1916. (Appl. No. 13,720 of 1916.)

ROAD surfaces are rendered dustless by damping them and then covering them with a mixture of 1 part of finely ground salt-crust from brine pans and three parts of pulverised stone or slag. The wet mixture is immediately rolled in.—A. B. S.

Concrete or artificial stone; Composition of— for blocks and the like. E. O. C. Howells, Coventry. Eng. Pat. 101,595, Mar. 23, 1916. (Appl. No. 7771 of 1916.)

BLOCKS for kerbs, channels, mullions, etc., are

made of concrete composed of 4 parts of granite and 1 part of Portland cement to which is added 10% of crushed Bessemer steel slag. It is claimed that such blocks are 60% stronger than those made of ordinary concrete.—A. B. S.

Cement; Process of producing—and recovering potassium compounds. F. W. Huber and F. F. Reath, Riverside, Cal. U.S. Pat. 1,219,315, Mar. 13, 1917. Date of appl. Sep. 26, 1916.

THE flue dust from cement kilns is mixed with an alkaline-earth halide (such as calcium fluoride) and then heated to a cement-forming temperature under conditions capable of liberating and volatilising the alkalis. The volatilised alkali is collected in the form of a flue dust which is mixed with calcium fluoride and digested with water to extract the potash.—A. B. S.

Timber and other material; Impregnating—with a preservative. O. P. M. Goss, Seattle, Wash. U.S. Pat. 1,219,388, Mar. 13, 1917. Date of appl. Oct. 11, 1915.

THE timber is heated with a bituminous preservative in a closed container at 230° F. (110° C.) first under atmospheric pressure and then in a vacuum of 15 to 28 in. for at least 30 mins. The vacuum is then broken and sufficient pressure applied to force from 5 to 20 lb. of the preservative into each 1 cu. ft. of timber. The fluid may then be heated for a further period of 1 to 6 hrs. under atmospheric pressure, after which it is allowed to run out of the container, and a vacuum of 15 to 28 in. is created in the latter.—A. B. S.

Process of fireproofing fibrous materials. U.S. Pat. 1,216,729. See under X.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Steel forgings; Heat treatment of— H. H. Ashdown, Inst. Mech. Eng., Mar. 16, 1917. Engineering, 1917, 103, 266—270.

FURNACES of the approximate dimensions, 8 ft. by 10 ft. by 100 ft., with a total capacity of 150 tons of miscellaneous forgings, are now extensively employed in large steel works. The temperatures employed, which vary from 650° C. (1200° F.) to 927° C. (1700° F.), are generally controlled pyrometrically, though through non-uniformity the values recorded are necessarily only local temperatures, according to the position of the pyrometer. Unless the former temperature is exceeded, comparatively little change is effected in the structural condition of the metal. Forgings, or any part of them, which have been raised to a high temperature and received little or no subsequent working, retain on cooling a very coarse structure with consequent mechanical weakness. The best structural conditions are obtained by allowing the heated forging first to fall below its recalescence temperature and then reheating somewhat above this point and preferably cooling in air. The maximum hardening of steel is obtained by quenching at a temperature just above its recalescence point, by ensuring that the temperature is uniform throughout the metal, and by cooling as rapidly as possible until the critical range has been passed. In both quenching and annealing, the best results have been obtained by not exceeding 813° C. (1500° F.). Above this point a coarse structure develops and increases the more rapidly the higher the temperature. Excessive heating before quenching also renders the cooling medium unnecessarily hot and thus causes a comparatively

slow cooling of the forging through its critical stage, allowing partial precipitation of the ferrite. Water serves as a very satisfactory quenching medium, and in the case of large masses of steel, such as gun forgings, has the advantage of obviating the expense and risk attending the use of large quantities of oil. Steels may be annealed for the purpose of subsequent machining by burying in sand, which for small forgings should first be heated, so that the metal is completely covered before the temperature has fallen below the critical point. Failures in the annealing of forgings of irregular shape have been caused by the large difference in time taken by the different parts of the forging to acquire a given temperature during the heating, thus causing deterioration of the areas of smaller section through prolonged exposure to high temperatures. This defect has been obviated by subjecting the forging for a long interval to a temperature of about 704° C. (1300° F.), when little structural change is undergone, and then gradually raising to the predetermined temperature.—J. N. P.

[Steel] forgings; Heat treatment of large —. W. Beardmore. Inst. Mech. Eng., Mar. 16. 1917. Engineering, 1917, 103. 270—271.

The difficulties of the heat treatment of forgings increase with the size, as the mechanical properties, which depend on the crystalline growth or size of grain, are largely influenced by the time the material is maintained at any chosen temperature and by the rate of cooling. A limit is thus ultimately reached in the size of the forging beyond which a plain carbon steel cannot be used with safety and an alloy steel becomes necessary. The slowness of cooling of the inner layers of heavy masses of steel results in the formation of large crystal grains in the centre, and necessitates oil quenching to accelerate the cooling and diminish the size of the grain. In these cases a subsequent reheating is generally necessary to remove the hardness introduced by the quenching. In the case of very large forgings, however, the effect of oil quenching is limited to the outer layers, an area in the centre remaining unaffected. An oil-treated shaft of 18 inches diameter, and of the following percentage composition: C, 0.18, Mn, 0.65, Si, 0.10, S, 0.048, P, 0.037, was maintained for two hours at 820° C. (1505° F.), and cooled in oil, giving a product with the following properties:—

	Elastic limit.	Ultimate stress.	Elongation on 2 in.	Reduction of area.
	Tons per sq. in.	Tons per sq. in.	Per cent.	Per cent.
Outside layer	17.5	33.1	27.0	53.1
Centre	15.0	29.0	31.0	46.0

The intimate relation which exists between the nature of the grain and the amount of work applied during forging makes it desirable that in every part the cross-section should be reduced to at least one-third of the original section of the ingot. For materials of a tensile strength exceeding 40 tons, it is generally safer to use an alloy steel, while for a tensile strength below this figure, an oil-treated low-carbon steel is satisfactory. In the furnace treatment of forgings of non-uniform thickness, the premature heating of the areas of smaller section, resulting in the progressive growth of the crystalline grain, can be avoided by enclosing the narrower parts in asbestos sheets. When, by machining, the outside surface has been removed from large forgings, which have been quenched during the heat treatment, distortion is apt to

occur, probably owing to internal stresses acquired during the operation of quenching. It is advisable on this account first to machine roughly the forging after treatment and then to re-anneal before the final machining.—J. N. P.

Steel: Determination of carbon in — by micro-graphical examination. A. Portevin. Rev. Mét., 1916, 13, 426—428.

THE estimation of carbon in steels by measuring under the microscope the relative proportions of ferrite and pearlite, may be disturbed by the inequality of the distribution of carbon throughout the metal. This heterogeneity, which is not indicated by chemical analysis, may be detected by observing large surfaces with a low magnification. Errors may also arise through the ferrite and pearlite being deposited in laminated schist-like form. In this case, duplicate sections, one parallel, and the other perpendicular, to the direction of the alinement of the layers, should be examined. Variations in the fineness of the texture lead to the necessity of varying the magnification with each specimen, so as to bring the mean dimensions of the areas of ferrite and pearlite to the same scale. Samples of metal for examination must first be subjected to the same conditions of annealing, as the structure of the pearlite and its association with ferrite and cementite are largely modified by the heat treatment received. The presence of manganese and chromium, which affect the relative proportions of ferrite and pearlite, gives an illusory high value in the micrographical estimation of carbon. —J. N. P.

Development of United Kingdom Mineral resources. New branch of the Ministry of Munitions.

A NEW Branch of the Ministry of Munitions has been established under Sir Lionel Phillips, Bart., as Controller, to deal with the examination and development of such mineral properties (other than coal or iron ore) in the United Kingdom as are considered likely to be of special value for the purposes of the war. The Minister of Munitions has appointed the following gentlemen to act as an advisory Committee on the development of mineral resources:—Sir Lionel Phillips, Bart. (Chairman), Mr. F. J. Allan, Mr. C. W. Fielding, Mr. R. J. Frecheville, Professor F. W. Harbord, F.I.C., Assoc. R.S.M., Mr. F. Merricks, Sir Harry Ross Skinner, Dr. A. Strahan, LL.D., F.R.S. (representing the Geological Survey), and Mr. Edgar Taylor, together with a representative to be nominated by the Board of Trade.

[Silver:] Sodium sulphide precipitation [of —] at Niissing. R. B. Watson. Bull. Canadian Inst. Min. Eng., Nov., 1916. Eng. and Min. J., 1917, 103, 378—379.

OWING to the increased cost of aluminium, sodium sulphide has been substituted for aluminium powder (this J., 1913, 660) for precipitating cyanide solutions. The solution is agitated with sodium sulphide solution, the required amount of the latter being ascertained by constant testing of the spent solution leaving the filter-press. The slight excess of sulphide required for complete precipitation is destroyed by aeration, after which the regenerated cyanide liquor is returned to the treatment tank. The silver sulphide precipitate is made into a pulp with 4 parts of 8% caustic soda (0.03 lb. NaOH per oz. Ag). The pulp circulates through a small tube-mill containing 300 lb. of aluminium ingots. After 10—12 hours, desulphurisation is complete: $2Al + 3NaOH + 3Ag_2S = Na_2Al_2O_4 + 6Ag + 3NaSH + H_2O$. The metallic precipitate is filter-pressed, washed for

2 hours, and melted down to bullion (996 fine). The slag is saved and put through a small blast-furnace. The process cannot be used for precipitating gold from cyanide solutions.—W. R. S.

Flotation [of oxide ores]; Notes on —, J. M. Callow. Amer. Inst. Min. Eng., Feb., 1917. Met. and Chem. Eng., 1917, 16, 250-252.

THE tailing of the Magma (Ariz.) mill, carrying considerable quantities of oxides, is sulphidised by hydrogen sulphide, and subsequently concentrated by flotation (this J., 1916, 929). The gas is forced by means of a centrifugal pump through the pulp in a closed cell. It was found that hydrogen sulphide in proper quantity promotes the flotation of natural sulphides refractory to other concentration processes, and uniform recovery of both the natural sulphides and the oxides coated with a film of sulphide is obtained. The hydrogen sulphide is made by heating sulphur with $2\frac{1}{2}$ parts of California crude oil to 300°C . in a retort. The solution is blown at the head of the first flotation cell, as free gas in the pulp is harmful. The sulphur consumption is $\frac{1}{2}$ — $1\frac{1}{2}$ lb. per ton of tailing, and 3 lb. per ton of carbonate ores containing 3—4% of copper.—W. R. S.

Tungsten-molybdenum alloys. F. A. Fahrenwald. Amer. Inst. Min. Eng., Feb., 1917. Met. and Chem. Eng., 1917, 16, 249.

THE alloys were prepared by compressing mixtures of reduced tungsten and molybdenum, in the form of powder, into briquettes and heating by an electric current in an atmosphere of hydrogen. The solidus curve was found by optical pyrometer measurements. The equilibrium diagram showed no critical points, and the curve for hardness was typical of an uninterrupted series of solid solutions. The two metals were found to be completely isomorphous. All the alloys of the series are malleable and ductile.—W. R. S.

Resiliency tests [on metals]. G. Charpy and A. Cornu-Thenard. Comptes rend., 1917, 164, 473—477.

THE degree of bending of metals by impact reveals differences in the physical condition which are not shown by other mechanical tests. Measurements were repeated about five times with bars of steel and copper prepared as far as possible under the same conditions and the extreme and mean variations are tabulated. The resistance to impact of a number of carefully notched test-pieces of metal gave results of a regularity comparable with those obtained in measurements on yield point, elongation, and hardness. Measurements by the falling weight method of the resiliency of similar straight bars of steel were found to give results which were independent of the height of fall, value of weight, and dimensions of the apparatus. With notched test-pieces the resiliency falls rapidly in proportion to the depth of the groove, but with metals of similar size and shape is a definite physical constant.—J. N. P.

Dealings in lead. Ministry of Munitions Order. See page 408.

Mineral production of the United Kingdom. See page 414.

Mineral production of Canada. See page 411.

Cobalt industry in Canada. See page 141.

Fixation of nitrogen. Bucher. See VII.

Method for the determination of the dissociation pressures of sulphides, and its application to covellite (CuS) and pyrite (FeS_2). Allen and Lombard. See VII.

The Penfield test for carbon. Mixer and Haigh. See VII.

PATENTS.

Refining volatile metals [electrically]. S. Hultdt, Stockholm, Sweden. Eng. Pat. 101,211, July 27, 1916. (Appl. No. 10,613 of 1916.) Under Int. Conv., Aug. 14, 1915.

THE zinc or other volatile metal to be refined is introduced into the chamber of an electric arc radiating furnace through an opening in the furnace wall, until a molten metallic bath is formed, and the opening is then closed. Fresh material is introduced at the bottom of the bath through a liquid trap formed by the molten metal, and the zinc distilled from the surface of the metal is continuously exhausted for condensation through an outlet in the top of the chamber.—B. N.

Ores; Reduction of — [electrically]. G. E. Heyl, London. Eng. Pat. 104,064, Apr. 7 and 13, 1916. (Appl. Nos. 5132 and 5129 of 1916.)

THE ore is crushed with the necessary fluxes and reducing agents, and the mixture, in the form of a thin rod or ribbon, is fed by a suitable apparatus into an enclosed chamber to a region, immediately below an electric arc or series of arcs, in which a reducing temperature is maintained.—B. N.

Rust-proofing metal; Process for —. W. H. Allen, Assignor to Parker Rust-Proof Co. of America, Detroit, Mich. U.S. Pat. 1,215,463, Feb. 13, 1917. Date of appl., Nov. 6, 1915.

ARTICLES of iron and steel are rendered rust-proof by immersing them in a boiling solution containing 0.8% of acid ferric phosphate.—B. N.

Ore; [Electrically] sintering and smelting —. A. S. Dwight, New York. U.S. Pat. 1,215,635, Feb. 13, 1917. Date of appl., Mar. 31, 1910. Renewed June 15, 1916.

A LAYER of ore is sintered by the combustion of contained materials into a continuous sinter cake, and the latter is moved continuously away from the region where it is formed. The intermediate portion of the cake is subjected to an electric current to raise its temperature, and a current is also passed from the forward end of the cake to a conducting electrode which is relatively stationary.—B. N.

Ores; Process for treating —. Apparatus for roasting and sintering ores. A. S. Dwight, Assignor to Dwight and Lloyd Sintering Co., Inc., New York. U.S. Pats. (A) 1,215,636 and (B) 1,215,637, Feb. 13, 1917. Dates of appl., (A) July 7, 1913, and (B) Oct. 21, 1914.

(A) SULPHIDE ore is roasted in shallow layers to obtain a uniformly porous sinter-cake, and air is passed through the material. Whilst the ore and gases are still hot, the air is again passed through the material to enrich the gas in sulphur dioxide. (B) Two grate surfaces are arranged for supporting and roasting a relatively thin layer of ore, and a box is arranged under each grate surface for collecting the products of combustion. The air-box under the first grate is divided into two chambers, one of which is connected by a gas duct to the suction side of a fan, and the latter drives

the gas into a hood covering the ore on the second grate, so that the gas again passes through the ignited ore. The products of combustion, from the second chamber of the divided air-box, and also from the box under the second grate, are led away through suitable ducts.—B. N.

Metalliferous ores; Process for treating—
R. L. Lloyd, Assignor to Dwight and Lloyd Metallurgical Co., New York. U.S. Pat. 1,215,672, Feb. 13, 1917. Date of appl., Dec. 30, 1912. Renewed Nov. 1, 1915.

FINELY divided metallic sulphide ore is treated by air-blasting a stream of the ore into a confined chamber, and oxidising it at a high temperature to burn off the sulphur. Whilst in a "highly heated and nascent state," the particles are arrested before reaching the chamber exit and agglomerated, forming small molten bodies in which incipient smelting takes place, and they are then collected in a smelting bath, whilst the gases are withdrawn from the interior of the chamber.—B. N.

Furnaces for melting metals and for other purposes.
I. Hall, Birmingham. Eng. Pat. 104,792, May 22, 1916. (Appl. No. 7251 of 1916.)

Heat treatment of articles such as are capable of travelling along inclines; Automatic furnaces for—
J. R. C. August, Sowerby Bridge, Yorks. Eng. Pat. 104,521, Feb. 7, 1916. (Appl. No. 1792 of 1916.)

Puddling iron. J. E. Fletcher, Dudley, and J. Harrison, Tipton. U.S. Pat. 1,220,081, Mar. 20, 1917. Date of appl., July 31, 1916.

SEE Eng. Pat. 7691 of 1915; this J., 1916, 849.

Powdered or granulated metal; Production of—
H. J. Jack and A. G. Lobley, London. Eng. Pat. 17,145, Dec. 6, 1915.

SEE Fr. Pat. 480,563 of 1915; this J., 1917, 144.

Zinc; Art of recovering — from zinc-bearing ore, including the manufacture of briquettes of zinc-bearing ore. D. B. Jones, Lake Forest, Ill., U.S.A. Eng. Pat. 104,564, Mar. 23, 1916. (Appl. No. 4311 of 1916.)

SEE U.S. Pat. 1,193,680 of 1916; this J., 1916, 969.

Fluxes for soldering aluminium. C. F. W. Kriewas, Cleveland, Ohio, U.S.A. Eng. Pat. 104,633, Aug. 7, 1916. (Appl. No. 11,140 of 1916.)

SEE U.S. Pats. 1,208,798 and 1,208,799 of 1916; this J., 1917, 223.

Casting under an explosive-like pressure into moulds; Process and device for—
H. Talla, Heilbronn, Assignor to Präzisionsgusswerke System Schmidt-Reichardt Ges., Frankfort, Germany. U.S. Pat. 1,217,662, Feb. 27, 1917. Date of appl., Oct. 10, 1916.

SEE Eng. Pat. 7466 of 1915; this J., 1916, 639.

Tungsten; Production of — from scheelite.
J. C. Butterfield, London, Assignor to A. Ashworth, Bury. U.S. Pat. 1,217,913, Mar. 6, 1917. Date of appl., Dec. 8, 1915.

SEE Eng. Pat. 16,562 of 1915; this J., 1916, 1066.

Tungsten; Extraction of — from tungsten ores.
J. C. Butterfield, London, Assignor to A. Ashworth, Bury. U.S. Pat. 1,217,914, Mar. 6, 1917. Date of appl., Dec. 23, 1915.

SEE Eng. Pats. 10,117 and 17,186 of 1915; this J., 1916, 743.

Metals; Apparatus for refining — by heating.
A. Helfenstein, Vienna. U.S. Pat. 1,220,111, Mar. 20, 1917. Date of appl., June 5, 1912.

SEE Ger. Pat. 249,932 of 1911; this J., 1912, 995.

Material [alloy] for electrical resistances or the like.
U.S. Pat. 1,217,578. See XI.

XI.—ELECTRO-CHEMISTRY.

Electrometric titration of zinc with ferrocyanide.
Russell v. Bichowsky. See XXIII.

PATENTS.

Electrolytic cells. H. C. Jenkins, H. F. Pattison, and R. Wellesley, London. Eng. Pat. 104,600, June 14, 1916. (Appl. No. 8393 of 1916.) Addition to Eng. Pat. 25,415, Nov. 8, 1913 (this J., 1914, 1096).

ELECTROLYTE is admitted into an inverted bell electrolytic cell by means of a pipe which opens into the bell a little above the lower edge of the latter. In order to cause the inflowing electrolyte to spread out in a horizontal layer below the base of the electrode, whilst preventing the displaced electrolyte inside the cell from entering the pipe by eddy motion, the supply pipe projects a short distance into a recess of slightly larger diameter than the pipe, cut into the base of the electrode. This recess or pocket is connected by a narrow channel leading upwards through the electrode to the gas space above. The supply pipe is provided with a projecting flange a short distance below the level of the base of the electrode.—J. N. P.

Battery; Electric —. Battery depolariser. M. E. Holmes, Lakewood, Ohio, Assignor to National Carbon Co., Cleveland, Ohio. U.S. Pats. (A) 1,216,450 and (B) 1,216,451, Feb. 20, 1917. Dates of appl., (A) July 23 and (B) Nov. 22, 1913.

(A) A depolariser for dry cells consists of manganese peroxide, precipitated, at approximately 100° C., from a solution of manganous chloride by potassium permanganate, and then calcined at approximately 300° C. (B) A mixture of several neutral manganites is used as depolariser.—B. N.

Battery-depolariser. M. E. Holmes, Lakewood, Ohio, Assignor to National Carbon Co., Cleveland, Ohio. U.S. Pat. 1,218,772, Mar. 13, 1917. Date of appl., Dec. 13, 1913.

PRECIPITATED manganous hydroxide is oxidised by chlorine, and the acid simultaneously formed is neutralised by a hydroxide. The chlorine and hydroxide are produced by electrolysis of a chloride.
—J. N. P.

Insulating compositions. L. H. Baekeland, Yonkers, N.Y., Assignor to General Bakelite Company, New York. U.S. Pats. (A) 1,216,265 and (B) 1,216,266, Feb. 20, 1917. Dates of appl., Oct. 17, 1913, and Jan. 26, 1915.

A CONDENSATION product obtained by the reaction of phenols with anhydroformaldehyde-aniline, is transformed by heating into an infusible body, and, after separating from any of the uncombined constituents, is dissolved in a hydrocarbon which possesses high insulating properties, is immiscible with water, and has a high solvent action on the product. (B) A condensation product prepared as above is dissolved in symmetrical dichloroethane in place of a hydrocarbon.—J. N. P.

Rubber or the like : [Insulating] article composed partly of —. W. O. Kennington, Assignor to Remy Electric Co., Anderson, Ind. U.S. Pat. 1,218,568, Mar. 6, 1917. Date of appl., May 25, 1914.

A mass of rubber, having metallic contacts embedded therein, and designed to form a contact surface adapted to co-operate with a rotary distributor brush, is placed in a mould; then a distinct mass of plastic phenolic condensation product is placed in the mould, and the whole is subjected to sufficient heat and pressure to cause the plastic condensation product to flow into the interstices of the mould, and subsequently harden into close association with the rubber portion.—E. W. L.

Electrical resistances and the like : Material [alloy] for —. W. B. Driver, Newark, N.J. U.S. Pat. 1,217,578, Feb. 27, 1917. Date of appl., Apr. 29, 1911.

AN alloy containing copper, together with 5% or more of manganese, and about 5% of tin.
—J. N. P.

Ozone : Apparatus for producing —. M. R. Tennant, Colorado Springs, Colo. U.S. Pat. 1,218,817, Mar. 13, 1917. Date of appl., July 12, 1913.

A SERIES of mica plates are inserted at close intervals in a frame of non-conducting material, and secured in the correct position by means of spacing strips. Sheets of metallic gauze are fixed in the centre of each compartment by attaching to the spacing strips, and are connected successively to alternate poles of a high-tension circuit.—J. N. P.

Galvanic battery-cell of the mercury oxide type. J. N. Brønsted, Assignor to Høllersens Enke & V. Lødvigsen, Copenhagen. U.S. Pat. 1,219,071, Mar. 13, 1917. Date of appl., Aug. 4, 1915.

SEE Eng. Pat. 9684 of 1915; this J., 1916, 897.

XII.—FATS; OILS; WAXES.

Linseed oil : Effect of heat and oxidation on —. J. A. N. Friend. Chem. Soc. Trans., 1917, 111, 162–167.

ON thickening Baltic linseed oil by heating (a) to 200° C. for 30 hours; (b) to about 300° C. for 36 hours; (c) to about 300° C. for about 12 hours without appreciable oxidation, the coefficient of expansion steadily falls and the density and viscosity rise with the temperature and length of treatment, whilst the molecular weight in benzene solution, calculated at infinite dilution, rises from 740 for the untreated oil to 760, 1000, and 1420 respectively. Linseed oil when exposed to oxidation as a thin film, loses very appreciable quantities of water, carbon dioxide, and organic vapours, so that the determination of the maximum increase in weight only represents a point of equilibrium at which the oxygen absorption counterbalances the loss due to escaping vapours, and there can be no proportionality between the increase in weight and the iodine value. Investigation of a sample of pure Calcutta linseed oil during the various successive stages of oxidation showed that the density of the oil gradually increased whilst the coefficient of expansion fell, there being an increase in volume up to the setting point of the oil, after which the linoxyn slowly contracted. The maximum increase in weight, 18.57%, took place after the oil had reached the setting point. The expansion is dependent on the increase in

weight, so that addition of substances to the oil which reduce the maximum increase in weight, probably by facilitating the escape of volatile substances, also reduces the expansion. The contraction suffered by linoxyn on prolonged exposure to air affords an explanation of the cracking of old paint.—T. C.

Soap : Detergent action of —. S. U. Pickering. Chem. Soc. Trans., 1917, 111, 86–101.

THE detergent action of soap must be attributed partly to its power of emulsifying oil, the globules of which become coated with a pellicle which prevents them from rendering adjacent objects oily; partly to the low surface tension between the soap solution and the oil; and possibly in part to the acid soap produced in the hydrolysis forming a colloidal compound with the dirt. The experiments cited show, however, that the main factor is that soap will dissolve oils, including paraffin oil, forming soluble compounds, some of which contain approximately equal proportions of oil and soap. In order to prevent the emulsification of a portion of the oil, the globules of which then become coated with a pellicle which prevents further combination with the soap, it is necessary to have a considerable excess of oil, if the soap is to combine with the maximum quantity of oil. The addition of water in excess does not decompose the oil-soap compound, but preliminary dilution of the soap solution causes more oil to be emulsified, with the result that a much smaller proportion combines with the soap. In the incorporation of oil with soaps three stages may be observed. For example, in the case of potassium stearate paste and benzene, the paste first becomes thickened owing to the oil being incorporated to form a coarse sort of emulsion; then the mixture becomes limpid owing to the formation of a soluble compound between the oil and the solid stearate; and thirdly this liquid rapidly solidifies to an opaque stiff mass owing to the globules of oil, through combination with the stearate, becoming sufficiently reduced in size to form a true emulsion. The extent to which these stages occur depends on factors such as the proportion of emulsion formed, the viscosity of the reagents, etc. The proportions of oil and soap which will unite depend both on the chemical and on the physical character of the reagents. For example, in the case of three samples of purified paraffin oils, the volumes dissolved of the oil boiling at 257° C., were intermediate between the volumes dissolved of the oils boiling at 98° C. and 198° C. respectively. Changes of temperature take place during the combination of the soap and oil, the nature and extent of the change depending upon the character of the oil. It is probable that the combination is invariably exothermic in character, but that the heat absorbed in the fusion of the solid stearate or semi-solid soap usually more than counterbalances the heat evolved. Naphthalene dissolves to a limited extent in soap, but partly separates out in crystalline form on cooling or diluting the solution. Soap will dissolve less paraffin oil in the presence of naphthalene.—C.A.M.

Cholesterols and phytosterols from the scientific and industrial point of view. Dubosc. See XIV.

PATENTS.

Fat rendering or roasting apparatus. J. W. Mason, and Mason Bros., Liverpool. Eng. Pat. 104,213, Feb. 24, 1916. (Appl. No. 2771 of 1916.)

A HORIZONTAL cylinder, provided with a stirring apparatus, has a fire-brick lining and is surrounded by a brick casing containing a series of flues. The material, e.g., fats or bones, is introduced into the

cylinder through a hopper, and the cylinder is heated by a furnace situated beneath, the hot gases passing through the flues in the brick casing. Vapours from the cylinder are conducted through a pipe which is connected with an upper flue through which the hot gases escape. Means are provided for removing the contents of the cylinder and for cooling the latter, the hot gases being by-passed and cold air admitted to the flues.

—W. P. S.

Hydrogenation [of oils]: Process of —. C. Ellis, Montclair, N.J. U.S. Pat. 1,217,118, Feb. 20, 1917. Date of appl., Mar. 20, 1912. Renewed Sep. 11, 1916.

OILY material is brought into contact with hydrogen in the presence of a catalyst prepared by heating a decomposable nickel salt in an oily menstruum.—W. P. S.

Kiln for drying vegetable substances [copra, etc.]. E. W. Andersen, Aarhus, Denmark. U.S. Pat. 1,218,156, Mar. 6, 1917. Date of appl., Aug. 4, 1915.

SEE Eng. Pat. 10,597 of 1915; this J., 1916, 609.

Fats, oils, and their derivatives: Process of bleaching —. B. E. Reuter, Assignor to Reuter Process Co., Chicago, Ill. U.S. Pat. 1,219,486, Mar. 20, 1917. Date of appl., Nov. 8, 1912.

SEE Fr. Pat. 457,496 of 1913; this J., 1913, 1020.

Sulphonated palmitic compound. I. Levinstein, Assignor to Levinstein, Ltd., Manchester. U.S. Pat. 1,219,967, Mar. 20, 1917. Date of appl., Feb. 12, 1913.

SEE Eng. Pats. 18,333 and 18,714 of 1912; this J., 1913, 1119.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Oil of turpentine from Pinus pinaster: Italian —. M. Palazzo. Annali Chim. Appl., 1917, 7. 88—94. (See also this J., 1916, 1122.)

ITALIAN oil of turpentine is usually a mixed product of *Pinus pinca* and *P. pinaster*, Sol. Two pure samples of the oil from *P. pinaster* gave the following results:—Sp. gr. at 15° C., 0.867 and 0.871; n_D^{20} = 1.4700 and 1.4707; n_D^{25} = -35° at 26° C. and -35° at 23° C.; and flash point 33.5°C. The oil began to boil below 154° C., and from 151 to 163° C. yielded 85 to 90% of distillate. The only difference between the Italian and French oil from *P. pinaster* is that the former has a slightly higher optical rotation, the value for α_D for French oils ranging from -29° to -33°. The higher optical rotation of the Italian oil is due to the presence of a larger proportion of *l*-pinene. A commercial sample of the normal Italian product of mixed oils had the following characters: Sp. gr. at 15° C., 0.863; n_D^{20} = 1.4678; α_D = -48.15; flash point, 35.5° C.; and solubility in 90% alcohol, 1 in 5.1 at 25° C. When distilled it yielded 80% of distillate between 155° and 165° C. —C. A. M.

Dealings in lead. Ministry of Munitions Order. See page 408.

Effect of heat and oxidation on linseed oil. Friend. See XII.

Cholesterol and phytosterols from the scientific and industrial point of view. Dubosc. See XIV.

PATENTS.

Coating materials: Preparation of dull-finish —. R. H. McKee, Orono, Me. U.S. Pat. 1,216,338, Feb. 20, 1917. Date of appl., Mar. 13, 1916.

A DULL-FINISH coating material is prepared by treating inferior grades of barium sulphate with concentrated sulphuric acid, then diluting the mixture gradually, and recovering the product. —W. P. S.

Pigment and method of preparing the same. H. A. Gardner, Washington, D.C. U.S. Pats. (A) 1,216,980 and (B) 1,216,981, Feb. 20, 1917. Dates of appl., July 11 and Oct. 26, 1916.

THE compositions claimed consist of an organic vehicle, and a pigment consisting of (A) an insoluble compound of zirconium (zirconium oxide) precipitated in presence of a base pigment the hiding power of which is inferior to, or its refractive index less than, that of zirconium oxide; (B) an insoluble compound of beryllium (beryllium oxide) precipitated in presence of a base pigment.—E. W. L.

Pigment and paint. L. E. Barton, Niagara Falls, N.Y., Assignor to Titanium Alloy Manufacturing Co., New York. U.S. Pat. 1,218,161, Mar. 6, 1917. Date of appl., Mar. 21, 1916.

THE pigment consists of particles of a sulphate base, with smaller particles of titanic oxide adhering thereto, mixed with white lead.—E. W. L.

Printing ink for stencil duplicating apparatus. J. Stevenson, and Roneo, Ltd., London. Eng. Pat. 101,429, May 30, 1916. (Appl. No. 7638 of 1916.)

THE ink contains calcium chloride as the hygroscopic substance, instead of glycerin, and may be composed of equal parts of a saturated solution of calcium chloride, and a 33 $\frac{1}{3}$ % solution of gum, to which 2 to 5% of lampblack or other inert colouring matter may be added.—E. W. L.

Rosin: Process for producing high-grade — from low-grade rosin. M. G. Donk, Washington, D.C. U.S. Pat. 1,219,413, Mar. 13, 1917. Date of appl., Apr. 1, 1915. (Dedicated to the public.)

THE light amber-coloured components are separated from the dark-coloured constituents of low-grade rosin by distillation at a pressure not exceeding 100 mm. and a temperature at which there is no material destructive distillation. The constituents of the distillate may be separated by fractional condensation. The still outlet is guarded with projections for preventing frothing of the heated rosin.—E. W. L.

Phenolic condensation product and process of making same. L. H. Baekeland, Yonkers, and A. H. Gottlieb, Hastings-upon-Hudson, N.Y. U.S. Pat. 1,217,115, Feb. 20, 1917. Date of appl., Oct. 17, 1913.

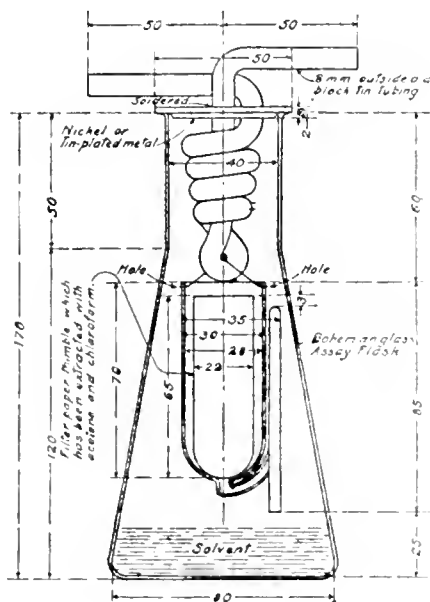
INFUSIBLE phenolic condensation products are prepared by heating a fusible phenolic condensation product with a sufficient proportion of a reactive methylene compound (anhydroformaldehydeaniline), which does not in the reaction yield a readily volatile by-product.—E. W. L.

Insulating compositions. U.S. Pats. 1,216,265 and 1,216,266. See XI.

XIV.—INDIA-RUBBER ; GUTTA-PERCHA.

Rubber Insulation Committee : Report of the Joint ——. J. Ind. Eng. Chem., 1917, 9, 310-317.

IN preparing the sample of rubber for analysis by the method described in the preliminary report (this J., 1914, 150), the insulation should be removed entirely from sufficient wire to give a sample weighing about 25 grms. This is ground to fine pieces in a No. 0 "Enterprise" coffee mill or similar mill, so that not more than 20% will pass through a 40-mesh sieve. The material is again sifted through a 20-mesh sieve, and what remains on the sieve is reground and again sifted, until the whole of the material has passed through the sieve. The wires of both sieves should be evenly spaced, in both directions, and should be 0.016 and 0.010 in. in diameter respectively. Any metal is then removed by means of a magnet and the sample is thoroughly mixed. The sampling should be done as soon as possible after vulcanisation, and, if possible, prior to saturation of the braid. When this is impossible the braid should be removed, and the insulation rubbed with sand paper to a depth of at least 0.005 in., and wiped with a damp cloth; but this treatment is not advisable, since it is liable to cause appreciable error in the acetone extract. The acetone extraction apparatus must be of the form and dimensions (in mm.) shown in the diagram. It should be heated so that the period



of filling an empty siphon cup with acetone and completely emptying it is between 2½ and 3½ mins. If there is any delay in starting the chloroform extraction after the extraction with acetone, the sample must be kept in a vacuum of at least 50 mm. of mercury. With regard to the specifications (*loc. cit.*), option is given to the purchaser to insert or omit the limit for total sulphur. Where such limit is omitted, certain sulphur-containing fillers may be used, whilst the use of man, kinds or an excessive quantity of reclaimed rubber would be guarded against by the limits for the various constituents of the acetone extract. For the determination of sulphur the following method is specified in place of the sodium peroxide method

described in the preliminary report:—0.5 gm. of the sample is treated with 20 c.c. of strong nitric acid to which has been added an excess of bromine, and the covered crucible allowed to stand for 1 hour, and then heated for an hour, after which the liquid is evaporated to dryness. The residue is fused with 5 grms. of a mixture of potassium nitrate and sodium carbonate (1:1); the melt digested with water for 3 or 4 hours on the water bath, the filtrate and washings (about 500 c.c.) treated with 10 c.c. of hot 10% barium chloride solution, and the barium sulphate filtered off after 12 hours.—C. A. M.

Cholesterols and phytosterols from the scientific and industrial point of view. A. Dubosc. Reprint from Caoutchouc et Gutta-Percha. 102 pages.

A SUMMARY is given of the constitution, properties, and compounds of the cholesterols and isomeric compounds. The presence of considerable quantities of phytosterols in the resins of indiarubber, etc., has caused attention to be directed to the means of utilising them industrially. Some years ago Morton proposed to utilise the resins of Pontianak for the production of isoprene, his method being based upon the fact that when cholesterol is heated in a tube in a current of hydrogen chloride, it is decomposed, with the formation of hydrochlorides of terpenes and water, and, on raising the temperature, of isoprene hydrochloride. This method, however, does not appear to have been used on an industrial scale. The fact that cholesterols are not affected by alkalis or basic substances has led Ellis to advocate their use for the preparation of protective varnishes for metal work in buildings. Soda-lime and potash-lime, however, decompose cholesterol at 250°C., yielding hydrogen and fatty acids. Cholesteryl stearate is prepared by heating a mixture of 1 part of cholesterol with 5 parts of stearic acid for 10 hours in a sealed tube at 200°C., and extracting the uncombined cholesterol with ether. It is prepared industrially from the resins of rubber, and is used as a substitute for animal and vegetable waxes in boot polishes. In the author's method of separating phytosterols from the resins of Jelutong rubber, the raw material is dried *in vacuo* at 100°C., which removes from 42 to 45% of water, and is then separated into an α -resin melting at 80–82°C., which can be extracted with acetone, and a β -resin melting at 105°C., which is soluble in ether and other solvents. They both have the formula $C_{24}H_{44}O$. The method of Lewkowitsch (this J., 1892, 134) is particularly suitable for the separation of cholesterol from other alcohols, but in the case of mixtures of cholesterol with mineral oil or tar the acetate method is preferable. The following method of determining the phytosterols in the acetone extracts of rubber is recommended. The residue left after evaporation of the acetone is boiled for 3 hours beneath a reflux condenser with 20 c.c. of acetic anhydride, which converts the phytosterol, lupeol, and α - and β -amyrols into their respective acetates. The acetic anhydride solution of the acetates is diluted with 100 c.c. of water and boiled for 3 hours beneath a reflux condenser to convert the acetic anhydride into acetic acid. The crystalline acetates are separated, washed with hot water, and boiled with 200 c.c. of standard alcoholic potassium hydroxide solution, the excess of which is titrated. Each gm. of potassium hydroxide neutralised by the acetic acid from the acetates corresponds with 7.393 grms. of phytosteryl acetate or 6.625 grms. of the resin. The di-iodide method is only applicable after the separation of waxes and tarry substances which may be present in the acetone extract, whilst the digitonin method is very accurate but requires the complete saponification of any esters of cholesterol which may be present.—C. A. M.

PATENTS.

Rubber latex; Coagulating—G. M. Thomas and M. D. Maude, Teluk Anson, Fed. Malay States. Eng. Pat. 104,323, Dec. 22, 1916. (Appl. No. 18,414 of 1916.)

LATEX of *Hevea brasiliensis* is allowed to coagulate spontaneously in vessels from which air is excluded. Such vessels are constructed with a trough running round their upper edge, and are provided with a lid with flanges dipping into the trough, thus forming, when the latter is filled with water or other liquid, a liquid seal which will permit of the escape of gases generated by fermentation, but will prevent the ingress of air. The vessel is filled nearly to the brim with latex, and the lid is then placed in position, the air pressure within and without being equalised by introducing a U-tube under the flange of the lid before water is poured into the trough, or by other similar device. Coagulation is complete within 24 hours, the coagulum being practically free from discoloration, and devoid of unpleasant smell.

—E. W. L.

Rubber; Compounding or treating of—A. E. Alexander, London. From Morgan and Wright, Detroit, Mich., U.S.A. Eng. Pat. 104,661, Dec. 13, 1916. (Appl. No. 17,896 of 1916.)

DIFFERENT varieties of crude rubber are blended in the course of the washing process between rollers, instead of being washed and dried separately and blended subsequently.—E. W. L.

Rubber; Process of treating—H. Hunter, Assignor to Hunter Dry Kiln Co., Indianapolis, Ind. U.S. Pat. 1,218,261, Mar. 6, 1917. Date of appl., Sept. 25, 1915.

RUBBER is exposed to a current of air, maintained at a relative humidity of 20 to 75%, and a substantially constant temperature, between 110° F. and 170° F. (43°–77° C.), and continually supplied with fresh air from the atmosphere.—E. W. L.

Caoutchouc-like bodies; Production of—H. Stern, Munich, Germany. U.S. Pat. 1,218,713, Mar. 13, 1917. Date of appl., July 30, 1915.

A VULCANISED, caoutchouc-like substance is obtained by adding sulphur dichloride to a mixture containing a ketone capable of yielding isoprene and caoutchouc, or to a ketone and an alcohol, and allowing these substances to interact.—E. W. L.

Diolefines (isoprene), caoutchouc, and caoutchouc-like substances; Manufacture of—H. Stern, Munich, Germany. U.S. Pat. 1,218,332, Mar. 6, 1917. Date of appl., July 17, 1914.

SEE Eng. Pat. 297 of 1915; this J., 1915, 1217.

Method of impregnating fabrics. U.S. Pat. 1,219,349. See V.

[*Insulating*] article composed partly of rubber or the like. U.S. Pat. 1,218,568. See XI.

XV.—LEATHER; BONE; HORN; GLUE.

Tanning phenomena in jellies; Ultra-microscopic investigation of—W. Moeller. Kolloid Zeits., 1916, 19, 205–213. J. Chem. Soc., 1917, 112, ii, 132. (See also this J., 1917, 225.)

AN account is given of the ultra-microscopic structures which are exhibited by gelatin jellies when these are subjected to the action of alcohol, tannin, chromic salts, and formaldehyde. The micro-photographic records show that the phenomena associated with the action of these reagents on jellies are closely similar to those

which are characteristic of the tanning of hide fibres. The actual differences are due solely to the circumstance that the fibrils in the hide are orientated, whilst those in the jelly are distributed in all possible directions. It is assumed that gelatin contains two substances, α - and β -gelatin, of which only the α -gelatin forms the structural units, whilst the β -gelatin is structureless and occupies the spaces between the fibrils of α -gelatin. In the jelly these fibrils are independent of one another, and under the influence of external forces, the irregular net-work may be transformed into a system in which the fibrils are orientated, and in this way structures are developed which vary according to the nature of the forces to which the gelatin jelly is subjected.

Jellies; Internal and surface structures in—W. Moeller. Kolloid Zeits., 1916, 19, 213–219. J. Chem. Soc., 1917, 112, ii, 132.

THE author has examined the structure of gelatin subjected to the action of water vapour and warm water, of gelatin jellies before and after dehydration, and also the structure of gelatin which has been heated to a temperature at which it begins to decompose or has been subjected to the action of superheated steam and subsequently drawn out into threads. The observations afford evidence in support of the view that gelatin consists of an irregular conglomerate of fibrils forming a network of α -gelatin with β -gelatin in the intervening spaces. The structure becomes visible when the gelatin is subjected to any action which removes the β -gelatin partly or completely. In these circumstances the fibril units of α -gelatin undergo orientation to a greater or less extent, forming fibril groups which are visible in the ultra-microscope.

PATENTS.

Artificial leather, felt products, paper products, or the like; Manufacture of—T. Schmid and J. Foltzer, Horn, Switzerland. Eng. Pat. 101,536. Aug. 24, 1916. Under Int. Conv., Sep. 23, 1915. (Appl. No. 12,024 of 1916.)

RAW vegetable or animal fibrous material is carded, and passed through a cross-fleece or Blamire's apparatus, by which the fibres lying in the longitudinal direction and discharged by the doffer of the carding machine, are placed cross-wise and transversely. The web thus produced is passed between two pressure rolls, one of which has a wholly or partly roughened surface, and the other a rubber coating. By one of these rolls cellulose solution is delivered to the web from an underlying trough, and forced into the fleece by the pressure of the rolls. The fleece is then passed, preferably in a stretched condition, through a cellulose-hardening liquid, e.g., a solution of caustic soda or potash, or, for softer products, an acid bath. By using bleached fibre, and hardening with acid of 50°–60° B. (sp. gr. 1.53–1.71), a product similar to stiff Japanese paper is obtained. These products are impermeable to air, and where this is undesirable may be passed between needle rolls in order to provide them with artificial pores.—E. W. L.

Cork and leather substitute and process of making the same. U.S. Pat. 1,218,982. See V.

XVI.—SOILS; FERTILISERS.

Granitic soils; The forms of phosphorus in—C. Vincent. Comptes rend., 1917, 164, 109–111.

GRANITIC soils are generally supposed to be poor in phosphoric acid, on the ground that increased yields follow the application of phosphates in various forms. The application of lime or chalk,

however, has a similar effect, and the reason is that granitic soils are not really so poor in phosphoric acid, but a large proportion of it exists in organic combination with the humus and is not available until the latter has been neutralised. If these soils be digested near the boiling point with concentrated nitric acid for four hours, only a portion of the total phosphoric acid is found on analysis, but if the soil be first neutralised with lime, or dried and calcined, before digestion, the whole of the phosphoric acid is obtained; the difference may be very considerable. Under these conditions the granitic soils are found to be moderately rich in phosphoric acid and some of them very rich; in the majority of cases the application of a light dressing of lime, calculated for 1–5 years, combined if necessary with potash and farmyard manures, will suffice to make the phosphoric acid and a portion of the nitrogen readily available.—J. F. B.

Soil: Effect of irrigation water and manure on the nitrates and total soluble salts of the —. F. S. Harris and N. I. Butt. J. Agric. Res., 1917, 8, 333–359.

GLASS jars containing 800 grms. of a soil which had been preserved in the laboratory for 2½ years, were treated with varying amounts of water, and kept under observation from Jan., 1912, to Aug., 1911, any moisture lost by evaporation being replaced. It was found that the total soluble salts were at a maximum when the soil contained 29% of moisture, and the maximum nitrate-content was attained with 24%. The curves followed one another very closely, showing that the nitrates constituted the greater part of the soluble salts. A fertile loam soil rich in magnesium and calcium carbonates was potted in large galvanised iron tanks, in half of which New Zealand wheat was cultivated, the rest remaining fallow. The tanks were placed in a vegetation house and kept under treatment for over two years. In the cropped soils the initial moisture content was 15% and in the fallow about 22%. As the amounts of water increased, the quantities of total salts and nitrates both decreased, the nitrates being particularly low in a water-logged soil. Both constituents were much lower in the cropped than in the fallow soil. The optimum moisture content was 20–28% for the cropped soil. Field experiments were carried out during 1911, 1913–1915, in plots at the Grenville Experimental Farm, Utah, on a soil consisting mostly of fine sand, silt, and clay, which was of remarkable uniformity down to 10 ft., and which was rich in all plant nutrients except nitrogen. Dakota Sunshine corn (maize) was grown on the cropped plots. Under these conditions the nitrate content in both cropped and fallow plots was found to be greater during the summer than after the maize was harvested; it was higher in the fallow soil when 5 or 15 tons per acre of mixed horse and cow manure, fairly well rotted, was applied, than when no manure was given, the effect being most marked in the top 2–3 ft. of soil. On the cropped plots, 5 tons of manure produced no effect, but 15 tons increased the nitrate content. The nitrate content of manured soil was about three times as great with a fallow as with a cropped soil; in unmanured soil, about twice as great. Irrigation diminished the nitrate content in both soils, and the more water applied the lower the nitrate content. The total soluble salts were at a maximum in the fallow plots manured with 5 tons, and at a minimum with 15 tons; in the cropped plots the maximum was with no manure and the minimum with 5 tons. Irrigation reduced the content of soluble salts, particularly in the surface foot of soil, and this effect was greater in the cropped than in the fallow soil. The nitrates

were more affected by manuring and irrigation than the total soluble salts. The ratio of soluble salts to sodium nitrate in cropped soil rose from 21.5:1 without irrigation to 37.5:1 when 40 in. of water was applied; in the fallow plots the increase was from 8.9:1 to 16.2:1. The low nitrate content of soils under heavy irrigation is probably due partly to leaching and partly to diminished nitrification.—E. H. T.

Soil disinfection: New experiments on —. Miège. Comptes rend., 1917, 164, 362–365.

ON experimental plots measuring 20 sq. m. in a medium clay soil at Rennes, haricot beans, tomatoes, carrots, potatoes, and buckwheat were grown in presence of some or all of the following antiseptics: toluene, carbon bisulphide, hydrogen peroxide, lysol, formaldehyde, potassium permanganate, copper sulphate, sulphur, bleaching powder, and wood charcoal. The effects produced upon the crops were favourable and well marked, both from the standpoint of yield and from that of absence of disease. Thus with haricot beans, potassium permanganate and charcoal each produced a doubled crop, and the yield with bleaching powder was about 150% above that of the control. Bleaching powder increased the yield of tomatoes by nearly 50%, and the increased yields of carrots were about 150% with toluene or carbon bisulphide, and 200% with lysol or formaldehyde. Potatoes responded readily to all the antiseptics mentioned above, the increases varying from 50% with hydrogen peroxide, formaldehyde, or charcoal, to 100% with sulphur. The increases with buckwheat were considerably smaller. In a second series the effects of the same antiseptics, used mostly in combination, were observed upon tomatoes, and to a lesser extent upon cucumbers and carnations, grown in a soil that had been used continuously for 15 years, 6000 sq. m. being under glass and 1 hectare open field. The results were again favourable, the best resulting from the application of toluene or carbon bisulphide. In these cases the maximum yield of tomatoes was 3300 kilos. of fruit per plot (400 sq. m.); the lowest yield was obtained with copper sulphate—2100 kilos. per plot.—E. H. T.

Nitrates in soils: Phenoldisulphonic acid method of determining —. C. W. Davis. J. Ind. Eng. Chem., 1917, 9, 290–293.

THE presence of ammonia fumes does not affect the colorimetric determination of nitrates by the phenoldisulphonic acid method, but since light has an influence on the colour, the readings should be made without delay. It makes no difference to the results whether the reagent is applied hot or cold, or with or without stirring, nor does the temperature of the solution at the time when the alkali is added affect the results, except at freezing temperature, when it causes a slight loss. A loss of nitrates is caused by the presence of a chloride, whilst sulphates and carbonates reduce the loss. The presence of sodium acetate does not affect the results. No loss of nitrates occurred when potassium chloride was added immediately before the development of the colour with potassium hydroxide. In the method as ordinarily applied, a pronounced loss of nitrates takes place during the heating on the water-bath, but this may be prevented by keeping the liquid alkaline during the evaporation. The addition of 2 drops of hydrochloric acid to a solution containing 25 parts per million of nitrates caused a loss of all nitrates. When chlorides were present loss occurred on the addition of the phenoldisulphonic acid. This loss was prevented by evaporating the solution to dryness with an excess of calcium hydroxide, and by pouring an excess of phenoldisulphonic acid rapidly over the salt. It was

found that by the use of this modification it was possible to determine colorimetrically all the nitrates in a soil to which known quantities had been added. Ordinary alum may be used as a clarifying agent in preparing the soil solution, without risk of losing nitrates, but clarification with copper sulphate causes a great loss of nitrates.—C. A. M.

Ammonium salts; Characteristic effect of — on plant physiology. H. G. Söderbaum. Medd. No. 125 Centralanst. jordbruksförsök, Stockholm, 1915, 13. J. Chem. Soc., 1917, 112, i, 192.

PHOSPHATIC manures in the form of superphosphate, basic slag, and bone meal were applied to barley, with cross-dressings of sodium nitrate, ammonium sulphate, and ammonium chloride. Each plot was subdivided into three parts, two of which received also magnesium salts (one the carbonate and the other the sulphate), whilst the third received no magnesium. The ammonium salts caused considerable depression of growth, especially when used with superphosphate, and to a less extent when used with bone meal. The leaves yellowed, and some plants died. With basic slag, however, the results were different; all plots were normal, as were all those which received magnesium carbonate; moreover, affected plots recovered rapidly with applications of magnesium carbonate, but not with magnesium sulphate. The author attributes the physiological disturbances of the plants not so much to any physiological acid reaction of the ammonium salts as to an actual toxic effect produced by them.

Fixation of nitrogen. Bucher. See VII.

PATENTS.

Manure; Treatment of —. P. J. A. Maignen. Philadelphia. U.S. Pat. 1,218,678, Mar. 13, 1917. Date of appl., Feb. 3, 1915.

THE manure or other material of fertilising value is mixed and macerated with an aqueous solution containing calcium and sodium compounds, capable of combining with the organic compounds present in the manure. The solution is then separated and concentrated, until the danger of putrefaction or fermentation is temporarily overcome.—J. B. C. K.

Seeds; Treatment of —. H. E. Fry, Dorchester, and C. E. De Wolf. London. U.S. Pat. 1,218,850, Mar. 13, 1917. Date of appl., June 3, 1916.

SEE Eng. Pat. 8994 of 1915; this J., 1916, 552.

Process of cleaning animal hair [wool] and producing fertiliser. U.S. Pat. 1,218,573. See V.

XVII.—SUGARS; STARCHES; GUMS.

Glucose [; Determination of — in cane molasses]. H. Pellet. Ann. Chim. Analyt., 1917, 22, 43—47.

VAN EKENSTEIN and Lobry de Bruyn have shown that glucose, the non-fermentable reducing sugar formed from hexoses by the action of alkalis, occurs in cane molasses, and the author suggests procedure for determining its amount. 100 grms. of molasses, diluted about ten-fold and slightly acidified, is fermented for 3 days with 50 grms. of bottom-fermentation yeast, any pentoses present being destroyed under these conditions (cp. this J., 1916, 1075). The reducing power of the fermented liquid is determined at 63°—65° C. with a duration of heating of 30 mins., after defecation with normal lead acetate and removal of excess of lead by sodium carbonate. Assuming the reducing

power of glucose to be half that of invert-sugar, the author found in cane molasses quantities of glucose ranging from 2.6 to 5%.—J. H. L.

Pentoses; Influence of — in the determination of reducing sugars at 63—65° C. H. Pellet. Bull. Assoc. Chim. Sucr., 1916, 34, 21—24.

FOLLOWING the method of determining reducing sugars previously described (this J., 1914, 35), the author found that at 63—65° C. 0.05 gm. of arabinose reduced 0.095—0.100 gm. of copper in 10 mins., and 0.128 gm. in 30 mins. At 90—92° C. 0.05 gm. reduced 0.128—0.130 gm. of copper in 15 mins. In determining the joint reducing action of invert-sugar and pentoses at 63—65° C. it is therefore advisable to heat for 40 mins. Every operator should construct his own tables for these sugars under the conditions of working adopted, and determine also the corrections necessary when sucrose is present (cp. Maquenne, this J., 1915, 1263; 1916, 268, 320, 373).—J. H. L.

Cane molasses and vinasses; Determination of reducing sugars in — for the calculation of the amount of sugar fermented. H. Pellet. Bull. Assoc. Chim. Sucr., 1916, 34, 24—28.

THE non-fermentable matters of cane molasses exert a certain reducing action which, like that of sucrose (see Maquenne, this J., 1916, 268), increases considerably with the temperature. The influence of these substances may be minimised by carrying out the determination of reducing power at 63—65° C. (see this J., 1914, 35), heating for about half an hour to allow the pentoses and glucose to exert their full reducing action (see preceding abstracts). This procedure is specially recommended in determining the reducing substances in molasses and the corresponding vinasses, with a view to calculating the amount of sugar fermented, since usually the quantities of molasses and vinasses used for analysis do not correspond, and therefore contain different amounts of non-fermentable reducing substances.—J. H. L.

Mannose; Preparation of pure crystalline — and a study of its mutarotation. C. S. Hudson and H. L. Sawyer. J. Amer. Chem. Soc., 1917, 39, 470—478.

A METHOD is described for the preparation of mannose from vegetable ivory (from seeds of the tagua palm, *Phytolophus macrocarpa*), in which the material is hydrolysed with sulphuric acid, and a yield of 30—35% of the crystallised sugar is obtained without intermediate conversion into phenylhydrazone. The mutarotation of mannose is a unimolecular reaction. Its velocity constant increases about 2.6-fold for a rise in temperature of 10° C., and is independent of concentration below 10%, but increases above to a maximum at 45 grms. per 100 c.c. and decreases again beyond. Like that of dextrose, the mutarotation of mannose is accelerated by acids, and to a much greater extent by alkalis. It is doubtless due to a balanced action between α - and β -forms. Crystallised mannose is generally assumed to be the β -form.—J. H. L.

Achrodextrinase. Effront. See XVIII.

PATENTS.

Sugars; Process for decolorising —. J. J., J. C. N., and A. G. Eastick. London. Eng. Pat. 104,231, Mar. 8, 1916. (Appl. No. 3425 of 1916.) Addition to Eng. Pat. 5900 of 1914 (this J., 1915, 195).

IN decolorising sugar solutions by means of charcoal, acid is added at an early stage together with the charcoal, the proportion of acid being the maximum amount which can be used without

causing a degree of inversion during the decolorising process which would be detrimental to the finished product. Products containing 1—10% of invert-sugar suitable for many confectionery and preserving purposes, may be produced by this treatment with a considerable economy in charcoal. For good raw sugars a 50% solution should show an acidity of about $N/10$ concentration. —J. F. B.

Sugar: Process and apparatus for granulating and drying —. G. Engel, Brooklyn, N.Y. U.S. Pats. 1,216,554 and 1,216,555, Feb. 20, 1917. Date of appl., Nov. 10, 1915.

WET sugar is disseminated into an air passage and nearly dried sugar is disseminated into a second air passage; a relatively small body of cool air is passed through the second air passage in a direction opposite to that in which the sugar is fed, and the air from the second passage, with the addition of a large volume of warm air, is passed through the first passage in a direction opposite to the travel of the sugar in that passage, whereby the dry sugar dust from the second passage is intercepted by the moist sugar in the first. The apparatus comprises a rotary cylinder, means for breaking up the moist material to be granulated as it falls continuously within the cylinder, means for forcing warm air through the cylinder, a second granulating means adapted to receive the material as it is discharged from the cylinder, means for forcing a relatively small blast of air through the second granulating means and thence through the cylinder with the warm blast. —J. F. B.

Revivification of used, finely powdered decolorising carbon. Eng. Pat. 101,156. See I.

XVIII.—FERMENTATION INDUSTRIES.

Achrodextrinase. J. Eflront. Comptes rend., 1917, 164, 415—416.

CERTAIN species of *B. mesentericus*, cultivated in a nitrogenous medium, secrete an enzyme capable of liquefying starch. The best media for the production of the enzyme are feeding-cake, deprived of starch, and distillers' spent grains; from 1 kilo. of grains it is possible to obtain a quantity of the liquefying enzyme equivalent to that in 20 kilos. of good malt. The enzyme converts starch and erythrodextrin into achrodextrin very rapidly, but its saccharifying power is very restricted. If comparative conversions be carried out with soluble starch or starch paste at 40° C. until no further colour reaction with iodine solution is obtainable, the proportion of maltose produced by the bacterial enzyme is only about 40%, whereas with other diastases of vegetable or animal origin the proportion of maltose at the same stage is about 70%. Achrodextrinase is also characterised by the fact that the products of the conversion of starch paste, carried out at 50° C. until 42% of maltose is produced, possess a much lower viscosity than the products of the other diastases. Achrodextrinase is precipitated by alcohol and by ammonium sulphate; it acts most rapidly at 40° C. It is fully active in a medium neutral to methyl orange and is decidedly resistant to alkalinity, being still active in presence of 1 gm. per litre of sodium carbonate. On the other hand, it is very sensitive to an acid reaction, its activity being completely inhibited by the presence of 0.1 part of hydrochloric acid per 1000. The bacterial diastase may be substituted for malt in the textile industry, and may be used for the production of dextrin syrups from the residues

of starch factories. It may also be employed for removing starch in laundry work and a saving of 50% of soap may be effected by its use. —J. F. B.

Wines: White "cassee" of —. Fonze-Diacon. Comptes rend., 1917, 164, 199—200. (See following abstract.)

BOUFFARD in 1902 (compare this J., 1902, 922) described cases of white *cassee* in wine, characterised by the appearance of an opalescence and finally of a deposit which he concluded was due to oxidation and contained lime and possibly iron. The author investigated a white wine which showed this defect very strongly; the greyish-white deposit, formed after prolonged oxidation by means of a current of air, was found to contain organic matter, a small quantity of lime, and larger amounts of iron and phosphoric acid in proportion corresponding to $Fe_2O_3 \cdot 2P_2O_5$. This *cassee* only appears when the sulphurous acid, present in all white wines, has been oxidised, and the oxidising action of the air becomes effective. The use of sulphurous solutions of ammonium phosphate, employed at present in place of potassium metabisulphite in the manufacture of wines, appears to be one of the main causes of the appearance of this disorder. —J. H. L.

Wines: White "cassee" of —. J. Laborde. Comptes rend., 1917, 164, 441—443. (See preceding abstract.)

THE author has previously shown that the so-called white *cassee* or turbidity in wines is due to oxidation of traces of dissolved iron, from the ferrous to the ferric state, and their separation from solution as ferric phosphate which is often accompanied by other colloidal matters. This may take place in presence of free tartaric or even sulphurous acid, but when these are absent or present only in very small amounts the oxidised iron separates as tannate as well as phosphate and then produces black *cassee*. Treatment of wine with 0.5 gm. of citric acid per litre often prevents the appearance of white *cassee* and in other cases it promotes coagulation of the suspended particles. The best method of treating white *cassee* is as follows:—If the wine contains sulphurous acid it is aerated sufficiently to provoke the separation of all the ferric phosphate capable of being formed. Citric acid is then added and after standing for several weeks the wine is drawn off and clarified by means of finings or by filtration. Similar treatment may be applied in cases of blue *cassee* of red wines. —J. H. L.

Methyl alcohol [in ethyl alcohol]: Detection and determination of small amounts of —. E. Elvove. J. Ind. Eng. Chem., 1917, 9, 295—297.

SIMMONDS (this J., 1912, 150) recommended that the solution in which methyl alcohol was to be determined by the method of Denigès (this J., 1910, 585) should always contain 10% of ethyl alcohol. The author, however, finds that the test is rendered much more sensitive by reducing the proportion of ethyl alcohol to 0.5% by vol., as little as 0.1 mgm. of methyl alcohol in 5 c.c. then giving a coloration on standing for 40 mins. The following method of preparing Schiff's reagent for the test gives a much more stable solution than that obtained by the usual method:—Finely powdered Magenta (0.2 gm.) is dissolved in about 120 c.c. of hot water, and when cold the solution is mixed with a solution of 2 grms. of anhydrous sodium sulphite in about 20 c.c. of water, then treated with 2 c.c. of hydrochloric acid (sp. gr. 1.19), and diluted to 200 c.c. with water. After standing for about an hour the reagent is ready for use. A solution thus prepared gave the same results after six weeks, in the colorimetric determination of formaldehyde as

when freshly made. In the oxidation of the methyl alcohol with acid permanganate, it is necessary to allow the solution to cool before adding the reagent, since otherwise a deeper coloration is obtained. When formaldehyde is also present in the solution, it should first be determined by means of the reagent, and a series of methyl alcohol standards containing the same concentration of formaldehyde then prepared and used for comparison with the solution after oxidation of the methyl alcohol and treatment with the reagent.—C. A. M.

Enzyme: Non-specific character of the animal and vegetable reducing —. [Reductase.] A. Bach. Comptes rend., 1917, 164, 248–249.

EXPERIMENTS were made with milk and with potato-pulp to ascertain whether the reduction of nitric acid which these substances are able to effect in presence of aldehydes, is influenced by the nature of the particular aldehyde present. Fourteen aldehydes, fatty and aromatic, were tested, and the results, though showing quantitative differences, indicate that the action of the reducing enzyme is not specific in this respect.—J. H. L.

Phenol: Production of — by bacteria. A. Berthelot. Comptes rend., 1917, 164, 196–199.

THE author has isolated from human faeces a new species of intestinal bacteria, *B. phenologenes*, of which the power of producing phenol is about ten times as great as that of any other known bacteria. Cultivated in peptone-water it formed 0.278 grm. of phenol per litre, whilst in a liquid containing as organic matter only 2 grms. of tyrosine per litre, 0.8 grm. of phenol per litre was produced. The organism is capable of developing to some extent in presence of concentrations of phenol up to 6.8 grms. per litre.—J. H. L.

Mull (Restriction) No. 2 Order. See page 409.

Determination of reducing sugars in cane molasses and vinasses for the calculation of the amount of sugar fermented. Pellet. See XVII.

Relative influence of micro-organisms and plant enzymes on the fermentation of corn [maize] silage. Lamb. See XIXA.

PATENTS.

Pasteurising apparatus [for beer]. E. M. Lundgren, Burton-upon-Trent. U.S. Pat. 1,217,470, Feb. 27, 1917. Date of appl., Feb. 19, 1916.

SEE Eng. Pat. 2745 of 1915; this J., 1915, 1224.

Process for the utilisation of waste sulphite [mu'] liquor. U.S. Pat. 1,218,638. See V.

XIXA.—FOODS.

Wheat flour: Nitrogen in amino-form as determined by formal titration, in relation to some other factors measuring quality in —. C. O. Swanson and E. L. Tague. J. Amer. Chem. Soc., 1917, 39, 482–491.

PREVIOUS work at the Kansas Agricultural Experiment Station has shown that relatively large amounts of amino-nitrogen, whether artificially added in the form of amino-compounds, or produced by germination of the wheat, are detrimental to the quality of flour. The authors now present the results of determinations of amino-nitrogen by Sørensen's method, in the different "stream flours" from the same wheat in one particular mill, and in "patent," "clear," and "low grade" flours from a number of mills. The determinations were made by digesting 1 part of flour with 10 parts of water for 2 hours at 40° C., filtering, and titrating with N/20 barium hydroxide, first

directly for the original acidity, and then after addition of formaldehyde for the amino-nitrogen. The results show that the content of amino-nitrogen varies in general with the ash-content and the acidity, being much lower in "patent" than in "low grade" flours, but the differences are less marked because amino-nitrogen is more uniformly distributed throughout the wheat grain than mineral matter and acids.—J. H. L.

Wheat kernel: Phytic acid of the — and some of its salts. P. W. Bontwell. J. Amer. Chem. Soc., 1917, 39, 491–503.

FROM 2.5 lb. of wheat bran the author extracted, by a method based on that used by Clark (this J., 1914, 436), 25 grms. of phytin as a hygroscopic solid in spheroidal crystals, insoluble in water and free from inorganic phosphorus. Its composition indicated a calcium-magnesium salt not corresponding with any such salt of inositolhexaphosphoric acid, though containing equimolar proportions of carbon and phosphorus. The free acid was isolated as a hygroscopic solid which underwent some decomposition on drying *in vacuo*. The barium salt, crystallised from cold dilute hydrochloric acid, agreed in composition with an equimolecular mixture of the tri- and tetrabarium salts of inositolhexaphosphoric acid; crystallised from hot acid it possessed a rather different composition. Phytin extracted from wheat embryos appeared identical with that described above. The phytase of wheat bran exhibited greater activity in presence of 0.1% hydrochloric acid than in pure water or 0.2% hydrochloric acid, and its action was not affected by formaldehyde at 2% concentration. The enzyme was found present also in wheat embryos. Dry heating of wheat bran at temperatures from 105° to 165° C. increased the amount of inorganic phosphorus dissolved during subsequent extraction, without apparently destroying the phytase.—J. H. L.

Wheat offals: Composition and classification of —. T. B. Wood and R. H. Adie. J. Board Agric., 1917, 23, 1179–1187.

MUCH confusion has arisen owing to the variation in milling practice in different districts and to the fact that whilst the larger mills separate their products (offals) into four grades, many of the smaller mills are satisfied with a much less complicated separation. Systematic examination of a number of samples of offals showed that they differed from one another in size of particles and chemical composition. Nearly all millers take out the coarsest offals as *bran*, and the *flour* consists of particles which pass through silk sieves (No. 10) having 136 meshes to the linear inch; the remaining portion, which will not pass through this sieve, constitutes the *offals*. Offals fall approximately into three grades, namely:—Grade 1, usually called "fine middlings," which does not pass silk sieve No. 10, but passes silk sieve No. 3; grade 2, usually called "coarse middlings," which does not pass sieve No. 3 but passes wire sieve No. 24; grade 3, called "pollards," which does not pass wire sieve No. 24 but passes sieve No. 16. Bran is retained by wire sieve No. 16 (about 16 meshes to the in.). The following analyses show that this classification has a definite value:

	Water.	Protein.	Fat.	Carbo- hydrates.	Fibre.	Ash.
Fine middlings	12.73	15.75	3.41	63.80	1.86	2.42
Coarse middlings	13.46	16.12	5.03	56.22	3.29	3.58
Pollards	13.32	14.39	4.76	55.50	7.70	4.33
Bran	13.63	13.15	3.92	53.12	10.58	5.40

The quantities of carbohydrates and fibre increase continuously as the size of the particles becomes larger, but in the case of fat and protein, the largest amounts are found in coarse middlings, probably due to the concentration of the germ in this grade. The products from many mills, however, do not fall entirely in any one of these grades; some of them are mixtures of two or even three grades. Mixtures of grades 1 and 2 may be called "straight run middlings," of grades 2 and 3 "straight run pollards," of grades 1, 2, and 3 "straight run offals," and of grade 3 and bran "coarse pollards." The composition of these products varies according to the proportion of the grades present. It is suggested that millers should adopt a uniform system of grading and naming their offals, and that, whilst head trade names might be retained, each product should be sold under its grade number. For instance, fine middlings, which are sold in different districts under the names of seconds, fine thirds, biscuit middlings, etc., might still be sold under any one of these terms with the addition of the letters "S. G. 1" (standard grade 1) indicating that it is the finest grade of offals, separated between silk sieves Nos. 3 and 10, and so on. With such a system, a large number of samples might be collected and analysed and a definite standard composition assigned to each grade. W. P. S.

Silage: Relative influence of micro-organisms and plant enzymes on the fermentation of corn [maize]
— A. R. Lamb. J. Agric. Res., 1917, 8, 361—380.

DIFFERENTIATION between bacterial and enzymic activities during silage fermentation is extremely difficult, as the conditions favourable to both and the effects of such conditions are practically the same. The silage used in the investigation was made of chopped maize (*Zea mays*), which was packed tightly in cylindrical jars closed with rubber bungs carrying an outlet tube for the escape of gases and a pinchcock. The product so obtained differed in no essential from farm silage; it was pressed in a Buchner press and the juice was analysed for total acidity, volatile acidity (i.e., after distillation in steam free from carbon dioxide), alcohols (by two methods), total sugars, amino-nitrogen (Van Slyke's method), ammoniacal nitrogen (by distillation with magnesium oxide), and moisture. No conclusive results were obtained when silage was made in presence of certain antiseptics, but toluene seemed to stop all change, and chloroform prevented the development of bacteria. Equally inconclusive results attended the attempts to destroy the enzymes by heat and then to inoculate with infusion from normal silage; the treated material, however, showed marked changes. Silage containing tartaric acid, in amount (2%) sufficient to inhibit bacterial action but to favour that of yeasts, gave 1.76 grms. of alcohol per 100 c.c. of juice; normal silage gives 0.20–0.15 gm. A study of the curves representing the rates of chemical changes during fermentation led to more satisfactory results, inasmuch as the types of curve due to enzymic and bacterial actions are different. In purely enzymic actions the rate of change decreases as the action progresses, but where active organisms are present, the rate increases for a longer time owing to their multiplication. In this way it was found that the production of acid and the disappearance of sugar are due mainly to bacteria, and that the formation of alcohol and proteolysis are chiefly caused by the activities of enzymes, although in the latter cases, micro-organisms play a part in the later stages. The evolution of carbon dioxide is greatest during the first day or two, and nearly ceases after about four days. It is produced by enzymic action, assisted to some extent by bacteria and

yeasts after the period of greatest evolution. The rise in temperature within the silo is caused by micro-organic action, but enzymes possibly play a restricted part.—E. H. T.

Manufacture of Flour and Bread Order. Flour Mills Order. See page 409.

Inflammability of carbonaceous dusts. Brown. See XIXE.

PATENTS.

Coffee: Process for treating — E. R. Eden, Montclair, N.J. U.S. Pat. 1,216,671, Feb. 20, 1917. Date of appl., Oct. 30, 1915.

GREEN coffee beans are immersed in water at a temperature at which the caffeine is readily soluble; they are then withdrawn, the excess of water is driven off, and the beans are roasted while moist.
—J. H. J.

Baking powders. E. C. R. Marks, London. From Royal Baking Powder Co., New York. Eng. Pat. 101,658, Dec. 7, 1916. (Appl. No. 17,594 of 1916.)

SEE U.S. Pat. 1,211,726 of 1917; this J., 1917, 401.

Fresh meals: Process for treating — with a view to conserve the same in a fresh condition in open air. J. J. Monvoisin, Paris. U.S. Pat. 1,219,130, Mar. 13, 1917. Date of appl., Nov. 11, 1914.

SEE Eng. Pat. 22,669 of 1914; this J., 1916, 433.

Air shafts for drying apparatus. Eng. Pat. 104,327. See under 1.

Apparatus for drying grain. U.S. Pat. 1,212,275. See under 1.

XIXB.—WATER PURIFICATION ; SANITATION.

Bacteria in water: Direct microscopical counting of —. B. E. Nelson. J. Amer. Chem. Soc., 1917, 39, 515—523.

THE respective advantages of plating and direct counting, for the enumeration of bacteria in water, are discussed. The latter method occupies much less time than the former and gives an opportunity for the examination of other organisms present. In making direct counts with potable waters, it is first necessary to concentrate the bacteria into a small volume, for which purpose the author recommends adding to 1 litre of the water 1–5 c.c. of 5% zinc sulphate solution followed by 0.7–3.7 c.c. of N/1 sodium hydroxide. The organisms are trapped by the precipitate of zinc hydroxide and are concentrated with it to a small volume by sedimentation, filtration, or centrifuging. Practical details of all three methods of operating are given; the last is by far the most rapid, enabling counts to be started 15–20 mins. after the commencement of a test, but a method of filtration with sand, described fully in the paper, gives rather higher results. When the precipitate has been concentrated to 1–2 c.c., the zinc hydroxide can be redissolved by adding ammonium chloride, and after addition of a drop of alkaline Methylene Blue or clear "carbol-fuchsin," counting is proceeded with. Methods of making the counts are described. The results are more accurate than those obtained by plating, but are not directly comparable with them, as they commonly exceed them by 50–100% or more.—J. H. L.

Hypochlorite solutions; Volumetric method for determining the strength of ——. Analysis of hydrogen peroxide. A. Bury. J. Pharm. Chim., 1917, 15, 189—193.

A METHOD for determining the strength of hypochlorite solutions used for sterilising water in the field consists in measuring the volume of oxygen liberated when the hypochlorite is mixed with excess of hydrogen peroxide. The reaction proceeds according to the equation: $\text{NaOCl} + \text{H}_2\text{O}_2 = \text{NaCl} + \text{H}_2\text{O} + \text{O}_2$, and the volume of oxygen is equal to that of the chlorine which is liberated by treating the hypochlorite with an acid. One c.c. of the hypochlorite solution is placed in a graduated tube which is closed at the bottom and provided with a bulb and tubulure at the top; water is added slowly until the tube is nearly filled, followed by hydrogen peroxide up to the zero mark. The tubulure is then closed with a rubber stopper carrying a short length of capillary tube, the finger is placed over the outer end of this tube, the apparatus is inverted and its contents mixed. When gas is no longer evolved, the finger is removed slightly from the capillary tube. The volume of liquid which is forced out is equal to that of the oxygen liberated, and this volume is ascertained by placing the tube in its normal position and reading the volume of the liquid remaining in it. The tube is so graduated that the readings give directly the quantity of available chlorine in the hypochlorite solution. The reaction may be used, inversely, for the analysis of hydrogen peroxide.—W. P. S.

Infection from wounds; Prevention of ——. Comparative study of various antiseptics. H. Vincent. Comptes rend., 1917, 164, 153—156.

As a first-aid dressing for wounds, particularly those caused by shell splinters, a mixture of calcium hypochlorite, 10, and boric acid, 90 parts, was found to be the most efficient; it should be dusted over the surface of the wound, and does not produce any unpleasant sensation. It acts as a preventive against gangrene and also has a haemostatic action, due to the presence of calcium chloride in the mixture. Of other substances examined iodoform, ferrous sulphate, borax, boric acid, potassium permanganate, zinc chloride, and sodium formate were not sufficiently active to destroy the more resistant bacteria; copper sulphate and sodium fluoride were found to be effective, but their use is not recommended on account of their toxic properties.—W. P. S.

Carbonaceous dusts; Inflammability of ——. H. H. Brown. J. Ind. Eng. Chem., 1917, 9, 269—275.

TESTS were made with an apparatus devised by the Bureau of Mines, U.S.A., for testing the inflammability of coal dust, under the following standard conditions. All the dusts, with the exception of malt and two samples of maize dust, were first dried at 105°C . in a current of air. In each case 75 mgrms. was forced into the explosion bulb by air under a pressure of 20 cm. of mercury, through a funnel with a capillary 6 cm. long and 2.0 mm. in diam., a coarse screen being placed over the funnel except when very fibrous dust was tested. The funnel was 4 mm. in internal diam., with a bowl $\frac{3}{8}$ in. deep and $\frac{5}{8}$ in. across at the top, and having a bend at right angles, $\frac{5}{8}$ in. below the bowl, with a small wire screen inside. When used for coal dust 100 mgrms. of the more inflammable and 300 mgrms. of the less inflammable coals was introduced into the explosion bulb by means of oxygen under a pressure of 15 cm. of mercury. The temperature of the igniting coil, measured by means of a thermocouple, was maintained at 1200°C ., and the pressure generated on ignition was expressed

in lb. per sq. in. The following are typical results thus obtained, and indicate the relative order of inflammability under these conditions:—Lycopodium, 17.5; dextrin dust, 13.9; tan bark dust, 13.3; wheat starch, 13.1; maize dust, 12.5; powdered sugar, 12.2; oat dust, 12.0; potato flour, 11.7; rice starch, 11.3; malt dust, 10.6; tapioca flour, 10.4; cocoa dust, 9.9; fine sulphur flour, 8.8; ground cork dust, 7.4; arrowroot powder, 3.9; potato starch, 3.2; and gelatin dust, 1.4.—C. A. M.

PATENT.

Sewage and other liquids; Purification of ——. W. Jones, and Jones and Attwood, Ltd., Stourbridge. Eng. Pat. 104,187, July 11, 1916 (Appl. No. 462 of 1916.)

THE sewage enters at the end of a long tank divided lengthways down the middle and having a bottom of ridge and furrow form with air diffusers in the bottom of the furrows. The flow is directed by baffles and sunk walls to the opposite end, where the sewage turns at right angles into the other division of the tank, along which it flows in the reverse direction. Before being discharged from the tank, the sewage is received in a settling chamber with a bottom sloping towards the division wall of the tank. At this point, part of the wall is cut away to allow a connection to the other division of the tank. At the foot of the wall on the first division side is an air diffuser, and a shallow wall is built round the diffuser and both sides of the opening in the wall so as to form a well. When the air supply is turned on, an upward current of sludge and sewage is formed up that side of the wall, and a current of sludge and sewage is induced to flow through the opening from the other side. In this way sludge can be transferred from the exit to the entry end of the tank. At intervals along the base of the dividing wall are openings formed similarly to the foregoing; in this way sludge can be transferred from one side to the other along the whole length of the tank. In another form of the apparatus, instead of one long tank there are a number of short tanks arranged side by side and connected in series; in this form the tanks have a flat bottom and the air diffusers are placed at each end of the short tanks.—J. H. J.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Alkaloids; Determination of — by physico-chemical volumetric analysis. P. Dutoit and Meyer-Lévy. J. Chim. Phys., 1916, 14, 353—360.

THE method of measuring the end point of a reaction by observing the change in electrical conductivity (this J., 1911, 1411) may be applied to the determination of alkaloids, especially in very dilute solutions. The reactions available are: (1) neutralisation of the alkaloid bases, (2) the displacement of alkaloids from their salts by means of a strong alkali, and (3) precipitation of insoluble alkaloid salts. The neutralisation method is not usually very reliable, nor is the displacement method for soluble alkaloids. When the free alkaloid is insoluble or nearly so, the reaction of its salts with caustic soda gives a curve with a well-defined end point. Amongst the precipitants chlorplatinic acid and picric acid give satisfactory determinations of a number of alkaloids in the presence of sodium acetate; potassium bichromate in neutral solution may be used for brucine and strychnine. Silicotungstic acid in the presence of sodium acetate appears, however, to be the best general reagent. It is used in solution of N. 2 to

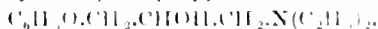
N 20 concentration conveniently standardised against a pure strychnine salt. The concentration of alkaloid should be between N 100 and N 1000. Two or three molecules of sodium acetate should be used for each molecule of alkaloid. The composition of the silicotungstate, which is not the same for all alkaloids, must be determined beforehand. Observing these conditions the authors have been able to use their method for twenty of the best known alkaloids. W. H. P.

Opium: Ammonia in. J. N. Rakshit. Pharm. J., 1917, 98, 255.

In determining morphine in Indian opium by the method of the British Pharmacopœia, an ammoniacal odour was always noticed on mixing the opium with lime in a mortar. Experiments described showed that this was due to the liberation of ammonia, amounting to 0.2–0.3% of the weight of the opium, together with traces of a volatile organic base not identified. J. H. L.

Chemical constitution and physiological action: Relation between in certain substituted amino-alkyl esters. F. L. Pymon. Chem. Soc. Trans., 1917, 111, 167–172.

ETHYL *p*-aminophenylacetate, m. pt. 51° C., prepared by the reduction of ethyl *p*-nitrophenylacetate, differs from ethyl *p*-aminobenzoate (anæsthesine) in containing a phenylacetyl group in place of a benzoyl group, and this substitution causes the loss of all local anæsthetic property. *β*-Diethylaminoethyl *p*-aminophenylacetate, obtained by heating the hydrochloride of *β*-diethylaminoethyl alcohol with *p*-nitrophenylacetyl chloride and then reducing with iron filings and acetic acid, differs similarly from *β*-diethylaminoethyl *p*-aminobenzoate (novecaine) and also possesses no local anæsthetic action. *β*-Diethylamino-*β*'-phenoxy-*iso*-propyl alcohol,



prepared by heating together phenylglycid ether and diethylamine in a sealed tube, gives a hydrochloride, m. pt. 90–92° C., which produces distinct local anæsthesia and on benzoylation yields *β*-diethylamino-*β*'-phenoxy-*iso*-propyl benzoate, which forms salts so strongly acid that they could not be satisfactorily tested for local anæsthetic properties. *β*-Benzoyloxy-1-methyl-1,2,3,4-tetrahydroquinoline, m. pt. 58–59° C., prepared by benzoylating 8-hydroxy-1-methyl-1,2,3,4-tetrahydroquinoline, gives a hydrochloride, m. pt. 188° C., too strongly acid to be tested for local anæsthetic action. The corresponding *p*-aminobenzoylethyl derivative could not be obtained. *p*-Aminobenzoylethyl-*p*-phenetidine, m. pt. 157–158° C., prepared by heating *p*-nitrobenzoylethyl chloride with *p*-phenetidine and subsequently reducing, is almost insoluble in water and produces no local anæsthesia when introduced as powder into the conjunctival sac.

Iodation of hydrocarbons: Direct — by means of iodine and nitric acid. R. L. Datta and N. R. Chatterjee. J. Amer. Chem. Soc., 1917, 39, 135–141.

MOXO-IODO derivatives of benzene, toluene, *o*-, *m*- and *p*-xylenes, mesitylene, and thiophene were prepared, with yields ranging from 30 to 80% of the theoretical, by heating mixtures of hydrocarbon, iodine, and nitric acid, the last being usually added in the concentrated form, a small quantity at a time. The nitric acid was reduced in the course of the reaction. Small yields of iodoheptane and iodonaphthalene were obtained similarly, nitronaphthalene being also formed in the latter case. Anthracene yielded no iodo derivative, but was oxidised to anthraquinone.

J. H. L.

Iodation by means of nitrogen iodide or by means of iodine in the presence of ammonia. R. L. Datta and N. Prosad. J. Amer. Chem. Soc., 1917, 39, 141–156.

IODATION of phenols and *o*-, *m*-, and *p*-nitrophenols can be conveniently effected by dissolving them in concentrated ammonia and adding iodine dissolved in potassium iodide solution. The iodo-compounds are in many cases precipitated quantitatively, and the reaction appears suitable for use on a large scale, since the excess of ammonia and iodine can be recovered from the mother liquors. Phenolphthalein is similarly converted into its tetraiodo-derivative, and *o*-, *m*-, and *p*-hydroxybenzoic acids yield iodo-compounds together with secondary products. A monoiodo-derivative is formed from *p*-hydroxyphenylarsinic acid. Dimethylpyrone yields 2,6-diiodolutidone as main product, together with iodoform due to rupture of the ring. The conversion of pyrrole in ammoniacal solution into tetraiodopyrrole,



can be employed for the volumetric determination of the former, using for example N/5 iodine solution and starch indicator. Nitrogen iodide, washed and suspended in water through which acetylene is bubbled, is completely decomposed with formation of tetraiodo-ethylene, m. pt. 185° C. Nitrogen iodide is a stronger oxidising agent than iodine; it oxidises quinol rapidly and completely to quinoxaline and benzaldehyde, with evolution of much heat to benzoic acid. Iodoform is produced by the action of nitrogen iodide on ketones in general, but if the reaction is carried out in concentrated solutions and at lower temperatures iodo-ketones are formed, some of which have an intensely irritating action on the eyes. Iodoform can be obtained by the action of iodine and ammonia on malonic and acetoacetic esters, and on di- and triethylamines.—J. H. L.

Ethylsulphuric acid reaction: The —. P. N. Evans and J. M. Albertson. J. Amer. Chem. Soc., 1917, 39, 456–462.

THE formation of ethylsulphuric acid in equimolecular mixtures of 99.9% alcohol and 95% sulphuric acid at constant temperatures between 20° and 140° C., was studied by withdrawing portions at intervals, diluting them with water, and titrating with alkali in presence of methyl orange. It is concluded that the maximum proportion of sulphuric acid converted into ethylsulphuric acid is about 58% at all temperatures between 20° and 100° C., and that this condition is reached in 150 mins. at 20° and in less than 2 mins. at 70° C. and higher temperatures. On addition of water the reaction undergoes reversal very slowly. Above 70° C. the esterification reaction is accompanied by formation of ether, which proceeds more and more rapidly at higher temperatures. At the ordinary temperatures there is a slow formation of diethyl sulphate (or isethionic or ethionic acid), as indicated by a loss of 4% of the acidity in three weeks.—J. H. L.

Fixation of nitrogen. Bucher. See VII.

PATENTS.

Glycols: Manufacture of —. B. T. Brooks and L. Humphrey, Assignors to Gulf Refining Co., Pittsburgh, Pa. U.S. Pat. 1,215,903, Feb. 13, 1917. Date of appl., Mar. 23, 1916.

GLYCOLS are obtained by heating dichloro-olefines under pressure with an alkali formate and an alcohol, e.g., methyl alcohol. The temperature may vary between 140° and 200° C. and the pressure from 100 to 260 lb.—B. V. S.

Lymph-gland extract and method of making same. R. A. Archibald, Oakland, Cal. U.S. Pat. 1,216,046, Feb. 13, 1917. Date of appl., Apr. 6, 1916.

THE aqueous extract of normal lymph glands of healthy animals is freed from antiferments by heating to 58° C. and from proteins and insoluble matter by treatment with weak acid and filtering. It is then carefully neutralised with caustic soda and sterilised; tricresol is used as a preservative. The extract is used by injection and stimulates the production and activity of leucocytes and blood-platelets.—B. V. S.

Hydrogenisation and dehydrogenisation of carbon compounds. C. Bosch, A. Mittasch, and C. Schneider, Assignors to Badische Anilin und Soda Fabr., Ludwigshafen, Germany. U.S. Pats. (A) 1,215,334 and (B) 1,215,335, Feb. 13, 1917. Date of appl., June 4, 1914.

SEE Fr. Pat. 473,697 of 1914; this J., 1915, 731. Specific claim is made for the use, as catalysts, of mixtures of (A) nickel and boron oxide, and (B) nickel and calcium phosphate.

Barbituric acids; Substituted —. W. Hiemenz and L. Taub, Elberfeld, Germany, Assignors to Synthetic Patents Co., New York. U.S. Pats. 1,217,446 and 1,217,447, Feb. 27, 1917. Date of appl., Mar. 23, 1915.

SEE Ger. Pat. 295,492 of 1915; this J., 1917, 306.

Acetylsalicylic acid; Salts of — and process of manufacture of same. O. Gerngross, Grunewald, and H. Kast, Charlottenburg, Germany. U.S. Pat. 1,217,862, Feb. 27, 1917. Date of appl., Dec. 4, 1912.

SEE Fr. Pat. 461,081 of 1913; this J., 1914, 439.

Pharmaceutical product. [Compound of cholic acid and formic acid.] E. Rietz, Elberfeld, Germany, Assignor to Synthetic Patents Co., New York. U.S. Pat. 1,218,209, Mar. 6, 1917. Date of appl., Oct. 6, 1914.

SEE Ger. Pat. 288,087 of 1914; this J., 1916, 381.

Growth-controlling substance derived from the anterior lobe of the pituitary gland, and process for producing the same. T. B. Robertson, Berkeley, Cal. U.S. Pat. 1,218,472, Mar. 6, 1917. Date of appl., Oct. 8, 1915.

SEE Eng. Pat. 15,683 of 1915; this J., 1916, 557.

Belaine; Process for the manufacture of — from vinases. O. Bergami and C. Saemann, Assignors to Act.-Ges. f. Anilinfabr., Berlin. U.S. Pat. 1,219,226, Mar. 13, 1917. Date of appl., Mar. 4, 1914.

SEE Eng. Pats. 2813 and 2923 of 1914; this J., 1914, 658, 767.

(A) *Cephaeline [iso] butyl ether and process of producing the same.* (B) *Cephaeline ethyl ether.* (C) *Cephaeline propyl ether.* (D) *Cephaeline [iso] amyl ethers and process of producing same.* J. W. Meader, Assignor to The Eli Lilly and Co., Indianapolis, Ind. U.S. Pats. 1,219,571—1,219,574, Mar. 20, 1917. Dates of appl. (A), (B), (C), July 17, 1915. (D), Jan. 25, 1916.

SEE Eng. Pats. 11,717, 11,718, 11,719 of 1915, and 103,881 of 1916; this J., 1916, 978, 1271; 1917, 402.

XXII.—EXPLOSIVES; MATCHES.

"Nitron" as a gravimetric reagent for the analysis of substances used in explosives. W. C. Cope and J. Barab, J. Amer. Chem. Soc., 1917, 39, 504—514.

THE authors describe the various applications of

"nitron" (see Busch, this J., 1905, 289) in analysis, and add some new matter. For the determination of nitrates (see this J., Busch, 1905, 291, 638; 1906, 499; Gutbier, 1905, 158; Lange and Berl, 1905, 1190; Litzendorf, 1908, 83; Hes, 1909, 162; Franzen and Löhman, 1909, 546; Paal and Ganghöfer, 1909, 918), they found Gutbier's procedure most satisfactory. Busch's method for nitrocellulose (this J., 1908, 745) gave accurate results with this substance and with nitromannitol and nitrostarch, but with nitroglycerin it gave percentages of nitrogen about 0.4 too low; better results were obtained by a modified saponification process in which hydrogen peroxide of 30% instead of 3% concentration was used. True nitro-compounds cannot be determined in this way, but some of them form insoluble addition compounds with "nitron," and the authors determined picric acid (see Busch and Blume, this J., 1908, 83) and trinitrocresol accurately by precipitation with "nitron" in presence of sulphuric acid. Phenol and the mono- and dinitrophenols under the same conditions gave no precipitate, but in absence of sulphuric acid 1,2,4-dinitrophenol was quantitatively precipitated as a double compound, so that this substance could be determined in mixtures with picric acid. The authors determined perchloric acid in the same way as nitric acid (cp. Busch, this J., 1905, 291). Storm, and Burrell and Seibert (U.S. Bureau of Mines, Bull. 42) found that minute quantities of oxides of nitrogen in air could be determined, e.g., by shaking several litres of the air with 10 c.c. each of 5% potassium hydroxide and 3% hydrogen peroxide solutions, and precipitating the nitric acid in the usual way, avoiding unnecessary dilution. For microchemical tests with "nitron" see Visser, this J., 1907, 167. Solutions of "nitron" are not very stable and are best prepared in small quantities as required, by dissolving 1 gm. of the reagent in 10 c.c. of 5% acetic acid and filtering through an alundum crucible into a dark bottle. The reagent can be recovered from filtrates by precipitating with a slight excess of ammonia, and from precipitates by warming with dilute ammonia to 60° C., filtering quickly, and washing the "nitron" with cold water, then digesting with 5% acetic acid to dissolve it and finally re-precipitating with ammonia and washing. Decomposition may be avoided by conducting the filtering and washing in an inert atmosphere and as much as possible away from light.—J. H. L.

PATENTS.

Chlorate explosive. J. M. Brown, Johnson City, Tenn. U.S. Pat. 1,218,976, Mar. 13, 1917. Date of appl., Mar. 3, 1915.

SEE Fr. Pat. 478,383 of 1915; this J., 1916, 1181.

Blasting cartridges in which liquid air is used; Method of producing —. A. Kowatsch, New York. U.S. Pat. 1,219,615, Mar. 20, 1917. Date of appl., Nov. 29, 1913.

SEE Fr. Pat. 474,508 of 1913; this J., 1915, 1118.

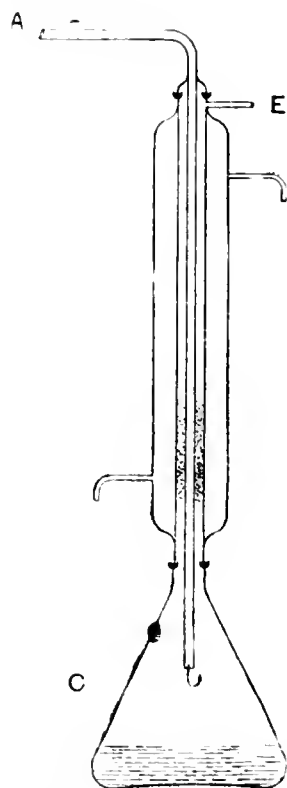
XXIII.—ANALYSIS.

Refractometer; Direct reading — with uniformly divided scale. G. W. Moffitt, J. Ind. Eng. Chem., 1917, 9, 305—309.

AN instrument is described by means of which the refractive index of a liquid is determined by placing a drop thereof on a convex surface, lowering the nose-piece of a microscope tube upon it, and focussing the eyepiece. The reading may then be made directly upon a uniformly divided scale on the focussing tube. Instead of the usual heating tank a circular trough may be provided, through

the centre of which passes a tube mounted on a spring, carrying the object scale at the lower end, and the lens on which the liquid is to be placed at the upper end, the lens being thus raised above the top of the heating jacket when the microscope is raised. At the lower end of the microscope tube is fixed a plane parallel plate, and within the tube at the right distance is a converging lens. With an eyepiece of fairly high power the degree of uncertainty in changing the setting for an alteration of refractive index from 1.000 to 1.500 need not exceed 0.02 cm. The theory upon which the construction of this instrument is based is discussed at length.—C. A. M.

Washing of gases: A simple apparatus for the —
H. H. Gray. Chem. Soc. Trans., 1917, 111, 179—183.



THE apparatus, designed to extract toluene from coal gas, is constructed so that a condensing mist of benzene vapour acts as absorbent. The gas is led in through the tube, A, and emerges laden with vapour of the solvent at E. The solvent (e.g., benzene) is heated to a suitable temperature in the flask, C, and at the conclusion of the extraction the mixture in C may be fractionated. The principal advantages over a train of washing bottles are: (1) greatly increased rapidity of washing; (2) absence of complications due to "back-pressure," and (3) limitation of the quantity of solvent required. The joints shown in the figure are mercury cup joints, but good

corks are quite satisfactory. —W. H. P.

Calorimetric combustion: Improvements in — and the heat of combustion of toluene. T. W. Richards and H. S. Davies. J. Amer. Chem. Soc., 1917, 39, 341—354.

SUCCESSIVE combustions of the substance under examination and of a standard substance are made in oxygen under about 22 atmospheres pressure, in a Berthelot bomb as modified by Atwater and Benedict (see Richards and Barry, J. Amer. Chem. Soc., 1915, 37, 993). The main improvements enumerated are grouped under the following headings. *Closing of the bomb.* A lead washer sunk into a suitable circular slot is used between the steel cover and the lower part of the bomb; the washer is covered by a continuous round plate of thin gold foil. Between the cover and the screw cap is a thin, smooth, flat ring of phosphor-bronze which avoids rupture of the platinum lining when closing the bomb. An improved method of insulating the current wire is also described.

Ignition of volatile liquids. These are weighed into very thin flat bulbs, and ignited by a ring of paraffin round the mouth of the crucible. This in turn is ignited by a tiny wisp of cotton wool which is heated in a platinum spiral. Iron wire is not used at all. *Control of temperature of environment.* The temperature rise of the calorimetric liquid is matched (after trial) in the surrounding bath (which is alkaline) by the automatically regulated admission of sulphuric acid. *Incomplete combustion.* This is greatly reduced by the method of ignition used, but in the case of volatile liquids it is controlled by determination of carbon monoxide in the products of combustion. Correction may also be necessary for the formation of nitric acid, though the bomb is always evacuated before the admission of oxygen. *Heat exchange between bomb and calorimeter.* If combustion is very rapid, the top of the bomb may become hot and heat be lost through radiation from the upper surface of the liquid. This is avoided by adequate stirring and by a rate of combustion similar to that adopted with the standard substance. With the above precautions and with naphthalene as standard, the heat of combustion of toluene is recorded as 19,158.18 calories or 42.47 kilojoules per gram (weighed *in vacuo*).—W. H. P.

Zinc: Electrometric titration of — with ferrocyanide. F. Russell v. Bichowsky. J. Wash. Acad. Sci., 1917, 7, 111—113.

THE single potential difference set up by a platinum electrode in a solution of potassium ferrocyanide, which can be measured in conjunction with a standard electrode, such as the normal calomel electrode, is about -0.08 volt. On titrating with a solution of a zinc salt, the potential increases slowly until near the end point, when the smallest excess of the zinc solution causes the E.M.F. to increase very sharply to -0.40 volt. With further excess the E.M.F. rises only slightly to a maximum of about -0.35 volt. If the process is reversed, and ferrocyanide admitted to the zinc solution, the platinum electrode, instead of having initially an E.M.F. of -0.15, can be made to assume almost any value between 0 and -0.5, depending on the previous treatment of the electrode. The abnormal values arising from polarization effects are dispelled by the presence of ferrocyanide, which gives rapid reversible reactions at the electrodes. If the electrode is charged to say -2.0 volts, while in contact with a zinc solution, the initial E.M.F. may reach the reversible value of -0.45 or even higher. After adjusting to this value, then titrating with ferrocyanide, the exact reverse of the previous curve is obtained, a sharp drop to -0.10 occurring at the end point, and continuing at nearly that value on further addition of ferrocyanide. If the platinum electrode has been treated to show an initial voltage of say 0.20 volt, on adding ferrocyanide, the E.M.F. increases instead of decreasing until the normal value is reached when, on continuing the titration, the reversible values are obtained as in the previous case. In all cases, if the solutions are stirred during the titration, the electrometric end point is perfectly sharp and reproducible and the device affords a convenient and accurate method for the estimation of zinc. —J. N. P.

Arsenic: Determination of small quantities of —. P. Klason. Arkiv Kem. Min. Geol., 1916, 6, No. 5, 1—16. J. Chem. Soc., 1917, 112, ii, 151—152.

THE author has investigated fully the Fresenius-von Babo method for the estimation of small quantities of arsenic. For the estimation, the substance was mixed with a mixture of 3 parts

of sodium carbonate to 1 part of potassium cyanide, and the mixture transferred to a bulb tube, the bulb having a volume of about 3.5 c.c. The bulb was heated by a ring burner, provided with a draught-chimney 20 cm. high, whilst a stream of carbon dioxide was passed through it. In order to prevent the arsenic subliming back, a piece of thick glass rod was put in the tube behind the bulb; the tube where the arsenic condensed was a capillary. In the first experiments, in accordance with the instructions usually given, the carbon dioxide was dried before passing through the tube, but it was found that this was not necessary. In later experiments the gas was simply washed and then passed through a tube containing cotton-wool, before coming to the bulb tube. The capillary tube must be quite clean and free from all traces of grease. When the deposition of arsenic was complete, the capillary tube was cut off and weighed on a micro-balance; it was then heated in an argand flame to expel the arsenic, and again weighed when cool, in order to determine the weight of arsenic. The results obtained, taking weights of arsenic oxide or sulphide varying between 0.0375 and 1.125 mgrm., were very variable and far from quantitative, the estimated quantities varying from 42% to 95% of the quantities actually taken. The loss was shown to be caused by some of the arsenic vapour being carried away in the stream of carbon dioxide. This was proved by attaching to the capillary of the bulb tube another (straight) tube packed with small bits of porcelain followed by a layer (3 mm.) of asbestos, this tube also ending in a capillary. During the estimation the asbestos layer became more or less dark, owing to the deposition of arsenic. When this arsenic was driven over into the capillary tube (in a stream of pure hydrogen) and its quantity estimated on the micro-balance, the amount found accounted for the low percentages mentioned above. By this means quantitative results could be obtained. A number of estimations of arsenic by the sodium carbonate-potassium cyanide method, as usually carried out (in Sweden) showed the accuracy to be about 90%. The reaction which takes place when the above reaction mixture is used cannot be simply the formation of potassium cyanate with the liberation of arsenic, since sodium carbonate is present. Reasons are given in support of the scheme: $5\text{NaAsO}_2 = 3\text{NaAsO}_3 + \text{As}_2 + \text{Na}_2\text{O}$. The sodium arsenate is then reduced by the potassium cyanide to arsenite, which again gives arsenate and arsenic, and so on to completion. It is further shown that if arsenic is present as a salt of ortho-arsenous or -arsenic acid, as is the case when magnesia is added to the reaction mixture, no reduction takes place. When the arsenic is present as sulphide, reaction takes place according to the equation: $\text{As}_2\text{S}_3 + 3\text{Na}_2\text{CO}_3 = \text{As}_2\text{O}_3 + 3\text{Na}_2\text{S} + 3\text{CO}_2$; reduction then takes place as above, no thiocyanate being formed.

The above method cannot be used when organic matter is present, but can be replaced by the following modification of Berzelius's method. The residues containing arsenic, if the latter is present as sulphide, are evaporated to dryness with concentrated nitric acid. The residue is then mixed with a mixture of equal parts of sodium carbonate and potassium carbonate and a little mercuric oxide, and the resulting mass put into the bulb tube and heated in a stream of oxygen until it is quite white and mercury is no longer deposited in the capillary. It is then reduced in a stream of hydrogen which has been purified by passing through dilute solutions of silver nitrate and mercury chloride. The arsenic deposited in the capillary is then weighed as given above. The temperature to which the bulb is heated should be such that the reaction mixture does not fuse. If fusion takes place and magnesia

is present, ortho-salts are formed, and these are no longer reduced by hydrogen, as mentioned above. Using quantities of arsenious oxide containing from 0.19 to 0.38 mgrm. of arsenic, good quantitative results were obtained.

Phosphorus: Dusart and Blondlot's method for the detection of — and its application in toxicology. Preparation of pure zinc for the detection of phosphorus or arsenic. H. J. Lemkes. *J. Pharm. Chim.*, 1917, 15 177–188.

CRITICAL examination of this method (formation of hydrogen phosphide by treatment with zinc and hydrochloric acid) showed that it could be employed for the detection of very small quantities (0.0025 mgrm.) of phosphorus in the form of phosphites or hypophosphites, provided that the gas first evolved was passed into silver nitrate solution, the precipitate of silver phosphide collected, again treated with zinc and hydrochloric acid, and the coloration of the hydrogen flame then observed. In dealing with phosphites, etc., the reduction proceeded most satisfactorily at about 55° C. The silver phosphide was not appreciably oxidised by contact with the excess of silver nitrate. There appeared to be no advantage in the spectroscopic examination of the hydrogen flame. In cases of poisoning by phosphorus, the method appears to be of use; the phosphorus is found chiefly in the stomach, remaining unoxidised for some few months, and phosphorus compounds do not appear to be formed during decomposition of the body. Pure zinc for use in the method may be obtained by fusing the metal with a small quantity of metallic sodium, followed by granulation (see Hehner, this J., 1902, 675).—W. P. S.

[Paper testing.] *Numerical expression for colour as given by the Ives tint photometer.* Kress and McNaughton. *See V.*

Iodometric determination of sulphur dioxide and sulphites. Ferguson. *See VII.*

The Penfield test for carbon. Minter and Haigh. *See VII.*

Determination of carbon in steel by micrographical examination. Portevin. *See X.*

Report of Joint Rubber Insulation Committee. *See XIV.*

Cholesterols and phytosterols from the scientific and industrial point of view. Dubosc. *See XIV.*

Phenoldisulphonic acid method of determining nitrates in soils. Davis. *See XVI.*

Determination of glucose in cane molasses. Pellet. *See XVII.*

Influence of pentoses in the determination of reducing sugars at 63°–65° C. Pellet. *See XVII.*

Determination of reducing sugars in cane molasses and vinasses for the calculation of the amount of sugar fermented. Pellet. *See XVII.*

Detection and determination of small amounts of methyl alcohol [in ethyl alcohol]. Elvove. *See XVIII.*

Nitrogen in amino-form as determined by formol titration, in relation to some other factors measuring quality in wheat flour. Swanson and Tague. *See XIXA.*

Direct microscopical counting of bacteria in water. Nelson. See XIXB.

Volumetric method for determining the strength of hypochlorite solutions. Analysis of hydrogen peroxide. Bury. See XIXB.

Determination of alkaloids by physico-chemical volumetric analysis. Dutoit and Meyer-Lévy. See XX.

Iodation by means of nitrogen iodide or by means of iodine in presence of ammonia. [Determination of pyrorole.] Datta and Prosad. See XX.

"Nitron" as gravimetric reagent for the analysis of substances used in explosives. Cope and Barab. See XXII.

PATENT.

Gas analysing plant. Aktiebolaget Ingeniörsfirma F. Egnell, Stockholm. Eng. Pat. 103,107, Sep. 26, 1916. (Appl. No. 13,635 of 1916.) Under Int. Conv., Dec. 31, 1915.

Is a plant for simultaneously and automatically determining several gases in a number of gas currents, apparatus is provided for the determination of one gas in each current, and by means of multiple-way cocks, gas from any of these currents may be conducted to a separate apparatus, common to all or several of the currents, for determination of a second constituent.—J. E. C.

Trade Report.

Chemical and allied industries in France during the war; Survey of— F. J. Le Maistre. J. Ind. Eng. Chem., 1917. 9. 229—232.

THE author of this survey was a member of an American Commission which inspected the chief industrial centres of France in the autumn of 1916. As regards general plant it is pointed out that in many cases allowance has not been made for the expansion of the industries. The present inferiority of French chemical industry is to be attributed to: (1) lack of standard factory methods; (2) insufficient general knowledge; (3) lack of technical education; and (4) banking conditions. In the past the chemist has been confined to analytical work, and it is only since the war that the importance of industrial research laboratories has begun to be recognised. *Dyes.* In 1912 the quantity of coke produced in France was equivalent to 3,925,000 tons of coal, and that purchased to 2,817,000 tons of coal, corresponding to a total tar production of 505,250 tons. It is estimated that by the adoption of the standard German method France should have produced 53,177 tons of benzol or four to five times the quantity obtained in 1915. Pending the erection of more coke-ovens it is probable that there will be an opportunity for the sale of considerable quantities of American dyes in France. *Electrochemical industries.* Many new plants have been erected since the war started, but in the case of many of these cost has been sacrificed in the interests of larger production.

In the French Alps alone the horsepower development has increased from 500,000 to 1,500,000, and plans are being made for further extensions. *Atmospheric nitric acid.* Although the manufacture has been greatly developed during the last two years, the production is small as compared with other countries. Special attention is being given to the Serpek method of producing nitric acid from the air, in which bauxite is used as the raw material. The following figures show the amounts of calcium cyanamide in metric tons produced prior to the war:—

	France.	Germany.	Canada	World.
1912 ..	5000	22,000	32,000	105,000
1913 ..	7500	24,000	48,000	155,000

In 1916 the world's production was approximately 210,000 metric tons, the bulk of the increase being due to the fact that Germany, unlike France, has had to depend upon artificial nitrates. *Pharmaceutical chemicals.* The French law does not allow particular pharmaceutical compositions to be patented, and it is claimed that the French tariff has helped to develop the German manufacture of these products. A plan has now been worked out for developing the manufacture of these preparations and of synthetic perfumes, in which, owing to climatic conditions, French manufacturers should be able to maintain the lead. *Sulphuric acid.* France is now independent of any outside source of supply. The largest plants are in the South of France. *Paper industry.* France now produces the whole of the paper required by the country. The principal woods used in the mills are spruce, birch, and poplar. *Cement manufacture.* France has manufacturing capacity to supply her own requirements and those of her colonies. *Refining of sugar.* All refineries have to sell sugar at a fixed price. The by-product, molasses, is used for the production of alcohol, and the residues as a binding agent for road material. During the period 1903 to 1914 the manufacturing tax on beet sugar was reduced by 40% and the consumption increased by 61%. *Butter substitutes and table oils.* Copra, palm kernels, and arachis nuts are the raw materials used in the factories in the Marseilles district. *Soda industry.* In 1912 France imported 314,348 tons of soda, of which about 40,000 tons was used in chemical industries. During the past two years the output from both the soda and chlorine plants has been much greater than ever before.

—C. A. M.

Sweden: Prohibited exports.

THE exportation of the following articles from Sweden has been prohibited:—Accumulator plates; chrome alum; gold and silver, unmanufactured (and scrap) or manufactured, including gold and silver coin; nitric acid; paper coated with glue or other adhesive substances; and fly-papers consisting of such papers; Roentgen apparatus; rosia pitch, and wool fat pitch; copper and alloys thereof with zinc, tin, or other non-precious metal (such as brass, bronze, German silver, Britannia metal, etc.); also aluminium, nickel, and metals not specially mentioned in the Swedish Tariff (whether alone or in the form of alloys)—all these metals, unmanufactured or manufactured; lead, manufactures of, not previously prohibited; tin, manufactures of, not previously prohibited; zinc, unmanufactured, and manufactures of zinc.

Journal of the Society of Chemical Industry.

No. 9. Vol. XXXVI.

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Official Notices.

ANNUAL GENERAL MEETING, 1917.

In accordance with the provisions of By-law 64, notice is hereby given that the Annual General Meeting will be held in The University Buildings, Edmund Street, Birmingham, at 10.30 a.m. on Wednesday, July 18th, 1917. A programme of the proceedings will be issued later.

In accordance with the provisions of By-law 24, those members whose names are printed in *italics* in the List of Council will retire from their respective offices at the forthcoming Annual Meeting.

Prof. Henry Louis has been nominated to the office of President under By-law 20; Dr. Charles Carpenter has been nominated Vice-President under By-law 20; Mr. John Gray, Mr. A. R. Ling, Prof. R. F. Ruttan, and Mr. J. T. Wood have been nominated Vice-Presidents under By-law 21.

Members are requested to nominate on or before May 23rd next, fit and proper persons to fill four vacancies among the ordinary Members of Council. Forms for this purpose can be obtained from the Secretary of the Society.

By-law 23:—An Ordinary Member of Council shall be nominated by ten or more members upon Form B in the Schedule, a copy of which form shall be furnished by the Secretary upon the written or verbal request of any member, but a member shall not be eligible to sign more than one such nomination form, and the member nominated shall sign the declaration set forth on the form. A nomination shall be declared invalid by the Council if:

a. The member thereon nominated is disqualified or election, or ineligible to be elected, as provided by the By-laws.

b. The nomination is not made on the authorised printed form or substantially not in the manner directed thereon.

c. The nomination form is signed by less than ten members not disqualified or not ineligible to nominate as provided by the By-laws.

d. The nomination form is not received before the day appointed therefor.

e. The member nominated has not signed the declaration printed upon the form.

A member whose nomination aforesaid is declared to be invalid, shall receive notice thereof from the Secretary, and shall not be submitted for election.

J. P. LONGSTAFF,
Secretary.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY.

The first volume of these reports is now ready. As the issue is strictly limited, those who desire to obtain copies are advised to apply for them without delay. The price is 3s. to members and 6 to non-members, including postage.

PROHIBITED EXPORTS.

An Order-of-Council, dated 1st May, 1917, declares that the Schedule to the Proclamation, dated 10th May, 1916 (see this J., 1916, 620), amended and added to by subsequent Orders-

of-Council, prohibiting the exportation from the United Kingdom of certain articles to certain or all destinations,* should be further amended, as follows:—

* The prohibition of exports is as follows:—

Goods marked (A), to all destinations;

Goods marked (B), to all ports and destinations abroad other than ports and destinations in British Possessions and Protectorates.

Goods marked (C), to all destinations in foreign countries in Europe and on the Mediterranean and Black Seas, other than France and French Possessions, Russia, Italy and Italian Possessions, Spain and Portugal, and to all ports in any such foreign countries, and to all Russian Baltic ports.

(1) The following headings are deleted:—

(C) Animal hoofs and other glue stock (including untanned pelts and hides not otherwise specifically prohibited), fish bladders and fish skins; (C) Camphor; (B) Candles manufactured wholly or partly of paraffin wax or tallow; (C) Gums (except such as contain caoutchouc and except gum tragacanth); (C) Iceland, Irish and Sphagnum moss, algin and its compounds; Metals and ores, the following:—(A) Iron and steel plates and sheets except when made from crucible cast steel or from carbon steel not manufactured in the United Kingdom by the Siemens or Bessemer processes, provided such crucible or carbon steel does not contain more than 5 per cent. of chrome, cobalt, nickel, or vanadium; (B) Steel articles containing chrome, cobalt, nickel, or vanadium; (A) Steel flats, rounds and other sections, with the following exceptions:—(i.) When made from crucible cast steel; (ii.) Carbon steel for tools not manufactured in the United Kingdom by the Siemens or Bessemer processes; provided such crucible or carbon steel does not contain more than 5 per cent. of chrome, cobalt, nickel, or vanadium. (B) Oil, whale (train, blubber, sperm), seal oil, shark oil, fish oil generally, and mixtures of the foregoing; (B) Paraffin wax; (C) Resins, resinous substances (except such as contain caoutchouc) and articles containing resins and resinous substances; (C) Talc; (A) Tallow, refined; (B) Waxes, animal, mineral, and vegetable (except carnauba), and composite waxes.

The following headings are added:—(A) Aerated and mineral waters; (C) Algæ; (C) Algin and its compounds; (A) Beer and ale; (B) Camphor; (C) Celluloid, articles partly manufactured of; Chemicals, etc., the following:—(C) Calcium silicide. (B) Cinchona bark; (C) Fluorine compounds, not otherwise prohibited; (C) Iron, oxides of; (C) Manganese compounds, not otherwise prohibited; (C) Sodium silicate, and mixtures containing sodium silicate; (C) Vanadium compounds. (B) Glue stock of all kinds (including animal hoofs, untanned hides and pelts, not otherwise specifically prohibited, fish bladders and fish skins; (C) Gold paint containing sulphide of tin; (B) Gum arabic; (A) Gum, dammar; (C) Gums not otherwise prohibited; (C) Lichens; Metals and ores, the following:—(A) Iron and iron articles containing chrome, cobalt, molybdenum, nickel, tungsten or vanadium; (A) Iron, angle, channels, joists, tees and other sectional material; (A) Iron bars, including flats, rounds and other sections and shapes; (A) Iron billets, blooms and slabs; (A) Iron bridge work, pier work and constructional material; (A) Iron hoops and strips; (A) Iron ingots; (A) Iron pipes (wrought); (A) Iron plates and sheets; (A) Iron sheet bars; (A) Iron tubes; (A) Steel and steel articles containing chrome, cobalt, nickel, or vanadium; (A) Steel bars, including flats, rounds and other sections and shapes; (A) Steel plates and sheets; (A) Moss, Carrageen; (C) Mosses, other than

Carrageen moss; (A) Oil, sea-elephant, and mixtures containing such oil; (B) Oil, fish and seal, not otherwise prohibited, and mixtures containing such oil; (A) Oil, whale, and mixtures containing such oil; (A) Paraffin wax; (A) Caramel, liquid or solid; (A) Egg powder; (A) Resins, resinous substances (except such as contain caoutchouc) and articles containing resins and resinous substances; (A) Spermaceti; (C) Talc, all forms, including French chalk; (A) Tallow; (B) Waxes, animal, mineral, vegetable, and composite waxes, not otherwise prohibited; (A) Whalebone; (A) Whale fins; (A) Whalebone meal.

IMPORTATION AND DISTRIBUTION OF PETROLEUM.

By the requirement of the Government, the principal petroleum companies have arranged to poll their distributing facilities in this country and also the tonnage employed in bringing supplies to the United Kingdom, with the object of releasing men for the Army and effecting economy in various directions.

A Controlling Board, with Mr. E. Houghton Fry (Director of Munitions Petroleum Supplies) as Chairman, has been appointed by the Government, the Offices of the Board being at the Ministry of Munitions, 8, Northumberland Avenue, London, S.W.1. The Board will have the title "Pool Board, Petroleum Supplies," and will consist of representatives of the following companies:—The Anglo-American Oil Company, Ltd.; the Anglo-Mexican Petroleum Company, Ltd.; the Bowring Petroleum Company, Ltd.; the "Shell" Marketing Company, Ltd.; the British Petroleum Company, Ltd.; the Homelight Oil Company, Ltd.; the Union Petroleum Products Company, Ltd.; and Messrs. H. P. Wheatley & Company, Ltd. Mr. Alfred C. Adams will also be a member of the Board and will act as Chairman of the Distribution Committee.

All products, except lubricating oils, hitherto delivered under proprietary brands, will in future be delivered under war brands, and distributed under the authority of the Pool Board.

SEEDS, OILS, AND FATS. MINISTRY OF MUNITIONS ORDER.

The Minister of Munitions, in exercise of the powers conferred upon him by the Defence of the Realm Regulations, and of all other powers enabling him, hereby orders as follows:—

1. As from May 1st until further notice no person shall purchase, sell or, except for the purpose of carrying out a contract in writing existing prior to such date for the sale or purchase of any of the articles specified in the first schedule hereto, deal in any of the said articles whether situated within or without the United Kingdom except under and in accordance with the terms of a licence issued by or under the authority of the Minister of Munitions provided that—

(a) No licence shall be required

(i) By a seller for the sale of any of the said articles situated within the United Kingdom in quantities not exceeding one ton provided that the total quantity of all the said articles sold by him or on his behalf to or on behalf of any one purchaser during any one calendar month does not exceed five tons.

(ii) By a purchaser for the purchase of any of the said articles situated within the United Kingdom in quantities not exceeding one ton provided that the total quantity of all the said articles purchased by him or on his behalf

in any one calendar month does not exceed five tons.

2. As from May 1st until further notice no person shall purchase, sell or deal in or offer to purchase, sell or deal in any of the articles specified in the second schedule hereto at a price exceeding the price set opposite to the same in the second schedule. Provided that this restriction on price shall not apply to any sale or purchase of any of the said articles under which clause 1 of this Order is authorised to be effected without any licence issued by or under the authority of the Minister of Munitions.

3. All parties to any of the transactions herein specified shall require or disclose (as the case may be) all such information as may be necessary for or required by such parties as aforesaid or by or under the authority of the Minister for the purpose of satisfying them or him that the provisions of this Order have not been contravened.

3. All persons affected by this Order shall make all such returns as to stocks, purchases, sales, payments, prices and dealings in any of the articles specified in the first schedule hereto as shall from time to time be required by or under the authority of the Minister of Munitions.

NOTE.—All applications for licences under or otherwise with reference to this Order should be addressed to—The Controller of Oils and Fats, Great George Street, Westminster, S.W. 1.

First Schedule.

Seeds, nuts, and kernels. Castorseed. Copra. Cottonseed. Gingelly (sesame seed). Ground nuts. Hempseed. Kapokseed. Linseed. Mowrahseed. Nigerseed. Palm kernels. Poppyseed. Rapeseed. Shea nuts. Sunflowerseed.

Oils and fats. Acid oils (from refineries). Castor oil. Coconut oil. Cotton oil. Deal oil. Gingelly (sesame). Ground nut oil. Hempseed oil. Kapokseed oil. Linseed oil. Maize oil. Mowrahseed oil. Neutral lard. Nigerseed oil. Oleo oil. Palm kernel oil. Palm oil. Poppyseed oil. Premier jus. Rapeseed oil. Shea butter. Soya oil. Sunflowerseed oil. Tallow.

Second Schedule.

Palm kernels, £26 10s. per ton East Coast Ports, £26 per ton West Coast Ports, usual quay or ex ship terms. Palm oil, £44 per ton, usual Liverpool quay terms. Palm kernel oil, £52 per ton (crushed) net naked ex mill, £51 per ton extracted. Linseed, £30 per ton (Incorporated Oilseed Association Contract delivered terms). Cottonseed, £19 per ton (Incorporated Oilseed Association Contract delivered terms).

SALE AND PURCHASE OF WHALE OIL. MINISTRY OF MUNITIONS NOTICE.

By an Order made on the 24th June, 1916, the Minister of Munitions, in pursuance of the powers conferred upon him by Regulation 30A of the Defence of the Realm Regulations, ordered that the war material to which the Regulation applies should include whale oil other than sperm oil. The Minister of Munitions now gives notice that he hereby until further notice authorises and permits the sale and purchase and negotiation for the sale and purchase of whale oil (other than sperm oil) situate in the United Kingdom subject to the following conditions:—

1. No person shall either by himself or his agent in any consecutive period of three calendar months sell or purchase or negotiate for the sale or purchase of more than a total quantity of 25 tons.

2. No sale, purchase or negotiation shall be otherwise than for delivery within the United Kingdom.

NOTE.—All applications for permits under the above-mentioned Order of the 24th June, 1916, otherwise in connection with the said Order or this Order should be addressed to The Controller of Oils and Fats, Ministry of Munitions, Great George Street, Westminster, S.W. 1.

REQUISITION OF STOCKS OF QUININE, PHENACETIN, AND FORMALDEHYDE.

The Army Council has issued an Order dated April 28th, as follows:—

In pursuance of the powers conferred upon them by the Detence of the Realm Regulations, notice is hereby given that it is the intention of the Army Council to take possession of stores of the following classes and descriptions, that is to say:—

All stocks of quinine sulphate excepting stocks of less than 100 ounces.

All stocks of quinine bisulphate excepting stocks of less than 25 ounces.

All stocks of quinine hydrochloride excepting stocks of less than 25 ounces.

All stocks of quinine bi hydrochloride excepting stocks of less than 25 ounces.

All stocks of phenacetin excepting stocks of less than 7 lb.

All stocks of formaldehyde solution 40% excepting stocks of less than 10 gallons.

If after this notice any person without the consent of the Army Council sells, removes or secretes any of the said stores, or deals with it in any way contrary to any conditions imposed in any licence, permit, or order which may have been granted in respect thereof, he shall be guilty of an offence against the said Regulations.

All persons having in their custody or control any stocks of the said articles in excess of the said quantities hereinbefore set out, in the case of each article respectively are required to make a return of such stocks in the form indicated in Schedule A hereto annexed, to the Director of Army Contracts, Imperial House, Tothill Street, Westminster, S.W. 1, and any such further and other particulars as may be required by him or on his behalf.

SCHEDULE A.

List of Chemicals in stock.

To be filled in Name.....
by Firm. Address..... Date.....

Item.	Total stocks held.	Prices at which you will deliver to Army Medical Reserve Stores at Woolwich.	Average price at which you obtained your stock.	Date of last purchase.	Name and address of your last supplier.
quinine sulphate	ounces				
quinine bisulphate	"				
quinine hydrochloride	"				
quinine bi-hydrochloride	"				
phenacetin	lb.				
formaldehyde solution, 40%	gallons				

CAKE AND PASTRY ORDER, APRIL 18th, 1917.

The Food Controller orders that, except under the authority of the Food Controller, the following regulations, *inter alia*, shall be observed by all persons concerned:—

No person shall after the 21st April, 1917, make attempt to make for sale, or after the 24th April, 1917, sell or offer to sell or have in his possession for sale: (a) Any crumpet, muffin, tea cake or fancy bread, or any light or fancy pastries.

or any other like article. (b) Any cake, bun, scone or biscuit, which does not conform to the requirements of the two following provisions of this Order.

In the making of any cake, bun, scone or biscuit, no edible substance shall be added to the exterior of the cake mixture or dough after it has been mixed, or to the article during the process of or after baking.

Cake. No cake shall contain more than 15% of sugar or more than 30% of wheaten flour. *Bun.* No bun shall contain more than 10% of sugar or more than 50% of wheaten flour. *Scone.* No scone shall contain any sugar or more than 50% of wheaten flour. *Biscuit.* No biscuit shall contain more than 15% sugar. The percentage shall be determined in every case by reference to the weight of the baked article taken at any time. The percentage of sugar shall be ascertained by analysis of a sample representing a fair average of the whole article, and all sugar contained in the baked article shall be taken into account, in whatsoever form it may have been introduced.

The foregoing provisions of this Order shall not apply to any cake or biscuit proved to have been made before the 23rd April, 1917.

For the purpose of this Order the expression "Wheaten flour" shall mean any flour for the time being authorised to be used in the manufacture of wheaten bread, and the expression "sugar" shall include glucose.

THE MAIZE, BARLEY AND OATS (RESTRICTION) ORDER, MAY 2ND, 1917.

PROHIBITION OF MANUFACTURE OF GLUCOSE.

The Food Controller orders that except under the authority of the Food Controller the following regulations shall be observed by all persons concerned:—

1. (a) No person shall after the 9th May, 1917, use or treat any maize, barley, or oats or any product obtained from maize, barley, or oats or any article containing maize, barley, or oats or containing any such product except for the purposes permitted by this clause.

(b) The permitted purposes are seed, human and animal food and the manufacture of articles of food, but do not include the manufacture of glucose.

(c) This clause shall not apply to such products

and articles as on the 9th May, 1917, are unfit to be used in human or animal food.

2. No person shall after the 9th May, 1917, use or treat any tapioca, sago, manioc or arrowroot for any purpose except for human food or in the manufacture of articles suitable for human food.

3. Any person authorised by the Food Controller may take samples of any cereal, or other article which he has reason to suspect is being used or treated or is intended to be used or treated in contravention of this Order.

Editorial.

CYANIDES FROM ATMOSPHERIC NITROGEN.

An interesting chapter in the history of cyanide manufacture is recalled by the paper by J. E. Bucher, read before a recent meeting of the American Institute of Chemical Engineers, and abstracted in the last issue of this Journal (page 151). In this paper the author claims to have devised an economical process for manufacturing cyanide by causing atmospheric nitrogen to act on a mixture of sodium carbonate, graphite, and powdered iron at comparatively low temperatures (not exceeding 950° C.). He ascribes the success of his process to the recognition of the fact, first observed by Thompson in 1839, that the presence of iron lowers the reaction temperature very materially—a fact which has been neglected or discredited by other workers.

A number of attempts have been made to convert nitrogen into cyanides on a commercial scale, but the engineering difficulties consequent on the high temperatures required (about 1300° C.) have proved so great and have involved so much expense that they have all been abandoned.

As early as 1828 Desfossez observed that potassium cyanide was formed by the action of nitrogen on carbon and potassium carbonate. The first attempt to apply this reaction on an industrial scale was made by Possoz and Boissière, who worked their process (Eng. Pat. 9985 of 1813) at Grenelle, France, in 1813, and at Newcastle from 1811 to 1817. In this process a hot mixture of nitrogen and carbon dioxide was passed over wood charcoal which had been saturated with potash solution and dried, the charcoal being contained in fireclay retorts. This process had to be abandoned owing to the losses of potash and the short life of the retorts, and although it has been investigated many times since, no more successful results have been achieved. T. Ewan expresses the opinion that the difficulties due to the high temperatures required are insuperable, and mentions that the potassium cyanide is formed very slowly from potassium carbonate at 1350° C., a temperature at which most of the cyanide volatilises and at which potassium vapour is evolved from a mixture of the carbonate with carbon.

A process which requires a somewhat lower temperature than when potassium carbonate is used, is that discovered by Margueritte and De Sourdeval (Eng. Pat. 1171 of 1860), in which barium oxide or carbonate is used in place of potassium carbonate. L. Mond (Eng. Pat. 433 of 1882; also this J., 1889, 505) found that in this process cyanide is formed at 1200° C., but that the most favourable temperature is 1400° C.; the barium compounds fuse readily at this temperature, however, and attack fireclay rapidly, but this difficulty was overcome by briquetting the barium carbonate and carbon with a small quantity of pitch. By this method 40% of the barium was converted into cyanide. The process was abandoned, however, since Mond's object was to obtain ammonia, which he found was more satisfactorily produced by the action of air and steam on coal.

J. B. Readman (Eng. Pat. 6621 of 1891; this J., 1895, 35) applied electrical heating methods to this process with advantage, and his method was worked by the Scottish Cyanides Co. at Leven between 1899 and 1907; the financial results, however, eventually caused the process to be abandoned. A granular mixture of barium oxide and coke, produced by coking a mixture of barium carbonate and ground coal, was treated

with producer gas (containing 70% of nitrogen) in an electric furnace built of magnesia bricks, with carbon electrodes. The cooled product was lixiviated with water and the solution treated with sodium bicarbonate. It has been found that moderately complete conversion of barium oxide into cyanide can only be effected at temperatures below 1200° C. in presence of a very large excess of nitrogen, owing to the ease with which barium cyanide is decomposed by the carbon monoxide formed in the process. At 1100–1500° C., however, nitrogen fixation proceeds in presence of considerable quantities of carbon monoxide, but in this case a large proportion is fixed as barium cyanamide.

The Frank-Caro process should also be mentioned here, although it does not involve the direct conversion of nitrogen into cyanide. In this process the nitrogen is caused to combine with barium or calcium carbide, forming the cyanamide, which is then converted into cyanide, the barium salt by sodium carbonate and carbon and the calcium salt by sodium chloride.

In the experiments described by Bucher in the paper referred to above, satisfactory results were obtained by using briquettes made of soda ash, coke, and powdered iron, in equal proportions, without binding medium. When nitrogen was passed over these for half an hour at a temperature not exceeding 920° C., in a "batch furnace," the resulting briquettes contained 30% of NaCN. Considerable quantities of cyanide are formed even below 820° C., so that the process compares very favourable in this respect with the older processes, which required temperatures at least 300° C. higher, and generally more. Air, producer gas, the gas, or combustion gases give just as good results as when nitrogen is used in the process. Bucher describes a continuous furnace and an electric furnace in which he has obtained good results; brief descriptions of these have already been given (*loc. cit.*).

The essential feature of the process is the presence of iron; without it very high temperatures are needed. Iron appears to be the only catalyst which can be used with alkali carbonates. It is also necessary to mix the constituents of the charge thoroughly, and not to heat the briquettes so strongly that the iron melts into globules.

Whether Bucher has arrived at a satisfactory solution of the problem from a manufacturing standpoint remains to be seen; he does not give sufficient data as to yields and costs to enable any definite conclusions to be drawn on the point, though from the details given the results certainly appear to be promising. (See also this J., 1913, 913; 1915, 716.)

Nottingham Section.

Meeting held at Nottingham on Wednesday, April 4th, 1917.

DR. R. M. CAVEN IN THE CHAIR.

THE STANNOUS CHLORIDE REDUCTION METHOD FOR ESTIMATING NITROTOLUENES.

BY LEUT. E. DE W. S. COLVER AND DR. E. B. R. PRIDEAUX.

In order to prepare the way for investigations upon mixtures of nitro compounds, the authors have had occasion to try some experiments upon the determination of NO₂ in such compounds by reduction. These notes of the results are pub-

lished in the hope that they will save some preliminary work to others who are undertaking similar researches. The method of Knecht and Hibbert suggested itself, in which the nitro compound is reduced by boiling with titanium trichloride, and the unoxidised part of this estimated by titration with iron alum and thiocyanate indicator. By boiling for some time in an atmosphere of carbon dioxide, good results were obtained from picric acid and *p*-nitraniline. Nitro compounds which are insoluble in water or acids must be previously sulphonated (*e.g.*, nitrobenzene) or dissolved in alcohol before boiling with the titanium trichloride (*e.g.*, *m*-dinitrobenzene). The necessity for sulphonation detracts from the convenience of the process, and in the case of the mono derivatives it is more than doubtful whether reduction would proceed in the presence of alcohol (see below, p. 482). Also titanium trichloride of suitable purity is not always to be obtained at short notice.

It did not appear that the older stannous chloride reduction method had been thoroughly investigated from the point of view of accuracy, nor were the conditions as given in the original papers found to be clearly defined or in complete agreement. The following is an outline of the method: About 150 grms. of tin is dissolved in sufficient hydrochloric acid, cooled, the solution decanted and made up to one litre. Solutions of 90 grms. of anhydrous sodium carbonate (or hydroxide) and 120 grms. of Rochelle salt in one litre, and of decinormal iodine are also prepared. About 0.2 grm. of the compound is treated with 10 c.c. of the stannous chloride solution in a 100 c.c. flask. After the mixture has been warmed for some time it is cooled quickly and made up to the mark with distilled water. Of this solution 10 c.c. is treated with the alkaline tartrate until the white precipitate first obtained is dissolved, and then titrated with iodine and starch indicator.* The results given in Altmann's paper are satisfactory for salts of sulphonated nitro compounds. By titration of the excess stannous chloride with permanganate instead of iodine, concordant results were obtained also for *o*-nitrophenol and *m*-dinitrobenzene. There was a considerable difference, however, between the stannous titre as determined by iodine and by permanganate, and these two sets of numbers were not in a constant ratio but varied with the volume of permanganate required. The method does not seem promising, especially in view of the observation of Altmann that the permanganate oxidises an acid solution of naphthylamine to a considerable extent. Finally it was found that good results were obtained for nitro-anilines and nitrotoluene after reduction for several hours in a sealed tube and with the addition of ferric chloride before titration. By the original alkaline tartrate method outlined above the following results were obtained with trinitrotoluene. When warmed with the stannous chloride the compound dissolves very slowly. If previously dissolved in alcohol and precipitated with stannous chloride it dissolves quickly on warming. In both cases the solution is yellow or orange in colour. The titration with tartrate gives results which are variable and very low. In most cases the end-point was indefinite, the blue of starch passing continuously into yellow or brown. The same appearances were observed with dinitrotoluene and a pure sample of Kahlbaum's metadinitrobenzene. The yellow solution probably contains a hydroxylamine compound. A solution of similar colour but somewhat browner is obtained by reduction of trinitrotoluene with zinc and ammonium chloride and addition of concentrated hydrochloric acid.

The reduction was then carried out at 100°. The same yellow colour was at first obtained, but in a few minutes the solution became colourless. Subsequent heating for a quarter of an hour or half an hour produced a faint brown colour, but it was afterwards found that this did not materially affect the analytical results. After this more lengthy reduction the alkaline tartrate titration gives a better end-point. In any case the addition of alkaline tartrate has to be carried out carefully, and at a rate varying with the ratio of hydrochloric acid to stannous chloride in the solution, in order to obtain a precipitate and then redissolve it. It would be desirable to avoid it if possible. Experiments were therefore made in order to find whether a direct titration with iodine in acid solution was feasible, and this was found to be the case, with certain precautions which are indicated below. The results agree with the highest obtained by the alkaline tartrate titration and seem to be more concordant than the latter. It seems probable that the tendency to use up iodine by substitution in the amines may be greater in the neutral or alkaline than in the acid solution. Another advantage of the acid method is that any alcohol added to dissolve the organic compound is unaffected by the iodine, whereas in the tartrate solution the alcohol may be attacked to a certain extent.

Procedure.—Such a weight of the compound is taken as will be reduced by about 10 c.c. of the 2 to 2.5-N stannous chloride. Of this, 20 c.c. is then added to the compound in a 100 c.c. flask and 10 c.c. for a blank to another 100 c.c. flask. Accuracy in measuring the concentrated stannous chloride solution is important. The relations between the volumes of the 10 and 20 c.c. pipettes, and also between those of the flasks and the pipettes and burettes used in the subsequent titrations, should be accurately known. The flask containing the blank stannous chloride may be heated, shaken, etc., in much the same way as the experimental flask, and under these conditions a special experiment showed that the difference in the atmospheric oxidation of the two quantities was negligible. It may be mentioned here that the stock solution loses strength at the rate of about 0.25% per day, and the approximately 0.2-N solutions after making up to 100 c.c. in the flasks at the rate of about 1% in 24 hours.

The sample, weighed accurately to within a milligram, is placed in the flask with the stannous chloride and about 3 c.c. of concentrated hydrochloric acid. The flask is then placed in boiling water and shaken. A bright yellow colour usually develops in the case of di- and tri-nitro compounds, which vanishes in a few minutes, leaving the solution colourless. If a slight yellow colour remains the acid titration still gives concordant results. After cooling and making up to 100 c.c. the blank and sample are diluted with water and titrated with iodine at the rate of about 2 drops per second. It is best to repeat the titration of blank and experimental solutions several times and take the mean of the results. One blank may be taken as giving the factor of the stannous chloride with sufficient accuracy for the duration of a working day, unless of course some experiments are performed under conditions far removed from the normal procedure. It is important to add the iodine at about the same rate to the sample as to the blank, since it was found that in both cases the iodine required was less for a slow titration than for a quick one. If the iodine is added in a continuous stream to the pure stannous solution, the results of the acid titration agree most closely with those of the alkaline tartrate titration. The iodine used in these titrations was controlled by resublimed iodine, by potassium bichromate,

* Altmann, J. prakt. Chem., 1911, 63, 379; this J., 1901, 622.

and sometimes also by arsenious oxide. The results were calculated as follows:—

(A) 10 c.c. of blank needs 21.75 of iodine (mean).

(B) 10 c.c. of solution needs 21.95 of iodine (mean). Ratio of 20 c.c. pipette (B) to 10 c.c. pipette (A)=1.97. Ratio of 100 c.c. flask (B) to 20 c.c. pipette=5.06. Hence total iodine equivalent to stannous chloride taken in (B)=21.75 × 1.97=42.85. Iodine equivalent of stannous chloride not used for reduction=21.95 × 5.06=111.1, and iodine equivalent of stannous chloride used for reduction=42.85=111.1=317.4.

Weight of T.N.T.=0.1200 gram. Factor of iodine=1.001.

Hence c.c. of normal iodine equivalent to one gram. of T.N.T.

$$\frac{317.4 \times 1.001}{0.1200 \times 10} = 75.67.$$

Compounds investigated.

The trinitrotoluene was recrystallised from the refined as well as from the crude product by the use of different solvents. The melting points as determined by a standard short range thermometer graduated in $\frac{1}{10}$ were between 80.2° and 80.8°. The weights of the compound taken for 20 c.c. of the stannous solution varied from 0.3 to 0.4 gram. The dinitrotoluene was recrystallised either from benzene and petroleum ether (hot) or from alcohol. The melting point on the same thermometer was from 69.9 to 70.1°. The weights taken varied from 0.38 to 0.42 gram. The mononitrotoluene used was the *p*-compound, possibly containing some *ortho*. The melting point as determined by a similar thermometer of different range was from 50.5° to 50.75°. Rintoul* gives 51.6° to 51.9° as the melting point of the pure para compound.

In the case of dinitrotoluene the reduction follows much the same course as with the trinitrotoluene. The acid titration may be carried out after a quick reduction, while for the alkaline tartrate titration the solution should be kept at nearly 100° for at least a quarter of an hour.

In the case of the mononitrotoluene reduction is much slower and does not proceed at all in the presence of some alcohol. The flask should be provided with a glass stopper and kept closed during the early stages of the reduction. There is little if any yellow colour at any stage. Reduction should be continued until there is no more smell of nitro compound.

The results for tri- and dinitrotoluenes are expressed in Tables A and B, referring to two different series carried out with entirely different reagents and apparatus. This serves as a check on their reproducibility.

Trinitrotoluene.

TABLE A.

c.c. of N/1 iodine equivalent to 1 gram. compound.	% of N.	% of NO ₂ .	Remarks.
75.8	—	—	Acid titration.
75.5	—	—	Acid titration.
75.7	—	—	Acid titration.
75.5	—	—	Acid titration.
75.5	—	—	Acid titration.
74.6	—	—	Reduced for $\frac{1}{2}$ hr. Acid titration.
74.2	—	—	Reduced for $\frac{1}{4}$ hr. Tartrate titration.
75.26	17.57	57.72	Mean values.
79.2	18.51	60.80	Theory for trinitrotoluene.

* This J., 1915, 34, 60.

TABLE B.

c.c. of N/1 iodine equivalent to 1 gram.	% of N.	% of NO ₂ .	Remarks.
75.6	—	—	—
75.5	—	—	Stannous solution nearly finished. Possibly not uniform in blank and sample.
76.4	—	—	—
75.7	—	—	—
71.0. 2 drops per second titration.	—	—	No good end-point with alkaline tartrate.
76.2 rapid titration.	—	—	—
75.72	17.68	58.08	Mean values.

Dinitrotoluene.

TABLE A.

c.c. of N/1 iodine equivalent to 1 gram.	% of N.	% of NO ₂ .	Remarks.
69.8	—	—	Reduced for a few mins.
61.4	—	—	Reduced for 1 hour.
62.7	—	—	Acid titration throughout.
62.13	—	—	—
62.70	—	—	—
62.90	—	—	—
62.61	14.62	48.03	Mean values of last four experiments.
65.9	15.38	50.5	Theory for dinitrotoluene.

TABLE B.

c.c. of N/1 iodine equivalent to 1 gram.	% of N.	% of NO ₂ .	Remarks.
63.2	—	—	Acid titration.
63.0	—	—	Acid titration.
63.15	—	—	Acid titration.
63.0	—	—	Acid titration.
62.5	—	—	Reduced for $\frac{1}{2}$ an hour until brownish colour appeared.
62.97	14.71	48.31	Mean values.

Mononitrotoluene.

c.c. of N/1 iodine equivalent to 1 gram.	% of N.	% of NO ₂ .	Remarks.
42.0	—	—	Slow titration acid.
41.0	—	—	Slow titration acid.
41.8	—	—	Quick titration acid.
59.3	—	—	Tartrate titration.
41.3	—	—	Slow titration acid.
41.3	—	—	Quick titration acid.
41.3	—	—	Tartrate titration.
41.8	—	—	Slow titration acid.
41.65	—	—	Quick titration acid.
41.65	—	—	Tartrate titration.
41.55	9.70	31.86	Mean values from acid titrations.
43.7	10.21	33.52	Theory for mononitrotoluene.

	General mean of experimental values.	Theory.	% of theory
Trinitrotoluene	75.50	79.3	95.1
Dinitrotoluene	62.82	65.9	95.2
Mononitrotoluene ..	41.55	43.7	95.0
<i>m</i> -Dinitrobenzene (Kahlbaum)	69.0	71.4	96.8

The uniform lowness of the results does not seem to admit of a sufficient explanation without further work. By the acid titration, the stannous chloride used appears to reach a limit as soon as the solution becomes colourless, i.e., in a few minutes. Where the solution is kept at 100° for $\frac{1}{4}$ to $\frac{1}{2}$ an hour, and a good end-point is obtained, the results of the tartrate titration in general agree with the acid titration, both iodine figures (blank and sample) being higher. Various explanations, such as the constant presence of some impurity in the nitro compounds, the substitution of iodine in the amine during titration, etc., have been considered, but there are difficulties in the way of all.

The possibility of a constant error in the iodine titration was to some extent tested by titrating the excess of stannous chloride also with decinormal iron alum (factor 1.08) until the solution was faintly yellow, and gave a pink colour with a drop of ammonium thiocyanate solution. For 10 c.c. of the solution containing the reduced trinitrotoluene 18.3 c.c. of ferric solution was required, and for 10 c.c. of the blank 21.5 c.c. The weight of trinitrotoluene was 0.3530 gm., and the titrations with iodine gave 74.0 and 76.2 c.c. of normal oxidising solution equivalent to 1 gram (Table B), the value now found by means of the ferric solution being 75.5. A similar experiment was carried out with 0.3936 gm. of dinitrotoluene, the solution and blank being made up exactly as in previous experiments. For 10 c.c. of the amine solution 19.45 c.c., and for 10 c.c. of the blank, 21.1 c.c. of the ferric solution were required. The number calculated from these results is 62.5, again agreeing well with the mean of the iodine values. The ferric titration is in some respects better than the iodine, and serves as a useful check on the latter.

The agreement of these results could no doubt be considerably improved by a worker who was examining a larger number of samples in a uniform manner. It seems, however, that the method as it stands does not compare altogether unfavourably with the determination of NO_2 as N_2 by combustion. This was considered by Altmann to be inapplicable to nitro compounds. In point of speed there is no comparison between a nitrogen combustion and the direct acid titration, which can easily be completed in half an hour when all solutions, etc., are ready.

The object of the research was, however, to find whether sufficiently constant numbers could be obtained to allow a calculation of the percentage composition of binary mixtures, and it seemed that this should be possible.

Mixtures of dinitrotoluene and trinitrotoluene.

Some known mixtures of the pure compounds described above gave the following results:—

Iodine equivalent of the trinitrotoluene, 75.6, and for dinitrotoluene, 63.0. For a mixture of 0.1612 gm. of trinitrotoluene and 0.2430 gm. of dinitrotoluene the iodine equivalent was 68.1 % of dinitrotoluene calculated from iodine = 59.5, and % of dinitrotoluene taken = 60.2, or taking the mean values of iodine numbers of trinitrotoluene and dinitrotoluene, the % of dinitrotoluene calculated is 59.2.

Mixtures of dinitrotoluene and trinitrotoluene.

A mixture of 0.2354 gm. of trinitrotoluene and 0.1582 gm. of dinitrotoluene had an iodine equivalent of 70.44. The mean value for dinitrotoluene is 62.82, and for trinitrotoluene 75.50. Hence percentage of dinitrotoluene calculated is 40.0 and of dinitrotoluene taken = 40.25 %.

Mixtures of mononitrotoluene and dinitrotoluene.

A mixture of 0.2053 gm. of dinitrotoluene and 0.3058 gm. of mononitrotoluene gave iodine

equivalents of 50.1 (acid titration slow), 50.6 (acid titration quick), and 50.2 (tartrate titration).

Hence taking the mean values for D.N.T. and M.N.T., the percentage of mononitrotoluene calculated = 58.3, and the percentage taken = 59.8. The slow acid titration gives 58.7 %.

This work was carried out partly at the Research Department, National Shell Filling Factory, Chilwell, and partly at University College, Nottingham.

Communications.

SOME NOTES ON AMMONIUM THIOSULPHATE-POLYTHIONATE SOLUTIONS; A CONTRIBUTION TO LIQUID PURIFICATION OF COAL GAS.

BY E. V. ESPENHAHN, MELBOURNE.

Investigations in the direction of the polythionic acids have proceeded from the mixture of these acids in the Wackenroder solution. Debus* carried out an exhaustive research on the potassium salts and proved the existence of pentathionic acid, which was later confirmed by other investigators.

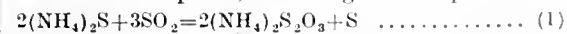
The salts of these acids assumed technical importance with the introduction of the Feld process† for the recovery of ammonia and sulphuretted hydrogen from illuminating and coke-oven gas. His solutions of the zinc and iron polythionates with thiosulphate were superseded by the simpler and more effective ammonium thiosulphate-polythionate washing solution. This solution consists of ammonium thiosulphate which is treated with sulphur dioxide and forms polythionate, when it is brought into intimate contact with the gas in rotary vertical washers. The reaction with the polythionate results in the absorption of the ammonia and part of the sulphuretted hydrogen. As the solution becomes concentrated, portion is withdrawn, treated with more sulphur dioxide and heated, whereby the polythionates are converted into sulphate. By evaporation a salt suitable for fertilising purposes is recovered, and the process claims to solve the problem of utilising the sulphur contained in the coal for the fixation of ammonia without first forming sulphuric acid.

The following investigations were carried out by the author:—

- (1) The reactions occurring between thiosulphate and sulphur dioxide.
- (2) The reactions between ammonium polythionate and ammonia.
- (3) The reactions between ammonium polythionate + free sulphur dioxide and ammonia at 100°.
- (4) The reactions between ammonium polythionate + free sulphur dioxide and ammonia and ammonium sulphide at 100°.
- (5) Application of the reactions to the industrial process.

1. Reactions between thiosulphate and sulphur dioxide.

An ammonium thiosulphate solution may be prepared by the action of sulphur dioxide on ammonium sulphide, according to the equation:—

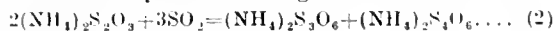


The sulphur is precipitated in the amorphous form as a flocculent mass, but a portion remains in solution, which is precipitated in the colloidal form on heating the solution to 100° C.

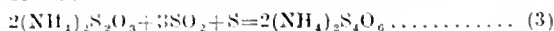
* Debus, Annalen, 1887, 244, 76—190.

† W. Feld, Z. angew. Chem., 1912, 20, 705. This J., 1912, 430.

On further addition of sulphur dioxide polythionates are formed; this reaction has been considered by Feld as being:—



or as:—



The analogous reaction with potassium thiosulphate has been stated by Debus to proceed according to the equation:—



which it was considered might also apply to the reaction with the ammonium salt.

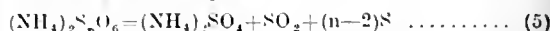
The determination of any two of the polythionic acids in the presence of thiosulphate may be carried out by titrating the sulphuric acid formed by the oxidation of these acids with mercuric chloride and alkaline hydrogen peroxide.* Thiosulphate is determined with standard iodine. The radicles may be calculated from the following values:—

1 c.c. of 1 grm. mol. per l.	c.c. N/10 iodine.	c.c. N/10 NaOH with	
		HgCl ₂ .	alk. H ₂ O ₂ .
S ₂ O ₃	10	20	20
S ₃ O ₆	—	40	40
S ₄ O ₆	—	40	60
S ₅ O ₆	—	40	80
S as colloid	—	—	20

With ammonium salts in solution, the determination with alkaline hydrogen peroxide was modified by affixing to the boiling flask a condenser and a catch containing an excess of N/10 acid to absorb the ammonia, which was added to the main solution before titrating in the cold.

Several ammonium thiosulphate-polythionate solutions were prepared, the polythionate being calculated as tri- and tetrathionate; the results appear in Table I. The test for pentathionate was carried out qualitatively by the addition of ammoniacal silver nitrate solution and noting the time taken for the precipitate to form and the bulk of the precipitate. For each test equal amounts of polythionate were measured into a test tube and the same amount of nitrate solution added.

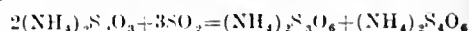
after about an hour. No sulphur had been deposited from the solutions, showing that decomposition of the polythionate had not occurred according to the equation:—



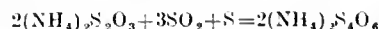
Sulphur was freely precipitated after treating solution (b) at 100° for different periods, and precipitates were immediately formed on adding the nitrate solution.

In experiment 2, a 1.2 grm.-mol. solution containing colloidal sulphur was partly converted into polythionate, which was afterwards decomposed at 100° C.

The above quantitative and qualitative tests show that the reaction between thiosulphate and sulphur dioxide proceeds primarily as:—

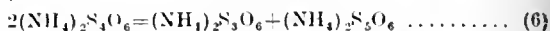


Free sulphur in colloidal form only is added to form tetrathionate and not pentathionate. The reaction:—



can hence only take place to a minor extent and is dependent on the amount of colloidal sulphur present in solution.

Before decomposition of the polythionate to sulphate salts (equation 5) interchange of the sulphur atoms of the tetrathionate molecule takes place.



This reaction may also take place at the same time as reaction 2, provided the period of conversion from thiosulphate to polythionate is of sufficient duration, but under ordinary conditions will not occur in the ratio as expressed by equation (1).

Under certain conditions, especially at higher temperatures, decomposition of the polythionate may set in before all sulphur dioxide has been absorbed by the thiosulphate. These reactions are complicated in nature and were investigated by Debus (*loc. cit.*). The general trend is the formation of polythionate molecules with an uneven number of sulphur atoms, which was borne out by experiments 1 and 2. These solu-

TABLE I.

Grm. mols. per litre.	S ₂ O ₃ .	Colloidal sulphur.	S ₃ O ₆ .	S ₄ O ₆ .	SO ₂ .	S ₅ O ₆ .	Remarks.
Exp. 1.	2.000	—	—	—	0.050	—	Solution before conversion.
Sol. a.	1.729	—	0.135	0.136	0.050	slight trace	After standing 20 hours at 12°.
Sol. b.	1.300	—	0.347	0.351	0.052	trace	
Sol. b.	1.200	—	0.250	0.404	0.196	fair ppt.	After heating at 100° for 10 min. and allowing to stand until neutral. After further heating.
Sol. b.	1.115	—	0.197	0.412	0.326	decided reaction	Solution before conversion.
Exp. 2.	1.215	0.065	0.005	0.005	—	—	After standing 16 hrs. at 15°.
Sol. a.	0.897	—	0.120	0.198	—	trace	After standing 3 days at 15°.
Sol. b.	0.443	—	0.282	0.401	0.099	fair ppt.	After heating at 100° for 30 min.
Sol. b.	0.093	—	0.135	0.365	0.593	strong reaction	

In experiment 1, sulphur dioxide was led into two portions of a 2 grm.-mol. per litre ammonium thiosulphate solution, which had been heated on the water-bath until all colloidal sulphur was precipitated. After standing for 20 hours at 12° the sulphur dioxide had been absorbed and converted into polythionate. On testing, solution (a) turned opaque after some time and a slight precipitate had formed next day. Solution (b), with more polythionate, showed somewhat more coloration, which developed into a precipitate

tions after decomposition consisted, besides the sulphate, chiefly of tri- and pentathionate molecules.

2. Reactions between ammonium polythionate and ammonia.

The velocity of this reaction was studied at various temperatures. A polythionate concentration of about 0.25 and 0.5 grm.-mol. was chosen and that of the total ammonium 1.2 grm.-mols. per litre.

The solutions were mixed cold, and after pipetting an aliquot portion, were run through

* Sander, this J., 1916, 421.

TABLE 2.

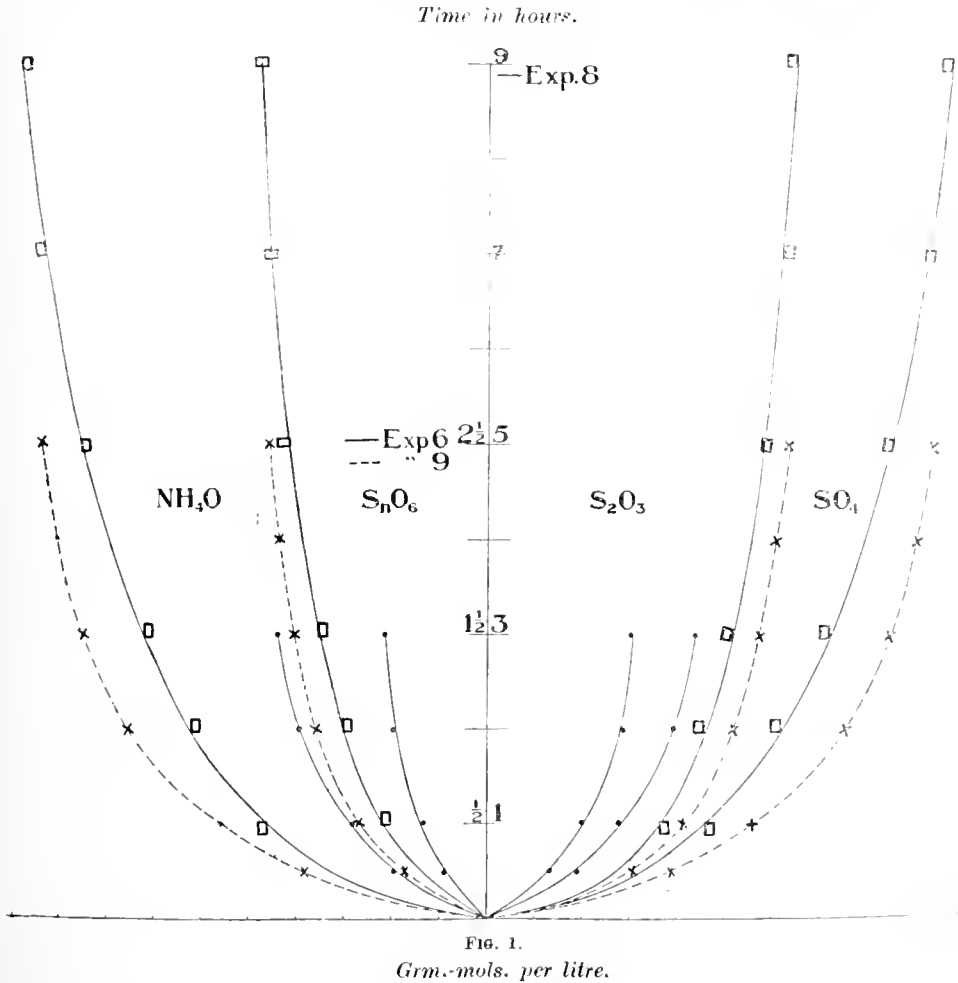
Exp. No.	Concentration of solution as gram.-mols. per l.				Reaction expressed as gram.-mols.				Temp. °C.	Time. hrs. min.
	(NH ₄) ₂ O.	S _n O ₆ .	S ₂ O ₃ .	Total conc.	(NH ₄) ₂ O	+ S _n O ₆	→ S ₂ O ₃	+ SO ₄ .		
3	0.236	0.234	0.700	1.200	233	219	320	132	40	65 —
4	0.250	0.250	0.685	1.200	245	240	318	167	60	9 —
5	0.246	0.244	0.700	1.200	224	224	313	147	75	2 30
6	0.240	0.240	0.700	1.200	223	207	300	140	80	1 30
7	0.260	0.260	0.550	1.200	226	220	306	150	100	— 17
8	0.508	0.504	0.308	1.420	491	474	634	309	60	9 —
9	0.492	0.475	0.317	1.400	477	452	624	305	75	2 30
10	0.469	0.467	0.326	1.400	463	425	617	271	80	1 30

a glass spiral, which acted as a preheater, into a flask in a thermostat. From time to time 10 c.c. was withdrawn, made up to 100 c.c. and the components determined. Free ammonia was arrived at by titration with *N*/10 acid and thiosulphate with *N*/10 iodine. The polythionate concentration was ascertained after oxidation with mercuric chloride, allowing for the free ammonia determined beforehand. The difference between the total double gram.-mols. of ammonia and these three components gave the number of gram.-mols. of SO₄ in solution. All tests were corrected to the original concentration.

The velocity of the reaction is dependent on the temperature, and a rise of 10° C. increases the

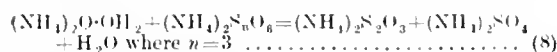
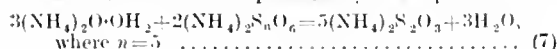
rate between two and three times. Otherwise the reaction is concluded independently of the number of gram.-mols. per litre participating. The end reaction, expressed as gram.-mols. in Table 2, does not vary with the conditions of the experiment and is approximately the same at all temperatures. It was also found that excess of either ammonia or polythionate is without influence on the velocity or the end reaction. No sulphur is precipitated and the solutions remain clear until the free ammonia has been absorbed, when with polythionate present the solution turns suddenly opaque. This point marks the completion of the reaction.

For the correct interpretation of the reaction



it is necessary to refer to the graphical representation in Fig. 1. Interaction first occurs without the formation of sulphate, which is indicated by the coincidence of the $S_2O_3-SO_4$ lines, although with all determinations sulphate was found to have been formed. At this period the ratio $\text{gm.-mols. } (NH_4)_2O \text{ to } S_8O_6$ approaches 1.5:1.0. The nearest approach to this reaction was afforded by experiment 3 at 40°, when at the end of the first hour the reaction was expressed as $31(NH_4)_2O + 24S_8O_6 = 55S_2O_3 + 38O_2$. As no sulphur is precipitated all the sulphur atoms of the polythionate molecule have been readjusted to form thiosulphate. Greater consistency is shown by the curves at the latter end of the reaction, when the $(NH_4)_2O-S_8O_6$ and $S_2O_3-SO_4$ lines as pairs run parallel to one another. Equal numbers of gm.-mols. of each component have therefore taken part in the reaction.

The reaction hence proceeds between two extremes, which are expressed by the equations:—



It was not ascertained to what extent the reaction depended on the different polythionates, as the solutions were kept at a low temperature after their preparation and undue decomposition prevented. It is probable that interchange of the sulphur atoms between the polythionate molecules takes place during the reaction, so that the end reaction appears uniform unless a great excess of any one polythionate is present.

The reactions between the polythionates and potassium or sodium hydroxide form an interesting comparison, inasmuch as combination takes place with the formation of SO_3 instead of SO_4 ions. By accelerating the reaction, effected by slowly pipetting the polythionate into an excess of boiling and fairly concentrated hydroxide solution, the reactions between the individual polythionates occur, but not with sufficient exactitude for the purposes of a quantitative determination. These are:—



Note.—The reactions 4–8 have been expressed with ammonia as base; the reactions refer equally to the polythionates of sodium and potassium, as indicated by the above three reactions.

3. Reactions between ammonium polythionate, free sulphur dioxide, and ammonia at 100° C.

Contrary to expectations no immediate reaction occurred on mixing thiosulphate with an ammonia solution containing sulphur dioxide slightly in

excess of the proportion $2(NH_4)_2O \cdot OH_2 + 3SO_2$, beyond the solution assuming the characteristic yellow coloration of S_2O_3 ions. After maintaining the solution at 100° for several hours the colour still remained, indicating that little if any polythionate had been formed. The absorption of sulphur dioxide by thiosulphate is thus greatly retarded by free ammonia, and probably does not proceed at a measureable rate at ordinary temperatures. It was found, however, that the reaction proceeded at a reasonable rate on the addition of polythionate molecules.

The reaction was studied with varying proportions of polythionate and sulphur dioxide. As no method is available for the determination of free ammonia, and sulphur dioxide in the presence of polythionate and thiosulphate, solutions of ammonia containing sulphur dioxide were standardised and mixed with the polythionate to give the desired concentration of ions. About 15 c.c. of the solution was measured into a test tube, closed with a stopper and a glass tube drawn out to a fine capillary, and after heating quickly over a Bunsen burner, were suspended in a large beaker of boiling water of approximately 100°. The time taken for the completion of the reaction was indicated by the opacity produced on the decomposition of the excess polythionate. After cooling quickly and standing for an hour, 10 c.c. of the solution was analysed as described in Section 2. The results of experiments 11–20 are set out in Table 3.

The rate of reaction is primarily dependent on the ratio of polythionate to free ammonia. With solutions containing a ratio 1:4 the reaction is extremely retarded, despite sufficient sulphur dioxide present to form an excess of polythionate (see experiment 19). By increasing the ratio 2:4 and maintaining the total gm.-mols. polythionate, the absorption of the same amount of ammonia is reduced to a fraction of the former rate. With equal gm.-mols. ammonia and polythionate the time is still further reduced and varies according to the free sulphur dioxide present, which acts as an accelerator. Acceleration is also attained with increase of the thiosulphate concentration.

The number of gm.-mols. of polythionate and thiosulphate of each reaction were ascertained from the difference of the composition of the solution as calculated beforehand and found after each experiment, assuming that two-thirds of the SO_2 combined with thiosulphate to form polythionate. The sulphate formed for each gm.-mol. of ammonia is identical with that in the former experiments and is independent of the polythionate originally in solution. Free sulphur dioxide is added to form polythionate, which is not decomposed to sulphate until the solution has been rendered neutral after the absorption of ammonia.

Free ammonia has therefore been proved not only to exert a decided retarding influence on the absorption of sulphur dioxide by thiosulphate,

TABLE 3.

Exp. No.	Concentration of solution as gm.-mols. per l.					Reaction expressed as gm.-mols.				Time. Min. Sec.
	$(NH_4)_2O$	S_8O_6	SO_2	Calc. as total S_8O_6	S_2O_3	Total conc.	$(NH_4)_2O + S_8O_6$	S_2O_3	SO_4	
11	0.250	0.200	0.265	0.375	0.635	1.100	250	205	305	13 30
12	0.255	0.200	0.130	0.290	0.635	1.100	255	220	320	14 45
13	0.245	0.100	0.395	0.365	0.780	1.150	245	210	305	15 45
14	0.250	0.100	0.265	0.275	0.780	1.150	250	210	310	15 39 45
15	0.460	0.465	0.235	0.620	0.205	1.200	460	400	575	285 11 30
16	0.460	0.230	0.465	0.540	0.470	1.200	460	460	640	280 44 30
17	0.465	0.230	0.695	0.695	1.000	1.800	465	465	650	280 17 20
18	0.165	0.230	0.165	0.540	1.000	1.800	465	420	600	285 29 0
19	0.465	0.120	0.695	0.575	1.120	1.800	Reaction not completed in 3 hours.			
20	0.460	0.465	0.165	0.770	1.260	2.400	460	430	590	300 6 30

but also to prevent the decomposition, even at high temperatures, of the polythionate so formed. The *grm.-mols.* S_nO_6 and S_2O_4 expressed in the end reactions are therefore higher with increasing concentration of sulphur dioxide.

4. *Reaction between ammonium polythionate, free sulphur dioxide, and ammonia and ammonium sulphide at 100°.*

The above reactions suggested the possibility of modifying the Feld process, and as an alternative it is suggested that the ammonia after it has been washed from the gas, could be absorbed in a polythionate solution, which would replace the sulphuric acid universally employed. Owing to the slowness of the complete conversion of sulphur dioxide by thiosulphate solutions at ordinary temperatures, the Feld washing solution contains the minimum of polythionate necessary for the extraction of ammonia, so that this solution would not meet the requirements arising with high ammonia concentrations. Hence the substitution of part of the total polythionate by free sulphur dioxide.

To approach the conditions arising in actual practice, where the ammoniacal liquor contains ammonia in combination with carbon dioxide and hydrogen sulphide, with excess of the former, the previous experiments were modified by adding ammonium carbonate in solution to the polythionate containing free sulphur dioxide. On mixing and heating to 100°, the carbon dioxide liberated carried away much of the ammonia added, unless a large excess of sulphur dioxide were present. By gradually raising the temperature after the solutions had been mixed and allowed to stand, no ammonia was lost and the end reaction was practically identical with those of former experiments. As it was desired also to determine the factor of time, and as the formation of polythionate was less accurate by the addition of sulphur dioxide in solution owing to the presence of free sulphuric acid, the procedure of the previous experiments was reverted to.

Freshly-prepared ammonium sulphide, standardised to contain 2 *mols.* of ammonia to 1 *mol.* of sulphuretted hydrogen was first added to the polythionate solution. On mixing this with the ammonia and sulphur dioxide the temperature rose appreciably and fine sulphur was precipitated. After heating to 100° this was absorbed and the solution remained clear until decomposition of the excess polythionate occurred.

The first reaction to take place on mixing the solutions appears to be according to equation (1). Reaction between polythionate, the remaining sulphur dioxide, and ammonia would then proceed after the manner of experiments 11–20. The number of *grm.-mols.* in the second phase was accordingly arrived at after assuming the absorption of 1.5 *mols.* SO_2 by each *mol.* $(NH_4)_2S$. (See Table 4.)

In contrast to these experiments, considerably less sulphate is formed by the ammonia molecules reacting in the presence of sulphuretted hydrogen.

and the reaction is completed in a considerably shorter time. The rate of fixation of the free ammonia is not affected to the same extent by a decrease in concentration of the original polythionate, and is even accelerated with low polythionate and high sulphur dioxide content (compare experiments 23 and 26). In experiment 23, where the total polythionate concentration was about the same as in experiment 19, the absorption of equal *grm.-mols.* of ammonia per litre was completed in the short time of 8 minutes. The rate of absorption is also more favourable with increase of the total concentration.

It would appear that a line of demarcation cannot be drawn between the two separate reactions as suggested above, which are in reality more complicated and occur simultaneously.

The absorption of free ammonia by polythionate and free sulphur dioxide is thus more favourable in the presence of sulphuretted hydrogen, as the amount of polythionate in the absorbing solution can be reduced to a minimum and the period of absorption considerably shortened.

5. *Application of the reactions to the industrial process.*

The requirements for the successful recovery of sulphate of ammonia would be met by a plant of the following description (see Fig. 2). The ammonium thiosulphate solution, containing also sulphate, is partly converted into polythionate by passing through the absorber, D_1 , in the opposite direction to that of the gases containing sulphur dioxide from the furnace, O , and runs into the tank, A_1 , until nearly full, when the solution is diverted to tank, A_2 . Sufficient condensate from the still, S , is then passed into A_1 to allow an excess of polythionate after absorption of the ammonia. The solution is then pumped through the heat-interchanger, C , into the tank, B_1 , whereby the temperature is raised to approximately that of the other solution issuing from the tank, B_2 , and this latter solution is cooled for the absorption of sulphur dioxide in D_1 . After maintaining the temperature at 90°–100° until the solution becomes opaque, it is passed in the reverse order into A_1 , whilst the solution from A_2 is forced into B_2 ; these operations are then repeated alternately. Any ammonia or sulphur dioxide liberated with the carbon dioxide from the tanks is recovered in the system by passing through D_1 .

Ammoniacal liquor is fed into the still, S , through the preheater, P , which is so regulated that the water vapour carried over with the ammonia may be kept constant and the solutions maintained at any desired concentration.

Portion of the solution is withdrawn periodically and pumped over the absorber, D_2 , where treatment with more sulphur dioxide is effected. The polythionate thus formed is decomposed into sulphate by heating in tank F , and the solution freed of its sulphur before running into the lower tank, H . From here it is drawn into the vacuum-evaporator, V , evaporated, and the salt dried

TABLE 4.

Exp. No.	Concentration of solution as <i>grm.-mols.</i> per l.						Reaction expressed as <i>grm. mols.</i>					Time.	
	$(NH_4)_2S$.	$(NH_4)_2O$.	S_nO_6	SO_4 .	Calc. as total S_nO_6	S_2O_4 .	Total conc.	$(NH_4)_2O + S_nO_6 \rightarrow S_2O_4 + SO_4$				Min.	Sec.
21	0.230	0.245	0.240	0.363	0.482	0.090	1.750	245	202	377	70	14	—
22	0.230	0.245	0.240	0.363	0.482	1.215	2.400	245	212	362	95	16	—
23	0.220	0.250	0.120	0.590	0.513	1.285	2.000	250	208	373	85	8	15
24	0.230	0.490	0.470	0.725	0.953	0.290	1.750	490	411	649	252	8	30
25	0.230	0.485	0.470	0.480	0.700	0.290	1.750	485	420	649	243	15	—
26	0.220	0.490	0.080	1.180	0.867	1.095	2.000	490	447	712	225	15	50

in the centrifugal, Z. The sulphur recovered is burnt in the furnace, O.

Being cyclic, the process would be adaptable to continuous operation and could prove effective provided that sulphur dioxide and ammonia admitted to the system were maintained in the correct and constant proportions.

It is evident that advantages are to be obtained by the accumulation of sulphuretted hydrogen in the ammoniacal liquor undergoing recovery. Firstly, the absorption of the ammonia will be completed within a more uniform and considerably shorter period. Secondly, the sulphur will be recovered from the gas as such, as it will be precipitated on decomposing the polythionate solution. Thirdly, the formation of sulphate will be

sulphur, in combination with the washing process of W. B. Davidson,* or with a simpler method for the purification of coal gas as described by O'Neill.†

The author hopes that these suggestions will prove useful in overcoming the difficulties in the recovery of ammonia, due to shortage of sulphuric acid, although he is aware that protection of the above suggestions is fully afforded by the patent rights of the Feld process.

Summary.

- (1) Reaction between thiosulphate and sulphur dioxide takes place according to equation (2).
- (2) Other reactions taking place under certain

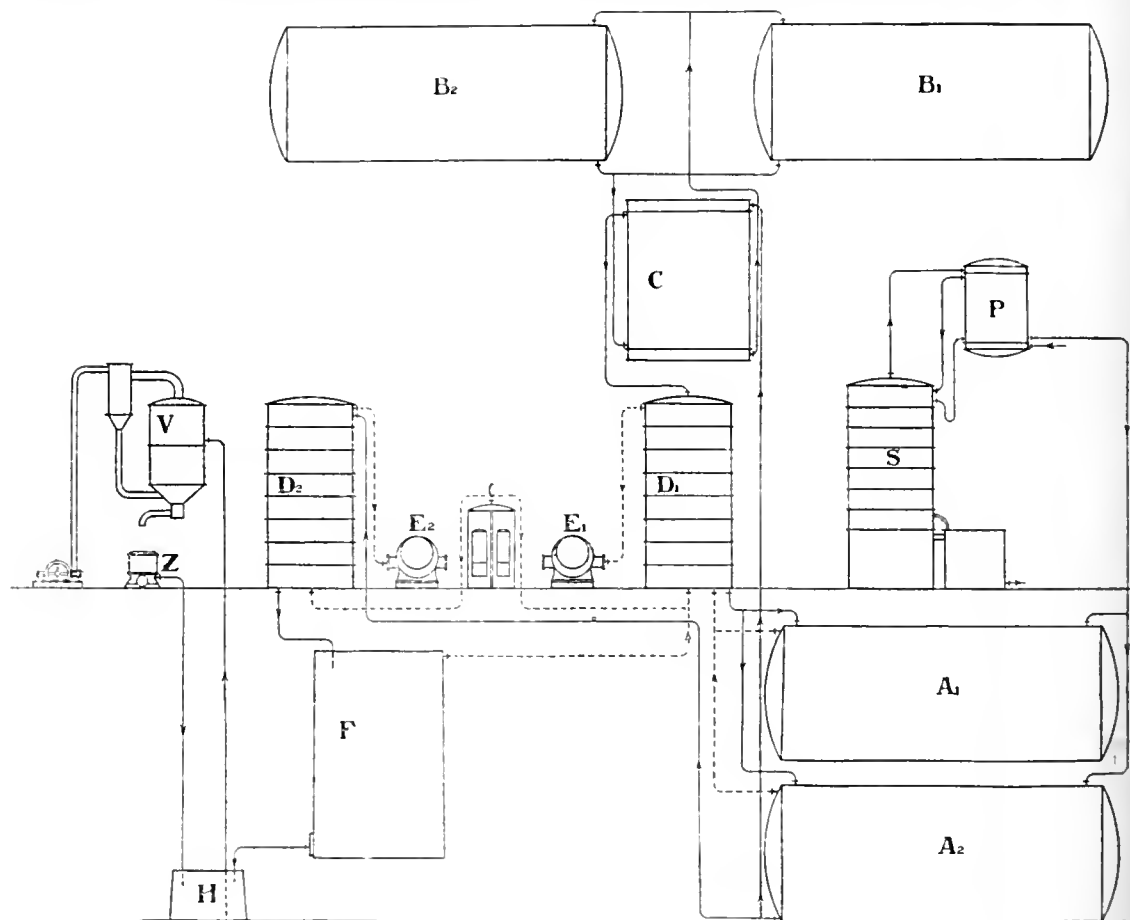


FIG. 2.

low and the process rendered more stable, since at no time must the concentration of thiosulphate in the absorbing solution decrease. Fourthly, subsequent purification of the gas will be rendered more economical, as a saving of space and labour is effected by relieving the work of the oxide of iron purifiers, and, fifthly, more H_2S would be absorbed from the gas, than by washing with an ammonium polythionate solution.

Other advantages are that the process for its inception would entail no extensive alterations to the plant for the general indirect method of recovery of ammonia, which has not been universally superseded by direct recovery processes using sulphuric acid. The process would also be specially suitable, as a means of utilising the

conditions, but not influencing the main reaction, take place according to equations (3) and (6).

(3) Although the reaction between polythionate and ammonia solution, as expressed by the products of the reaction, appears uniform, the reaction proceeds between too extremes, as represented by equations (7) and (8).

(4) The reactions between tri-, tetra-, and pentathionate and potassium or sodium hydroxide may take place separately according to equations (9) to (11).

(5) The velocities of these five reactions greatly increase with rise of temperature.

* J. Gas Lighting, 1913, 122, 948-958.

† 8th Intern. Congress Appl. Chemistry. See this J., 1912, 862.

(6) Sulphur dioxide is not absorbed by ammonium thiosulphate in the presence of ammonia unless polythionate is present in solution. It is then added to form polythionate, which does not decompose to sulphate at 100° , so that the amount of sulphate formed for each ammonium concentration is the same as with polythionate and ammonia.

(7) When ammonia acts upon ammonium polythionate and sulphur dioxide in the presence of sulphuretted hydrogen, that is ammonia and ammonium sulphide, less sulphate is formed than in the absence of sulphuretted hydrogen, and the velocity of the reaction is considerably greater.

(8) The Feld process of ammonia recovery could be profitably modified according to the results of the experiments and for the reasons set forth.

THE ESTIMATION OF XYLENE IN SOLVENT NAPHTHA.

BY PERCY E. SPIELMANN, PH.D., B.Sc., F.I.C.,
AND F. B. JONES, B.A. (Cantab).

The difficultly attendant on this estimation is due to the fact that xylene itself consists of three isomers of different boiling points and specific gravities, and that it exists as such in a complex mixture of cumene, trimethylbenzenes, and other substances which boil gradually up to 170° C. and over. It has been found that if the benzene, toluene, and xylene be completely removed by careful and repeated fractionation from different makes of solvent naphtha, and the fraction of the residue boiling from 143° — 170° C. be examined in a constant boiling point apparatus (such as that devised by Northall-Laurie in connection with his estimation of toluene) the constant boiling point obtained scarcely varies with the different makes.

Commercially pure xylene, fractionated and collected between 138° and 143° C., gives in the same apparatus the constant boiling point of 139.15° C. It becomes possible, therefore, from examination of known mixtures of xylene with the 143° — 170° C. residue, to construct a curve by means of which the composition of unknown similar mixtures may be found from their boiling points.

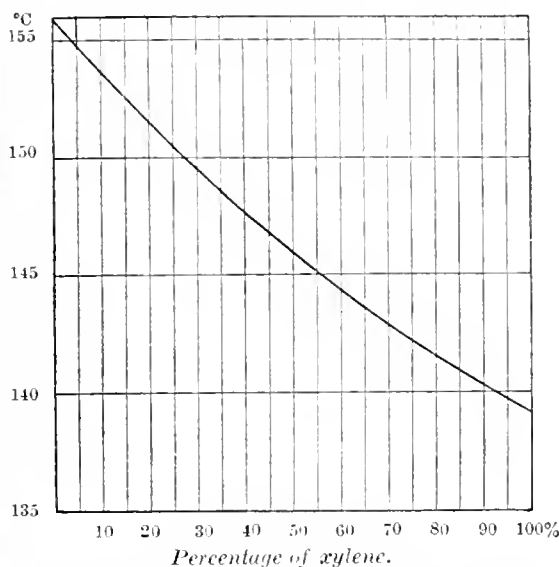
100 c.c.—or 200 c.c. if necessary, for Colman's analysis—of solvent naphtha, accurately measured, is distilled over a Young 12-pear head at the usual rate of one drop a second. The fractions up to 138° C. and from 138° C.— 170° C. (all temperatures being corrected) are collected in separate cylinders and measured.

The benzene, toluene, and xylene in the first fractions (up to 138° C.) are estimated by Colman's methods for examining toluols and solvent naphtha. The xylene in the 138° — 170° C. fraction is evaluated by taking the boiling point in the constant boiling point apparatus, and referring to the appended graph.

All possible care must be taken to get an accurate reading for the boiling point, corrections being made for barometric pressure, thermometer error, and unexposed stem, as is customary in such determinations. A steady temperature is usually attained after about 20 minutes' boiling at such a rate that the liquid condensed from the vapour, drops back from the end of the condenser at the uniform rate of one drop a second. After constancy is approximately attained, there is a slow rise in temperature on continued boiling, due, apparently, to the warming up of the unexposed stem of the thermometer, and of the end of the reflux condenser.

The accuracy of the boiling point curve may be

taken as $\pm 1\frac{1}{2}^{\circ}$, when the xylene content of the 143° — 170° C. fraction is above 50%, but owing to the divergence of boiling point of the "higher than xylenes" there may be an error of more than $\pm 2\frac{1}{2}^{\circ}$ when only small quantities of xylene are present. As, however, the average quantity of xylene in solvent naphtha is about 60%, the region of the curve showing the maximum error will not be employed in practice.



Determination of the composition of mixtures of xylene with the 143° — 170° C. residue from three makes of solvent naphtha, other than those from which the curve was constructed:—

	Taken (Xylene %).	Found (Xylene %).
1.....	11.6	14.0
2.....	29.3	28.8
3.....	66.9	63.5

For the sake of completeness, a full example is given of the examination of a sample of commercial solvent naphtha, including the corrections for unexposed stem and barometric pressure, and their applications.

The correction for unexposed stem may be calculated from the formula:

$$\text{No. of degrees to be added to observed reading} = 0.000143 (T-t) N.$$

T = observed reading.

t = temperature of external part of stem.

N = number of degrees not exposed to the vapour.

More conveniently and quickly this correction can be ascertained from a graph (Wheeler, this Journal, December 15th, 1916).

The correction for barometric pressure is given by the equation:

$$\Delta t = 0.046 (760 - p).$$

Δt is the number of degrees to be added or subtracted according to sign, and p is the corrected barometric pressure (corrected for temperature) at the time of experiment.

Example.

Volume from distillation of 100 c.c. over a 12-pear head up to 138° C. 22.1 c.c.

This 22.1 c.c. was mixed with 57.5 c.c. pure toluene and 20.4 c.c. pure benzene, and the mixture

analysed by Colman's method. The results indicated that the 22.1 c.c. contained benzene, nil; toluene, 6.2 c.c.; xylene (by difference), 15.9 c.c.

Volume from distillation of 100 c.c. over 12 pear head from 138° to 170° C.—69.7 c.c.

Boiling point of this fraction:—

Observed reading = 141.6° C.
 + thermometer error correction = 141.7° C.
 + barometric correction (for 755 mm) = 141.9° C.
 - unexposed stem correction = 143.25° C.

On reference to the curve the fraction is found to contain 67.2% xylene, corresponding to the corrected boiling point 143.25° C.

∴ total content of xylene in the original solvent naphtha = $15.9 + \frac{69.7}{100} \times 67.2 = 63\%$.

Paraffin.

An estimation of the proportion of paraffin associated with xylene may be made by the following procedure, based closely on the method of Wilson and Roberts (Gas Record, Chicago; J. Gas Lighting, 1916, 225-227; this Journal, 1916, 35, p. 681).

The quantity of the sample—100 c.c. is generally sufficient—is distilled over a Young 12-pear head at the rate of one drop a second, the portion distilling between 138°—143° C. (corrected) being collected separately. 10 to 20 c.c. of this fraction is vigorously shaken for about 40 minutes with $2\frac{1}{2}$ times the volume of weak oleum made by mixing one volume of 22% oleum with two volumes of 95% sulphuric acid.

The absorption of the aromatic hydrocarbons is carried out in a 100 c.c. flask, of which the neck is graduated into 10 c.c.s. and sub-divided into 10ths of a c.c. from the volume mark upwards. After sufficient shaking, the level of the liquid is driven up into the graduated neck by the addition of a further quantity of 95% sulphuric acid.

After standing—preferably over night—the paraffin will be found to be sharply separated.

Example.

100 c.c. of the solvent naphtha quoted above gave about 23 c.c. between 138° and 143° C. 20 c.c. of this fraction yield 2.5% of paraffin residue.

This is the quantity present in 20 c.c. of the xylene fraction, therefore, in 63 c.c. of the xylene (i.e., the quantity of xylene found in 100 c.c. of the solvent naphtha) there is $\frac{63}{20} \times 2.5 = 8\%$ of paraffin.

Therefore, this particular sample of solvent naphtha contains 5% of xylene, together with 8% of associated paraffin.

The inquisitiveness regarding the composition of the various fractions of light naphtha, which has been occasioned by the war, has given rise to much detailed work, so that now the main constituents of the whole series of fractions from benzole fore-runings to xylene can be estimated with considerable accuracy.

Benzol first-runings .. ..	..	..	Spielmann and Butler Jones, this J., Sept. 15th, 1916, p. 396.
Benzols .. ..	..	..	Spielmann and Wheeler, this J., April 15th, 1916, p. 396.
Commercial toluols .. ..	..	..	Colman, J. Gas Lighting, 1915, 1916, Edwards, this J., May 31st, 1916, p. 587, James this J., Feb. 29th, 1916, Wilson and Roberts, Gas Record, (Chicago); J. Gas Lighting, 1916, 134, 225-7; this J., 1916, 684.
Pure toluols (suited also to commercial quality) ..	..	..	Northall-Laurie, Analyst, 1915, p. 384.
Toluene in solvent naphtha ..	..	..	Colman, J. Gas Lighting, 1915, p. 314.
Xylene in solvent naphtha ..	..	..	Spielmann and Butler Jones,

Industrial Notes.

REPORT OF THE ONTARIO NICKEL COMMISSION.

The Royal Ontario Nickel Commission, appointed by the Ontario Government in September, 1915, to investigate the resources, industries, and capacities in connection with nickel and its ores, has presented its Report. The Commissioners are: G. T. Holloway, Dr. W. G. Miller, and McGregor Young, K.C., with T. W. Gibson as Secretary.

The Commissioners are of the opinion that:

(1) The nickel ore deposits of Ontario are much more extensive and offer better facilities for the production of nickel at a low cost than do those of any other country. Nickel-bearing ores occur in many parts of the world, but the great extent of the deposits in this Province, their richness and uniformity in metal contents, and the success of the industry, point strongly to the conclusion that Ontario nickel has little to fear from competition.

(2) Any of the processes now in use for refining nickel could be successfully worked in Ontario, and conditions and facilities are at least as good in this Province as in any other part of Canada.

(3) In view of the fact that practically no chemicals are required, that there is a much more complete saving of the precious metals, especially platinum and palladium, and that electric power is cheap and abundant, the most satisfactory method of refining in Ontario will be the electrolytic process.

(4) The refining of nickel in Ontario will not only benefit the nickel industry, but will promote the welfare of existing branches of the chemical and metallurgical industries, and lead to the introduction of others.

(5) The methods employed at the Ontario plants of the two operating nickel companies are modern and efficient, although there are differences in both mining and smelting practice. It is the consistent policy of both companies to adopt all modern improvements in plant and treatment. Even during the present time of acute pressure, the Canadian Copper Company has materially increased its output without substantial enlargement of its plant, and the losses in smelting are less, both at Copper Cliff and the Mond plant at Coniston, than they were a year ago. These companies have each had their experimental stage, neither has asked nor received any government assistance, and both have earned the success which they have achieved.

(6) The present system of mining taxation in Ontario is just and equitable and in the public interest, and is the best system for this Province. Any question of change is rather one of rate than of principle. This important question is dealt with at some length in chapter XII.

(7) Experiments have been undertaken by the Commission in the production of nickel-copper steel direct from Sudbury ore, and also in the electrolytic refining of nickel. Certain improvements in the latter process have been made the subject of application for patents in Canada, United States, and Great Britain.

Mention is made of the erection in Ontario of two large plants for the refining of nickel. The International Nickel Company of Canada is erecting a plant at Port Colborne, having an initial output of 15,000,000 lb. of nickel per annum, provision being made for doubling or quadrupling this capacity. The plant is expected to be in operation and turning out refined nickel in the autumn of the present year. The second refinery is that of the British America Nickel Corporation,

and will probably be erected at the Murray mine, about three miles from Sudbury. The Hybinette electrolytic process will be employed. This plant will have a capacity at the beginning of 5000 tons of nickel per annum.

In regard to the refining of nickel the Orford, Mond, and electrolytic processes are described and compared, the Commissioners remarking that the respective costs of producing refined nickel from the Sudbury ores by each of the three processes mentioned, do not differ to such an extent as to give any one process a material advantage over the others in competition. The electrolytic process, which the Commissioners regard as most suited to Ontario conditions, can be operated as cheaply and efficiently in Ontario as in Norway.

The production of nickel as a by-product in electrolytic copper refining is also referred to, and attention is drawn to the precious metal contents of the Sudbury ores. Roasted matte from two of the companies showed Pt. 0.1235 and 0.988 oz.; Pd, 0.197 and 0.984 oz.; Au, 0.027 and 0.256 oz.; Ag, 1.84 and 6.15 oz., respectively.

Chapters of the Report are devoted to the history of nickel production in Canada, the world's deposits of ores, the metallurgy and uses of nickel, and many other aspects of the subject.

SULPHURIC ACID MANUFACTURE BY THE CHAMBER PROCESS.

In our Feb. 28th issue (p. 196), an account of the Fairlie analytical method of control of the chamber process was published. A recent issue of the *Chemical Trade Journal* contains an article by H. E. J. Cory on the subject, in which the author gives it as his opinion that the Fairlie method, though excellent, does not go far enough, and he proceeds to note a number of directions in which scientific control of the process is necessary.

In the first place he mentions the necessity for maintaining an adequate supply of atmospheric oxygen in the system, this being regulated in conjunction with a comparatively rich burner gas. A series of daily tests of the burner gases for SO_2 , SO_3 , and oxygen are very necessary, and often considerable fluctuations are to be found, particularly in the case of hand-worked burners, the variations being due largely to working operations from time to time. Particularly on sets working with a low chamber space, a good supply of atmospheric oxygen is essential, since otherwise the nitre will supply the deficiency.

Granted an adequate supply of inlet oxygen in the burner gas (9 to 10% when using pyrites), a rich SO_2 is also desirable, say $6\frac{1}{2}$ to $7\frac{1}{2}\%$, and at the same time a sufficiency of oxygen at the exit should be available. With a "tight" set this latter figure should not fall below 5%, and to a large extent will regulate the composition of the burner gas itself.

The percentage of total acids and oxygen in the gases leaving the Glover tower, but before entering the first chamber, is another useful test, as it demonstrates the amount of work done by this tower and is an aid to the most effective working of the Glover. Again, the functions of the Glover tower are to be constantly observed, so that one obtains perfect denitration, effective gas admixture and cooling, satisfactory concentration of acid, efficient cooling of the acid leaving the tower, and free gas passage through the tower.

The temperatures of the gases at the front and back ends of the first chamber should be noted at regular intervals, and water gauges placed at various progressive points in the system serve to show the speed of the gases.

"Drips" placed at frequent intervals on all the chambers indicate the strengths of acid being made, and should be compared with the strengths of the "bottom acids" in the chambers. The "bottom acids" should be tested frequently for strength and nitrosity, and the drips occasionally and qualitatively for nitrosity.

The acid in the chambers should be thoroughly circulated, so that all acid is drawn off at the front end of the leading chamber after traversing the length of all the chambers in the system and always moving in the opposite direction to the gases. By using connecting chutes alternately at opposite ends of the various chambers such a circulation can be easily effected, and intimate contact between acid and gases is established, fresh acid surfaces continually presenting themselves. Also, the leading chamber may be used as a "denitrating" chamber, so that all acid run off from the chambers is free from nitrous compounds. This is not essential, and often not advisable where the whole or a large part of the acid make is concentrated by the Glover tower. Any nitre contained in the "bottom acid" flowing round through this leading chamber is thus evolved, and, intermingling with fresh gases from the Glover tower, proceeds through the system again. At times acid may be again despatched to the last chamber after having worked round, in order to come forward again, thus maintaining an active acid circulation continually. With acid continually on the move, a nitre content to a reasonable extent frequently helps the working, and at the same time does not damage the lead materially, as no stagnant acid is present in the system.

The acid distribution on the tower tops requires regular attention, and constant flows, particularly on the Glover tower, should be maintained. Any shortage or excess of nitrous vitriol in the circulating acids can be remedied by adjustment of the absorber tower feeds, the Glover feed never being reduced for this purpose.

As oxygen is required in the absorber towers to ensure correct reactions, gas tests taken between the last chamber and first absorber are most useful. The SO_2 at this point should not exceed 0.1 to 0.2%, and oxygen should be 5% or more, these figures applying to sets burning pyrites. A rise in these figures does not necessarily demonstrate a deficiency of nitre in the system, but may be due to excessive draught, which is easily righted.

Tests of the gases for total acids, i.e., SO_2 and SO_3 combined, together with oxygen, may be taken occasionally at the end of each chamber, and give the operator an indication of the comparative work done by each chamber in the set.

On the absorber towers cool acid is essential, and should not exceed 90° to 100°F. , while a minimum strength of 140° Tw. is desirable. Where two absorbers or a series are working, intelligent variation and adjustment of the flows render absorption the more satisfactory.

To maintain a good "nitre circulation," the acid flowing down the Glover should be frequently measured at the inlet, the nitre contents being tested simultaneously. This enables the circulation of nitre going forward from the Glover tower to be calculated.

Nitrosity tests of the acids leaving absorber towers should be taken thrice or more daily, and the gas "smell" test is very useful. In the latter test the operator takes a sample of chamber gas into a small hand aspirator at a place not too far back in the system. A little experience enables him to judge how the chambers are working by differences in the odour of the gases, and any variation or tendency towards "souring" is checked by an extra charge of nitre at the pots.

Exit tests may be done with advantage about thrice daily (express as grains SO_2 per cubic foot of gas), and a good working figure should usually not exceed 1.5 to 2 grains. As the "burner gases" at certain periods come forward into the chambers in "flushes," the following method of applying the nitre at the pots is recommended as being most economical. A minimum amount of nitre is added each hour at the pots, and this should be accurately weighed on a scale, and at intervals this amount is raised—*i.e.*, if 10 lb. per hour is being potted, perhaps every three or four hours, 20 lb. would be added in order to counteract the gas "flushes." This is undoubtedly more economical than using a regular and heavier charge of nitre hourly, and the "smell" test is of great utility at this point. With the latter method a continuous nitre saturation is present, and this state of affairs is certainly not beneficial to the leadwork, as, on the contrary, occasional "souring" of the gases has, if anything, a good effect upon the leadwork.

A fan worked by direct-coupled motor and equipped with variable speeds should be fitted between the two absorbers, and the speed taken at regular intervals. A convenient speed for most systems is 300 to 400 revolutions per minute on the fan. A control damper fitted in the draught pipe between the last chamber and the first absorber is very suitable, and the sizes of the draught pipes should gradually diminish throughout the system. Inspection doors fitted into the chamber curtains at a height of some 3 ft. or 3 ft. 6 in. above floor level enable the operator to observe the colour and movements of the gases, and are useful when acid samples are required. These doors should preferably be at an angle of 45° to the lead curtain. The speed or draught is an important factor requiring frequent observation.

The control of the burners or furnaces is the most important part of the system: the control of the burners largely depends upon the analysis of the "burner gases," but painstaking examinations of the burners themselves are necessary to ensure good and regular chamber workings.

By adopting such means of control as described, a most economical nitre usage with a maximum make of acid should be obtainable. A maximum figure for "nitre circulation" should be decided upon for each set, as too much nitre going forward, while reducing the amount to be added at the pots (to make good chemical and mechanical losses), has a detrimental effect upon the chamber leadwork. With a reduced chamber space, however, the nitre circulation requires usually to be raised, and this undoubtedly largely contributes to the increased wear and tear. Where several sets are working together or adjacently, as in many of the larger and more modern works, these methods of control should prove very useful. Where nitric acid is used the same rules apply, though nitre may also be used for the purpose of counteracting gas "flushes" where practicable.

NEW FRENCH CHEMICAL MANUFACTURES.

According to *L'Industrie Chimique* (April, 1917), a factory has been erected at Ponthierry (Seine-et-Marne) for the manufacture of sodium bichromate. Formerly the whole of the French requirements of bichromate, about 3000 tons annually, were imported from England and Germany. Owing to the difficulties of crystallising the salt, it was at first sent out in the form of a concentrated solution, but these difficulties have been overcome, and a crystalline product is now being produced at the rate of about 500 kilos. per day. The factory

is being enlarged so that the output will be quadrupled in the near future. A works at Château-Ponsac has recently commenced the manufacture of golden antimony sulphide. Prior to the war, this substance was made on a small scale in the north of France, but the greater part of the amount required was imported from Germany and Austria. At the same works potassium permanganate is also being manufactured, the daily output being 100 kilos., soon to be increased to 500 kilos. Potassium carbonate and other potassium salts are now being produced at Choisy-le-Roi from the residues from the molasses distilleries. Formerly this industry was carried on in the north of France on a fairly extensive scale, but the works where it was in progress are in the war zone.

ALCOHOL FROM CARBIDE IN SWITZERLAND.

According to a recent issue of the *Statist*, the leading Swiss hydro-electric concerns as well as the aluminium company, the Lonza, Ltd., have now completed their researches in connection with the production of pure alcohol for industrial purposes from calcium carbide. Industrial alcohol is under Government control in Switzerland. The introduction of this new industry will be the joint work of the Federation and the Lonza, Ltd. In spite of the high prices of coal (a truck load from Germany costs 600 fr.) the Lonza will be able to sell spirit of second quality at £21 2s. per metric ton and pure industrial spirit at £22 4s. per metric ton. This is far less than the Swiss Federation pays now for imported spirit. Switzerland will thus become an exporter instead of an importer of alcohol. The installations with about 20,000 h.p. in minimum and 30,000 h.p. in maximum (summer time) will produce annually 7500 tons of alcohol minimum, and 10,000 tons maximum.

G. C.

FERRO-CONCRETE SHIPS.

The increasing use of ferro-concrete for building ships in Scandinavia has drawn attention to the results of recent work on the effects of salt water on concrete. The theory most widely held to account for the destruction of concrete is that the magnesium sulphate in sea water reacts with the free lime in concrete, and that the calcium sulphate, being of greater volume, exerts a bursting effect on the structure. This has suggested the use of cements free from excess lime, *e.g.*, puzzuolana cements, which contain excess of silicic acid, and such cements have been used for the purpose for some years.

An extensive series of tests is being carried out at the island of Sylt, in the North Sea, with concrete blocks placed on the sea shore so that at high water they are completely submerged and at low water only partly so. Two mixtures were used, *viz.*, (A) containing 65% CaO and 6–8% Al_2O_3 and Fe_2O_3 , and (C) with 61–62% CaO and 10–12% $\text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3$. In 1:2 mixtures the blocks made of (A) were unaffected after 4 to 5 years, but the (C) mixture showed cracks after 2 to 3 years. In 1:4 mixtures the edges of blocks of (A) cement had suffered, and with poorer mixtures the blocks were much affected after 1 to 2 years.

In an exhaustive series of tests made recently in Germany, concrete mixtures of 1:3 and 1:6 were exposed to the effect of various solutions during a period of six months. Portland cement, with 63.23% of lime, was used. The following solutions were employed:—(1) Sodium chloride, up to 100 grammes per litre; (2) sodium sulphate,

up to 100 grms. per litre; (3) calcium sulphate, saturated; (4) magnesium sulphate, up to 100 grms. per litre; (5) magnesium chloride, up to 100 grms. per litre; (6) calcium chloride, up to 100 grms. per litre. The 1:6 concrete was all more or less affected, but all the 1:3 concrete tests showed that no harm had been done to the concrete, except in one case, in which the block had been kept in a closed desiccator during the hardening, and had been submerged in calcium sulphate solution. The use of too much fine sand in the mixture is undoubtedly injurious.

It is clearly evident that concrete can only be affected by sea water to the extent the water penetrates it. If the concrete is sufficiently dense, nothing but the surface is exposed to any risk, and the making of dense concrete is no longer a novelty.

Protective measures in the construction of concrete ships may be summed up as follow:—(1) The use of rich concrete; (2) the use of cement with but little free lime, gypsum, and alumina; (3) the addition of puzzuolana to fix the free lime; (4) the use of coarse sand; (5) the use of dense concrete; (6) surface treatment. Should the cement boat-building industry develop there should not be much trouble in guarding against decay if full use be made of our present knowledge.—*Engineering*.

Obituary.

JOHN H. SMITH.

Dr. J. H. Smith, an original member of this Society, died suddenly on March 20th, at the age of 57.

Born at Kircaldy, he received his scientific education at the Royal College of Science, Dublin, and later at the Zürich Polytechnikum under Lunge, taking his degree for a thesis on "The oxidation of sulphur compounds occurring in the manufacture of caustic soda" (see this Journal, 1883, 460, 525). From Zürich Dr. Smith went to Milan, where for a year he was engaged with a firm on the utilisation of tin scrap; some of the results of this work are described in this Journal, 1885, p. 312. Returning to England, he was appointed chemist to Messrs. Mawson and Swan, of Newcastle, but after some years he again went to Zürich to establish a manufactory of photographic plates and papers. About 1908 he installed a small factory in Paris for the manufacture of U'color bleach-out papers, a subject to which he devoted a large amount of attention; he found in thiosinamine and its derivatives a series of sensitisers much more powerful than anethol, which had previously been used for the purpose. His work on the subject shows the extreme difficulties encountered in the preparation of "bleach-out" papers of sufficient sensitiveness and yet yielding permanent results.

For some time prior to his death, Dr. Smith had been living in Manchester, where he had been carrying out research work at the Municipal School of Technology. The results of some of this work on phosphoric acid and the alkali phosphates are embodied in three papers which he read before the Manchester Section of this Society, on Jan. 12th last, and which were printed in the April 30th issue of this Journal.

FRANCIS SUTTON.

The death occurred at Norwich, on April 16th, at the age of 86, of Francis Sutton, the author of the widely-known work on "Volumetric Analysis."

After completing his apprenticeship in pharmacy at the age of twenty, he joined a former fellow-apprentice in business at Newcastle-on-Tyne, where he remained for three years. There he came under the influence of Dr. Glover, a physician, who advised him to take up chemistry as a profession, studied at the Durham College of Science, and duly qualified as a pharmacist. In 1851, he returned to Norwich to manage the business where he was originally apprenticed. Turning his attention increasingly to chemistry apart from pharmacy, he became Public Analyst for the County of Norfolk and other authorities. He was also consulting chemist to the local agricultural associations and, being specially interested in fertilisers, founded in 1870 a chemical manure and acid works at Runham, Great Yarmouth, of which he remained Managing Director until 1893, when he disposed of it to Messrs. Prentice Bros., Ltd. He was for many years a Member of the Council of the Pharmaceutical Society of Great Britain and one of the founders of the British Pharmaceutical Conference. In 1874, he represented British pharmacy at the International Pharmaceutical Congress at St. Petersburg, being a corresponding Member of the Imperial Pharmaceutical Society of that City and also of the Apotheker Verein of Vienna.

As a chemist he is known chiefly for his work on "Volumetric Analysis," which is accepted among chemists throughout the world as the standard work on the subject. The first edition appeared in 1862; a French translation of the fourth edition was published in Paris in 1883; and the eleventh English edition is now in preparation under the Editorship of his son, Mr. W. L. Sutton, and Mr. A. E. Johnson. He was an Original Fellow of the Institute of Chemistry, and contributed many papers to scientific journals, his earliest being two papers on the determination of phosphoric acid by means of uranium, published in the *Chemical News* in 1860.

THOMAS UTRICK WALTON.

The Sydney Section of the Society has sustained a heavy loss by the death on Feb. 1st of T. U. Walton, who had been Secretary since its inception in 1903; the success of our Australian Section was due in a very large measure to his energy and zeal.

Born at Greenock in 1852, he was educated at Greenock Academy and Glasgow University. After spending some years in Greenock sugar refineries, he went to Sydney in 1880 as Chief Chemist to the Colonial Sugar Refining Company, a position which he held until his death. He was one of the pioneers in the application of chemical control to a manufacturing business in Australia, and was responsible for the training of a very large number of chemists for the Company's works.

Since the commencement of the war he had been a member of the Chemical Section of the State Munitions Committee.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each, to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.
United States.—1s. each, to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—
 Patent number, date, name of patentee, and title of invention.
French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56, Rue Ferou S. Paris (3e.)
 Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

PATENTS.

Disintegrating machines. A. D. Furze and A. J. Neill, London. Eng. Pat. 104,485, Dec. 2, 1916. (Appl. No. 17,318 of 1916.)

A BOX, provided with a sliding discharge door, is fixed opposite an opening in the casing of a disintegrating machine with rotary beaters, below the outlet for the pulverised material and preferably at the point where the beaters commence their upward movement. Any unpulverisable materials entering the machine are thrown into the box and discharged from time to time.—W. H. C.

Pulverising machine. F. C. Ferry, East Cambridge, Mass. U.S. Pat. 1,217,930, Mar. 6, 1917. Date of appl. July 10, 1916.

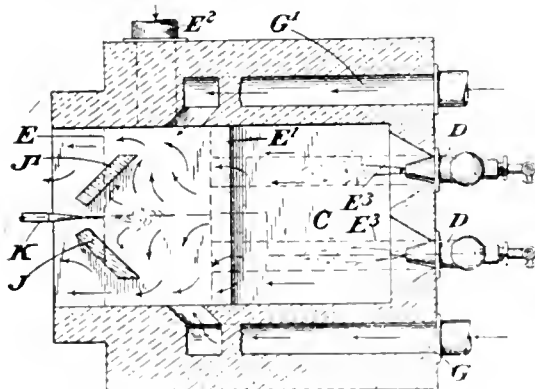
The apparatus consists of two superposed casings of different diameters, the lower, larger casing having a perforated bottom and a perforated rim extending upwards. Agitation is effected by a reciprocating perforated disc provided with agitator blades.—W. H. C.

Sandwasher for washing fine sand. J. Southall, Worcester. Eng. Pat. 104,637, Aug. 30, 1916. (Appl. No. 12,278 of 1916.)

To enable fine sand to be washed without excessive loss by suspension in the water, the sand is fed into the top of a vertical vessel opening at the bottom into a communicating passage between similar adjacent vessels on either side. The sand falling into this communicating passage is conveyed along a horizontal conduit by a screw conveyor, into a vertical conduit, through which it is raised by a bucket elevator. The washing water is admitted into the last-mentioned vertical conduit and passes through the apparatus in the opposite direction to the sand, except that it finally overflows from the slightly lower rims of the two vessels adjacent to the sand inlet. The sand is thus fed into a quiescent body of water and is not carried away by the overflow.—W. F. F.

Furnaces. J. Sackett and S. A. Cobbett, London. Eng. Pat. 104,766, Mar. 30, 1916. (Appl. No. 4711 of 1916.)

OIL fuel is injected through the nozzles, D, into the combustion chamber, C, shown in sectional



plan, while primary air is drawn in through the pipe, E², chamber, E, and passages, E³, below the chamber, C, where it is preheated, to the nozzle, D. The walls of the chamber, E, form a bridge of less height than the combustion chamber, and the combustion gases impinge on the wall, E¹, and pass over the top of the chamber, E, to the outlet. Secondary air is drawn in through the passages, G, G¹, where it is preheated, and complete mixing is ensured by high pressure superheated steam injected through the jet, K, and directed between the inclined baffle plates, J, J¹, as shown. The combustion gases circulate as shown by the arrows.—W. F. F.

Liquids and gases: Mutual treatment of —. F. E. Coombs, Au Sable Forks, N.Y. U.S. Pat. 1,217,156, Feb. 27, 1917. Date of appl. Apr. 15, 1913.

THE gases are drawn through or over the surface of the liquid by a steam injector. The mixture of steam and gas is then cooled to condense the steam, and the gas, still under pressure, but substantially free from steam, is forced through the liquid.—W. H. C.

Power plant. R. A. Fessenden, Brant Rock, Mass. U.S. Pat. 1,217,165, Feb. 27, 1917. Date of appl. Mar. 8, 1909.

A WORKING fluid is exposed to the heat of the sun's rays in a vessel provided with a transparent cover containing an iron salt, and is heated to a point short of the boiling point at atmospheric pressure. The heated liquid is converted into vapour at a lower pressure than that of the atmosphere, and the vapour so produced is used in a suitable low-pressure engine. Part of the energy produced by the engine is used to pump water from a lower to an upper tank to be used in the condenser of the engine.—W. H. C.

Filter-bodies: Method of testing —. E. Zahm, Assignor to Zahm Manufacturing Co., Buffalo, N.Y. U.S. Pat. 1,218,151, Mar. 6, 1917. Date of appl. Oct. 21, 1912. Renewed Jan. 26, 1917.

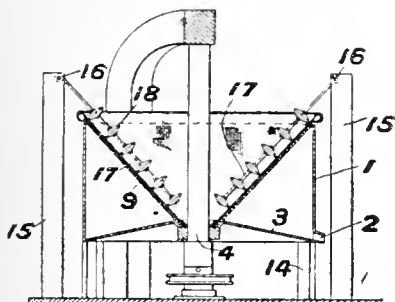
A POROUS filter body is wetted so that the interstices are sealed by liquid. It is then subjected to gas pressure, and the pressure at which the seal is broken is determined.—W. H. C.

Pressure-filter: Centrifugal —. F. K. and E. F. Atkins, New York. U.S. Pat. 1,219,796, Mar. 20, 1917. Date of appl. Dec. 13, 1915.

A VERTICAL cylindrical casing is provided with a concentric rotating hollow shaft carrying disc-like filtering elements spaced apart, and connected to the interior of the shaft, which acts as a discharge conduit for the filtered liquid. The liquid is supplied by a vertical pipe, at the side of the casing, having perforated nozzles projecting between the filtering elements. An inner pipe may be provided, movable longitudinally in the supply pipe, and having means for discharging liquid through any desired nozzle for cleaning the outer surfaces of the adjacent filtering elements. Another vertical pipe may be provided at the side of the casing, having short nozzles which discharge liquid simultaneously on the surfaces of all the filtering discs.—W. F. F.

Filter. W. H. Waggoner, Jeanerette, La. U.S. Pat. 1,218,915, Mar. 13, 1917. Date of appl., Feb. 29, 1916.

A PERFORATED cone, 9, carrying the filtering medium, is mounted on a vertical shaft, 4, so as to rotate within the tank, 1, which is provided with a conical bottom, 3, and an outlet, 2. A support,



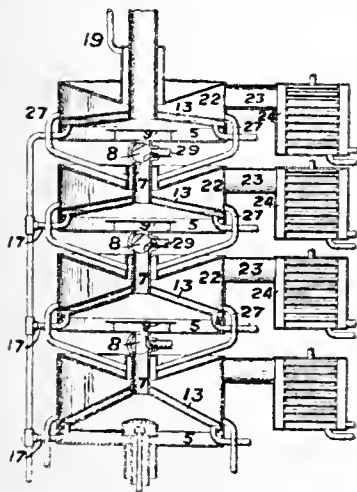
15, carries projecting arms, 17, pivoted at 16, the arms being provided with scrapers, 18, which rest on the conical surface and are rotated as the cone rotates.—W. F. F.

Dust particles and smoke from air and gases; Process for the separation of— W. J. Baldwin, Brooklyn, N.Y. U.S. Pat. 1,218,354, Mar. 6, 1917. Date of appl., Apr. 20, 1916.

THE gas is given a rotary motion and the washing liquid, heated to above its boiling point, is projected into it. Part of the liquid explodes into vapour and agglomerates the dust particles, and part serves to wash the agglomerated particles from the apparatus. The gas as it leaves the rotating apparatus is further washed by sprays of liquid directed against it, and leaves the apparatus by a different outlet from that by which the liquid and separated dust are discharged.—W. H. C.

Distillation; Apparatus for fractional— J. T. Davis, Alameda, Cal. Assignor to L. Levy and J. Rothschild, San Francisco, Cal. U.S. Pat. 1,218,840, Mar. 13, 1917. Date of appl., Sep. 12, 1916.

LIQUID to be distilled enters the uppermost vaporising chamber, 22, by the pipe, 19, and passes from the bottom of the chamber, by the pipes, 27, to the top of the vaporising chamber next below,



and so on. Hot gases pass upward through the series of heating chambers, 5, connected by flues, 7, provided with valves, 8, and escape pipes, 29.

Baffle-plates, 9, are provided in each heating chamber. Conical chambers, 13, of slope increasing gradually downward in the series, are interposed between the heating and vaporising chambers and supplied with steam by pipes, 17. Each vaporising chamber is connected by a pipe, 23, to a condenser, 24, for the distillate.—W. F. F.

Fluid-proofed hollow object and process for making hollow objects fluid-proof. C. M. Mapes, New York. U.S. Pat. 1,219,021, Mar. 13, 1917. Date of appl., July 1, 1916.

HOLLOW objects are rendered fluid-proof by subjecting them to the maximum pressure they will be required to withstand, and while in the stressed condition filling the voids in the walls under pressure with a molten "fluid-repellent material" which solidifies on cooling and remains permanently in the walls.—W. F. F.

Dryer. M. T. Cass, Schenectady, N.Y., Assignor to The Kellam and Shaffer Co. U.S. Pat. 1,219,981, Mar. 13, 1917. Date of appl., Mar. 31, 1916.

AN insulated chamber, mounted on wheels, is divided by horizontal longitudinal partitions into several superposed compartments. The partitions extend completely across from side to side but do not extend to the ends. The material to be dried is fed on to one end of the uppermost partition and is moved to the other end by a scraper conveyor. It falls over the end and is directed by a sloping guide on to the next shelf below, along which it is again moved by a conveyor; this guide also serves as a baffle to prevent the passage of the heating agent at this end of the shelf. The material thus travels in a zig-zag fashion to the end of the lowest shelf, from which it is discharged. Heated products of combustion from a furnace situated beneath the chamber travel in an opposite direction to the material and escape through a chimney near the feed opening.—W. H. C.

Drying [solid substances] and extracting [fluids]; Process of— D. B. Banks, Baltimore, Md., Assignor to The D. B. Banks Co. U.S. Pat. 1,219,406, Mar. 13, 1917. Date of appl., May 20, 1916.

FLUIDS, substances contained in solution or suspension in fluids, or fusible substances, are separated from cellular, fibrous, or porous substances by placing the material adjacent to a regulable heater in a casing containing a saturated gas under pressure. The whole is heated to the boiling point of the contained fluids, etc., at that pressure, and the temperature and pressure of the gas are then reduced while heat is supplied to the cellular or like substance to maintain it above the boiling point of the contained fluid at the reduced pressure, the fluid being thus removed by internal evaporation, into the surrounding medium. The substance is then subjected to the action of heat in a non-saturated gaseous medium.—W. F. F.

Decolorising materials; Method of making— R. M. Catlin, Franklin Furnace, N.J. U.S. Pat. 1,219,438, Mar. 20, 1917. Date of appl., Apr. 25, 1916.

A MIXTURE of silica and a carbonaceous material obtained from an industrial carbonising process, e.g., the residue of shale distillation, is treated with dilute hydrofluoric acid. The solid residue is separated and possesses decolorising properties.—W. F. F.

Mixing-machine. H. J. Ihaigh, Stapleton, N.Y. U.S. Pat. 1,219,730, Mar. 20, 1917. Date of appl., July 7, 1914.

A MIXING bowl is supported on a vertical standard which also supports a vertical shaft carrying the beater mechanism and a friction disc. The beater mechanism may be driven at a variable speed by a

number of friction rollers spring-pressed on the surface of the disc and capable of being adjusted simultaneously by a feed screw to any desired radius of the friction disc. The friction rollers are driven by suitable gearing.—W. F. F.

Atomiser for fluids. J. Patten, Assignor to Davison Chemical Co., Baltimore, Md. U.S. Pat. 1,219,394, Mar. 20, 1917. Date of appl. Apr. 23, 1914.

THE atomiser is mounted in the cover of a tank so as to atomise liquid within the tank. Liquid is supplied tangentially to a cylindrical chamber depending from a liquid seal in the cover of the tank, and terminating at its lower end in a frustum of an inverted cone. A concentric vertical shaft rotating at a variable speed carries a disc at its lower end almost closing the outlet of the cone, so that an annular rotating stream of liquid is delivered to the disc and sprayed from it by centrifugal force.—W. F. F.

Pulverising apparatus. J. Crites, Assignor to Raymond Bros. Impact-Pulverizer Co., Chicago, Ill. U.S. Pat. 1,221,111, Apr. 3, 1917. Date of appl. July 3, 1916.

SEE Eng. Pat. 103,963 of 1916; this J., 1917, 376.

Method of fixing the walls of lead chambers. Ger. Pat. 295,911. See VII.

Process for carrying out chemical reactions. U.S. Pat. 1,217,812. See VII.

II A.—FUEL; GAS; MINERAL OILS AND WAXES.

Coke; By-product—and coking operations. C. J. Ramsburg and F. W. Sperr, jun. J. Franklin Inst., 1917, 183, 391—431.

THE recent development in the building of by-product ovens in the United States and Canada has been remarkable and it is estimated that 9900 ovens will be in operation by Jan., 1918. The development is not altogether due to inflated war prices of by-products but to financial conditions favouring large investments. In addition to economic advantages from the recovery of by-products, attention is drawn to the conservation of the coal supply brought about by the introduction of modern methods. As far as fuel values are concerned, from a total of 1.4 to 1.5 tons of coal required to make 1 ton of coke, the by-products lost in the beehive coking process have a heat value of 625 lb. of coal, whilst an additional 200 lb. is wasted by combustion of a portion of the charge. The advantages of silica material in the erection of coke ovens are stated thus:—The conductivity at high temperatures is superior to that of fireclay material; the softening temperature is higher; the action under heat may be more accurately calculated owing to constant composition; the expansion and contraction between 2000° and 2600° F. (1090° and 1430° C.) is negligible. The use of silica material has brought about a shortening of the coking period and a more extensive use of coals richer in volatile matter, with increased yields of by-products. The authors give the effect of variations in the dimensions of a coke oven, a reduction in width giving the following advantages:—less sponge in the coke; better coke from the same coal; good coke from mixtures with a higher content of volatile matter; higher yields of tar, ammonia, and benzol; lower temperatures for the same coking velocity. In referring to benzol the authors emphasise the value of this product as a motor fuel, either alone or mixed with alcohol or gasoline. A brief account of the accepted theory of the coking process is given. The process is con-

ceived as involving the formation of a fused zone and the gradual advance of this zone towards the centre of the oven, the evolved gases and vapours depositing part of their carbon in the vesicular mass left as the zone progresses. The actual thickness of this zone is probably not over half an inch, the drop of temperature across it is very great, and the interior of the oven remains comparatively cool for a considerable part of the coking process. The average rate of advance of the zone towards the centre, with ovens 18 inches wide and a wall temperature of 1000° C., is about one-half inch per hour, the initial rate being more rapid but decreasing as the centre of the oven is approached. Coke adjacent to the wall is distinguished by its cauliflower-like appearance and dense layers of deposited carbon. Towards the centre of the oven the coke is more open and occasionally spongy. As a rule coke from coals with over 30% volatile matter is of a "fingery" type, but by careful regulation of the heat treatment, firm, "blocky" coke may be produced from such coals. For any accurate comparison of cell structure the authors prefer to make longitudinal sections with a thin emery wheel, thus eliminating the danger of confusing sections made at different distances from the oven wall. These sections are compared with standards cut from blocks of typically different coals. Numerous illustrations of standards and sections are given. The authors quote the verdicts of various observers on the exact function of coke in the most efficient and economical reduction of iron ore. As furnace conditions are better understood the range of quality of the coke used may be extended, but the importance of uniformity for any particular furnace cannot be too strongly emphasised. For each kind of coke there is evidently some limiting size for efficient service, i.e., just large enough to offer a minimum surface of attack for carbon dioxide and small enough to ensure complete combustion in a minimum of time at the tuyères. Harder grades of coke should be used in smaller sizes, coke of open cell structure requiring less attention in this respect.—J. E. C.

Dusts; Inflammability of carbonaceous—in atmospheres of low oxygen content. H. H. Browne and J. K. Clement. J. Ind. Eng. Chem., 1917, 9, 317—319.

HARGER (this J., 1912, 413) has recommended a low oxygen content (17.5%) in the atmosphere of mines as a preventive of dust explosions and experiments made by the authors show that an explosion of flour or similar dust cannot be initiated in a gas mixture containing less than 12% of oxygen. In the case of flour mills where the dust could be confined in enclosed machines, the gases might be introduced into the latter; under normal conditions the gases contain nitrogen, 79, oxygen, 11, and other gases, 10%, and there would be no necessity to remove the carbon dioxide as would have to be done in a mine where men were working.—W. P. S.

Gas purification oxides. A. H. Scott. New England Assoc. Gas Eng. Gas J., 1917, 138, 101.

THE author discusses the sources and methods of production of some of the better known forms of gas purification oxides, natural or manufactured, and their sulphur absorption properties. The value of bog ores after drying, screening, and grinding is influenced by the physical condition. They are easily mixed and are comparatively free from the defect of overheating in use. Manufactured oxides are mainly by-products from metallurgical operations, residues left after extraction of alumina from bauxite furnishing a considerable portion. A high-grade oxide is produced

in the manufacture of aniline, whilst the sediment from the water of certain coal mines yields a very efficient natural oxide. Metallic paint oxide has given good results. In absorption tests under similar conditions (four foulings to each test) the percentage of sulphur taken up was as follows:—Residue from aniline manufacture, 62; sediment from mine water, 61; Pennsylvania bog ore, 61; ground pyrites cinder, 53; hematite ore, 49; hydrated iron ore, 46; residue from American bauxite, 35; residue from French bauxite, 42; residue from English bauxite, 15; Cuban bog ore, 31; "metallic paint," 49.—J. E. C.

[*Lubricating*] oil; *Resistance of*—*to emulsification*. W. H. Herschel. Techn. Paper No. 86, Bureau of Standards, Dept. of Commerce, U.S.A. Feb. 17, 1917, 1—37.

THE term "demulsibility" (see Philip, this J., 1915, 697) is defined as the maximum rate at which an oil separates from an emulsion in c.c. per hour, and it is used as a measure of the resistance of the oil to emulsification. Any method of determining it must be empirical, and the following method is therefore suggested as embodying conditions which can be readily reproduced:—20 c.c. of the oil and 40 c.c. of distilled water are placed in a 100 c.c. cylinder having an internal diameter of 26 mm., and are heated to 55° C. in a water bath. They are then stirred for 5 mins. by means of a paddle (89 by 20 by 1.5 mm.) rotating at a speed of 1500 revolutions per min. The cylinder is allowed to stand for not more than 1 hour at 55° C., and from each of the readings, taken at intervals, of the volume of oil which separates, the average rate of settling between the time of stopping the paddle and the time of observation is calculated. A perfect non-emulsifying oil would show a rate of settling of 1200 c.c. per hour, the first reading being taken one min. after stopping the paddle. Care must be taken that an average sample of the oil is used for the test, and that if received in a glass bottle the oil is not exposed to sunlight. In the case of certain oils, notably marine engine oils, part of the water may not enter the emulsion, and it may then be necessary to reduce the speed of the paddle to 1000 r.p.m., or to increase the speed, or prolong the time of stirring. A low demulsibility is invariably found when the oil has a high acidity, but the reverse does not always hold good. A similar relationship is found between the percentage of ash and the demulsibility, but the relationship between the carbonisation properties and the demulsibility is less pronounced. With regard to steam-cylinder oils the conclusion is drawn that those showing strong emulsibility are undesirable, since as a rule they will contain soap, and will show too great a decrease in viscosity between the temperature at which they are tested and that prevailing within the cylinders. Transformer oils usually have a demulsibility of 1200, and a high demulsibility is thus a proof of great purity. It has also been found in practice that oils showing high demulsibility can be used for a longer time before becoming useless from the formation of deposits. The General Supply Committee has specified in some of its contracts for U.S. Government departments that turbine and spindle oils shall have a demulsibility of 300. This is approximately the value given by a mixture of 1 vol. of equal parts of kerosene oil and olive oil with 2 vols. of water. On the other hand, a demulsibility of zero is to be expected in the case of oils, such as marine engine oils, where an emulsifying oil is required. Since oils become acid and emulsify more readily with use, the demulsibility decreases, but as a general rule, oils which have low demulsibility when new do not show so rapid a decrease as those of higher demulsibility. In the

case of five new turbine oils the demulsibility ranged from 192 to 1200, whilst 13 oils which had been in use for 1 to 36 months gave values of 3 to 98. It is suggested that a demulsibility value might be found for any particular turbine beyond which it would be unsafe to go. Determination of the acidity would give the same information but is less sensitive than the demulsibility test.—C. A. M.

Analysis of light oils [for benzene, toluene, and xylene]. Egloff. See 111.

PATENTS.

Coke oven heating flues; Construction of—R. Fabry, Sheffield. Eng. Pat. 105,017, Dec. 19, 1916. (Appl. No. 18,169 of 1916.)

THE heating flues, and air-, gas-, and waste-heat-ports of a coke oven are so arranged that a large flow of products of combustion constantly dilutes the incoming gas and air. The mixture circulates through the heating flues at a much greater rate than that determined by the individual consumption of air and gas of each heating flue, with the object of maintaining more uniform temperatures throughout the length of the heating flues.—J. E. C.

Ammonium chloride; Recovery of—in the manufacture of gas or coke. E. Myers, and The Shelton Iron, Steel, and Coal Co., Stoke, Eng. Pat. 104,942, Mar. 31, 1916. (Appl. No. 4798 of 1916.)

AMMONIUM chloride is recovered in the usual manner by spraying the gas with water at a minimum temperature of 80° C. and at about 40 lb. pressure. The solution formed may be decolorised by agitating when at boiling point in the presence of carbon, or it may be first evaporated, the resulting dried salt mixed with 2% by weight of nitro-hydrochloric acid (two parts HCl to one of HNO₃), and the whole dissolved, the resulting solution being decolorised as described, then neutralised with ammonia, and evaporated to the required strength for crystallising.—J. E. C.

Gas from liquid hydrocarbons; Apparatus for and process of making—W. C. Dayton, Buffalo, N.Y., U.S.A. Eng. Pat. 104,822, Feb. 18, 1916. (Appl. No. 10,889 of 1916.)

IN a gas producer for making a fixed combustible gas by the reaction of a mixture of liquid hydrocarbon or other combustible and air or other combustion-supporting gas, of the type in which the mixture is introduced into a heated "converter" having tortuous passages formed by radial baffles, means are provided for preheating the hydrocarbon and air or the like. The pipe conveying the mixture into the "converter" is placed within the delivery pipe for the heated gaseous product. To prevent cracking of the converter due to expansion strains, it is made in the form of a flattened ellipse in cross-section instead of rectangular, and the radial passage conveying the mixture to the centre is cast integral with the baffle-plates, while the inlet pipe is connected to this passage by a shallow taper thread.

—W. F. F.

Hydrocarbons; Recovering—from absorbing oils. W. J. Mellersh-Jackson, London. From H. Koppers Co., Pittsburgh, Pa., U.S.A. Eng. Pat. 104,890, Feb. 28, 1916. (Appl. No. 2980 of 1916.)

IN an apparatus for the continuous distillation of hydrocarbons from an absorbing oil, the oil is preheated in heat-exchangers, first by benzol vapours, secondly by hot residual oil, and thirdly by live steam. The vapours from the steam superheater are conducted to the upper portion of the main still, the oil being admitted

to the same still at a lower level. The various heat-exchangers are horizontally disposed and adapted for easy access for repairs, spare units being then utilised.—J. E. C.

Mineral oils and the like: Process and apparatus for continuously distilling — C. H. Bornmann, Essen, Germany. U.S. Pat. 1,220,067, Mar. 20, 1917. Date of appl. July 29, 1912.

MINERAL oils having a boiling point above 100° C. are preheated and dehydrated, and continuously distilled in a main column by contact at first with superheated steam, and the vapour is passed into a cooler to condense the lighter oil vapours. A portion of the steam and oil vapour from the cooler is superheated and returned to the main column for distilling the oil and feeding the column. The separated oils boiling below 100° C. are re-distilled in another column by the remainder of the steam and oil vapour from the cooler, and the distillate is drawn off for separation of the lighter constituents.—W. F. F.

Hydrocarbon oils: Apparatus for dehydrating — E. I. Dyer, Oakland, Cal. U.S. Pat. 1,220,504, Mar. 27, 1917. Date of appl. Mar. 5, 1913.

HYDROCARBON oils are treated in a series of closed vessels each provided with a system of heat-circulating tubes and with vertical longitudinal baffles arranged to form a tortuous path for the oil. Heat from an outside source is supplied to the tubes of one vessel, the vapours from this vessel passing through the heating tubes of an adjoining vessel.—J. E. C.

Hydrocarbons: Process and apparatus for obtaining from gases. G. Linderborg and W. B. Scott, Los Angeles, Cal. U.S. Pat. 1,220,651, Mar. 27, 1917. Date of appl. Jan. 15, 1916.

NATURAL gas containing gasoline or similar hydrocarbons of low boiling point is passed, along with an emulsion of water and a hydrocarbon of high boiling point, through a body of filamentary material presenting sharp points. The absorbed hydrocarbon is recovered by heating the emulsion.—J. E. C.

Continuous stills for coal tar, mineral oils, and similar products. Eng. Pat. 104,636. See III.

Retort furnace for production of hydrogen from iron and steam. Ger. Pat. 294,911. See VII.

Apparatus for indicating the composition of gases. U.S. Pat. 1,220,637. See XXIII.

II.B.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

A polarisation flicker photometer and some data of theoretical bearing obtained with it. Ives. See XXIII.

PATENTS.

Electric conductors suitable for sealing into vitreous material. The British Thomson-Houston Co., Ltd., London. From General Electric Co., Schenectady, N.Y., U.S.A. Eng. Pat. 101,758, Mar. 25, 1916. (Appl. No. 4153 of 1916.)

A LEADING-IN conductor for sealing into electric lamps and the like is composed of an outer shell of copper, brass, platinum, or an alloy of nickel and iron, and an inner wire of brass, copper, or brass coated with copper, the intermediate space being filled with a layer of carbon or graphite,

or other refractory material such as silica, manganese dioxide, calcium oxide, chromium oxide, powdered cast iron or steel, plaster of Paris, or china clay. The outer shell is hermetically sealed into the glass and the ends are welded to ordinary wires or otherwise hermetically sealed as by soldering. The leading-in conductor may comprise a composite wire knotted to another composite wire, or to a solid wire, the knot being embedded and sealed in the glass. The composite wire may be in the form of a bight embedded in the glass with both ends on one side, the intermediate part being connected to a conductor on the other side.—W. F. F.

Insulator: Electric — [for lamp sockets]. N. Marshall, West Newton, Mass. U.S. Pat. 1,217,873, Feb. 27, 1917. Date of appl. Jun. 20, 1916.

AN insulating lining for lamp sockets is formed from a dielectric heat-resisting carrier, in the form of an asbestos tube, impregnated with decomposition and reaction products of an emulsion, formed from a mixture of 30 to 70% of sodium silicate and 70 to 30% of linseed oil, and baked at a high temperature so as to polymerise and oxidise the oil. The insulator varies in colour from brown to black, in accordance with the higher degree of heating employed in baking, the black material being more brittle than the brown.—B. N.

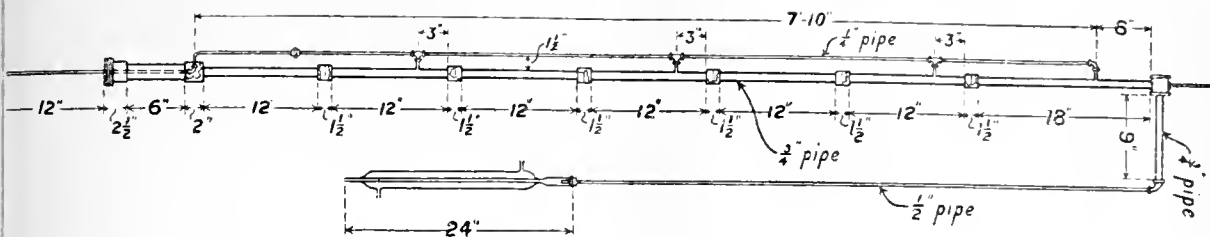
Method of making decolorising materials. U.S. Pat. 1,219,438. See I.

Preserving gas. U.S. Pat. 1,219,527. See XIX.B.

III.—TAR AND TAR PRODUCTS.

Light oils: Analysis of — [for benzene, toluene, and xylene]. G. Egloff. Met. and Chem. Eng., 1917. 16. 259–263.

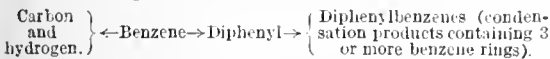
Distillation apparatus. The still consists of a copper flask of 4000 c.c. capacity, provided with a fractionating column, 8 ft. high, and a condenser 24 in. long. The column (see fig.) is made up of six 12 in. and one 18 in. lengths of $\frac{3}{4}$ in. and one 6 in. length of $1\frac{1}{2}$ in. iron pipe, connected by suitable unions; it has a reflux tube ($\frac{1}{4}$ in. diam.) which extends through the lowest section of the column to within 1 in. of the bottom of the flask when the latter is screwed into position. The reflux tube communicates with the main column at intervals, and the different sections of the column are separated by diaphragms of 30-mesh iron wire gauze, each of which supports an 8 in. column of glass rods 2 in. long and $\frac{1}{4}$ in. diam. The head of the column has an opening at the top for a thermometer and at the side a $\frac{3}{4}$ in. exit pipe connected with the condenser by a $\frac{1}{2}$ in. metal tube. The heating burners below the flask are surrounded by an asbestos draught screen; and when employed in draughty situations the whole column is set in a box provided with a hinged door. In testing the apparatus, 2000 c.c. portions of known mixtures of highly purified benzene, toluene, and xylene were distilled at the rate of 2 drops per sec., the rate being checked by means of a metronome and stopwatch. The mixtures contained 2–80, 3–90, and 6–58% of the respective hydrocarbons, and in every case the result obtained by a single distillation was in close agreement with the theoretical, the loss being very small. In the case of various commercial oils (e.g., Pintsch hydrocarbon oil) a much better separation of benzene, toluene, and xylene was effected by a



single distillation in this apparatus than by three successive fractionations with a standard Hempel column. *Method of analysis.* 2000 c.c. of the oil, contained in a vessel provided with a cooling coil and stirring apparatus, is agitated for about 80 mins. with 200 c.c. of 95% sulphuric acid (added at the rate of 1 drop per sec., or about 3.75 c.c. per min.), and the mixture allowed to stand for 30 mins.; the acid sludge is then discharged and the remaining oil, now free from olefines, agitated for 15 mins. with a 6% solution of caustic soda and allowed to stand for 30 mins. After separation from the alkali sludge, the oil is placed in a copper container of 4000 c.c. capacity and distilled with live steam until the temperature reaches 180° C. The oil is then separated from the distillate and, after thorough drying with calcium chloride, distilled in the apparatus described, the fractions boiling up to 95°, between 95° and 125°, and between 125° and 165° C., being collected, measured, and recorded as pure benzene, toluene, and solvent naphtha, unless the specific gravities (as determined at 15.5° C. by means of a Westphal balance) fall below 0.880, 0.871, and 0.870, respectively, when the presence of paraffins is indicated. In the latter case the proportion of paraffins present is calculated on the basis of the wide difference in specific gravity between paraffin and aromatic hydrocarbons distilling over the same range of temperature, or is determined by agitating 10 c.c. of the fraction with 25 c.c. of a mixture of 2 parts of ordinary (sp. gr. 1.84) and 1 part of fuming (20% oleum) sulphuric acid in a stoppered graduated cylinder, allowing the mixture to settle, and reading off the volume of undissolved oil. Specifications for benzene and toluene for use in the manufacture of phenol, picric acid, and trinitrotoluene are also given.—W. E. F. P.

Benzene; Thermal decomposition of — J. E. Zanetti and G. Egloff. *J. Ind. Eng. Chem.* 1917, 9, 350–356.

THE decomposition of benzene at 600° to 800° C. and ordinary pressure in an electrically heated iron tube furnace takes place in accordance with the following reactions:—



Below 750° C. the reaction velocity of the diphenyl formation is greater than that of the formation of carbon and hydrogen; above this temperature, the velocity of the carbon-hydrogen reaction becomes very great and the benzene is decomposed before other condensation products can be formed. The formation of diphenyl begins as low as 500° C. Acetylene and naphthalene are not formed during the reaction. Iron and nickel gauze favour the decomposition to carbon and hydrogen; the action of copper gauze is not marked except above 750° C., when the formation of carbon is accelerated. (See also McKee, this J., 1904, 403; Rittman, Byron, and Egloff, *ibid.*, 1916, 105.)—W. P. S.

Action of pyridine and piperidine on organic compounds containing sulphur. Raffa and Balduzzi. See XX.

PATENTS.

Coal tar, mineral oils, and similar products: Continuous stills for — H. Moore and C. Day, Stockport. Eng. Pat. 104,636, Aug. 29, 1916. (Appl. No. 12,188 of 1916.)

A PLANT for the continuous distillation of coal tar, mineral oils, and the like consists of two or more stills arranged so that the vapours of the distillate from one still are conducted by a coil through the body of the tar or the like in the adjacent still without actual contact. The vapours pass through the series of stills in the opposite direction to the tar or the like. Means are provided for collecting the vapours of the distillate separately from each still, after having withdrawn heat from them by passing through the coil in the previous still, and the dimensions of the stills are such that the ratio between the area of the upper tar surface, which is free for frothing, to the volume of tar employed is greater in the stills of lower temperature and less in the stills of higher temperature.—F. W. A.

Picric acid and other nitrophenols from certain gums or gum-resins: Manufacture of — H. C. Miller, London, and H. A. Irlam, Mill Hill, Middlesex. Eng. Pat. 104,352, Feb. 2, 1916. (Appl. No. 1588 of 1916.)

PURIFIED gums or gum-resins, alone or dissolved in concentrated acetic acid, are treated below 40° C. with nitric acid, any unconverted gum or gum-resin is removed, and the solution of picric acid or other nitrophenol is boiled and crystallised.

—F. W. A.

Nitro-compounds: Making — C. Ellis and A. A. Wells, Montclair, N.J., Assignors to Ellis-Foster Co. U.S. Pat. 1,220,078, Mar. 20, 1917. Date of appl., May 31, 1916.

CHLOROBENZENE is nitrated by heating with sodium nitrate and sulphuric acid (66° B.; sp. gr. 1.84) to a temperature at which the nitration progresses regularly without the evolution of large quantities of oxides of nitrogen.—F. W. A.

Pitch or like material; Method of disintegrating and lading hard — C. Still, Recklinghausen, Germany. U.S. Pat. 1,221,211, Apr. 3, 1917. Date of appl., Sept. 22, 1915.

SEE Eng. Pat. 13,546 of 1915; this J., 1916, 218.

Kelonic compounds; Process of producing — A. Lüttringhaus, Mannheim, and W. Koch, Assignors to Badische Anilin u. Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,220,218, Mar. 27, 1917. Date of appl., Oct. 1, 1914.

SEE Ger. Pats. 287,991 and 289,108; this J., 1916, 352, 353.

Alkylarylamine production. G. T. Morgan, London, Assignor to Levinstein, Ltd., Manchester. U.S. Pat. 1,221,077, Apr. 3, 1917. Date of appl., June 1, 1916.

SEE Eng. Pat. 102,831 of 1916; this J., 1917, 207.

Recovering hydrocarbons from absorbing oils. Eng. Pat. 104,899. See II A.

Process and apparatus for continuously distilling mineral oils and the like. U.S. Pat. 1,220,967. See II A.

Material for the preservation of lumber. U.S. Pat. 1,220,991. See IX.

IV.—COLOURING MATTERS AND DYES.

Pyrene colours. A. E. Everest, J. Soc. Dyers and Col., 1917, 33, 78—86.

IN a review of the chemistry of the natural and synthetic pyrene colours, the researches of Ohmann and Pauchard, A. G. Perkin, Kostanecki and Tamber, Watson, and the author are outlined. The synthetic colours are divided into two series: diphenylmethane, or xanthene, derivatives, and triphenylmethane, or phenylxanthene, derivatives; they differ somewhat, however, from the triphenylmethane series in that they are less easily decolorised by reduction, and when decolorised their leuco-compounds are more easily oxidised by air. In this respect they behave rather more like the *ortho*- than the *para*-quinonoid colours; the violet and blue members of this class, e.g., Fast Acid Blue, particularly show this resemblance to *ortho*-quinonoid substances.—F. W. A.

[*Methylene Violet and Methylene Azure.*] *Manufacture of Methylene Blue derivatives for microscopy.* L. Tribondeau and J. Dubreuil. Comptes rend., 1917, 164, 551—553.

THE action of alkalis on Methylene Blue yields products valuable in microscopy, e.g., silver oxide yields the blue of Borrel, potassium carbonate produces the Polychrome Blue of Unna, sodium borate gives the blue of Manson, etc. Methylene Violet and Methylene Azure are prepared as follows: 5–10% of ammonia solution is added to a 1% solution of pure medicinal Methylene Blue, the liquid is heated on a boiling water-bath and filtered hot. Evaporation of the filtrate to dryness at 37–40° C. gives practically pure Methylene Violet. The residue is exposed to air in an ice-chamber for at least 24 hrs. until it has become blue-black, when it is dissolved in distilled water, filtered, and the filtrate evaporated to give Methylene Azure. Three staining solutions are prepared from the two products: (1) a 1% solution of Methylene Azure in distilled water; (2) the Polychrome Blue by mixing 1% solutions of the two products, e.g., 1 part of the azure solution to 3 parts of the violet solution; and (3) an alcohol-glycerin (3:1) solution of Methylene Azure and Eosine ("azéo"), similar to the mixture of Giemsa. Details for their use in staining are given.—F. W. A.

PATENTS.

[*Sulphur*] *colouring matter or dyes: Treatment of certain gums or gum-resins for the manufacture therefrom of —.* H. C. Miller, London, and H. A. Islam, Mill Hill, Middlesex, Eng. Pat. 191,353, Feb. 2, 1916. (Appl. No. 1589 of 1916.)

GUMS or gum-resins produced from plants of the *Xanthorrhoea* genus, commonly known as grass-tree, acaroid, botany-bay, and black-boy gums, purified or otherwise, are treated with sulphuric acid, or with an alkali and sulphur and or a sulphur compound, e.g., sodium sulphide: the former yields brown dyes for leather, wood, wool, and the like; the latter gives products yielding bronze, brown, grey, or black shades. (Reference

is directed, in pursuance of Sect. 7, Sub-sect. 1, of the Patents and Designs Act, 1907, to Eng. Pat. 1189 of 1873.)—F. W. A.

Triarylmethane-azo dyestuffs and metal compounds thereof: Manufacture of leuco — and application of the dyestuffs and compounds in dyeing. O. Imray, London. From Soc. Chem. Ind. in Basle, Switzerland. Eng. Pat. 191,743, Mar. 17, 1916. (Appl. No. 3988 of 1916.)

BY coupling the diazo-compound of a leuco-triarylmethane derivative containing in the aryl residue a hydroxyl group in *ortho* position to an amino group with one of the usual components, leuco-triarylmethane azo dyestuffs are obtained. The new dyestuffs have pronounced mordant dyeing properties, and give fast dyeings on animal fibres by the usual processes for mordant and after-chrome dyestuffs, and may be converted into copper or other metal compounds which give dyeings on animal fibres fast to milling, potting, and light.—F. W. A.

Sulphonating coal-tar dyes. E. D. Kendall, Elizabeth, N.J., Assignor to L. T. and M. V. Haggin, A. McCulloch, and H. E. Moller, exors. of J. B. Haggin. U.S. Pat. 1,217,462, Feb. 27, 1917. Date of appl., July 13, 1916.

SODIUM hydrogen sulphate is converted into the disulphate which is "persulphated" with one chemical equivalent of monohydrated sulphuric acid, and the pulverised and dehydrated coal-tar dye to be sulphonated is added to the fused mass; after thorough admixture until sulphonation of the dye is effected, the mass is dissolved in water, the excess of sulphuric acid is removed with an equivalent amount of calcium hydroxide, and the filtrate is evaporated to dryness.—F. W. A.

Chlorinated products of xylene, aldehydobenzoic acids, and [triphenylmethane] dyestuffs therefrom: Manufacture of —. J. Schmidlin and M. Fischer, Frankfurt, Germany. U.S. Pat. 1,219,166, Mar. 13, 1917. Date of appl., May 16, 1916.

XYLENES chlorinated in the nucleus are chlorinated at elevated temperatures (100°–130° C.), whilst exposed to light, until four or five more chlorine atoms have been introduced in the side chains; the products are converted by means of concentrated sulphuric acid into chlorinated dialdehydes or aldehyde-carboxylic acids which are condensed with *o*-cresotic acid, and the resulting leuco-compound is oxidised with sodium nitrite in concentrated sulphuric acid solution. The triphenylmethane dyestuffs from chlorinated aldehydobenzoic acids and *o*-cresotic acid dye wool brown-red from an acid bath, yielding after chroming bright, violet-blue dyeings of very good fastness to washing and to milling.—F. W. A.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Setting of litharge-glycerol cement. Merwin. See XIII.

PATENTS.

Stocking [fabric]: Treated —. A. Gardos, Cleveland, Ohio. U.S. Pat. 1,219,151, Mar. 29, 1917. Date of appl., Oct. 4, 1915.

STOCKING fabric is impregnated with formaldehyde and treated with a wool fat solution to prevent the escape of the formaldehyde, which acts as a preservative and disinfectant and counteracts the butyric acid separated by the sweat glands.

—F. W. A.

Method of manufacturing oxalic acid [from waste paper pulp lyes]. U.S. Pat. 1,217,218. See VII.

Rubber composition and process of making the same. U.S. Pat. 1,217,157. See XIV.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

[*Alizarin* :] *Production of fast dyeings [with —].* O. Diehl. *Färber-Zeit.*, 1916, 27, 134—137. *J. Soc. Dyers and Col.*, 1917, 33, 91—92.

A LARGE amount of the preliminary treatment for obtaining satisfactory whites has been dispensed with by using a slightly acid Alizarin dye-bath, keeping the material in rapid motion, and rapidly raising the temperature to complete the dyeing within a quarter of an hour. Details of suitable mordanting and dyeing solutions are given.

—F. W. A.

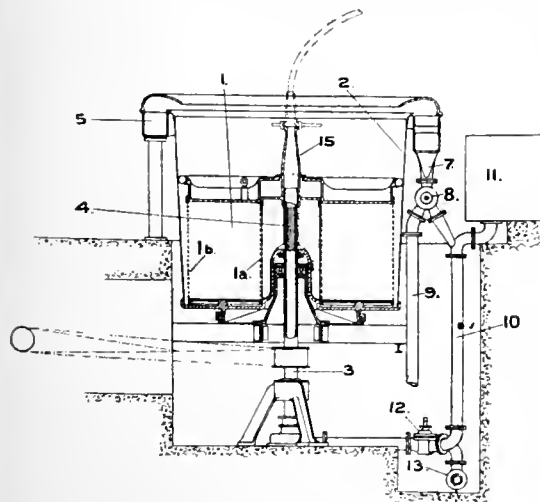
PATENTS.

Mercerising yarn: Machines for —. B. E. D. Kilburn, London. From Sulzer Frères Soc. Anon., Winterthur, Switzerland. Eng. Pat. 105,044, July 5, 1916. (Appl. No. 16,627 of 1916.)

IN a machine for mercerising yarn in the form of skeins or hanks, the lye tank and the trough for the neutralising liquor are mounted on shafts so that they can be swung alternately into and out of their operative position below the horizontally arranged yarn hanks. The lye tank has an outlet provided with an overflow opening into a channel, into which it discharges its contents on being turned.—F. W. A.

Dyeing, bleaching and the like of textile fibres or goods: Machines for —. H. J. Moysey, Gateshead, and H. Johnson, Leicester. Eng. Pat. 104,718, Mar. 11, 1916. (Appl. No. 3647 of 1916.)

A CONTAINER, 1, in an outer rotary pan, 2, keyed to a hollow shaft, 3, provided with slots, 4, to admit treating fluid, consists of an annular cage having a perforated central sleeve, 1a, surrounding the slots, 4, and a perforated outer cylindrical wall, 1b. The wall of 2 diverges upwards and terminates in a flared mouth opening into an annular collecting trough, 5, which has an outlet, 7, connected by a cock, 8, to either a waste pipe, 9, or a return pipe, 10, the latter being connected to



a supply tank, 11, and by means of a cock, 12, either to the hollow shaft, 3, or main waste pipe, 13. The connection, 15, may be connected to an exhausting apparatus or air compressor. On rotating 2, the liquor rises in the vat and is discharged into 5.—F. W. A.

Hook dyeing and finishing machines. F. F. Larivei, Bradford. In part from P. Fincato, Milan, Italy. Eng. Pat. 104,698, Feb. 8, 1916. (Appl. No. 1845 of 1916.)

A MACHINE for dyeing or similarly treating hanks of textile fibre contains a number of stub shafts driven from a main driving shaft through automatically reversing gearing, and having sockets to receive detachable sticks of non-circular cross-section, which support the hanks. (Reference is directed, in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pat., 1968 of 1868, 1810 of 1870, and 7969 of 1903; this J., 1903, 1345.)—F. W. A.

Manufacture of leuco-triethylmethane-azo-dyestuffs and metal compounds thereof, and application of the dyestuffs and compounds in dyeing. Eng. Pat. 104,743. See IV.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Sulphuric acid: Concentration of —. E. H. Armstrong. *J. Ind. Eng. Chem.*, 1917, 9, 386—388.

IN the tower method of concentrating sulphuric acid to 93 to 97%, quartz is used as the packing material and an oil flame for the heat. In practice it is usually necessary to discontinue the operation after a week to 10 days' working, and to wash the tower out. This has been found to be caused by the acid disintegrating the quartz, as much as 50% being removed in some cases, so that the tower became so open that it would not concentrate the acid beyond 63° B. (sp. gr. 1.775). This may be remedied by opening the top of the tower, and introducing small pieces of broken quartz through a cast-iron drain pipe serving as a funnel. In the author's experience a tower thus received as much fresh quartz during a period of several months as was used for the original charge. A tower working well will usually show a temperature of about 1200 to 1400° F. (650—760° C.) for the gas entering and about 280° to 290° F. (138—143° C.) with about $\frac{5}{8}$ in. suction in the outlet flue at the top. When it is not working well an increase in the temperature of the gas entering the tower and in the suction pressure in the flue will be observed, whilst there will be a decrease in the temperature of the gas leaving the tower. When this temperature falls to about 250° F. (121° C.) very little acid of 66° B. (sp. gr. 1.84) is being made. To remedy this condition the process should be interrupted and weak acid run down the tower until the packing becomes fairly cool, after which it is thoroughly washed with water for at least 12 hours. On restarting work the temperature of the entering gas will be about 200° F. (about 110° C.) lower and that of the gas leaving the tower about 40° to 50° F. (22—28° C.) higher than before, whilst the suction pressure in the flue will only show about one-half to $\frac{5}{8}$ in. A strong suction must be obtained by means of steam jets or a fan, to prevent condensation of the vapours and distillates within the tower. On the other hand when the tower becomes too open, the gases will leave the tower too hot (350° to 360° F., 177—182° C.), and the suction pressure in the flue will fall almost to nothing.

whilst the temperature of the entering gas will decrease by 200° to 300° F. (110°—167° C.). This condition is remedied by the introduction of quartz as described. In one case difficulty was experienced owing to the brick lining between the packing and the lead having become open. This was remedied by cementing the bricks with acid-proof cement (sodium silicate and "silax"). With regard to the losses of acid it is estimated that under normal conditions when the tower is being fed with 60,000 lb. of acid of 60° B. (sp. gr. 1.71) in 24 hours, the loss during that period would be 2000 to 4000 lb. of 60° B. acid, whilst about 39,000 lb. of 66° B. acid would be obtained, and the balance of 9208 lb. of 60° B. acid would be recovered in the scrubbers. This scrubber acid is of about 46° B. (sp. gr. 1.47), and is subsequently brought to 60° B. in the Glover tower. The loss of acid varies greatly with the draught, being much greater when a very strong draught is used. The best course is to have only just enough draught to take the distillate from the top of the tower.—C. A. M.

Salt manufacture by solar evaporation of sea water.
L. A. Palmer. Met. and Chem. Eng., 1917, 16, 317—319.

THE process is carried out at San Diego Bay in Southern California, a long and narrow land-locked arm of the Pacific Ocean. The sea water is admitted each fortnight at high tide from the bay to four tide ponds, from which it is transferred by pumps for another two weeks to upper secondary ponds, and then to lower secondary ponds. The calcium carbonate settles out in these ponds, and the liquor is then transferred to the "pickling pond," where calcium sulphate is precipitated. The brine is finally drained to the crystallising pond where the salt is separated, and from this pond the liquor is passed to the bittern ponds. The salt is shovelled into cars, delivering into a bin from which the salt is discharged by a screw conveyor and an elevator into the washer, where it is treated with brine from the pickling pond. It receives a further brine washing and is sprayed with fresh water whilst being elevated to the stack piles, where it is dried.—B. N.

Iodine: The form of — in marine alga. Y. Okuda and T. Eto. J. Coll. Agric., Tokyo, 1916, 5, 341—353.

THIS research demonstrated that by far the greater part of the iodine in the algae investigated was in organic combination. The inorganic iodine was found by the Fresenius method, and to determine the organic form the aqueous extract was acidified with sulphuric acid, filtered, treated with nitrite and chloroform, and the chloroform layer titrated with sodium thiosulphate. Organic iodine in the aqueous solution separated from the chloroform layer was determined by fusing with sodium hydroxide and nitre, and then estimating the iodide formed. The iodine in the sulphuric acid precipitate and in the insoluble residue was also determined by the fusion method. Of the total iodine found in *Ecklonia cara*, 90% was in a soluble organic form, and was not liberated by boiling with dilute sulphuric acid or potassium hydroxide. Fresh samples of *Ecklonia bicyclis* contained under 5% of the iodine in the form of iodide, and 95% organic; of the latter 90% was soluble. The amount of iodine in this plant increases from winter to summer, and old plants contain more than young plants. *Turbinaria fusiformis*, Yendo, *Sargassum enerve*, Ag., and *Sargassum horneri*, Ag., contained respectively 50, 78 and 66 (from different localities), and 66% of soluble organic, and 22, 16 and 17, and 12%, respectively, of the soluble inorganic element. The Japanese food "Dashikombu," made from *Laminaria* by

drying and partially fermenting, contains 95% of its iodine in an inorganic state. Experiments on *Ecklonia bicyclis* showed that it did not contain an enzyme, but some micro-organisms effect its gradual disintegration. Dilute solutions of sodium chloride, calcium chloride, and hydrochloric acid exerted a marked effect on the decomposition of the organic iodine compound in the same plant, as did also concentrated solutions of sulphuric acid and of sodium hydroxide. On heating the *Ecklonia bicyclis* with formalin, some iodine escaped and most of the remainder was converted into the inorganic form: hence boiling with formalin is a simple test for the detection of organic iodine in algae. The soluble organic iodine of *Ecklonia bicyclis* is precipitated by basic lead acetate and by Stutzer's copper reagent, but the chief iodine compound in the extract is not combined with protein. Algae from the open sea apparently contain more iodine than the same species from inland seas. Since the iodine content of dead algae readily diffuses into sea- or fresh-water, drifted algae are not suitable as a source of the element.—E. H. T.

Silicon and its thermoelectric power. F. Fischer and E. Baerwind. Z. anorg. Chem., 1916, 97, 56—72. Z. angew. Chem., 1916, 29, Ref., 536.

OF the two thermoelectrically differing kinds of silicon, the negative form (crystallised from zinc) does not contain, so far as can be shown analytically, more oxygen than the positive. Both have the same specific gravity (2.33). While the existence of two different modifications of silicon is not considered impossible, the authors favour the idea that the differing thermoelectric properties of the negative form are due to the presence of silicon dioxide in solid solution. The two kinds of silicon behave differently in their action as electrical rectifiers. In the analytical work with silicon, evidence was found that it took up oxygen while being ground in an agate mortar.—H. J. H.

Ozone; Determination of —. David. Compt. rend., 1917, 164, 430—431.

THE ozone in air is estimated by adding 5 c.c. of N/100 ferrous ammonium sulphate acidified with sulphuric acid to a vessel of 1 litre capacity, and then titrating back with N/1000 potassium permanganate. For higher concentrations of ozone, N/10 and N/100 solutions respectively may be used.—B. N.

Gas purification oxides. Scott. See IIA.

Utilisation of nitre-cake [for manufacture of glass]. Morgan. See VIII.

"Thiogen" process for removing sulphur [dioxide from smelter] fumes. Young. See X.

Aluminium and carbon. Ruff and Jellinek. See X. PATENTS.

Sulphuric acid chambers. J. Harris, Sheffield, and D. H. Thomas, Morriston, Glamorgan. Eng. Pat. 101,161, Aug. 15, 1916. (Appl. No. 11,517 of 1916.)

A SULPHURIC ACID chamber of circular construction is provided with a pipe for admitting the gases tangentially near the bottom, so as to direct them round the walls, and with a central hollow column extending upwards from the pan and opening at the upper part into the chamber to form an exit pipe for the gases. The central column may be cooled by sprays of weak acid or water directed against it, or by adjacent water-cooled pipes, and in the last chamber of a series it may be packed and supplied with acid to percolate down the packing with the gases, thus replacing part of the absorption towers at the end of the system.—F. Sp.

Lead chambers; Method of firing the walls of — H. Petersen, Berlin-Steglitz. Ger. Pat. 295,911, May 9, 1914.

THE framework supporting the wall is constructed of horizontal and vertical bars, for example of round iron, gas-pipe, or the like. Connecting bands partly or completely encircle the horizontal bars and have their free ends held firmly against the vertical bars by clamping devices. The lead straps attached to the lead wall for the purpose of supporting it on the framework are hook- or ring-shaped and encircle the horizontal bars of the framework. The lead wall may consist of alternate broad and narrow strips, of which only the latter are provided with horizontal rows of straps for fixing to the framework, the broad straps hanging free.

Oxalic acid [from waste paper pulp lyes]; Method of manufacturing — H. C. Reed, Stamford, Conn. U.S. Pat. 1,217,218, Feb. 27, 1917. Date of appl., Sep. 23, 1915.

WASTE liquor from the manufacture of paper pulp is reduced to an approximately dry residue, and concentrated nitric acid added in the proportion of 300 lb. of acid to 100 lb. of residue, the temperature being maintained at about 95° C. until oxidation is complete. Excess of nitric acid and water are then driven off by heat, and the oxalic acid recovered by crystallisation.—T. H. B.

Acetic acid; Preparation of — from acetaldehyde. Badische Anilin u. Soda Fabr. Ger. Pat. 294,724, Feb. 11, 1914.

ACETALDEHYDE is oxidised by air or oxygen in presence of iron compounds and organic salts of alkalis or alkaline earths, including magnesium and aluminium. The reaction is accelerated without the formation of per-acids. It proceeds rapidly and completely in the cold.—H. J. H.

Aluminium nitride; Process for the manufacture of — Soc. Gén. des Nitrures, Paris. Eng. Pat. 101,091, July 25, 1916. (Appl. No. 10,450 of 1916.) Under Int. Conv., Aug. 2, 1915.

AIR is blown through a heated chamber into a narrower passage into which powdered carbon falls from a hopper. The temperature of the air is sufficient to ignite the carbon, the supply of which is adjusted to produce with the air a mixture of carbon monoxide and nitrogen. The hot gases are further heated by passing across one or more electric arcs, and then receive from a hopper a regulated supply of aluminous material (alumina or bauxite) and carbon. If the formation of aluminium nitride is not complete, the mixture is carried through one or more electric arcs to finish the reaction.—F. SP.

Chemical reactions; Process for carrying out — [Preparation of aluminium nitride.] O. Serpek, Assignor to Soc. Gén. des Nitrures, Paris. U.S. Pat. 1,217,842, Feb. 27, 1917. Date of appl., Jan. 26, 1914.

ALUMINIUM nitride is produced by projecting aluminous material and carbon in powdered form through a space through which nitrogen is caused to flow in a direction across the flow of powdered material, the whole being heated to the temperature of the reaction.—F. SP.

Ammonium nitrate and other products; Process of making — F. S. Washburn, New York. U.S. Pat. 1,217,217, Feb. 27, 1917. Date of appl., May 6, 1916.

A MIXTURE of gases containing ammonia and oxygen is subjected to the action of a catalyst at such a rate that the reaction product contains nitrous gases and not more than 20% of free ammonia. A solution of nitric acid and ammonium nitrate is produced from the reaction

product, and free ammonia is added to convert all the nitric acid into nitrate, which may be isolated and treated to yield concentrated nitric acid.—T. H. B.

Flue-dust [from cement-kilns]; Leaching — F. W. Huber and F. F. Reath, Riverside, Cal., Assignors to W. G. Henshaw, San Francisco, Cal. U.S. Pat. 1,220,989, Mar. 27, 1917. Date of appl., Dec. 2, 1916.

POTASSIUM salts are extracted from flue-dust from cement kilns by agitating it with water and then separating the insoluble matter, both operations being carried out at a temperature above 85° C., in order to prevent the formation of the insoluble double salt, $\text{CaSO}_4 \cdot \text{K}_2\text{SO}_4 \cdot \text{H}_2\text{O}$.—A.B.S.

Sulphates and hydrochloric acid; Preparation of — Salzwerk Heilbronn A.-G., and P. Brandenburg, Heilbronn. Ger. Pat. 295,074, July 31, 1915.

FUSED alkali chloride is sprayed by means of sulphuric acid or a mixture of sulphuric acid with air or steam or with sulphur dioxide and steam. Decomposition occurs with the liberation of hydrochloric acid, and alkali sulphate is precipitated as a fine powder.—H. J. H.

Zirconium oxide; Preparation of pure — free from iron. K. Leuchs, Baselmühle. Ger. Pat. 295,246, Aug. 1, 1915. Addition to Ger. Pat. 285,311.

A SOLUTION of crude zirconium oxide in hydrochloric acid is treated with sulphuric acid ($3\text{ZrO}_2 \cdot 2\text{H}_2\text{SO}_4$) and allowed to stand in the cold or at 40° C. Zirconium sulphate separates in small prisms, which are free from iron and also titanium (cf. Hauser, this J., 1904, 677).—H. J. H.

Retort furnace for preparation of hydrogen from iron and steam. W. Näher and M. Nöding, Pforzheim. Ger. Pat. 294,911, May 4, 1915. Addition to Ger. Pat. 290,657 (this J., 1916, 602).

THE retorts used may be disposed horizontally, vertically, or inclined in the furnace and are capable of being easily replaced.—H. J. H.

Sulphur; Production of — O. Urbasch, Vienna. Ger. Pat. 294,912, Aug. 31, 1915.

SULPHUR is produced from materials which yield a portion of their contained sulphur on heating, e.g., pyrites, and spent oxide, by distillation in a vertical retort externally heated with producer gas, the oxygen-free combustion products from which are led through the charge. These combustion products complete the heating and carry away the sulphur in vapour from the condensers. The gases are led in and out of the charge through horizontal pipes which lie across the retort and have openings facing downwards. The residue may be roasted to yield the rest of its sulphur as sulphur dioxide in a muffle furnace below the retort.—H. J. H.

Arsenates; Production of metal — E. C. R. Marks, London, Assignee of T. A. Mitchell, Reading, Mass., U.S.A. Eng. Pat. 101,030, July 21, 1916. (Appl. No. 10,408 of 1916.) Under Int. Conv., July 23, 1915.

SEE U.S. Pat. 1,183,316 of 1916; this J., 1916, 737.

Base-exchanging silicates; Manufacture of — The Permutit Co., Assignees of H. Kriegsheim, New York. Eng. Pat. 101,961, May 11, 1916. (Appl. No. 6765 of 1916.) Under Int. Conv., Mar. 21, 1916.

SEE U.S. Pat. 1,208,797 of 1916; this J., 1917, 215.

Sulphur dioxide: Utilisation of—. J. B. Garner and H. D. Clayton, Pittsburgh, Pa., Assignors to Metals Research Co., New York. Reissue No. 14,277. Mar. 27, 1917, of U.S. Pat. 1,173,566, Feb. 29, 1916. Date of appl. Feb. 8, 1917.

SEE this J., 1916, 469.

Recovery of ammonium chloride in the manufacture of gas or coke. Eng. Pat. 101,942. See IX.

Water-electrolysing apparatus. U.S. Pats. 1,219,813 and 1,220,262. See XI.

VIII.—GLASS; CERAMICS.

Nitre-cake: Utilisation of— [for manufacture of glass]. G. T. Morgan. Econ. Proc. Roy. Dublin Soc., 1917, 2, 238–247.

A METHOD is suggested for the utilisation of nitre-cake which avoids serious loss of either sulphur or alkali and also the difficulties of transit or storage of the nitre-cake itself. If nitre-cake is heated with sand, sulphuric acid is evolved and a soda frit is obtained which, however, still contains some sulphate. Increase of the proportion of sand reduces the amount of residual sulphate, and this is reduced still further by the use of charcoal, sulphur and sulphur dioxide being then formed along with the sulphuric acid. The soda frit may be converted into a glass by melting with suitable oxides, etc. If the use of fluorides is avoided, the recovery of the sulphur and the formation of a glass may be carried out at one operation, the retort being connected with a sulphuric acid plant. In one experiment a mixture of nitre-cake (65 grms.), sand (100 grms.), limestone (18 grms.), and wood charcoal (6 grms.) gave 120 grms. of soda-lime glass, 2.37 grms. of sulphur, and 23.1 grms. of 80% sulphuric acid, the total percentage of sulphur recovered being 52.8. By increasing the quantity of charcoal in this mixture up to 8 grms., the sulphur recovery rose to 66% to 70%; higher amounts of charcoal led to the production of black glasses. In these experiments a nitre-cake was used containing 68.8% of sodium bisulphate. For further experiments on the production of a lead glass, the nitre-cake contained 80% of bisulphate, red lead with a little nitre and borax replacing the limestone and charcoal. Coloured glasses were obtained by the addition of the usual oxides. The efficiency of sulphur recovery was about 66%, as in the case of soda-lime glass, all as sulphuric acid, the oxidising action of the red lead and nitre preventing the separation of sulphur. The time of heating varied in the case of the soda-lime glass from 9 hrs. up to 18 hrs., most of the sulphur being evolved in the first 2 hrs.; in the case of the lead glass the time varied from 4 hrs. to 7 hrs.

—B. V. S.

PATENTS.

Enamel and process of making same. M. Mayer, Berlin-Tempelhof, and B. Havas, Berlin-Schöneberg. Assignors to Chemisch-Metallurgische Ind. G.m.b.H., Berlin, Germany. U.S. Pat. 1,220,253. Mar. 27, 1917. Date of appl. May 29, 1915.

AN opaque white enamel is prepared by adding a mixture of titanic oxide and zirconium oxide to the enamelling material.—A. B. S.

Refractory bricks; Manufacture of—. J. E. Legor, Schaerbeek-Jez-Brussels, Belgium. Eng. Pat. 12,987, May 27, 1914. Under Int. Conv., May 28, 1913.

SEE Fr. Pat. 472,640 of 1914; this J., 1915, 491.

IX.—BUILDING MATERIALS.

Setting of litharge-glycerol cement. Merwin. See XIII.

PATENTS.

Building blocks, slabs, and tiles. E. O. C. Howells, Coventry, Eng. Pat. 105,051, Mar. 23 and May 4, 1916. (Appl. Nos. 2101 of 1917 and 6128 of 1916.)

BUILDING materials are made of 6 parts of breeze to 1 of Portland cement with sufficient water to make a paste. One-twelfth of the breeze may be replaced by granite dust where a tougher and denser material is desired. The blocks, etc., have a low sp. gr. and a coarse and open texture and can be produced in larger sizes than when made of other materials.—A. B. S.

Lumber; Material for the preservation of—. P. C. Reilly, Indianapolis, Ind. U.S. Pat. 1,220,001, Mar. 20, 1917. Date of appl. Mar. 28, 1914. Renewed June 9, 1916.

A MIXTURE of coal-tar distillates boiling up to at least 700° F. (about 370° C.) and having a sp. gr. greater than 1.11, is dissolved in a solvent such as the lighter oils produced in the distillation; the remaining distillates of coal-tar boiling up to 1000° F. (about 540° C.) may also be incorporated. —W. E. F. P.

Paving bricks. Method of making bricks and the like. J. W. Tucker, Kissimmee, Fla., and W. A. McCool, Beaver Falls, Pa. U.S. Pats. (A) 1,220,292 and (B) 1,220,293, Mar. 27, 1917. Date of appl. Nov. 20, 1916.

(A) BRICKS or blocks are made by impregnating comminuted non-resinous wood (as cypress) with a light or thin asphaltum and uniting these into a solid mass by means of a heavier asphaltum. (B) The material is prepared as in (A) but any suitable light and heavy "hydrocarbon material" may be substituted for the asphaltum, and heavy pressure is used when forming the material into bricks.—A. B. S.

Cement; Water- and acid-proof— and process of making same. U. Wedge, Ardmore, Pa., Assignor to Electro-Chemical Supply and Engineering Co., Philadelphia, Pa. U.S. Pat. 1,220,575, Mar. 27, 1917. Date of appl. Mar. 1, 1915.

SILICIOUS material is mixed with an acid and afterwards with sodium silicate. The acid decomposes the silicate and precipitates finely divided silica which makes the cement water- and acid-proof.—A. B. S.

Building material; Waterproof—. A. C. de Caudenberg, Nice, France. U.S. Pat. 1,220,401, Mar. 27, 1917. Date of appl. Nov. 29, 1913. Renewed Aug. 10, 1916.

SEE Fr. Pat. 451,618 of 1912; this J., 1913, 605.

Hydraulic lime and cement; Production of— from combustion residues of sewage, canal-sludge, or the like. J. Elsner, Berlin-Friedenau, Germany. U.S. Pat. 1,220,735, Mar. 27, 1917. Date of appl. Dec. 26, 1913. Renewed Jan. 29, 1917.

SEE Fr. Pat. 458,551 of 1913; this J., 1913, 1158.

Cement. H. H. Morgan, Assignor to G. S. Johnston Co., Chicago, Ill. U.S. Pat. 1,221,571, Apr. 3, 1917. Date of appl. Mar. 18, 1915.

SEE Eng. Pat. 9173 of 1915; this J., 1916, 891.

Leaching flue-dust [from cement kilns]. U.S. Pat. 1,220,989. See VII.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Bessemer and open-hearth practice: Temperature measurements in —. G. K. Burgess. Trans. Amer. Inst. Min. Eng., 1917, 293—306.

THE most satisfactory instrument for controlling furnace and casting temperatures is an optical pyrometer using monochromatic light and permitting observations from a distance. The corrections to the observed pyrometer readings for emissivity of iron ($e=0.10$ for red light) and liquid iron oxide ($e=0.53$) are sufficiently well known to allow of correct results being obtained, but there may be uncertainty in the case of liquid slags (e =usually about 0.65). Temperature measurements of Bessemer converter charges are not deemed practicable by pyrometric methods. The open-hearth furnace can be controlled by observing the temperature of the roof of the metal bath, and of the slag through ports. The temperature of the roof, which may vary rapidly and within wide limits, does not necessarily bear any relation to that of the bath, which is usually kept between 1600° and 1670° C. The temperature of the metal may be ascertained fairly accurately from a sample taken with a spoon. A series of temperatures observed in practice are tabulated.—W. R. S.

Steel; Spontaneous generation of heat in recently hardened —. C. F. Brush and R. A. Hadfield. Proc. Roy. Soc., 1917, A, 93, 188—211.

STEELS of various types were found to generate measurable quantities of heat spontaneously, but at a steadily diminishing rate, for a considerable time after being quenched at a high temperature and hardened. Curves and tables are given showing the results obtained with carbon tool and "high-speed" tungsten-chromium steels over periods of 150 hrs., and the rate of such heat generation in nickel-chromium steels during periods of 24 hrs. Under the heat-insulating conditions of the experiments, an actual rise of temperature of 1.1° C. was clearly observed in some cases; but it is pointed out that in practice the heat evolved has every facility for dispersing without increasing the temperature of the steel. The evolution of heat appeared to be unaccompanied by chemical change, since the hardness of the specimens was not affected; but it is pointed

of strain or molecular rearrangement, doubtless accompanied by a further generation of heat, and so on until annealing is effected.—W. E. F. P.

Ferro-uranium. H. W. Gillett and E. L. Mack. J. Ind. Eng. Chem., 1917, 9, 312—317.

A DESCRIPTION is given of experiments carried out with the object of obtaining iron-uranium alloys. By using pure uranium dioxide, a low-ash coke, and pure iron as raw materials it is possible, employing a titling, direct arc type furnace with water-cooled magnesite hearth and sides, to produce a ferro-uranium of any desired uranium content (10 to 70%), with carbon below 2%, silicon below 0.75%, vanadium below 0.5%, and traces of aluminium, sulphur, phosphorus, and manganese. If experiments with such a ferro-uranium show that uranium steels high in uranium are not valuable, but that a little uranium is useful, and if the amount required is so low that the carbon introduced by the ferro-uranium is harmless, then the furnace might have an uncooled hearth and the ferro-uranium would contain 1 to 5% of carbon.—W. P. S.

Current density in copper refining. L. Addicks. Met. and Chem. Eng., 1917, 16, 311—315.

IN general, the temperature of the electrolyte should be raised as near 150° F. (65.5° C.) as possible in order to employ as high a current density as may be desirable from the point of view of cost of operation; heating of the electrolyte by exhaust steam will be necessary to maintain this temperature, unless a very high density, permitted by very unusual conditions, is employed. The relations between the power cost, cost of plant, age of electrodes, metal tied up, and the current density are discussed, with the view of showing the points to be considered in designing an electrolytic plant. These general relations between current density and cost are summarised in the following table, for five localities where the probable power cost is estimated at $\frac{1}{10}$ c., $\frac{1}{8}$ c., $\frac{1}{6}$ c., $\frac{1}{4}$ c., and 1 c. per kilowatt-hour respectively. It is assumed that the gain from released heat just offsets the loss from decreased current efficiency as the density is raised; that the interest and depreciation on the tank house and power plant are 20% per annum; that the silver and gold values in the anodes amount to \$100 a ton; and that other conditions are equal.

Current density.	Kw. hrs. per ton.	\$ Investment per ton—day.	Cost in dollars per ton.						Dollars per ton									
			Interest and depreciation.	Metal interest.	Metal loss.	Labour.	Power.		Total operating cost.									
									$\frac{1}{10}$ c.	$\frac{1}{8}$ c.	$\frac{1}{6}$ c.	$\frac{1}{4}$ c.	1 c.	$\frac{1}{10}$ c.	$\frac{1}{8}$ c.	$\frac{1}{6}$ c.	$\frac{1}{4}$ c.	1 c.
5.....	1.04	7540	4.19	6.67	0.69	0.18	0.10	0.26	0.52	0.78	1.04	11.23	11.39	11.65	11.91	12.17		
10.....	1.98	4360	2.42	3.34	0.25	0.24	0.20	0.50	0.99	1.49	1.98	6.45	6.75	7.24	7.74	8.23		
15.....	2.90	3420	1.90	2.22	0.48	0.39	0.29	0.73	1.45	2.18	2.90	5.28	5.72	6.44	7.17	7.89		
20.....	3.86	3140	1.74	1.67	0.75	0.46	0.39	0.97	1.93	2.90	3.86	5.01	5.69	6.55	7.52	8.48		
25.....	4.80	3080	1.71	1.33	1.12	0.52	0.48	1.20	2.40	3.60	4.80	5.16	5.88	7.08	8.28	9.48		
30.....	5.74	3140	1.74	1.11	1.60	0.57	0.57	1.44	2.87	4.31	5.74	5.49	6.46	7.89	9.33	10.76		
35.....	6.70	3280	1.82	0.95	2.25	0.63	0.67	1.68	3.35	5.03	6.74	6.32	7.33	9.00	10.68	12.35		
40.....	7.62	3420	1.90	0.83	3.00	0.70	0.76	1.91	3.81	5.72	7.62	7.19	8.34	10.24	12.15	14.05		

out that the present methods of determining hardness give only approximate values. The results obtained are regarded as showing that hardened steel is in a condition of very great molecular strain and somewhat unstable, especially at first, after being quenched. Spontaneous relief of a small portion of the strain causes generation of heat until stability at atmospheric temperature is reached. Any considerable rise in temperature, as in tempering, permits further spontaneous relief

The figures worked out for total costs are not the actual costs of refining, but simply totals which vary as the actual costs will when the density is varied. The density which will give the minimum cost for each power cost, may be found from the curves in Fig. 1, in which the density is plotted against the variation in total operating costs. These minima are again plotted against the current in the curve marked "theory" in Fig. 2, and the curve found in practice is added

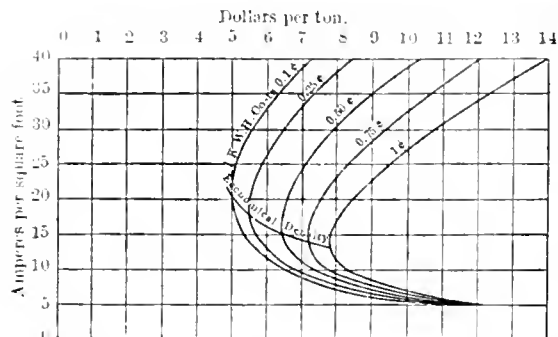


FIG. 1.

for comparison. The two curves agree well except at the lower power costs, where practice runs at a higher current density than would be expected, and this is due largely to the fact that although a certain density may show minimum

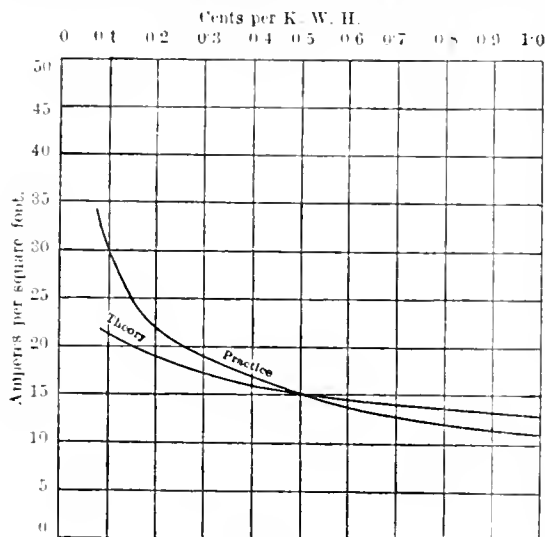


FIG. 2.

cost, a higher density may show maximum profits owing to a greater quantity of copper being treated by the plant at the higher density.—B. N.

Zinc; Determination of.—J. H. Hastings. *Met. and Chem. Eng.*, 1917, 16, 263—265.

SOLUTION of the ore and separation of iron and manganese are effected as usual, the zinc being determined by titration with standard potassium ferrocyanide in a boiling, slightly acid solution (volume about 200 c.c., containing 5 c.c. excess of hydrochloric acid) containing hydrogen sulphide, a saturated aqueous solution of which (50 c.c.) is added to prevent decomposition of the ferrocyanide by oxidising agents and precipitate any small quantity of copper present. A 5% solution of uranium nitrate is employed as external indicator.—W. E. F. P.

Aluminium dust; Analysis of.—J. E. Clennell. *Eng. and Min. J.*, 1917, 103, 496—499.

ONE GRM. is dried at 100° C. to constant weight and the loss reported as moisture. The dried material is transferred to a dry 200 c.c. beaker and washed with ether till free from grease. The filtered extract is evaporated in a tared flask and the grease weighed. The residue from the extraction is transferred to a 300 c.c. flask and dissolved

in dilute hydrochloric acid; the hot acid solution is filtered through the filter previously used into another flask, and the filter washed with hot water. The insoluble residue is washed back and treated with nitric acid; this solution is filtered through the same filter into a separate flask. The ignited insoluble residue consists of silica mixed with some carbon which resists ignition very persistently. It is fused with a small quantity of sodium peroxide and the silica separated as usual; this is calculated to silicon. The nitric acid filtrate is evaporated with sulphuric acid and added to the main hydrochloric acid filtrate. This is precipitated with hydrogen sulphide, and the precipitate digested with hot 50% hydrochloric acid to separate copper and lead. The residual copper sulphide is dissolved in nitric acid and the copper titrated with cyanide. The lead solution is neutralised with ammonia, acidified with acetic acid, and precipitated with bichromate. The filtrate from the hydrogen sulphide precipitate is oxidised and treated with excess of caustic soda; the precipitate is dissolved and re-precipitated with ammonia; the filtrate from the ferric hydroxide is used for the estimation of magnesium. The alkaline filtrate containing aluminium and zinc is precipitated with sodium sulphide, and the zinc sulphide determined with N/10 iodine and thiosulphate. The aluminium may be roughly determined by acidifying the last filtrate, expelling hydrogen sulphide by boiling, making up to 500 c.c., and titrating 100 c.c. with N/1 alkali first with methyl orange, and then with phenolphthalein as indicator. The interval between the two end-points is proportional to the aluminium; the alkali is standardised against pure aluminium. Special methods for the separate determination of the impurities are also described.—W. R. S.

Aluminium and carbon. O. Ruff and E. Jelinek; *Z. anorg. Chem.*, 1916, 97, 312—336. *Z. angew. Chem.*, 1916, 29, Ref., 536.

PURE aluminium shavings were heated with the theoretical quantity of finely powdered ash-free carbon for 30 minutes at 2000° C. in a closed carbon crucible in an atmosphere of nitrogen-free hydrogen. The dark orange-coloured product contained, in addition to the carbide, Al_4C_3 , some aluminium or a carbide less rich in carbon. With hydrochloric acid it gave a mixture of methane and hydrogen containing 7.7% of the latter. A grey-coloured carbide, approximately Al_3C_2 , can be prepared by heating a mixture of aluminium and carbon in the calculated proportions. Under atmospheric pressure at 2200° C., the carbide, Al_4C_3 , dissociates into the elements, the carbon being graphitic; vapours of carbide are given off and these are richer in carbon, the higher the temperature and pressure. Curves are given in the original showing the relation between the composition of the carbide vapours and the temperature and pressure.—H. J. H.

"Thiogen" process for removing sulphur [dioxide from smelter] fumes. S. W. Young. *Amer. Inst. of Chem. Eng. Met. and Chem. Eng.*, 1917, 16, 309—310.

THE process has been designed for reducing the sulphur dioxide from smelter furnaces to free sulphur, by means of petroleum hydrocarbons or other carbonaceous material. In the dry process, the sulphur dioxide and hydrocarbon vapours are passed over a catalytic agent, such as plaster of Paris, at a bright red heat, the calcium sulphate being reduced to sulphide by the hydrocarbons, and again oxidised to sulphate by the sulphur dioxide. It has been found that the gas must contain at least 7% of sulphur dioxide for successful working, and that the gases must be preheated before passing over the contact material. In the

wet process, the sulphur dioxide is absorbed by water in towers, and the solution mixed with a paste or solution of a suitable sulphide, such as barium sulphide, thus forming a sludge which contains free sulphur and complex insoluble sulphur salts. The sludge is settled, filtered, dried, and heated to 450°–500° C. to distil off the sulphur, the residue being afterwards reduced to sulphide in a furnace. Barium sulphide is preferable to the cheaper calcium sulphide, as it is very soluble, gives insoluble sulphur salts, and the barium salts crystallise in the anhydrous state, an advantage in the last stage of the process where the free sulphur is distilled off.—B. N.

By-product coke and coking operations. Ramsburg and Sperr, jun. See IIa.

Accurate determination of silica in commercial analysis. Hawley. See XXIII.

PATENTS.

Steel-making and like furnaces or mixers. Wellman, Seaver and Head, Ltd., London, and R. Gray, Redcar, Yorks. Eng. Pat. 104,657, Nov. 29, 1916. (Appl. No. 17,147 of 1916.)

IN steel furnaces or mixers in which a port structure is used to give communication between the furnace port and the port of the regenerator (see Eng. Pat. 23,245 of 1908) and in which a double seal is used between the port structure and the regenerator, the end of the port structure opposite the regenerator is protected by a cooling device or water-jacket which may be a continuation of the upper seal trough.—W. R. S.

Steel-making process. G. G. McMurtry, New York. Assignor to United States Steel Corporation, Hoboken, N.J. U.S. Pat. 1,217,972, Mar. 6, 1917. Date of appl., Jan. 27, 1915.

STEEL is treated first with a basic slag and then with an acid slag in the same furnace having a lining of zirconia.—W. F. F.

Iron ores; Process of treating —. T. S. Maffitt, St. Louis, Mo., Assignor to Mississippi Valley Iron Co., Wilmington, Del. U.S. Pat. 1,219,338, Mar. 13, 1917. Date of appl., May 9, 1916.

THE ore with its gangue is subjected to the action of heat in the presence of a reducing agent, such as gas containing carbon or hydrocarbons. The iron is thus rendered magnetic and is separated magnetically from the gangue before the temperature has fallen below 450° F. (about 230° C.).—J. H. J.

Cast-iron; Method of making —. H. W. Lash, Cleveland, Ohio. Assignor to The West Coast Iron Co. U.S. Pat. 1,220,349, Mar. 27, 1917. Date of appl., Nov. 21, 1912.

STEEL scrap is melted under non-oxidising conditions, in a reverberatory furnace, with a mixture of carbonaceous material, silica, and finely divided cast-iron in equal proportions.—W. E. F. P.

Iron; Composition for polishing —. M. Yasuda, Koishigawa, Japan. U.S. Pat. 1,216,643, Feb. 20, 1917. Date of appl., Mar. 14, 1914.

A COMPOSITION for polishing iron consists of 3 parts by weight of dehydrated alum. 2 parts by weight of finely divided uncoated metallic aluminium, and 5 parts by weight of powdered crystalline silica, the ingredients being in intimate contact and capable of reacting with each other and with the iron rust.—T. H. B.

Iron and steel; Process for rust-proofing —. W. H. Allen. Assignor to Parker Rust Proof Co. of America, Detroit, Mich. U.S. Pat. 1,219,526, Mar. 20, 1917. Date of appl., Sep. 25, 1916.

AFTER treatment with a hot, aqueous solution of phosphoric acid to remove the scale, the articles,

while still wet, and without preliminary washing, are immersed in an aqueous solution of acid ferrous and ferric phosphates until black basic phosphates of iron are formed upon their surfaces.—W. E. F. P.

Ferrophosphorus; Process of producing — from *nelsonite*. J. J. Gray, jun., Rockdale, Tenn. U.S. Pat. 1,216,306, Feb. 20, 1917. Date of appl., June 26, 1916.

A CHARGE of carbon and nelsonite ore containing tricalcium phosphate, iron oxide, titanium oxide, and alumina is mixed with phosphatic material and silica in excess, and smelted at a constant temperature in a blast-furnace so as to cause a maximum reduction of iron oxide, indirectly, and also a direct maximum reduction of the phosphate, without fluxing the titanium oxide. A reducing atmosphere is maintained throughout. After fluxing and smelting, the charge is followed by one of iron ore, basic material, and coke. The process is designed to prevent the "dirty hearth" usually produced in making ferrophosphorus in the blast-furnace.—T. H. B.

Aluminium; Production of —. E. E. P. J. P.S.J. de St. Laurent, Twickenham, Middlesex, and R. D. Mackintosh, Mortlake, Surrey. Eng. Pat. 11,820 of 1915; date of appl., Mar. 16, 1916.

DRIED and powdered clay, made into a thick cream with acidified distilled water, is treated with superheated steam, whereby the impurities are rendered insoluble and a solution is obtained from which pure aluminium hydroxide is subsequently precipitated by ammonia. The washed and dried precipitate is reduced by heating with carbonaceous matter.—W. E. F. P.

Metallic compounds [aluminium] from carbides; Production of —. P. R. Hershman, Chicago, Ill., Assignor to The Mineral Products Co., New York. U.S. Pat. 1,220,843, Mar. 27, 1917. Date of appl., Dec. 21, 1914.

To produce metallic aluminium from aluminium carbide, the latter is heated to about 2200° C., in the presence of a small amount of an aluminium compound to facilitate decomposition, until the charge begins to melt, when the temperature is lowered to about 2100° C. Alternatively, the carbide is heated under pressure in the presence of a gas containing hydrogen which has no influence on the decomposition.—W. E. F. P.

Metal [tin] from scrap or waste sheet metal or sheet metal articles; Recovery of —. H. A. Leaver, Westcliff, Essex, and H. H. Hosack, Twickenham, Surrey. Eng. Pat. 13,168 of 1915; date of appl., Mar. 15, 1916.

IN an electrolytic detinning process, the waste metal is conveyed through the electrolyte on a horizontal, endless rubber band. The surface of the band is provided with inter-connected, metal parts constituting the anodes upon which the material rests and to which the current is supplied; and a number of vertical, stationary cathodes are arranged in the electrolytic tank on each side of the conveyor.—W. E. F. P.

Concentration of ores; Apparatus for —. Minerals Separation, Ltd., London. From Minerals Separation and De Bavay's Processes Australia Proprietary, Ltd., Melbourne. Eng. Pat. 104,366, Feb. 26, 1916. (Appl. No. 2902 of 1916.)

THE level of liquid in a separating vessel forming part of an apparatus for the concentration of ores by the froth flotation process, is controlled by a device comprising the combination of a float in the separating vessel, a cock on the air-inlet pipe, and an operative connection between them, so

that the air supply is reduced as the level of the liquid falls. A number of flotation vessels and centrifugal pumps are arranged in series, and each pump withdraws material from the bottom of one vessel, agitates it, and delivers it to the next flotation vessel, the delivery of the pumps being controlled as described.—T. H. B.

Concentration of ores; Apparatus for —.
Minerals Separation, Ltd., London. From F. J. Lyster, Broken Hill, N.S.W. Eng. Pat. 101,367, Feb. 26, 1916. (Appl. No. 2903 of 1916.)

WITHIN a separating box of rectangular form having an outlet for tailings at the bottom, and an overflow at the top, both discharging into launders, are arranged two hollow vessels, adjustable in height, with their open lower ends immersed in the liquid and their upper edges a little above the level of the liquid; these vessels are cylindrical at their lower portions and conical at the upper part, with launders round their upper edges. The ore pulp, together with a frothing agent, such as eucalyptus oil, passes from a feed box above the separating box, through pipes extending down into the hollow vessels, and discharging below the surface of the liquid. These pipes are provided with air inlets near the upper end, through which air is sucked in by the flowing pulp, and baffle-plates are fixed within the hollow vessels immediately under the ends of the pipes, in such a position that emulsification of the pulp is ensured. The froth of concentrates floats to the surface of the liquid in the hollow vessels and overflows into the launders, and the excess liquor overflows from the separating box and is returned to the circuit.—T. H. B.

Ores; Apparatus for separating — by flotation.
H. E. T. Haultain, Toronto, Canada. U.S. Pat. 1,218,400, Mar. 6, 1917. Date of appl. Apr. 19, 1915.

A RECEPTACLE for the mixed pulp discharges on to a number of substantially triangular, overlapping, inclined and closely set plates. The plates are arched in cross-section so as to spread the pulp in fan shape. The pulp is discharged into a second receptacle, and currents of air are blown on to its surface in front of the inclined plates from a series of nozzles. An overflow discharge is also provided in the second receptacle.—W. E. F.

Concentrating ore; Method and apparatus for —.
H. M. Dunn, Hurley, N. Mex. U.S. Pat. 1,219,089, Mar. 13, 1917. Date of appl. May 11, 1915.

IN an agitation-froth process, a mixture of ore pulp and frothing agent is passed continuously, by means of a current of air, into the lower part of the frothing compartment of a separator. This compartment has a concave side against which the stream of ore is delivered, so that on this side the pulp is raised to a higher level than that of the bulk and receives additional aeration in falling back upon the main surface.—W. E. F. P.

Magnetic ores; Method and apparatus for separating —.
J. Weatherly, Assignor to Electric Ore Separator Co., New Cumberland, Pa. U.S. Pat. 1,218,916, Mar. 13, 1917. Date of appl. June 12, 1915.

THE ore in the form of small particles is carried by a travelling belt between two electromagnets, the poles of which are of opposite sign, and are alternately and rapidly reversed so that the magnetic particles are caused to rotate and thus detach themselves from the non-magnetic particles. The ore is then subjected to a magnetic field between pole-pieces of the same but rapidly alternating polarity, so that the magnetic particles repel one another and settle in a surface layer on the non-magnetic particles.—W. E. F.

Zinc, lead, and sulphur from sulphide ores; Recovery of —.
F. H. Haviland, London, Eng. Pat. 101,516, Jan. 3, 1916. (Appl. No. 86 of 1916.)

ZINC sulphide ore mixed with an excess of carbon is heated in a furnace with a flame of reducing gas mixed with not more than the required amount of air to cause combustion of the nascent hydrogen or hydrogen sulphide which is formed; free sulphur is thus produced, and the zinc is reduced and volatilised. The fume from the furnace is subjected to electrostatic precipitation in two stages to separate first the zinc in liquid form, and then the sulphur, preferably in separate chambers. The ore may be desulphurised in a furnace as described and the oxidised residue transferred to an electric furnace to recover the zinc. If the ore contains lead, the volatilised metals are fractionally precipitated as oxides in separate chambers by electrostatic means. The sulphur and zinc may be precipitated together and subsequently separated.—W. R. S.

Zinc; Extraction of —.
H. L. Sulman, H. F. K. Picart, and The Metals Extraction Corporation, Ltd., London, Eng. Pat. 101,697, Jan. 22, 1916. (Appl. No. 1063 of 1916.)

IN a cyclic process, successive small quantities of powdered, oxidised zinc ore are agitated with a 10% solution of sulphuric acid until the acidity of the liquid is reduced to between 1 and 2%, when neutralisation is completed quickly by agitation with the requisite quantity of zinc hydroxide (obtained in a previous operation); in the presence of decomposable silicates the mixture is preferably maintained at 90°–100° C. The neutralised pulp is then filtered, the strong solution of zinc sulphate being treated to remove copper, cadmium, and iron, and finally electrolysed for the recovery of zinc and regeneration of the acid solvent; the residue is washed with water and the washings treated with milk of lime to precipitate zinc hydroxide for subsequent use in neutralisation.—W. E. F. P.

Zinc; Condenser in the metallurgy of —.
J. Thomson, New York, and F. A. J. FitzGerald, Niagara Falls, Assignors to John Thomson Press Co., Jersey City, N.J. U.S. Pat. 1,219,193, Mar. 13, 1917. Date of appl. June 21, 1916.

THE lower end of an inclined condenser communicates with a receptacle for liquid zinc, the condenser and receptacle being enclosed in a single structure but provided with separate heating flues. The flow of zinc fume and the temperature of the condenser are controlled so that condensation is practically complete at 750°–700° C.—W. E. F. P.

Zinc-distilling furnace; Electric —.
J. Thomson, New York, and F. A. J. FitzGerald, Niagara Falls, Assignors to John Thomson Press Co., Jersey City, N.J. U.S. Pat. 1,219,194, Mar. 13, 1917. Date of appl. June 21, 1916.

THE heating chamber of an electric distilling furnace is divided into upper and lower communicating compartments by a slightly inclined, transverse partition having an opening at the lower end. The lower or distillation compartment contains a suspended resistor which is enclosed by an open-bottom casing on the top of which a layer of granular carbon is disposed; and vertical flues, communicating with the interior of this casing by means of openings in the vertical sides, are provided between the latter and the furnace walls. The zinc fume from the interior of the resistor casing is thus caused to pass around the latter before entering the upper or fume compartment on its way to the condenser.—W. E. F. P.

Furnaces; Pot — for melting metals. Gibbons Bros., Ltd., and R. Masters, Lower Gornal, Staffs. Eng. Pat. 101,583, May 1, 1916. (Appl. No. 6167 of 1916.)

Two or more pot furnaces are combined in a brick-work structure, each furnace having an up-cast or down-cast waste heat flue and a down-cast hot air flue or flues arranged at the side of the waste heat flues or between these and the furnaces. The hot air flues have air inlets at their upper ends and are connected at their lower ends with closed ash-pits under the fire-bars.—W. R. S.

Furnace; Open-hearth —. N. Thomas and A. W. Allen, Birmingham, Ala. U.S. Pat. 1,217,367, Feb. 27, 1917. Date of appl., Dec. 16, 1915.

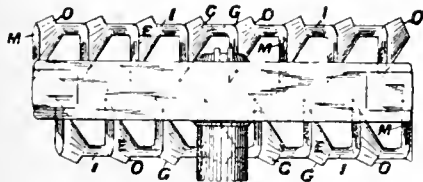
THE hot gases pass upward from a common inlet through a number of vertical flues connected at the top at an acute angle to extensions which are inclined downward toward the furnace hearth. A supply of fluid may be delivered to each flue by a pipe which passes through the end wall of the furnace and extends into and parallel with the inclined part of the flue, terminating short of the flue outlet.—W. F. F.

Furnace; Basic open-hearth —. S. Naismith, Chicago, Ill. U.S. Pat. 1,220,441, Mar. 27, 1917. Date of appl., Apr. 17, 1916.

IN a basic open-hearth furnace, a series of removable water coolers is disposed in the walls at the s'ag line and close to the lining; the weight of the walls is borne by a series of external buck stays.—W. E. F. P.

Rabble for mechanical roasting-furnaces. W. Hommel, Zürich, Switzerland. U.S. Pat. 1,220,513, Mar. 27, 1917. Date of appl., Aug. 23, 1916.

IN a rabble (see fig.) having two series of scraper blades arranged alternately and provided with inclined working faces perpendicular to the hearth level, each blade has an outwardly and down-



wardly inclined face, *c*, forming a sharp cutting edge, *g*, with the base. The blades are connected with each other by bridge-like stays, *i*; a vertical web, *m*, terminating in a cutter, adjoins each outer cutting face; and a small, inclined face, *o*, adjoins each of the outer cutting edges, *g*.
—W. E. F. P.

Ores; Process of treating —. G. F. Downs, Buffalo, N.Y. U.S. Pat. 1,216,667, Feb. 20, 1917. Date of appl., Dec. 7, 1914.

THE ore is fed into the upper end of a slightly inclined rotating cylinder, through which it moves longitudinally and at the same time has a transverse tumbling movement. The ore is progressively heated by hot gases moving through the cylinder in the opposite direction, and finally passes into a part of the cylinder where it is subjected to blasts of air or other gas, so directed as to produce violent radial agitation and thereby facilitate chemical reaction between the ore and the gas.—W. F. F.

Oxide ores of copper; Process of concentrating —. R. Gahl, Miami, Ariz. U.S. Pat. 1,217,437, Feb. 27, 1917. Date of appl., Dec. 27, 1916.

COPPER is dissolved from the ore by acid and

precipitated by metallic iron, undissolved iron is separated magnetically from the pulp, and the residue containing cement copper is subjected to flotation.—T. H. B.

Clad metals; Process of making —. B. E. Eldred, New York, Assignor to The Commercial Research Co. U.S. Pat. 1,217,581, Feb. 27, 1917. Date of appl., Jan. 21, 1910. Renewed Feb. 10, 1916.

A BODY of steel is placed in a mould and a body of copper placed in contact therewith and the temperature is raised until the copper melts. The mould and contents are then cooled from below by abstraction of heat from the bottom, while still heating the rest of the mould, so that the topmost layer is the last to solidify.—T. H. B.

Metallic compound. H. B. Coho, Mount Vernon, N.Y., Assignor to United Lead Co. U.S. Pats. (A) 1,217,710, and (B) 1,217,711, Feb. 27, 1917. Dates of appl., June 7, 1915, and July 29, 1916.

(A) A MIXTURE of lead, copper, tin, and antimony sulphide. (B) A mixture of lead and copper is fused with antimony sulphide associated with sodium.—W. F. F.

Metallurgical process. [Electrolysis of fused copper sulphide.] W. E. Greenawalt, Denver, Colo. U.S. Pat. 1,218,177, Mar. 6, 1917. Date of appl., Nov. 23, 1912. Renewed Jan. 17, 1917.

COPPER sulphide is fused at a high temperature and subjected to electrolysis to separate the metal from the sulphur. Steam and reducing gases are applied to the highly heated liberated sulphur to form hydrogen sulphide.—W. F. F.

Lead and molybdenum; Process for separating — from mineral wulfenite. A. Kissock, Tucson, Ariz. U.S. Pat. 1,218,412, Mar. 6, 1917. Date of appl., Dec. 11, 1915.

LEAD molybdate (wulfenite) is mixed with carbon and a suitable flux such as soda ash, and heated in a furnace to a state of quiet fusion, when metallic lead and a slag containing sodium molybdate are produced, and are separately withdrawn. The slag is cooled, ground in a suitable crusher, and mixed with carbon and silica, with or without iron. The mixture is again heated to quiet fusion, and the metallic molybdenum and slag produced are separately withdrawn.—W. F. F.

Ores; Process for extracting metals from their —. W. E. Greenawalt, Denver, Colo. U.S. Pat. 1,218,996, Mar. 13, 1917. Date of appl., June 1, 1915.

THE ore is charged into a vertical cylinder, in which it is roasted by a blast. The lower end of the cylinder is submerged in a tank containing an acid solvent. The roasted ore is cooled and wetted while still in the vertical column, and transferred from the lower end to the extracting solution. The exhausted ore is continuously withdrawn from the tank, means being provided for removing the sands and slimes separately.—W. R. S.

Ores; Automatic controlling system for continuous agitation and transfer systems for treatment of —. J. W. Bucher and R. P. Akins, Assignors to Colorado Iron Works Co., Denver, Colo. U.S. Pat. 1,219,210, Mar. 13, 1917. Date of appl., Oct. 7, 1915.

A CONTINUOUS flow of pulp is made to circulate through a series of communicating tanks in one direction and a continuous flow of solvent in the opposite direction. The transfer and supply of pulp and solution from one tank to another is controlled automatically. Air under pressure is used for agitating and transferring the liquors.

—W. R. S.

Blast-furnace gases; Process of preheating —. O. Oesterlen, Zweibrücken, Germany. U.S. Pat. 1,219,852, Mar. 20, 1917. Date of appl. Apr. 1, 1915.

A PORTION of the filtered or unfiltered waste gases from blast-furnaces is burnt in preheaters through which the main volume of the gases is conducted before being burned in the hot blast ovens.

—W. E. F. P.

Separator and amalgamator; Centrifugal —. H. R. Zimmer, Los Angeles, Cal. U.S. Pat. 1,220,051, Mar. 20, 1917. Date of appl. Aug. 4, 1914.

ORE is fed from a hopper to the bottom of a rotating bowl containing mercury. The bowl is provided with superposed annular shelves, the edges of which are bevelled downward and inward. The top of the bowl projects inward forming a vertical wall, so that a pocket is formed with the uppermost shelf for the reception of the amalgam. The ore-feed pipe carries an inner adjustable stationary bowl, having a vertical wall at the top, a passage-way being formed between this wall and the vertical wall of the rotating bowl.—W. E. F.

Process and means for filtering [jewellers' waste wash] water. U.S. Pat. 1,217,397. See XIXB.

XI.—ELECTRO-CHEMISTRY.

Silicon and its thermoelectric power. Fischer and Baerwind. See VII.

PATENTS.

Furnace-wall construction; Electric —. I. Hechenbleikner, Charlotte, N.C., Assignor to Southern Electro-Chemical Co., New York. U.S. Pat. 1,217,306, Feb. 27, 1917. Date of appl. Sep. 27, 1915.

THE body of the furnace is water-cooled and connected to a tapered non-cooled portion above, which in turn is connected to a non-cooled elbow section, the connections being made by channel steel sections bolted together. A lining of chilled slag, substantially uniform in thickness, extends completely around the sides and over the bottom of the water-cooled and non-cooled parts.—B. N.

Furnace; Electric —. C. A. Pfanstiehl, Waukegan, Ill., Assignor to Pfanstiehl Co., U.S. Pat. 1,217,497, Feb. 27, 1917. Date of appl. July 11, 1914.

A TUBE of refractory, porous, heat-resisting material, such as alundum, forming a heating chamber, is surrounded by a steel shell so as to form an annular space into which hydrogen is passed, and the shell is embedded in heat-resisting material contained in an outer receptacle. The hydrogen percolates through the tube into the heating chamber. A carbon resistance element, of substantially semicircular cross-section, is disposed within the alundum tube, and arranged to support articles to be treated in the heating chamber. The resistance element is heated by an electric current, connected through terminals provided with channels for the passage of a current of cold water.—B. N.

Furnaces; Terminal for electric —. T. F. Baily and F. T. Cope, Assignors to The Electric Furnace Co., Alliance, Ohio. U.S. Pat. 1,218,042, Mar. 6, 1917. Date of appl. Apr. 27, 1915.

THE terminal of the furnace is composed of an electrode surrounded by loose refractory material in a container with means for supporting and insulating the container from the furnace. Laminated conductor strips are connected to a supply main, the extremities of the strips being located upon each side of the electrode, with

metal blocks between each strip and the adjacent side of the container. A plate is located upon each side of the container, adjacent to the metal blocks, with means for drawing the plates towards each other.—B. N.

Furnace; Electric —. F. T. Cope, Assignor to The Electric Furnace Co., Alliance, Ohio. U.S. Pat. 1,218,058, Mar. 6, 1917. Date of appl. Apr. 27, 1915.

A REFRACTORY trough, containing a granular resistance material, is supported within the heating chamber of the furnace by spaced walls disposed transversely, so that the trough is spaced upon all sides from the upper, lower, and side walls of the furnace, and circulation of air is thus allowed transversely around the trough between the spaced walls.—B. N.

Induction furnace; Electric —. P. Wright, Vancouver, British Columbia. U.S. Pat. 1,218,151, Mar. 6, 1917. Date of appl. May 11, 1914.

THE furnace comprises a core and winding, the core being surrounded by a secondary coil provided with an element of good electrical-conducting material, such as copper, and having enlarged terminal electrodes at the ends. A cast-iron chambered resistor, closed at its ends by the electrodes, is in circuit with the latter, and is adapted to hold a body of melted metal between the electrodes and in contact with them.—B. N.

Furnace; Electric —. C. A. Pfanstiehl, Waukegan, Ill., Assignor to Pfanstiehl Co., North Chicago, Ill. U.S. Pat. 1,218,582, Mar. 6, 1917. Date of appl. Apr. 15, 1915.

A HOLLOW cylindrical tube of alundum is provided on its outer surface with a glaze impervious to air or gas, and a wire for conducting the electric current is coiled helically within the tube, substantially in contact with the inner walls. The interstices between the coils are filled with a refractory cement, so as to form a smooth cylindrical inner surface, and the open ends are stopped by refractory plugs. A supply of hydrogen is conveyed by pipes to and from the interior of the tube.—B. N.

Battery [; Electric —]. J. M. Flannery, Pittsburgh, Pa. U.S. Pats. (A) 1,217,738 and (B) 1,217,739, Feb. 27, 1917. Date of appl. May 3, 1916.

(A) AN ioniser for electric batteries comprises a thin sheet of perforated celluloid, insoluble in the electrolyte, and carrying radioactive material incorporated in it. (B) An ioniser comprises a perforated separator for the plates of the battery, with a coating of radioactive material carried in an insoluble vehicle.—B. N.

Electrode for generating pure oxygen. J. F. Sanders, Assignor to O. P. Coshov, Roseburg, Oreg. U.S. Pat. 1,218,584, Mar. 6, 1917. Date of appl. Aug. 4, 1915.

A COMPOUND electrode is composed of hydrogen-absorbing porous palladium, and a catalyst of rhodium, adapted to make the palladium give up its hydrogen when brought into contact with oxygen in solution.—B. N.

Water-electrolysing apparatus. R. J. J. Mueller, Chicago, Ill., and E. G. Rowlands, Milwaukee, Wis., Assignors to Universal Oxygen Co. U.S. Pat. 1,219,843, Mar. 20, 1917. Date of appl. Mar. 21, 1913.

A DEEP metal tank is divided into communicating compartments by vertical partitions which form, with the sides, a series of electrodes of the same polarity; the tank has an arched, metal cover from which depend a number of metal plates, one nearly to the bottom of each compartment, forming

a corresponding series of electrodes of opposite polarity. The cover is insulated from the tank by a diaphragm through openings in which the metal plates extend; and each plate is surrounded by a tube of flexible, non-corrodible material, the latter being pervious to liquid but impervious to gas when wet and depending from the under side of the diaphragm. The arrangement is such that, during operation, the gases evolved at the cover and tank electrodes are collected separately above and below the diaphragm respectively.—W. E. F. P.

Water-electrolysing apparatus. R. J. J. Mueller and E. G. Rowlands, Sheboygan, Wis., Assignors to Universal Oxygen Co. U.S. Pat. 1,220,262, Mar. 27, 1917. Date of appl. Jan. 2, 1914. Renewed Jan. 17, 1917.

A CELL for the electrolysis of water consists of a tank, constituting one electrode: a neutral member forming an extension to the upper part of the tank but insulated from it: and a cover resting upon but insulated from the neutral member, and forming the other electrode. Suspended from the cover is an electrode plate which extends into the tank through an opening in the neutral member and is surrounded by a diaphragm depending from the latter.—W. E. F. P.

Electrolytic gas-generator. I. H. Levin, Newark, N.J., U.S. Pat. 1,219,966, Mar. 20, 1917. Date of appl. Nov. 18, 1916.

THE electrode compartment of the generator has a gas outlet which is sealed with water, and through which water is supplied to the compartment, from a chamber above. The water chamber is provided with a gas outlet and a water supply conduit.—W. E. F. P.

Electric conductors suitable for sealing into vitreous material. Eng. Pat. 104,758. See II B.

Electric insulator [for lamp sockets]. U.S. Pat. 1,217,873. See II B.

[Electrolytic] water-purifying apparatus. U.S. Pat. 1,219,333. See XIX B.

Preserving-gas. U.S. Pat. 1,219,527. See XIX B.

[Electrolytic] purification of sewage containing organic matter. Ger. Pat. 294,957. See XIX B.

XII.—FATS; OILS; WAXES.

Fatty acids; Action of aromatic amines on —. [Analysis of fats.] E. de Conno. Gazz. Chim. Ital., 1917, 47, 1, 93—132.

GLYCERIDES are hydrolysed when heated in a sealed tube at 230° C. with an aromatic amine, such as aniline, and yield the corresponding amides of the liberated fatty acids. The decomposition is not quantitative, but the resulting anilides contain a portion of all the fatty acids in the relative proportions in which they were present in the fat, so that the method may be used for the qualitative and possibly for the quantitative analysis of fats. The anilides of the fatty acids prepared distilled under reduced pressure (10 mm.) without alteration and at intervals of about 10° C. for the different members of a series. They can thus be separated by fractional distillation, and when they are heated with strong hydrochloric acid in a sealed tube for 3 hours at 150° C. the corresponding fatty acid is liberated. They are insoluble in water, sparingly soluble in petroleum spirit, readily soluble in acetone and hot acetic acid, and very soluble in ether, chloroform, benzene, and toluene. They are best crystallised from

hot alcohol or methyl alcohol. The anilides of the saturated fatty acids melt at temperatures from 81.5° to 132° C., and those of the unsaturated fatty acids at 41° to 114° C., with the exception of linolenic anilide, which is liquid. The *p*-phenylenediamides of the saturated fatty acids from myristic to arachidic acid and of the unsaturated fatty acids (oleic, erucic, and linolenic acids) are insoluble in all the above-mentioned solvents, but can be purified by recrystallisation from hot amyl alcohol. They melt at the following temperatures:—From myristic acid, 162.5°; palmitic acid, 181.5°; stearic acid, 179.5°; arachidic acid, 139.8°; oleic acid, 158.7°; and erucic acid, 151° C. The other amides prepared include those of *p*-toluidine, *m*-dimethylaniline, *p*-hydroxyaniline, *p*-methoxyaniline, *p*-ethoxyaniline, α -naphthylamine, and β -naphthylamine. When fatty acids are heated in a sealed tube with an equimolecular proportion of the aromatic amine, they yield from 85 to 87% of the corresponding fatty acid amide.—C. A. M.

Resistance of an oil to emulsification. Herschel. See II A.

Studies in steam distillation. IV. Propionic, butyric, valeric, and caproic acids. V. Some applications of Duclaux's method. Richmond. See XX.

PATENTS.

Copra-drying apparatus. J. D. McCord, Manila, Philippine Islands. U.S. Pat. 1,219,016, Mar. 13, 1917. Date of appl. Mar. 20, 1916.

THE copra is dried in a chamber surrounded by a heat-flue communicating with a heater, whilst an air-flue is interposed between the heat-flue and the chamber, and means are provided for circulating heated air through the air flue and into the chamber.—C. A. M.

Fats and oils; Process for decomposition of —. B. E. Reuter, Assignor to Reuter Process Co., Chicago, Ill. U.S. Pat. 1,219,485, Mar. 20, 1917. Date of appl. May 20, 1912.

FATS or oils are mixed first with water, and then with sulphuric acid (0.03 to 1%) and a quantity of a catalyst (0.1 to 0.4%) insufficient to effect complete decomposition of the fats, the mixture is boiled for 12 to 18 hours with constant agitation, and the resulting fatty acids are bleached.—C. A. M.

Fats and fatty substances; Process for emulsifying —. J. Schlieck, Hamburg, Germany. U.S. Pat. 1,220,010, Mar. 20, 1917. Date of appl. Aug. 12, 1916.

A FAT poor in cholesterol and melting between about 26° and 36° C., is thoroughly mixed with skim-milk or other liquid containing albumin, and about 0.1 to 0.4% of cholesterol.—C. A. M.

Soft soaps; Manufacture of —. Robinson Bros., Ltd., and H. Swithenbank, West Bromwich. Eng. Pat. 104,409, Mar. 28, 1916. (Appl. No. 4560 of 1916.)

MARINE animal oils are sulphonated with strong sulphuric acid, the product treated with water, and the aqueous layer containing the glycerol separated from the sulphonated oil. The latter is then saponified with caustic soda, and sufficient water is added to obtain a clear, transparent, soft soap, which is free from fishy odour. The consistency of the soap may be varied by varying the temperature at which sulphonation is effected. Rosin may be added prior to saponification and sodium silicate after the saponification.—C. A. M.

Fats and fatty substances; Process for emulsifying —. J. Seidnick, Hamburg, Germany. Eng. Pat. 101,933, Mar. 27, 1916. (Appl. No. 4506 of 1916.)

SEE U.S. Pat. 1,220,610 of 1917; preceding.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Litharge-glycerol cement; Selling of —. H. E. Merwin. J. Ind. Eng. Chem., 1917, 9, 390.

LITHARGE which had been passed through a 200-mesh sieve was mixed with a large excess of glycerol on a microscope slide under a cover glass, and the mixture examined under the microscope. The formation of a crystalline compound was observed after about 1 hour; and after 24 hours, the grains of litharge were bound together by crystalline aggregates of radiating fibres. Grains kept at 80°C. for an hour were also firmly cemented. Similar crystals were obtained when glycerol diluted with 5 to 10% of water or alcohol was heated to boiling-point and agitated with litharge, but the crystals were less closely aggregated. The best specimen thus prepared contained about 10% of unattacked litharge and 90% of crystals. The crystals contained 70.8% of lead oxide, corresponding with 5% of residual PbO and 95% of the compound $C_3H_5O_2.PbO$. After standing for several days in contact with glycerol the centres of the litharge grains were still unattacked, and probably coarser grains would remain so indefinitely. This cement is employed for lining the digesters used in the manufacture of sulphite pulp.—C. A. M.

Phenol resin compounds; Printing plates from —. L. V. Redman, A. J. Weith, and F. P. Brock. J. Ind. Eng. Chem., 1917, 9, 388—390.

THE original zinc etching is placed on the top of a sheet of a plastic phenol resin compound which has been previously heated until soft and pliable, and both are gradually pressed in a hot press up to a pressure of about 2000 lb. per sq. in. The press heads are prevented from coming together by means of controlling bars, whilst the plastic compound is allowed to flow out around the edges. After hardening for a few minutes the mould is removed, and may be used immediately for the production of positive plates in the same way from fresh plastic sheets. A layer of oiled paper, metal foil, or talc dust, etc., is used to prevent the cast from sticking to the mould, and this improves the printing properties of the plate as compared with the original zinc etching.—C. A. M.

PATENTS.

Resin and turpentine; Process and apparatus for making —. G. Pissimis and J. Rigopoulos, Schenectady, N.Y., Assignors to P. Chiboucas, Albany, N.Y. U.S. Pat. 1,219,998, Mar. 20, 1917. Date of appl. July 14, 1916.

CRUDE turpentine is heated and agitated in a tank by passing steam through a chamber under the tank and also into the liquid. Impurities are withdrawn from the bottom of the tank and vapour from the top. Liquid is drawn from the tank at different levels through a filter to a second tank. The liquid is forced from this tank to an auxiliary tank by steam pressure on the surface of the liquid in the filter. The auxiliary tank is heated and the vapour passed through condensers and collected. The resin is collected from the bottom of the second tank.—W. F. F.

Manufacture of picric acid and other nitrophenols from certain gums or gum-resins. Eng. Pat. 101,352. See III.

Treatment of certain gums or gum-resins for the manufacture of colouring matters or dyes. Eng. Pat. 101,353. See IV.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Rubber exports from Brazil. India-Rubber J., Apr. 14, 1917.

EXPORTS of rubber of all kinds from Brazil in 1916 amounted to 31,195 tons, against 35,165 tons in 1915 and 33,531 tons in 1914. The value of the exports increased from £7,010,000 in 1915 to £7,496,000 in 1916. As usual the greater part of the quantity exported was sent to the United States and the United Kingdom, the respective figures for 1916 being 19,965 and 10,379 tons.

Rubber hose for use on aeroplanes. P. A. Houseman. J. Ind. Eng. Chem., 1917, 9, 356—358.

THE following tests are suggested for ascertaining the suitability of rubber hose for conveying petrol from the tank to the engine on aeroplanes. *Flexibility.* The tube when bent into a circle, the diameter of which varies from 4 in. for tubes of 0.5 in. internal diameter to 18 in. for 1.5 in. tubing, should not decrease in diameter at any point by more than 10% of the original diameter. *Immersion in petrol.* The tubing is immersed in petrol (sp. gr. 0.720) for 200 hours, or boiled in petrol under a reflux condenser for 1 hour and then left in cold petrol for 24 hours. Under this treatment the diameter of the tube should not decrease by more than 25%. The adhesion of the rubber to the canvas should remain good, and the "nerve" of the rubber should not be seriously affected. *Permeability to petrol.* A piece of the tubing 12 in. long, is fixed vertically, the lower end is plugged, and a piece of glass tubing fitted in the upper end. The tubing and glass tube are filled with petrol and the level of the petrol is maintained at 9 to 12 in. above the top of the tubing. After 48 hours, the amount of petrol passing through the walls of the tubing during the succeeding 24 hours should not exceed 100 c.c. per sq. ft. of internal surface. *Heat test.* The rubber must remain elastic after the tubing has been heated at 132°C. for 2 hrs. A freezing test (in carbon dioxide snow) does not give any useful information. The rubber portion of the tubing should contain at least 40% of rubber, the layer of rubber between each turn of the canvas should be at least twice as thick as the canvas itself, and the inner layer of rubber should be seamless. Tubing more than 6 months old should not be used. Rubber hose for use with oil must withstand immersion in castor oil at 100°C. for 8 hours without serious injury and not increase in weight by more than 5% during this treatment.—W. P. S.

PATENTS.

Rubber composition and process of making the same. M. F. Coughlin, Boston, Mass., Assignor to American Gum Products Co., Covington, Va. U.S. Pat. 1,217,157, Feb. 27, 1917. Date of appl. Oct. 21, 1916.

RUBBER is incorporated with dry sulphite waste lye solids, blown petroleum, and asphalt, with or without other loading materials.—W. H. C.

Indiarubber; Roller apparatus for use in the treatment of —. J. Hodgins, Cork, Ireland. Eng. Pat. 104,914, Mar. 22, 1916. (Appl. No. 4215 of 1916.)

XV.—LEATHER; BONE; HORN; GLUE.

Tarwad [*turwah* or *cassia*] bark as a tanning agent. D. B. Limaye, Bull. No. 1, Ranade Industrial and Economic Inst., Poona, India, 1916, 18 pages.

TARWAD bark, the product of the perennial shrub, *Cassia auriculata*, is used very considerably in the tanning industry of Bombay and district, but has not up to the present been used in Europe. Samples of the bark were obtained from various districts of Central India and the Deccan, and showed from 15.2% to 19.6% tannin. The results showed that plants three years old contain distinctly more tannin (usually about 2%) than do plants only one year old. Commercial samples obtained in the ordinary markets proved to contain 15.5% to 18.7% tannin. The author considers that an increased production of the bark will cause an increase in price, unless the bark is cultivated as a crop. The low tannin content will not allow of profitable export, but a concentrated extract could be manufactured in India.—F. C. T.

Tannins; Detection and differentiation of vegetable and synthetic —. R. Laufmann. Chem. Zeit., 1917, 41, 273—275 and 286—288. (See also this J., 1916, 551.)

A GENERAL scheme is given for the identification of the various vegetable tannins by the ordinary methods, including the ammonium molybdate test. Reactions are also described as follows for the detection and distinction in leather of sulphite-cellulose extract and artificial tannins of the Neradol class. Finely divided leather is allowed to stand overnight in ten times its weight of 2% caustic soda solution. The solution is then filtered, slightly acidified with hydrochloric acid, filtered again, and diluted so as to contain 0.6% organic matter. It is then tested by the aniline test or by cinchonine sulphate. A negative result shows the absence of both sulphite-cellulose and Neradol. A positive result indicates sulphite-cellulose if Neradol is subsequently proved to be absent by special tests. (1) 3—4 drops of an ice-cooled diazotised solution of *p*-aminophenol are added to a well-cooled mixture of 5 c.c. of alcohol and 5 c.c. of the above solution. A blue colour indicates Neradol. If the result is negative, the reaction mixture is extracted with ether, the ethereal layer removed and poured on to water to which caustic soda solution is then slowly added. A deep blue-grey colour at the water-ether surface indicates Neradol. (2) 5 c.c. of the leather extract is rendered alkaline with caustic soda after the addition of one drop of a solution of dimethyl-*p*-phenylenediamine hydrochloride; 1—2 drops of 5% potassium ferricyanide solution are then added. In the presence of Neradol a blue colour develops. (3) The leather extract is treated with a solution of diazotised *p*-nitroaniline, the precipitate filtered off, and the filtrate rendered alkaline with caustic soda. A deep blood-red colour indicates Neradol. These tests (1 to 3) need some modification if the Neradol is a naphthalene product. According to Moeller, sulphite-cellulose and Neradol can be distinguished as follows:—The solution, as concentrated as possible, is mixed thoroughly with absolute alcohol and filtered. The filtrate is evaporated to remove alcohol, diluted, and treated with sulphuric acid to precipitate phlobaphenes and humic substances. The solution is filtered again and neutralised with sodium carbonate. A fair excess of 2½% solution of pure aniline hydrochloride is then added, which causes a precipitate in the presence of Neradol. The precipitate first obtained by mixing the original aqueous solution with alcohol, as above, is tested by the Procter-Hirst method for sulphite-cellulose.—F. C. T.

Hide powder; Adsorption of chromium oxide by —. A. W. Davison. J. Phys. Chem., 1917, 21, 190—197.

QUANTITIES of hide powder were shaken with basic chromium sulphate solutions, under conditions absolutely uniform except for the concentration of chromium sulphate. Preliminary experiments showed that four hours' shaking was sufficient to allow of the attainment of equilibrium between the solution and the tanned hide powder. After shaking, the solution and the chromed hide powder were both analysed to determine the concentration of chromium in each case. These values when plotted as ordinates and abscissae respectively, gave a perfectly smooth curve of the type well known in cases of adsorption. The author's results thus favour the physical as against the chemical theory of tanning.—F. C. T.

Glue for use on aeroplanes. P. A. Houseman. J. Ind. Eng. Chem., 1917, 9, 359—360.

THE following arbitrary method is suggested for testing the quality of glue used for joining together the laminae of aeroplane propellers. Pieces of straight-grained walnut wood, each 9 in. by 2 in. by ½ in., are dried at 36° C. for 24 hours, then roughened by a tooth-plane, and two of the pieces are glued together so that their ends overlap by 2 in.; the area of the glued surface is therefore 4 sq. in. The glue is prepared by soaking the pieces for about 18 hours in water, then heating the mixture to 60° C. and applying it at this temperature; usually, 1 part of glue to 2 parts by weight of water gives a suitable concentration. The joint is clamped under moderate pressure for 48 hours and tested after a further 24 hours, the tests, in duplicate, being made as follows:—*Regular test*. The joints are pulled apart in a testing machine and the breaking strain per sq. in. of glued surface is recorded. *Heat test*. The joints are heated at 45° C. for 2 days and then pulled apart, and the breaking strain recorded. *Immersion test*. The joints are completely immersed in water at 20° C. for 12 hours and then pulled apart. Results of from 450 to over 600 lb. per sq. in. of glued surface are found in the regular test, and about the same figures in the heat test, whilst the immersion test results are sometimes lower and sometimes higher than the regular test results. The addition of a small proportion (5%) of phenol to the glue solution increases the strength of the joint; addition of ammonia does not affect the regular test results but raises the heat and immersion test figures. A Swiss casein glue, of the type used on German aircraft, and consisting of about 66% of casein, 23% of mineral matter (sodium salts, silica, lime and alumina), and 1% of petroleum, gave a particularly high result in the immersion test.—W. P. S.

Fish-gelatin; Hydrolysis of —. Y. Okuda. J. Coll. Agric., Tokyo, 1916, 5, 355—363.

To ascertain if fish-gelatin differed in chemical composition from ordinary bone-gelatin, material derived from the skin of a shark was hydrolysed with hydrochloric acid, baryta, and sulphuric acid, and the products investigated. The total nitrogen and its distribution were found to be practically the same for both sorts; but the fish-gelatin gave rather more monoamino-acid, and much more glycocoll, alanine, leucine, phenylalanine, glutamic and aspartic acids than the bone-gelatin. The proline and serine contents of the fish-gelatin found by the ester method were low, probably the results of experimental errors. The diamino-acids were present in about equal quantities in the two gelatins.—E. H. T.

PATENT.

Keratin bodies; Process of treating — C. G. Stebbins and A. Gelow, Assignors to The Warren Featherbone Co., Three Oaks, Mich. U.S. Pat. 1,219,787, Mar. 20, 1917. Date of appl., Apr. 12, 1915.

KERATIN bodies are shredded, and the filaments heated to a sufficient temperature to inhibit bacterial action and expel all moisture, and then immersed in an elastic, waterproofing medium. Absorbent keratin substances may be sized prior to the heating.—C. A. M.

XVI.—SOILS; FERTILISERS.

Humogen; Report on — E. J. Russell. J. Board Agric., 1917, 24, 11—20.

EXPERIMENTS made with "humogen," or "bacterised peat" (see this J., 1913, 878; 1915, 871) on plants in pots, at Kew, and at Wisley, having given remarkable results, a series of investigations was carried out at Rothamsted to ascertain if the product possesses a similar value in agriculture. The humogen used in the experiments was obtained from two different sources, and contained 0.57 and 0.13% N (1.29 and 1.32% in the dry matter) respectively. It is stated by Prof. Bottomley that there was a serious error in the manufacture of the product, owing to the use of an excessive amount of alkali, resulting in the production of a chemically treated peat containing excess of soda, and not a properly "bacterised" peat. Field experiments with mangolds gave entirely negative results, the humogen showing no special fertilising effect; in the only cases where increases were produced they were no greater than were obtained with untreated peat. Mustard grown in pots showed similar results to the trials with mangolds, and peas gave entirely negative results. In experiments with barley in water cultures, the plants receiving humogen were darker in colour than the others, but the difference in weight was less than 5%, and no significance is attached to this result. Experiments carried out at the same time at the Harper Adams Agricultural College, with wheat and with mangolds, gave similar results; with wheat, in fact, the crop was somewhat depressed by humogen, whilst in the case of mangolds some increases were observed, but the fertilising action is believed to be no greater than that due to the moisture-retaining properties of peat. It is concluded that the agricultural value of humogen is no greater than that of any other organic manure with the same nitrogen content. The claims made for it in the press and elsewhere are considered to have no substantiation and its present price (£5 per ton) is excessive.

Soils of south New Zealand; Lime requirements of — L. J. Wild. J. Agric. Sci., 1917, 8, 151—177.

THE Hutchinson-MacLennan method (this J., 1915, 365) gave results superior to those from ordinary analytical methods, provided it was carried out under uniform conditions. The results, however, always showed a higher lime requirement than that required by field practice; hence a correcting factor should be used; that for the soils of Canterbury Plains is about 0.10%.—E. H. T.

Calcium cyanamide; Some conditions affecting the value of — as a manure. T. D. Moss crop. J. Agric. Sci., 1917, 8, 175—181.

LETTUCE seeds were germinated on tiles under water-sealed bell-jars, in each of which was

placed a crucible containing 4 grms. of calcium cyanamide mixed with water, or the same mixed with damp soil or with soil water; in no case did the fertiliser itself come in contact with the seeds. The cotyledons of the seeds were soon blackened and disorganised, and the air and water became strongly alkaline; on germinating fresh seeds in presence of ammonia vapour the effect upon them was exactly the same. Barley and turnip seeds were found to withstand the influence of 1 gm. of calcium cyanamide under the same conditions. A quantitative examination of the gases evolved by the action of 100 c.c. of water on 1—5 grms. of calcium cyanamide during one week gave: carbon dioxide 0.0237%, ammonia 0.43%. When soil was used in addition to water 2.86% of ammonia was obtained. For seeds with a thin testa and for non-oily seeds, the calcium cyanamide should be applied a week before sowing.—E. H. T.

Superphosphates; Use of — in agriculture. N. A. Barbieri. Gazz. Chim. Ital., 1917, 47, 1, 38—51.

ANALYSES described show that the whole of the phosphorus in plants and in animals is in the form of phosphoric acid combined with alkalis, alkaline-earth bases, and some other mineral bases. After elimination of all the phosphates from cereals and leguminous plants by extraction with water, ether, and alcohol, the residue contained no trace of phosphorus. Plants do not contain mono-calcium or dicalcium phosphates, the whole of the phosphoric acid being in the form of tricalcium phosphate. Germination experiments with the seeds of the vetch and wheat under various conditions showed that the plants do not absorb monocalcium or dicalcium phosphate, but that these salts check the germination of the seeds and growth of the plants. Cereals and leguminous plants from soil manured with superphosphates contained less phosphorus than the plants from adjacent soil which had not been treated with superphosphates. Moreover, superphosphates destroy seeds with which they come in contact. The general conclusion is drawn that if plants require mineral fertilisers the substances used should be those which the plants contain.—C. A. M.

Phosphoric acid [in fertilisers]; The volumetric or Pemberton method for determining — with some experiments showing the influence of temperature and the sulphuric acid radical on the results. P. McG. Shuey. J. Ind. Eng. Chem., 1917, 9, 367—370.

THIS method was found to be trustworthy. The presence of sulphuric acid caused the results obtained to be too high by about 1%, but when the sulphuric acid was removed by the addition of barium chloride the results were correct. The temperature at which the phosphoric acid was precipitated with molybdic acid reagent had a considerable effect; the most concordant results were obtained by precipitating at 30° to 40° C. It is recommended that a control determination, using a standard phosphate rock, should be made when acid phosphates (superphosphates) are being analysed, this precaution applying particularly when it is necessary to destroy organic matter in the sample by means of sulphuric and nitric acids; the sample and control should be treated exactly alike. (See also Fairchild, this J., 1912, 350.) —W. P. S.

Practicability of the recovery of nitrogen in sewage sludge. Copeland. See XIXb.

XVII.—SUGARS; STARCHES; GUMS.

Galactobioses; Biochemical synthesis of two — by means of emulsin. E. Bourquelot and A. Aubry. *Comptes rend.*, 1917, **164**, 443—445, 521—523.

THE product of the prolonged action of emulsin on concentrated solutions of galactose (this J., 1916, 867) has yielded two crystalline galactobioses by successive treatments with alcohol. They crystallise from methyl alcohol, are only slightly sweet, and have cupric-reducing powers about half that of galactose. These two galactobioses, which have $[\alpha]_D = +35.05^\circ$ and $+33.05^\circ$, probably correspond with the two glucobioses hydrolysable by emulsin, *viz.*, gentiobiose and cellobiose, which have $[\alpha]_D = +10^\circ$ and $+33.3^\circ$ respectively.—J. H. L.

PATENT.

Sugar-separating machine. L. M. Clairain and O. J. Suares, New Orleans, La. U.S. Pat. 1,217,705, Feb. 27, 1917. Date of appl. June 5, 1915.

A LONG trough has, near one end, an opening in the bottom, covered by a screen, below which is a funnel-shaped collector connected with an exhausting device. Mounted longitudinally within the trough is an endless conveyor, carrying at intervals transverse scraping lugs which engage the bottom of the trough to spread the material thereon and carry it over the screen. Means are provided for feeding syrup into the trough at the end near the screen and for discharging sugar at the other end.—J. H. L.

XVIII.—FERMENTATION INDUSTRIES.

Barley extract; Determination of —. R. Kutscha. *Woch. Brau.*, 1916, **33**, 233—235, 245—247, 252—254, 259—261, 270—272, 277—279, 285—286, 291—293. (See also Seibriger, this J., 1910, 893; 1914, 97.)

THE numerous methods which have been proposed for the determination of barley extract are described. The author has had extensive experience with Pawlowski's and Seibriger's, and usually found good agreement (*i.e.* within 1%) between them and several others, but differences in the quality of barleys do not always affect the results of different methods to the same extent. The relation between the percentage extract yield of barley and that of the corresponding malt, both being calculated on dry substance, depends on the type of malt produced; in the case of pale, low-cured malts the two values are often practically identical, but more highly-cured malts give results 1 or 2% lower. For given malting conditions, the relation between barley and malt extracts is influenced also by the quality of barleys, and may vary with the latter from year to year. For example, the author found that with barleys of 1913 and 1914, Pawlowski's and Seibriger's methods gave results usually about 1% above the laboratory yields of extract obtained from the corresponding malts (pale Pilsener type); with barleys of 1915, which were of rather poor quality, the results were on the average about 2% higher than the extract yields of the malts estimated by the official method of the Bonn convention. With these 1915 barleys the method recently proposed by Heintz (*Woch. Brau.*, 1916, **33**, 65, 268, 305) gave results in good agreement with those for the malts. The nitrogen-content of barleys, taken alone or in conjunction with the 1000-corn weight, does not afford a basis for computing the extract yield either of the barley

or of the corresponding malt (*cp.* Lintner, this J., 1911, 1080). The author found differences of 5% between the extract yields of barleys of equal nitrogen-content.—J. H. L.

[*Brewing; Pre-mashing and the protein-rest* (in —)]. F. Lehmann. *Woch. Brau.*, 1916, **33**, 281—283.

THE author agrees with Windisch (this J., 1916, 1170) as to the advantages of pre-mashing and the protein-rest in working with short-grown malts. To obtain the best results from the protein-rest a high acidity is necessary, to promote proteolysis. Phosphoric acid and acid phosphates appear to exert a specific influence on wort proteins, tending to prevent the formation of protein-turbidity on heating or on chilling. A solution of acid phosphates, used for sprinkling green malt in the course of germination, improves the quality of the malt produced. The results obtained with pre-mashing and the protein-rest depend on the character of the brewing water, and magnesium salts in the latter are particularly injurious, possibly because they may precipitate phosphoric acid as dimagnesium phosphate. This precipitation is hindered by a high lactic acidity such as may be produced by pre-mashing for a longer time or at a higher temperature. A portion only of the total malt need be pre-mashed and sufficient acid developed in this portion for the whole mash. This reduces the danger arising from the presence of the husk during pre-mashing (*see loc. cit.*), and is simpler than screening the whole grist to remove the husk portions.—J. H. L.

Alcoholic fermentation in presence of alkalis; Course of —. I. Cell-free fermentation in alkaline solutions. C. Neuberg and E. Färber. *Biochem. Zeits.*, 1916, **78**, 238—263.

THE fermentation of 5% sugar solutions by yeast maceration juice was found to proceed to completion in presence of 0.1—0.2 gm.-mol. of sodium or potassium carbonate, potassium metaborate, or tripotassium phosphate, or 0.02 gm.-mol. of sodium or potassium sulphite, per litre, when the alkaline substance was added before fermentation had commenced; but when the addition was made after fermentation had well started, about twice the above amounts did not prevent complete fermentation of the sugar. The authors conclude that alkalis have a special inhibitive influence on the inception of the first stages of fermentation which precede the evolution of carbon dioxide. Fermentations which had been arrested by adding large amounts of alkali were resumed on addition of free phosphoric or lactic acid, but not on addition of soluble phosphates or hexose-phosphates.—J. H. L.

Alcohol; Immersion refractometer in the determination of small amounts of — in hopped beverages. A. Fonyo. U.S. Master Brewers' Assoc. Amer. Brewers' J., 1917, **41**, 112—113.

USING the methods and tables of the Association of Official Agricultural Chemists (U.S.A.), the author carried out determinations of alcohol with unhopped wort, and with hopped worts containing up to 0.5% of added alcohol, determining the sp. gr. of the distillates and also their refractometer readings in a Zeiss-Pulfrich instrument at 20°C. (*cp.* this J., Ackermann and Steinmann, 1905, 563; Barnard, 1907, 707). The pyknometric results showed no alcohol in the unhopped wort, but the hopped wort containing no alcohol showed 0.01%, and the results for the hopped worts containing alcohol were all high by about the same amount. This is attributed to traces of volatile hop constituents not removed during ordinary

wort boiling, which are carried over during distillation and reduce the sp. gr. of the distillate slightly. The refractometric results were accurate, subject to the qualification that the limit of sensitiveness was about 0.08%, this amount being indicated alike in the distillates from pure water and from hopped wort containing 0.05% of alcohol. In using the refractometer, an error of 1° C. in the temperature of the liquid observed, was found to produce an error of about 0.2% in its apparent alcohol-content. For the concentration of alcohol from worts containing only small amounts, Bacon's method (see this J., 1912, 42) was found very satisfactory.—J. H. L.

Biochemical synthesis of a second galactobiose. Bourquelot and Aubry. See XVII.

PATENTS.

Beer: Compounds for preserving —. G. Rottenkolber, Cornwall, Ont., Canada. U.S. Pat. 1,217,641, Feb. 27, 1917. Date of appl. July 21, 1916.

THE products claimed consist of "potassium pyrosulphite," tartaric acid, and sodium bicarbonate, e.g., in the proportions 13 : 2 : 1.—J. H. L.

Beverage: Carbonated — and method of making same. C. G. Kummerlander, Washington, D.C. U.S. Pat. 1,218,190, Mar. 6, 1917. Date of appl. Dec. 22, 1916.

SOLUBLE albuminoid matter is treated with a proteolytic enzyme, and after removal of unhydrolysed protein the product is added to a carbonated beverage at any stage of manufacture. Egg albumin in water may be hydrolysed by pepsin, diluted, boiled with hops, chilled, filtered, and employed in the preparation of non-alcoholic carbonated beverages.—J. H. L.

XIXa.—FOODS.

Condensed milk, dried milk, and malted milk. U.S. Dept. Agr., Food Inspection Decision 170, Mar. 31, 1917.

THE following definitions and standards for sweetened condensed milk, condensed skimmed milk, sweetened condensed skimmed milk, dried milk, dried skimmed milk, and malted milk were adopted by the Joint Committee on Definitions and Standards, August 7th, 1916, and were approved by the Association of American Dairy, Food, and Drug Officials, August 10th, 1916, and by the Association of Official Agricultural Chemists, November 22nd, 1916:—*Sweetened condensed milk, sweetened evaporated milk, sweetened concentrated milk*, is the product resulting from the evaporation of a considerable portion of the water from the whole, fresh, clean, lacteal secretion obtained by the complete milking of one or more healthy cows, properly fed and kept, excluding that obtained within fifteen days before and ten days after calving, to which sugar (sucrose) has been added. It contains not less than 28.0% of total milk solids, and not less than 8.0% of milk fat (see also this J., 1915, 416). *Condensed skimmed milk, evaporated skimmed milk, concentrated skimmed milk*, is the product resulting from the evaporation of a considerable portion of the water from skimmed milk, and contains not less than 20.0% of milk solids. *Sweetened condensed skimmed milk, sweetened evaporated skimmed milk, sweetened concentrated skimmed milk*, is the product resulting from the evaporation of a considerable portion of the water from skimmed milk to which sugar (sucrose) has been added. It contains not less than 28.0% of milk solids. *Dried milk* is the product resulting from the removal of

water from milk, and contains not less than 26.0% of milk fat, and not more than 5.0% of moisture. *Dried skimmed milk* is the product resulting from the removal of water from skimmed milk and contains not more than 5.0% of moisture. *Malted milk* is the product made by combining whole milk with the liquid separated from a mash of ground barley malt and wheat flour, with or without the addition of sodium chloride, sodium bicarbonate, and potassium bicarbonate in such a manner as to secure the full enzymic action of the malt extract and by removing water. The resulting product contains not less than 7.5% of butter fat and not more than 3.5% of moisture.

Milk: Study of certain ferments [enzymes] with a view to determining a method for the differentiation of pasteurised milk from raw —. I. Reductases. R. E. Lee and M. G. Mellon. J. Ind. Eng. Chem., 1917, 9, 360—367.

AN outline is given of the classification, distribution, and reactions of certain enzymes and a description of experimental work concerning the source, nature, and action of reductase in its relation to methods which have been proposed for the differentiation of pasteurised milk from raw milk. It was found that the Methylene Blue in Schardinger's reagent (a solution containing Methylene Blue and formaldehyde) was not decolorised by normal fresh milk in less than 20 mins. unless the milk contained more than 1,000,000 bacteria per c.c., or by recently pasteurised milk. The reagent was decolorised by milk which had been allowed to "age" for 24 to 48 hours. Pasteurisation increased the time required for decolorisation. Generally, there was no parallelism between the number of bacteria present in a milk and the time required for the decolorisation of the reagent, but a certain relationship seemed to exist in a given sample of milk indicating that reductase is of bacterial origin, and that not all the bacteria existing in milk produce this enzyme. Formaldehyde appeared to retard the action of the reductase or even to destroy it.

—W. P. S.

Lecithin in egg-yolk: Non-existence of free or combined —. N. A. Barbieri. Gazz. Chim. Ital., 1917, 47, I, 1—37.

EXPERIMENTS described in detail show that fats may be quantitatively separated in a pure state from egg-yolk by extraction with neutral solvents. On saponification they yield only glycerol and fatty acids. These fats are able to keep in solution or suspension nitrogenous substances, colouring matters, and phosphates, and these substances can be separated by dialysis, by hydrolysis with a very weak (0.1%) acid, or by repeatedly washing the alcoholic solution with water. The residual fats remain completely unaltered. The whole of the phosphorus in egg-yolk is in the state of phosphoric acid in combination with alkali bases (potassium, sodium), alkaline-earth bases (calcium), and magnesium. Glycerophosphoric acid cannot be separated by means of neutral solvents, but only by saponification. On decomposing the soap with acids the glycerol and the phosphoric acid derived from the phosphates pass into the aqueous solution. No trace of choline is present in egg-yolk. The so-called choline constituent of the alleged lecithin is a product of the hydrolysis of orocromin or a putrefaction product. In view of these facts the conclusion is drawn that lecithin (containing glycerol, phosphoric acid, and stearic acid) is not present in egg-yolk.—C. A. M.

Protein of swede turnips: Hydrolysis of the soluble —. G. Williams. J. Agric. Sci., 1917, 8, 182—215.

THE expressed juice of healthy swedes was filtered

and heated to 90° C. for half an hour. The precipitated protein after repeated washings with hot water, alcohol, and ether, weighed 0.15 gm. per 100 c.c. of juice, and analysis gave N=14.09% (or 15.63% ash-free), H_2O = 1.81%, and ash 8.60%. The ash contained calcium and phosphoric acid corresponding to 26.33% of calcium phosphate, and the sulphur-content of the protein—mostly present in the ash—was 4.2%. On hydrolysis with dilute sulphuric acid the content of diamino-acids was found to be: arginine 3.12% of the protein, histidine 3.04%, lysine 4.35%. After hydrolysing with concentrated hydrochloric acid, 3.18% of glutamic acid and 6.98% of aspartic acid were found by Foreman's method (J. Agric. Sci., 1911, 4, 431); there was also 0.27% of glycine, 3.58% of alanine, 9.95% of valine, 9.01% of leucine and isoleucine, 4.47% of phenylalanine, 4.17% of proline, 2.92% of tyrosine, 1.21% of ammonia, and 4.74% of humin bodies; tryptophan and cystine were also present. The Levene and Van Slyke method of separating alanine and valine (J. Biol. Chem., 1912, 12, 285), the picrate method of separating glycine and alanine, and the separation of valine and the leucines by the lead method (this J., 1909, 1100) were all found to work well, and if pure chemicals are used the first-named method can be used for preparing pure alanine and pure valine. This physiologically-active protein differs from the vegetable proteins already studied by containing much more glutamic acid than aspartic acid; further, the valine content is unusually high and the ammonia content low. As cereals have a high glutamic acid content, the combination of swedes with cereals for feeding stuffs is recommended.—E. H. T.

Pectic substances of plants. S. B. Schryver and D. Haynes. Biochem. J., 1916, 10, 539—547. Analyst, 1916, 42, 141.

PECTINOGEN is separated from plants, fruits, and vegetables by extracting the residue remaining after the expression of the juices with warm 0.5% ammonium oxalate solution, followed by concentration of the extract to small bulk, and precipitation with acidified alcohol. The gelatinous precipitate so obtained is washed with alcohol and finally air dried, when it yields a granular white powder. The yield from 100 kilos. of turnips is 355 grms. The pectinogen so obtained has an acidic character, and if kept in alkaline solution for a short time readily undergoes conversion into pectin, which is also of acidic character, soluble in alkalis, and precipitated from its alkaline solution by acids as a gel insoluble in water. Analyses of pectins agree with the formula $C_{17}H_{24}O_{16}$. On distillation with hydrochloric acid, pectinogen yields fufural in such quantity as to indicate that one pentose group is present in each complex of 17 carbon atoms. Pectin would appear to be not a carbohydrate but an acid.—J. N. P.

Form of iodine in marine alga. Okuda and Eto. See VII.

Inflammability of carbonaceous dusts in atmospheres of low oxygen content. Brown and Clement. See IIa.

PATENTS.

Milk and cream; Process of manufacturing products from —. C. E. Gray. Eureka, Cal. U.S. Pat. 1,219,291, Mar. 13, 1917. Date of appl., Dec. 13, 1910.

MILK and cream are heated under diminished

pressure, whereby the incorporated oxygen and some aqueous vapour are removed. An amount of water equivalent to the aqueous vapour is added to the product, which is then cooled and agitated under oxygen-free conditions.—J. H. J.

Process for emulsifying fats and fatty substances. U.S. Pat. 1,220,010. See XII.

XIXB.—WATER PURIFICATION; SANITATION.

Water; Determination of the quantity of hypochlorite required to sterilise —. Massy. J. Pharm. Chim., 1917, 15, 209—213.

THE criterion of purification being the total destruction of *B. coli*, the most satisfactory means of determining the quantity of hypochlorite required for the treatment of an impure water would be the bacteriological examination of the water after the addition of varying quantities of the hypochlorite solution, but in the case of water required for the use of armies in the field, the time required for the examination precludes its adoption. A rapid method which serves practically the same purpose consists in treating small quantities of the water with increasing amounts of hypochlorite solution and then testing for the presence of free chlorine by the potassium iodide-starch reaction. As described by Gascard and Guy-Laroche (Presse Med., Aug. 5, 1915), several similar quantities of the water are treated with successively increasing volumes of the hypochlorite solution, and, after 20 mins., potassium iodide and starch are added: the test containing the largest quantity of hypochlorite without exhibiting a blue coloration is the one containing the required amount of hypochlorite. The British Army uses the same method with the modification that the potassium iodide and starch are added immediately after the hypochlorite and the observation is made after the lapse of 30 mins. The two methods yield practically the same results. The author has attempted to use sodium sulphindigotate as indicator in place of iodide and starch, but the results obtained were unsatisfactory.—W. P. S.

Nitrogen in sewage sludge; Practicability of the recovery of —. W. R. Copeland. J. Ind. Eng. Chem., 1917, 9, 374—376.

THE sludge hitherto obtained by the best known methods of sewage treatment has contained from 1.2 to 3.0% of nitrogen, the loss, as compared with the raw sewage, being attributable to removal of nitrogen in colloidal matter in suspension in the effluent, and in the case of chemical precipitation works, to the formation of ammonia by the added lime. It is also estimated that from 10 to 60% of the solids deposited in septic tanks is converted into soluble or gaseous form. In the so-called "activated sludge" process (see this J., 1917, 264) recently tried in America and England, the colloidal and suspended matters are collected in the sludge, and if over-aeration be avoided the solids are not liquefied to the same extent as in septic tanks and therefore the nitrogen does not escape. For example, in the case of Milwaukee City sewage the digested sludge accumulates in the Imhoff tanks at the rate of 1 to 10 cub. yds. per 1,000,000 galls. of sewage treated, whereas by the "activated sludge" process from 20 to 80 cub. yds. or more may be deposited in the settling tanks. The following analyses (parts per million) show the results before and after treatment by the two processes:—

Month, 1915.		Suspended matter.	Nitrogen as:			
			Free NH_3 .	Albuminoid NH_3 .	Organic N.	Nitrate.
August	Sewage	253	14.6	7.88	29	0.15
	Effluent, Imhoff	105	16.2	6.10	27	0.19
	Effluent, activated sludge	14	3.8	3.19	6	6.00
September	Sewage	300	13.5	8.81	29	0.25
	Effluent, Imhoff	116	15.4	7.10	27	0.19
	Effluent, activated sludge	8	5.7	2.22	9	5.01

The dry "activated sludge" contained from 1 to 4.5% of nitrogen, but it would be necessary to remove part of the 98 to 99% of water before the material could be sold as a fertiliser. The best means of effecting this was found to be a preliminary settling and decantation, whereby the moisture content was reduced to about 96%, followed by mechanical pressure, reducing the water to 75%, and drying the press cake in a drying apparatus to obtain a product with 10% or less of water. The colloidal matter in the sludge does not interfere with the pressing, and little if any nitrogen is lost in the drying process whether indirect heat (*e.g.*, by a steam jacket) or semi-direct heat is used. The cost of the finished product is estimated at \$8.00 to \$12.00 per ton, including labour, fuel, and depreciation of plant. Four samples of the dried sludge (10% moisture) contained 4.36 to 5.06% of nitrogen as ammonia, and 0.39 to 0.81% of available phosphoric acid. The conclusion is drawn that the dried sludge is a good fertiliser without any further additions, and that its market value at the present time is about \$9.00 to \$15.00 per ton. It could therefore be profitably produced for a large local market.—C. A. M.

Inflammability of carbonaceous dusts in atmospheres of low oxygen content. Brown and Clement, *See* HA.

PATENTS.

Water softening: Apparatus for — G. J. Gibbs, Preston, Eng. Pat. 101,591, June 1, 1916. (Appl. No. 7768 of 1916.)

The pipe conveying the raw water to the apparatus is provided with a valve which divides the water into two portions, passing upwards in two pipes of the same height and being delivered, one into the top of the measuring and reagent apparatus, and one into the top of the reaction tank. The water passing through the reagent apparatus is overdosed with the reagent and passes on into the reaction tank, where it mixes with the rest of the water. By means of the valve, the proportions into which the water is divided can be finely adjusted while the apparatus is at work, the proportions being indicated on a scale. The two branch pipes for the raw water are as nearly alike as possible in length and disposition, so that they each discharge against the same static head, whereby the water in the two pipes is kept at a constant ratio for a given setting of the valve. Instead of one valve, the pipe for the raw water may bifurcate before being valved, and in this case each branch pipe carries an independent valve.—J. H. J.

Filling [jewellers' waste wash] water: Process and means for — F. P. Boland, Providence, R.I. U.S. Pat. 1,217,397, Feb. 27, 1917. Date of appl. Nov. 23, 1915.

JEWELLERS' waste wash water, containing non-liquid particles of precious metals in suspension, is collected in a tank from which it flows slowly

through a restricted opening into the top of another tank of the waste water, whereby particles not readily burned are collected in the bottom of the first tank, and particles of precious metals in suspension are carried over into the second tank. The water in the second tank is slowly withdrawn through a restricted opening, whereby the particles of precious metal are separated as before. The discharge from the second tank is filtered through a combustible filter, which is then burned, and the precious metals collected.—J. H. J.

Water-purifying apparatus [; *Electrolytic* — J. D. Kynaston, Washington, D.C. U.S. Pat. 1,219,333, Mar. 13, 1917. Date of appl. Nov. 15, 1916.

WATER enters at the bottom of an upright conveying vessel, and has a gyratory motion imparted to it. As it passes up through the vessel, it meets electrodes arranged as battle-plates connected in series, the anodes being of aluminium and the cathodes of carbon. The water leaves at the top of the vessel and passes to the bottom of a filtering and settling tank.—J. H. J.

Liquid purifying apparatus. L. Linden, Claygate, Surrey, Eng. Pat. 101,710, Mar. 10, 1916. (Appl. No. 3613 of 1916.)

IN a vertical apparatus for the sterilisation of liquids by violent agitation (*see* Fr. Pat. 478,797; this J., 1916, 1129), the liquid to be purified is admitted at the top and falls on to filtering material contained in a holder supported on trunnions at each side, so that it can be inverted. After passing through the filter, the liquid is received on the floor of the upper part of the apparatus and then passes through a valve into the intermediate part of the apparatus, which has the form of a double-walled cylinder in the centre of which is mounted a vertical Archimedeian screw driven by outside power. When the liquid has filled the cylinder, the screw is set in motion and forces the liquid violently against the sides, and at the same time exerts a downward force so as to cause a circulation of the liquid downwards in the cylinder and upwards between the double walls. When the liquid has circulated sufficiently, a valve in the floor of the cylinder is opened and the liquid passes on to filtering material contained in a tray. From the filter, the liquid is received in the bottom of the apparatus which is of cup-shaped form, tapped at the bottom, and acts as a reservoir. Tubes pass into the sides of the reservoir, through which air can be blown into the liquid. When the filtering material requires to be cleaned, the top filter is inverted and the liquid allowed to flow through as before, the washings being run off by a pipe in the side. The bottom filter can be removed bodily through a door in the side and replaced by another tray of clean material. A portable form of the apparatus can be mounted on a motor vehicle, and the motor of the vehicle can be used to supply the power for the working of the apparatus.—J. H. J.

Sewage and other foul liquids; Apparatus for aerating—R. Ames, Brighton, Eng. Pat. 164,361, Feb. 25, 1916. (Appl. No. 2850 of 1916.)

THE apparatus consists of a circular tank in which is a central standpipe supporting a chamber carrying horizontal radial arms, capable of being revolved above the level of the liquid in the tank. The sewage enters by a pipe, in which it is mixed with compressed air, along the bottom of the tank to the central standpipe, from openings in the bottom of which the sewage passes into the body of the tank. Air is supplied to the chamber carrying the radial arms, and pipes depend from these arms nearly to the floor of the tank, with atomisers attached to their ends. The atomisers consist either of a metal casing containing a porous block or layers of wire gauze, or of a hollow metal block with narrow slots. The radial arms are rotated by the pressure of the escaping air on the liquid, or by mechanical means. The purified liquid is drawn off intermittently or continuously. —J. H. J.

Sewage containing organic matter; [Electrolytic] purification of—G. ter Meer, and K. Reubold, Hannover-Linden. Ger. Pat. 294,957, Sep. 8, 1911.

THE precipitation of colloidal organic matter from sewage can be effected electrolytically in the presence of a small quantity of chemical precipitant. Using iron or aluminium electrodes, oppositely charged hydroxides in the colloidal form are produced which bring about the coagulation of the organic colloids. This fails sometimes because the latter behave as protective colloids. In such cases the addition of electrolytes, in general, is inadequate, but the addition of aluminium sulphate is effective if from one-quarter to one-third of the quantity which would itself cause precipitation of the colloid, is taken. —H. J. H.

Preserving-gas, J. N. Alsop, Assignor to Alsop Electrical Co., Owensboro, Ky. U.S. Pat. 1,219,527, Mar. 20, 1917. Date of appl., Apr. 28, 1913.

"VAPORISED products of wood" are mixed with atmospheric air, and the mixture is exposed to the action of an electric arc. The resulting gas has germicidal and therapeutic properties.—J. H. J.

Sewage and other waste liquids; Apparatus for treating—T. K. Irwin, Assignor to Anglo-Continental Fertilizers Synd., Ltd., London. U.S. Pat. 1,220,990, Mar. 27, 1917. Date of appl., Sept. 4, 1914.

SEE Eng. Pat. 20,816 of 1913; this J., 1914, 565.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Acetylsalicylic acid; Analysis of—M. François. J. Pharm. Chim., 1917, 15, 213—222.

To detect the acetic acid residue in the acetylsalicylic acid molecule, the substance is treated with an excess of calcium hydroxide and a small quantity of water; calcium acetate and calcium salicylate are thus formed, the latter being insoluble. After 1 hour, the mixture is filtered, the calcium salicylate washed with a small quantity of water, the filtrate evaporated to dryness, the residue gently ignited to destroy any remaining trace of salicylate, and the usual tests for acetates then applied. Acetylsalicylic acid should volatilise completely when heated (the presence of sugar, tartaric acid, and certain alkaloids such as quinine

may often be detected by the odour of the vapour given off during ignition), and should not give a violet coloration with ferric chloride (absence of free salicylic acid). Its m. pt. is 132° C.; in determining the m. pt. the oil-bath should be heated to 125° C. before the capillary containing the substance is introduced, and the temperature then raised at the rate of 1° per min. Acetylsalicylic acid may be determined by means of the acid or saponif. values of the substance. Two samples of "aspirin" examined by the author consisted of crystallised magnesium sulphate, 53.2 and 48.4, lactose, 38.9 and 46.6, acetylsalicylic acid (containing free salicylic acid), 7.8 and 7.9%, respectively.—W. P. S.

Hexamethylenetetramine; Explosive peroxide derivative of—A. Leulier. J. Pharm. Chim., 1917, 15, 222—229.

By dissolving 140 grms. of hexamethylenetetramine in hydrogen peroxide, adding 140 grms. of pure nitric acid, then introducing more hydrogen peroxide until the total weight of the mixture was 1500 grms., and keeping this mixture at 20° to 25° C. for 3 hours, a crystalline precipitate was obtained which, when dried, weighed 60 grms. This substance contained carbon, 31.46, hydrogen, 10.06, oxygen, 45.50, and nitrogen, 10%; it was practically insoluble in water, ether, and cold alcohol, but soluble in hot alcohol. It exploded violently when struck with a hammer or when heated, the force of the explosion being about two-thirds of that of melinite. Dilute sulphuric acid converted it into formaldehyde and ammonium sulphate. Its composition and properties showed it to be $\text{NH}(\text{CH}_2\text{CH}_2\text{O.OH})_2$, and to be identical with the "hexamethylene triperoxide," prepared previously by Von Girsowald (this J., 1912, 1058), although the latter considered that the substance contained 2 atoms of nitrogen in its molecule.—W. P. S.

Organic compounds containing sulphur; Action of pyridine and piperidine on—M. Raffo and O. Balduzzi. Gazz. Chim. Ital., 1917, 47, I., 65—73.

WHEN a solution of thiourea in pyridine is boiled, decomposition of the thiourea takes place, with the formation of hydrogen sulphide, guanidine thiocyanate, and ammonium trithiocarbonate as the final products. Cyanamide is probably formed as an intermediate product, as in the case of the decomposition effected by yellow mercury oxide, but this would at once react with the ammonium thiocyanate also produced in the reaction to form guanidine thiocyanate. In like manner thioaminophenol when heated with pyridine yields hydrogen sulphide and diaminophenyl sulphide, and thioacetanilide gives hydrogen sulphide and acetanilide. Piperidine has an analogous desulphurising action upon organic sulphur compounds. For example, diphenylthiourea when dissolved in piperidine and boiled, yields as the final products of decomposition, aniline, triphenylguanidine, and piperidine thiocarbonate (m. pt. 169—171° C.).—C. A. M.

Distillation; Studies in steam—Part IV. Propionic, butyric, valeric, and caproic acids. Part V. Some applications of Duclaux's method. H. D. Richmond. Analyst, 1917, 42, 125—139. (See also this J., 1908, 705, 897.)

IN continuation of the work on formic and acetic acids, propionic, butyric, iso and active valeric, normal caproic, and diethylacetic acids were purified, and their dilute solutions distilled in fractions, as previously described. The rate of

distillation relative to that of water, a , was calculated from the ratio,

$$\frac{\log y}{\log x}$$

where $x = 1 - \frac{\text{percentage of total water distilled}}{100}$

and $y = 1 - \frac{\text{percentage of total acid distilled}}{100}$

Continued purification of the acid in each case led to a constant value of a being approached for the A and B fractions. The factors for the different acids at $N/100$ concentration were in close agreement with those calculated from the formula $a = 0.4013 \times 1.72^n$, where n is the value in the formula $C_nH_{2n+1}COOH$, as shown in the table:—

Acid.	a (from experiment).	n .	0.4013	1.72^n .
Formic	0.4013	0	0.4013	
Acetic	0.677	1	0.69	
Propionic	1.224	2	1.18	
Butyric	2.00	3	2.04	
Valeric	3.50	4	3.51	

The results with the caproic acids do not agree with the formula. The estimation of the factor a provides a means of determining the purity of these acids; and in the case of a mixture of two homologous acids enables the relative proportions to be calculated; thus with a mixture of acetic and propionic acids, which was made to contain 0.488 mol. of propionic to 0.512 of acetic, the mean result indicated 0.493 mol. of propionic acid as shown in the following table giving the values for the successive fractions:—

x .	y .	y calc. for acetic.	y calc. for propionic.	y corrected	Ratio $\frac{P}{A+P}$.
0.900	0.9025	0.931	0.8755	0.904	0.513
0.9785	0.807	0.8585	0.7565	0.809	0.595
0.698	0.7115	0.782	0.641	0.714	0.500
0.5985	0.619	0.7045	0.5295	0.620	0.488
0.4985	0.523	0.6215	0.4215	0.5245	0.492
0.3985	0.429	0.533	0.320	0.430	0.488
0.2995	0.2375	0.333	0.1365	0.238	0.486
0.0995	0.132	0.206	0.0575	0.134	0.498

The use of Duclaux's method is best exemplified by the analysis of acids of the acetic series. During the distillation of a simple mixture of two such acids, the amount distilled in each fraction is calculated for each of the acids as a percentage of the acid present at the commencement: an agreement between the ratios deduced for each fraction will show that no other acids are present, and the mean ratio will give the molecular proportions. The quantity of butyric acid present in acetic acid can advantageously be estimated in this way as an alternative to the method of titration of the weighed anhydrous acid with standard alkali. In discussing the analysis of acetic anhydride, the method of Menschutkin and Wasiljew (J. Russ. Phys. Chem. Soc., 1889, 21, 190), is referred to as the best, and as it escaped abstraction in English is given in detail by the present authors. The purity of acetyl compounds can be determined by separating the acetic acid by hydrolysis and distilling in fractions. With small quantities of salicylic acid present in acetic acid, if the acid is exactly neutralised, then 99% of the solution distilled, while nearly 80% of the acetic acid is thus removed only 15% of the salicylic acid is lost, and the delicacy of the test is thus greatly enhanced. Substituted malonic acids (e.g., a mixture of malonic, ethylmalonic, and diethyl-

malonic acids) can be conveniently tested by heating to 190° C., when conversion into the corresponding members of the acetic series occurs and the product may be examined by the Duclaux method. After deducting for the estimated amount of free acetic acid, the values of y are compared with those calculated for butyric and diethylacetic acids, and the proportions of these deduced.—J. N. P.

PATENTS.

Medicinal aluminium preparation; Method of manufacturing a—, Monneron et Guye, Lausanne, Switzerland. Eng. Pat. 104,609, June 23, 1916. (Appl. No. 8878 of 1916.) Under Int. Conv., June 5, 1916.

AN aluminium preparation which dissolves gradually in the intestines and there acts as a mild astringent, is produced by precipitating an aluminium salt with caustic alkali in the presence of a protective colloid, rendering the colloid insoluble, and washing out the alkali salt with water. *Example*:—To a clear solution of 200 grms. of aluminium sulphate in 500 c.c. of hot water is added 30 grms. of gelatin dissolved in 300 c.c. of warm water. The acid reaction is exactly neutralised with 35% soda lye (about 145 c.c.), and 18 grms. of tannic acid dissolved in 100 c.c. of warm water is added with constant stirring. The thick flaky pulp produced is filtered, washed free from sodium sulphate, dried, and pulverised. It is useful in the treatment of diarrhoea.—F. Sp.

Cephaeline butyl ether and salts thereof. J. W. Meader, Indianapolis, U.S.A. Eng. Pat. 104,652, July 18, 1916. (Appl. No. 16,036 of 1916.) Addition to Eng. Pat. 11,717, Aug. 13, 1915 (this J., 1916, 1271).

CEPHELINE butyl ethers (as distinguished from the isobutyl ether claimed in the principal patent) are made by the action of an alkali metal and a butyl halide on cephaeline. The details of the preparation and the properties of the product are the same as for the isobutyl ether.—F. Sp.

Cephaeline allyl ether and process for making same. J. W. Meader, Assignor to The Eli Lilly & Co., Indianapolis, Ind. U.S. Pat. 1,209,575, Mar. 20, 1917. Date of appl., Jan. 25, 1916.

CEPHELINE allyl ether, $C_{25}H_{37}O_3N_2OC_3H_5$, is prepared by treating cephaeline with sodium ethylate and allyl bromide.—J. H. J.

Nitromethane and homologues; Preparation of—, H. Krause, Dresden. Ger. Pat. 294,755, Dec. 1, 1915.

A FINELY powdered mixture of a nitrite and a salt of an alkylsulphuric acid is made into a cream with water and distilled. Above 100° C. the nitroparaffin passes over and this continues after the mass has been evaporated to dryness. Decomposition of the alkyl sulphate to form sulphuric acid or an acid sulphate is to be avoided as it causes a loss of yield. The sulphuric acid formed liberates nitrous acid, and this reacts with the nitroparaffin causing a further loss of yield. To obviate this, a little alkali or salt with an alkaline reaction is added to the mixture before distillation. The yield of nitromethane is 50% of theory and of nitroethane 35%.—H. J. H.

Hydrocarbons and their derivatives; Preparation of—, Badische Anilin u. Soda Fabr., Ger. Pat. (A) 295,202, May 31, 1914, and (B) 295,203, June 23, 1914. Additions to Ger. Pat. 293,787 (see Fr. Pat. 468,427 of 1914; this J., 1914, 984).

(A) IS the reactions between hydrogen and carbon monoxide under pressure in contact with catalysts,

spontaneous local heating and deposition of free carbon can be hindered by increasing the thermal conductivity of the contact mass. Where possible the catalyst may be used in the form of metallic gauze, wool, or turnings, or it may be deposited on metal or on a ceramic mass mixed with metallic particles. (B) The catalyst may be a metallic carbide preferably of the iron group of elements. The carbide as such may be used, *e.g.*, cast iron, or it may be prepared *in situ* as a result of the carburising of a low-carbon steel by the carbon monoxide or hydrocarbons in the compressed gas mixture.—H. J. H.

Ethyl ether; Process for purifying — G. Michaelis. Albany, N.Y., U.S.A. Eng. Pat. 105,204, Oct. 24, 1916. (Appl. No. 15,145 of 1916.)

SEE U.S. Pat. 1,189,602 of 1916; this J., 1916, 907.

Altol; Manufacture of — W. Herrmann and M. Mugdan, Assignors to Consortium für Elektrochemische Industrie, Nuremberg, Germany. U.S. Pat. 1,220,746, Mar. 27, 1917. Date of appl., Sep. 3, 1913.

SEE Eng. Pat. 19,463 of 1913; this J., 1914, 219.

Hydrocarbons; Producing partially-hydrogenised monocyclic — O. Schmidt, Ludwigshafen, and K. Hochschwender and T. Eichler, Mannheim, Assignors to Badische Anilin u. Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,221,382, Apr. 3, 1917. Date of appl., Oct. 11, 1912.

SEE Fr. Pat. 441,203 of 1912; this J., 1912, 843.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

A polarisation flicker photometer and some data of theoretical bearing obtained with it. Ives. See XXIII.

XXII.—EXPLOSIVES; MATCHES.

Explosive peroxide derivative of hexamethylene-tetramine. Leulier. See XX.

PATENTS.

Manufacture of picric acid and other nitrophenols from certain gums or gum-resins. Eng. Pat. 104,352. See III.

Making nitro-compounds. U.S. Pat. 1,220,978. See III.

XXIII.—ANALYSIS.

Photometer; A polarisation flicker — and some data of theoretical bearing obtained with it. H. E. Ives. Phil. Mag., 1917, 33, 360—380.

In the instrument described a double image prism forms two images of each half of the photometric field, the horizontally polarised image of one half being superposed on the vertically polarised image of the other half; a rotating Nicol prism alternately extinguishes each half but gradually and with no mechanical edge effect. The rotating Nicol may be placed near the eye, in which case its faces must be at right angles to the beam of light, or it may be placed between the double image prism and the diaphragm, when the faces may be oblique

to the beam of light. A special mixture photometer was used having two similar flashed opal glass plates mounted one over the other on a common vertical axis parallel to their faces and rotatable in opposite directions by means of suitable gears: this arrangement was placed at the intersection of two photometer tracks and viewed from behind. The effect of rotation of the Nicol on a polarised beam follows the cosine law postulated in previous discussions (Phil. Mag., 1911, 708; 1916, 290). The relationships between relative and absolute intensities of compared fields and critical speeds are shown to be in agreement with theory. The flicker photometer is specially adapted for colour difference comparisons owing to the failure of hue discrimination as compared with brightness discrimination with rapid fluctuations and the amount of this failure has been determined.—B. V. S.

High temperature measurements without platinum instruments. M. Neumann. Chem.-Zeit., 1917, 41, 288.

A NEW thermo-element recently introduced for the measurement of temperatures between 900° C. and 1100° C., is constructed of nickel and nickel-chromium and is very reliable. An improved and simplified form of optical pyrometer has also been introduced, in which the regulating electrical resistance is in the form of a ring on the telescope tube, which is made of aluminium.—F. C. T.

Silica; Accurate determination of — in commercial analysis. F. G. Hawley. Eng. and Min. J., 1917, 103, 511—513.

ATTENTION is directed to sources of error in the determination of silica due to the solubility of silica in hydrochloric acid, the presence of silica in the fusion mixture itself, and to impurities retained by the washed silica. The solubility of the silica, which may amount to 2% in samples containing less than 20% of silica, may be diminished by heating the saline residue at 150° C. for 30 mins., then adding 15 c.c. of 60% hydrochloric acid, heating the mixture to boiling for 3 mins., and collecting the silica on a filter where it is washed successively with water, dilute hydrochloric acid, and water. To determine silica in ores containing much lead, copper, antimony, etc., the ore may be fused in a nickel crucible with a mixture of sodium hydroxide and sodium peroxide (equal parts by weight), followed by the above method of separation. Under these conditions, the loss of silica by solution is about 0.4%, but this loss is balanced approximately by impurities in the silica and the quantity of the latter derived from the fusion mixture.—W. P. S.

Resistance of an oil to emulsification. Herschel. See IIa.

Analysis of light oils [for benzene, toluene, and xylene]. Egloff. See III.

Manufacture of Methylene Blue derivatives [Methylene Violet and Methylene Azure] for microscopy. Tribondeau and Dubreuil. See IV.

Determination of ozone. David. See VII.

Determination of zinc. Hastings. See X.

Analysis of aluminium dust. Clennell. See X.

Action of aromatic amines on fatty acids. [Analysis of fats.] De Courno. See XII.

Rubber hose for use on aeroplanes. Houseman. See XIV.

Detection and differentiation of vegetable and synthetic tannins. Lauffmann. See XV.

Glue for use on aeroplanes. Houseman. See XV.

Volumetric or Pemberton method for determining phosphoric acid [in fertilisers], and influence of temperature and the sulphuric acid radical on the results. Shuey. See XVI.

Determination of barley extract. Kutscha. See XVIII.

Immersion refractometer in the determination of small amounts of alcohol in hopped beverages. Fonyo. See XVIII.

Study of certain ferments [enzymes] with a view to determining a method for the differentiation of pasteurised milk from raw milk. I. Reductases. Lee and Mellon. See XXA.

Determination of the quantity of hypochlorite required to sterilise water. Massy. See XIXB.

Analysis of acetylsalicylic acid. François. See XX.

Studies in steam distillation. IV. Propionic, butyric, valeric, and caproic acids. V. Some applications of Duclaux's method. Richmond. See XX.

PATENTS.

Gases: Apparatus for indicating the composition of —. H. Haupt and M. Werner, Berlin. U.S. Pat. 1,220,037, Mar. 20, 1917. Date of appl. Apr. 9, 1915.

THE composition of gases is indicated by using the principle of diffusion. A diffusion chamber and an air supply chamber are combined with a number of similar auxiliary chambers, separated from each other, and having their opposite end walls provided with ports controlled by valves mounted on a rotating shaft. The valves are so arranged as to permit, during each half turn of the shaft, an exchange of air between the auxiliary chambers, the diffusing chamber, and the supply of air.—W. F. F.

Method of testing filler bodies. U.S. Pat. 1,218,151. See I.

Books Received.

GAS CHEMISTS' HANDBOOK. Published by the American Gas Institute, 29, West 39th Street, New York City. 351 pages, 8 $\frac{1}{2}$ × 6 in. Price \$3.50 in the United States and Canada; elsewhere \$3.75.

THE Committee on Chemical Tests of the American Gas Institute, under the chairmanship of C. C. Tutweiler, has for the past two years been engaged in revising the first edition of this book, compiled in 1911 by W. H. Fulweiler. Some of the methods there described have been discarded in favour of simpler and more accurate processes, and the Committee is continuing its work with a view to collecting a number of methods of analysis all of which are approved by the Institute. The methods given for the analysis of coal and coke, cements and iron and steel are the official methods of the U.S. Bureau of Mines and of the American Society for Testing Materials.

The analytical methods are subdivided as follows: I. Coal, coke, gas oil, purification material. II. Illuminating gas, ammonia, tar, cyanogen. III. Impurities in gas. IV. Tar products. V. Constructional materials, alloys, lubricating oils.

THE CHEMISTS' YEAR BOOK, 1917. Edited by F. W. Atack, Sherratt & Hughes, 34, Cross Street, Manchester. In two vols. 1030 pages, 6 × 4 in. Price 10s. 6d.

THE third edition of this useful Year Book fully maintains the standard of its predecessors, and has, it is to be hoped, now established for itself a permanent place in our periodical literature. New sections are included on "Analysis of essential oils," by L. G. Radcliffe; "Efficiency of boiler plant," by T. O. Morgan; "Cement," by A. Grounds; and "Paints and pigments"; while the section on "Textile fibres" has been re-written by W. F. A. Ermen, and other sections have been considerably revised.

THE FLOTATION PROCESS. Compiled and edited by T. A. Rickard. Mining and Scientific Press, Chicago. 364 pages, 9 × 6 in. Price 8s. 6d.

THIS is a useful collection of papers published in the *Mining and Scientific Press* on the practice and theory of the flotation process, which has developed so largely during the past five years (it is stated that fully 50,000 tons of ore is being treated daily in the United States by this method). The contributors include G. L. Allen, T. M. Bains, J. A. Block, C. Butters, D. Butler, J. M. Callow, J. E. Clemell, W. H. Coghill, W. F. Copeland, A. E. Brucker, C. T. Durell, F. A. Fahrenwald, J. Hebbard, W. H. Kenyon, V. F. S. Low, E. P. Mathewson, W. Motherwell, D. H. Norris, T. A. Rickard, O. C. Ralston, W. A. Scott, W. Shell-shear, and J. H. Wise.

CONCENTRATING ORES BY FLOTATION. By T. J. Hoover. Mining Magazine, Salisbury House, London, E.C. 320 pages, 9 × 6 in. Price 12s. 6d.

THE progress that has been made in the applications of the flotation process since the publication of the second edition of this book, in 1914, has necessitated a further edition. In this however, the text of the second edition has been retained in its entirety, and a chapter on recent progress has been added to bring the matter up to date. The early chapters of the book deal with the history of the process and the litigation which has resulted in connection with it. The Potter-Delprat, De Bavay, Elmore, and Minerals Separation processes are fully described, and some of the other processes are also considered. In the chapter on more recent work, the fallow process is described fully, and an account is given of the characters of the oils and soluble frothing agents used in the process. The bibliographies and lists of patents are very complete.

THE MANUFACTURE OF SULPHURIC ACID AND ALKALI. By G. LUNGE. Supplement to Vol. I. Gurney & Jackson, 33, Paternoster Row, London, E.C. 317 pages, 8 $\frac{1}{2}$ × 5 $\frac{1}{2}$ in. Price 15s.

THE author has collected, in this supplementary volume, notes on the various papers and patent specifications on sulphuric and nitric acids which have appeared since the publication of the fourth edition in 1913, and has also added particulars obtained from official reports and private communications. To facilitate reference, the chapters are numbered in the same way as those in the original volume.

Journal of the Society of Chemical Industry.

No. 10, Vol. XXXVI.

MAY 31, 1917.

No. 10, Vol. XXXVI.

Official Notices.

ANNUAL GENERAL MEETING, 1917.

In accordance with the provisions of By-law 64, notice is hereby given that the Annual General Meeting will be held in The University Buildings, Edmund Street, Birmingham, at 10.30 a.m. on Wednesday, July 18th, 1917. A programme of the proceedings will be issued later.

In accordance with the provisions of By-law 24, those members whose names are printed in *italics* in the List of Council will retire from their respective offices at the forthcoming Annual Meeting.

Prof. Henry Louis has been nominated to the office of President under By-law 20; Dr. Charles Carpenter has been nominated Vice-President under By-law 20; Mr. John Gray, Mr. A. R. Ling, Prof. R. F. Ruttan, and Mr. J. T. Wood have been nominated Vice-Presidents under By-law 21.

Mr. A. G. Bloxam, Mr. W. J. Rees, Mr. Edwin Thompson, and Prof. James Walker have been nominated to fill the four vacancies among Ordinary Members of Council, under By-law 25. No ballot will be required.

J. P. LONGSTAFF,
Secretary.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY.

The first volume of these reports is now ready. As the issue is strictly limited, those who desire to obtain copies are advised to apply for them without delay. The price is 3s. to members and 5/6 to non-members, including postage.

PROHIBITED EXPORTS.

A Proclamation, dated May 10th, consolidates, amends, and adds to the list of goods which were prohibited to be exported from the United Kingdom to certain or all destinations, by the Proclamation of May 10th, 1916, as amended and added to by subsequent Orders of Council (see this J., 1916, 620, 710, 756, 870, 909, 982, 1086, 1134, 1184; 1917, 49, 102, 240, 307, 356, 404, 477). The full text of the Proclamation will be found in the "Board of Trade Journal" for May 17th, pages 360-375.

PROHIBITED IMPORTS.

A Proclamation, dated May 10th, prohibits as from that date the importation into the United Kingdom of gum copal, gum kauri, and manufactures of rubber, except under licence given by or on behalf of the Board of Trade.

SEEDS, OILS AND FATS.

With reference to the Orders of the Minister of Munitions made and published on the 1st May and the 9th May, 1917, restricting dealings in seeds, oils and fats, the Minister of Munitions gives notice that he licenses until further notice all sales and purchases of special quality seeds of any of the descriptions referred to in the said Orders specifically for cultivation irrespective of quantity, and also all sales and purchases of home melt tallow and grease for any purposes and in any quantities.

SEEDS, OILS, AND FATS.—MINISTRY OF MUNITIONS ORDER, MAY 9th, 1917.

The Minister of Munitions hereby orders that on and from the day following the date of this Order until further notice the schedule hereto shall be deemed substituted for the second schedule to the Order of the 1st May, 1917 (this J., 1917), and accordingly no person shall purchase sell or deal in or offer to purchase sell or deal in any of the articles specified in the schedule to this Order at a price exceeding the price given. This restriction on price shall not apply to any sale or purchase of any of the said articles which under clause 1 of the Order of the 1st May, 1917, is authorised to be effected without any license issued by or under the authority of the Minister of Munitions nor to any sale or purchase of special quality seeds sold and purchased specifically for cultivation.

Schedule.—Maximum prices (per ton).—Seeds, nuts, and kernels. Castorseed, £37; copra, £46; cottonseed, £19; gingelly (sesamé) seed, £32; ground nuts, £32; hempseed, £30; linseed, £30; nigerseed, £28; palm kernels, £26 10s. East Coast Ports; £26 West Coast Ports; rapeseed, £30. All these prices are net prices for seeds, nuts, and kernels in bags ex ship, quay or warehouse in the United Kingdom. *Oils and fats.*—Castor oil, £80 per ton; coconut oil (crude), £70; (refined), £85; cotton oil (crude), £60; (refined soap oil), £67; (refined edible oil), £75; (American refined), £95; gingelly (sesamé) oil, £65; ground nut oil (crude), £78; (refined), £90; kapokseed oil (crude), £55; (refined), £70; linseed oil (raw), £58; (boiled), £61; (refined), £63; nigerseed oil (crude), £60; oleo oil, £120; palm kernel oil (crude extracted), £51; (crude crushed), £52; (refined), £67; palm oil, £44; premier jus, £91; rapeseed oil (crude), £66; (refined), £71; (edible), £81; soya oil (crude), £60; (refined) £75; seal oil (crude), £60; tallow (imported), £68. All the above prices are for oil or fat net naked ex ship, mill, or warehouse in the United Kingdom. Packages may be charged extra at current market rates but not exceeding £4 per ton on the oil or fat.

SUPPLIES OF SICILIAN SULPHUR.

The Minister of Munitions announces that, in connection with the distribution of Sicilian sulphur, the Italian Government have allotted certain specified quantities to each of the Allied Governments, and requested that His Majesty's Government should purchase direct from the Italian Government the quantity allotted to Great Britain, and should be responsible for its distribution.

His Majesty's Government have agreed to this course, and the following Committee has been appointed to deal with the matter:—Mr. A. D. Cooper, Foreign Office; Mr. B. A. Collins, India Office; Mr. C. W. Dixon, Colonial Office; Mr. R. J. Thompson, Board of Agriculture and Fisheries; Mr. F. Gossling, Board of Trade; Mr. R. A. Alston, Ministry of Munitions; and Mr. H. S. Mingard, Ministry of Munitions, who will act as Secretary to the Committee.

In view of the increased demand for sulphur in connection with the production of explosives, it was found necessary, after careful consideration, that the export of sulphur should be prohibited, but, provided every care is exercised to avoid waste in the use both of sulphur and of products and compounds in the manufacture of which

sulphur is consumed, it is anticipated that agriculturists and manufacturers will not experience any great difficulties.

The Committee has decided to offer to supply imported sulphur in lots of not less than 5 tons for use in approved trades and industries. The prices for the present, including delivery to the purchaser's nearest railway station, will be:—Flowers of sulphur, £23 per ton; roll brimstone, £21; thirds, £12 10s. From the prices mentioned above a discount of 2½%, will be allowed to recognised sulphur merchants and dealers, but not to consumers. Applicants claiming this discount must furnish satisfactory evidence that they were recognised sulphur merchants or dealers before the war. The Committee understands that "recovered" sulphur can be procured, in the ordinary way of business, from the home producers.

Application for sulphur must be made on special forms, which may be procured from the Secretary, Sulphur Committee, Ministry of Munitions, Explosives Department, Storey's Gate, S.W.1. All applications must be accompanied by remittance of the purchase price in full.

Editorial.

RESEARCH IN THE CERAMIC INDUSTRY.

The immense importance of the refractory materials industry has recently been brought into increasing prominence, in view of the development of new industries, with their needs of constructional materials capable of withstanding a wide range of stresses. Quite recently a "Refractory Materials Section" of the English Ceramic Society has been formed to deal specially with this branch of the subject, whilst on the educational side may be noted the increased activities and usefulness of the Stoke-on-Trent Pottery School, and the opening, in December last, of the Ceramic Engineering Building of the University of Illinois; an interesting description of this building is given in University of Illinois Bulletin No. 12, Vol. 14, copies of which may be obtained from the Registrar of the University, Urbana, Ill., U.S.A.

All these movements indicate the growing appreciation of the necessity for research on the refractory materials—a subject which, owing to the complexity of the problems involved, has received all too little attention during recent years. In order to promote some definite scheme according to which such research work might be organised and carried out, a conference was held in March at which representatives of the Geological Survey, the National Physical Laboratory, and the principal technical Societies concerned were present, and as the result of their deliberations a Committee was appointed to enquire into the extent of the research work now in progress, the facilities for such work, and the facilities existing for collecting and making available published information on the subject. The Committee is also engaged in collecting information as to the various problems which call urgently for action. This Society is represented on the Committee by Prof. J. W. Coble, of the University, Leeds, who will be glad to receive suggestions for research on refractory materials in connection with chemical industries which call for immediate attention. Some of the problems in connection with metallurgy, mentioned by Mr. Cosmo Johns at the May meeting of the Iron and Steel Institute (see page 536), are also applicable to chemical industries, but there are numerous others which require investigation, especially in regard to the

behaviour of refractory materials when subjected to chemical action at high temperatures or under high pressures; particularly is this the case in regard to the materials which have come into use during more recent years, such as alundum, siloxicon, calcined magnesite, chromite, zirconia, etc. It is to be hoped that the Committee, mentioned above, will be advised of these problems as soon as possible, in order that their work may be facilitated.

New York Section.

Meeting held at Chemists' Club on March 23rd, 1917.

FOOD VALUES.

BY GRAHAM LUSK.

(Abstract.)

The author referred to the report of the Eltzbacher Commission on the food situation in Germany at the outbreak of war, and to the various errors made in that report, such as overestimates of the available supply and underestimates of the amounts required by women who took up the work of men and by growing children. In Germany it is the urban dweller who has suffered in regard to food supply, the farmer living in his usual manner. The circumstance that in spite of the undoubted shortage of food the German people are not starving, is explained by the fact that in extreme cases of under-nutrition it is possible to reduce the food supply to only 40% of its former level.

Extended reference is made to the report of the Royal Society's Commission on food supplies in Great Britain, which has already been fully noted (this Journal, 1917, 279), and the author points out that the restricted diet (flour, meat, and sugar) which the Food Controller has requested the population to adhere to, would yield about 1750 calories per "man" daily, leaving the individual to supply about an equal quantity from other sources.

In regard to the question of calorific value, the author urges that as far as possible all foods should be purchased with a knowledge of their calorific and nutritive values, and that packages should be labelled with this information. Regard should also be had for the different values of the various proteins. It is pointed out that at the present time the prices of cereal products are all in proportion to their calorific values.

Experiments were quoted to show that meat in quantity is not necessary to maintain vigorous muscular power, small amounts only being needed to replace the protein loss of the organism. It is the carbohydrate foods and fats which provide the greater part of the requisite energy.

The author concluded by giving particulars of a dietary for five people, in which very small quantities of meat had a place, costing \$1.11 daily for 4400 calories. The principal items in this diet are as follows, per day: milk, 3 qts.; bread, 2 lb.; cereal, ½ lb.; oleomargarine, ½ lb.; rice or macaroni, 1 lb.; dry "navy" beans, 10 oz.; fat pork, 6½ oz.; dry fruit, 1 lb.

Prof. Lafayette B. Mendel also read a paper on "Food Fads."

Yorkshire Section.

*Meeting held at Queen's Hotel, Leeds, on Monday,
April 30th, 1917.*

PROF. J. W. COBB IN THE CHAIR.

SOME FUTURE LINES OF ADVANCE IN COKING PRACTICE.

BY G. E. FOXWELL, ASSOC. M.I.M.E.

In this paper the author's intention is to bring forward some of the problems at present awaiting solution in connection with the coking of coal and to indicate briefly some lines on which research might with advantage be undertaken.

The coking industry, like all other branches of chemical industry, is faced with many problems—some of urgent importance, others not immediately vital—but most of which will require to be solved in the near future.

It will be necessary to speed up considerably, to shorten the carbonising period in order to increase the output. In this country probably no coke ovens, even those working with low-volatile coal, are carbonising consistently in less than 24 hours. In America quite different conditions prevail. The carbonising period is very much shorter, and larger ovens are in use. To cite an actual instance:—At an installation of 560 Koppers ovens at Gary, U.S.A., each oven has a capacity of 12½ tons of coal per charge and the charge is burnt off in 16½ hours. The coal contains 18% of volatile matter and yields 12,200 cu. ft. of gas per ton. Just under 4 galls. of tar and 18 lb. of sulphate of ammonia are also produced per ton of coal carbonised. Such coal in an English oven would probably produce 10,000 cu. ft. of gas, 5–6 galls. of tar, and 20 lb. of sulphate of ammonia, and would take 26 hours to burn off. Moreover, very few English ovens take a charge of more than 10 tons of coal, and in most cases only 8 tons.

The secret of the quick-burning American oven is said to be that the walls are made of brick containing 95% of silica, and this, owing to its higher fusing point, enables the ovens to be worked at a much higher temperature. In England, on the other hand, brick containing 80% of silica is generally used.

A great deal of work is required in connection with refractory materials, both in connection with their manufacture and use. The ideal brick for coke oven walls should be hard, in order not to break in transit or wear away when pushing out the coke; it should be a thoroughly good conductor of heat; the expansion and contraction should be under 1%, and the tendency for the brick to crack on cooling should be as small as possible. The brick should also be resistant against chemical action, as coke oven walls in certain districts are subjected to a very serious corrosion, owing, it is supposed, to the action of the soluble salts, and particularly sodium chloride, contained in the coal.

Coke oven bricks are at present far from being satisfactory. As supplied by different makers they are of very uneven quality, some being very friable, others offering considerable resistance to the passage of heat, others again cracking badly on cooling from a high temperature, while none resist corrosion. Here lies an exceedingly wide field for research.

Another point of difference between English and American practice lies in the scientific mixing of coals before coking. English coking plants are usually—though by no means always—built at a colliery. The slack coal from all the different pits is sent to the ovens, and as long as a good quality of coke is produced no further attention is

paid. Certain coals do not yield a saleable coke when carbonised alone, and these are not sent to the coking plants. It so happens that, generally speaking, coals yielding a poor quality of coke give a higher yield of by-products than coals yielding good coke. If scientific blending were to be carried out, much of our non-coking coal could be used in the coke oven and the yield of by-products increased without materially affecting the quality of the coke. In American practice the plant is worked for some days on a known mixture of certain coals and the results noted. The proportions are then changed and a test again carried out. By proceeding in this way the best mixture for the purpose is found and is then rigidly adhered to.

Another point worthy of serious attention is the quenching of the coke. As the coke is issuing red-hot from the oven it passes through a spray of water and the quenching is then finished by hand spraying. Unless the quencher is highly experienced the coke will contain either too much or too little water; in the former case there is trouble with the buyer, in the latter case the railway waggons are apt to be burnt. It is also very difficult to quench coke properly by night, since coke which appears to be perfectly quenched by day may appear red-hot by night. The adoption of some form of mechanical quencher would be a valuable improvement. In one appliance of this sort the hot coke falls into an iron basket, and is thence conveyed to a trough, where it is immersed in water for a definite time and then withdrawn. It is said to be possible to reduce the water content to under 1% regularly by this means.

The utilisation of coke breeze should be developed. At present the greater portion of this material finds its way to the colliery refuse heap. From 3 to 8% of the total coke is usually produced as breeze, the proportion depending on how the coke is handled. According to the Home Office Report on Mines and Quarries, for 1915, the total quantity of coke produced at coke ovens was 11,908,940 tons. If the breeze produced is taken at 5% this amounts to 595,500 tons. From the point of view of fuel economy it is essential that this should be utilised either for briquette making or some other purpose. If briquettes were to be manufactured from the whole of this it would incidentally provide an outlet for some 40,000 tons of pitch annually.

Apart from improvements in the coking process, very great advances are capable of being made in connection with the recovery of by-products. The recovery of by-products should start before the coking process. Large quantities of iron pyrites are washed out of the coal and these should be recovered, partly for the value of the iron, but more especially for the sulphur. No effort whatever is made to recover these. In most instances the whole of the output from a colliery passes through the washery, and large quantities of carbonaceous shale containing a good deal of coal are produced. Doubtless in many instances the shale is too high in mineral matter and too low in pyrites to make it worth treating, but with improved methods a great deal of sulphur could be recovered from this source.

The author does not profess to have gone very deeply into this particular question, but as a tentative suggestion would put forward the following two methods:—

(1) The washery refuse is treated in a specially designed producer of the Mond type. The producer gas, containing sulphuretted hydrogen, sulphur dioxide, and ammonia, is passed into the main conveying the crude coal gas from the ovens, and is treated for simultaneous recovery of ammonium sulphate and sulphur by the Feld "Polythionate" process. This process will be referred to later. The advantage of this method

would be that a large proportion of the nitrogen contained in the washery refuse would be recovered as ammonia. The diminution in the quality of the gas for heating the ovens would not be of any importance, since at least one battery of coke ovens in this country is heated by Mond producer gas having a calorific value of 140 B.Th.U. per cu. ft., and on the Continent blast furnace gas of 105 B.Th.U. per cu. ft. is used in some places.

(2) The second method consists in passing coke oven gas, after extraction of the products, over the carbonaceous shale and pyrites, heated to a suitable temperature by means of the surplus gas. The result would be the formation of sulphuretted hydrogen, sulphur, and metallic iron. The sulphuretted hydrogen would be recovered by oxide of iron purifiers. In either case the residue, if containing sufficient iron, could be sent to blast furnaces. Laboratory tests with the second method have given very encouraging results.

All coals give off sulphuretted hydrogen on carbonisation; the amount varies from 0.03 to 0.7%, by weight of coal carbonised, the figure usually being between 0.2 and 0.4%. In many instances the amount of this is such that if converted into sulphuric acid it would provide sufficient acid for the manufacture of sulphate of ammonia from the whole of the ammonia evolved. If sulphur were recovered from the pyrites as referred to above, every coal would yield sufficient for this purpose. In very few instances is anything done to utilize this sulphur.

A method is wanted which would enable the ammonia to be recovered as sulphate, using the sulphur contained in the coal to provide the necessary sulphuric acid. Not one of the methods at present suggested for doing this has come into general application. The most obvious method is to extract the sulphur from the gas by means of iron oxide, convert the sulphur thus extracted into sulphuric acid by the well-known lead chamber process, and use the sulphuric acid to extract the ammonia from the gas in the usual way. This process is not adapted to any but the largest works owing to the small amount of sulphuric acid required. A 40-oven plant will use about 15 to 20 tons of 142 Tw. B.O.V. a week. The author is informed that it does not pay to put down a sulphuric acid plant for less than about 30 tons of acid per week.

Two other processes have been devised and worked out on a practical scale, but neither has come into anything like general use. The object of each of these is to avoid the necessity for manufacturing sulphuric acid in an independent plant; future advance will almost certainly lie along these lines.

The Burkheiser process consists in extracting the sulphur from the gas by oxide of iron, burning this to sulphur dioxide and introducing the latter into the gas main. The resulting salt is a mixture of sulphite and sulphate, and this is the weak point, since contrary to expectation it was found very difficult to convert the sulphite to sulphate by atmospheric oxidation.

The Feld process, which has found some application on the Continent, consists of treating the crude gas containing ammonia and sulphuretted hydrogen with sulphur dioxide in presence of free sulphur. The recovered ammonia is thus first converted into thiosulphate and then polythionate, which is finally oxidised to sulphate with liberation of sulphur.

The whole problem bristles with difficulties and the inventor of a simple commercial process for doing this would find himself amply rewarded.

The present method of recovering ammonia is by no means the best or the most rational and much work remains to be done on this. In

the first place the system of recovering the whole of the ammonia as sulphate seems irrational. A large portion of the chlorine contained in coal is liberated on carbonisation in the form of hydrochloric acid, the amount depending on the state of combination of the chlorine, the temperature of the coke oven, and the duration of heating. As soon as the temperature in the mains is low enough this combines with the ammonia and forms ammonium chloride. Under the present system this is decomposed by milk-of-lime, and converted into a less valuable compound—ammonium sulphate.

In places where the chlorine content of the coal is sufficiently high, any ammonium chloride formed should be recovered as such. The author has done some work on this subject and recommends the following method:—The gas while still hot—about 100–130°C.—is scrubbed with a spray of water at 70°C. The water is used over and over again until nearly saturated. The solution is then concentrated further by evaporation and allowed to crystallise, any evolved gases being led into the gas main. The mother liquor is diluted with water and again used for washing the gas. If care is taken that the tar is properly separated from the liquor and if only a moderate quantity of crystals is obtained at each evaporation, a reasonably pure product may be manufactured without any necessity for recrystallisation. When the accumulation of other salts in the liquor gets so great that the chloride is contaminated, the liquor is sold to some works having a lime still and the cycle of operations recommenced with fresh water.

In an actual experiment conducted on a works scale, the liquor obtained had the following composition:—

	grms per 100 c.c.
Ammonium carbonate.....	0.22
" sulphide	traces
" cyanide	0.10
" sulphate	nil
" ferrocyanide.....	9.52
" chlorine.....	

Without doubt the ammonium chloride content could have been raised to three times this amount by longer circulation.

On evaporating a portion of this in the laboratory the chloride obtained had the following composition:—

	Salt obtained.	Theoretical.
Ammonia as NH_3	30.80	31.85
Chlorine as HCl	67.89	68.15

The salt was of a grayish-white colour.

The recovery of ammonia as chloride is practised in a few works, but there is no reason why it should not be adapted to every existing plant. The recovery of the hydrochloric acid evolved in the distillation of coal could in this way be easily and completely effected and at the same time yield considerable profit.

In the author's opinion the recovery of the tar and ammonia from coal will ultimately take place somewhat on the following lines:—

The hot gas from the ovens will be allowed to cool to a temperature of about 120°C. and will then be sprayed with hot water at 70°C. This will extract ammonium chloride and the tar fog. The author finds from practical experience that it is necessary to provide means whereby the gas entering the chloride extractor may be either

warmed or cooled in order that the temperature may be under complete control.

After spraying with hot water to recover ammonium chloride, the gas containing sulphuretted hydrogen and ammonia will pass on to an apparatus where sulphate of ammonia will be recovered direct. As has been mentioned before, one of the most promising lines of research is the discovery of some economical process which will effect this.

Another compound which has been neglected is naphthalene. The market for this product is growing, and will increase even more in the future with the development of internal combustion engines using this as fuel. At some direct recovery plants there has been trouble owing to naphthalene blocking up the mains; this has necessitated the installation of naphthalene recovery apparatus. The method has been to spray the hot gas leaving the saturator with cold water. This treatment is not possible with any other type of plant, as the essential feature is sudden cooling. In other types of plant the naphthalene is absorbed by creosote oil when extracting benzol. In order to recover the naphthalene, another fraction is taken after the benzol has been driven off from the creosote oil by distillation, and this is allowed to cool in pans and the naphthalene fished out. The original intention of this process was to prolong the life of the benzol scrubbing oil by preventing it from becoming unduly viscous, and as far as this is concerned it has succeeded admirably. As a process for recovering naphthalene, however, it is very inefficient. Only a small proportion of the naphthalene taken up by the oil is recovered in the fraction distilled, and it would not be economical to distil to, say, 230° C. simply in order to recover naphthalene. The oil takes up more and more naphthalene until a point is reached when it is in equilibrium with the gas. It is clear from a consideration of the physico-chemical factors involved that the naphthalene absorption must be very inefficient. A process is wanted for carrying this out on more efficient lines.

The method of washing the crude benzol is open to improvement. At present the benzol is washed first with 5 to 8% of its volume of sulphuric acid (D.O.V.) in two washings, then with water, followed by caustic soda and more water. This takes considerable time and attempts are being made to make the washing of benzol continuous. In one such plant the benzol vapours from the still are passed through hot acid and caustic soda. In another plant the liquid falls down a series of tubes in which it is treated with the washing reagents. Whether either of these processes will prove commercially workable has yet to be seen. Some system of continuous washing is, however, very desirable.

No attempt is made to recover the phenol, pyridine, or thiophene washed out of the benzol, and in view of the large quantity of benzol dealt with on coke oven plants this would be a useful step forward. Under present conditions of working it would probably not pay. The phenol content of 65% benzol is usually under 2%. Much of the pyridine present in the gas is taken out by sulphuric acid in the saturator; and until new uses are found for thiophene it will not be worth recovering on coke oven plants. The recovery and utilisation of these substances is a matter for research.

The present system of recovering 65% benzol is not the one calculated to give the best results. It is found in practice that by manufacturing benzol of 55% strength there is a very considerable increase in the amount of toluene recovered. It seems, therefore, preferable to recover benzol of much lower strength than is the case at present, and to wash this for phenol. Occasionally the creosote oil should be distilled up to, say, 210° C.,

and the half-spent caustic soda which has been used for washing the benzol used for the first washing of this creosote fraction. In this way it may be found possible to recover considerable quantities of phenol. With the price of 60's carbolic at 3s. 4d. a gallon this should be well worth considering.

It would be very advantageous if a system could be found whereby the carbon bisulphide could be recovered from the gas before taking out the benzol. Carbon bisulphide is not usually recovered on coke oven plants, being regarded merely as an objectionable nuisance. This is not easy to understand, as a good price is obtainable for it. Benzol will frequently contain 5% of this compound.

In all probability the coke oven plant of the future will not stop at the recovery of crude 65% benzol or washed 90% benzol. It will manufacture pure benzene, toluene, and xylene, and probably also nitrobenzene, nitrotoluene, aniline, toluidine, and possibly pure naphthalene, together with α - and β -naphthol. The manufacture of the raw materials for dyes would be more rationally carried out on coking plants than at the dye works; and it would leave the manufacturers of dyes more opportunity to concentrate on the production of colours if coke oven plants would undertake the manufacture of these raw materials.

A necessary step before this ideal can be reached is the training of qualified men capable of taking charge of such works, and coke oven managers and chemists must be more highly trained in the future than they have been in the past.

The utilization of the surplus gas from regenerative coke ovens is a matter which is now receiving considerable attention. The author recently pointed out (*Trans. Inst. Min. Eng.*) that the surplus gas evolved from by-product regenerative coke ovens is equivalent to over a million tons of coal per annum. In a great number of cases this gas is allowed to burn at a blow-off pipe in order to get rid of it. It would be possible to transfer this gas to neighbouring towns by means of high pressure mains, as is done in the case of natural gas in the United States. There is, of course, also the possibility of using it in gas engines to generate electricity, which could then be distributed over a large area.

It also seems possible that the mixture of unsaturated hydrocarbons, methane, and hydrogen in the gas may be found capable of being transformed into valuable products either by chemical or physical means.

ADDENDUM.

With reference to the possibility of using coal gas for the synthetic production of valuable compounds, alluded to in the last paragraph, reference may be made to the paper on "*Production of the lower chlorides of methane from natural gas*" by W. Bedford (*J. Ind. Eng. Chem.*, 1916, 8, 1090—1094; see this J., 1917, 46). By subjecting a mixture of chlorine and natural gas, in a chamber containing blocks of ice, to the action of light from the white flame arc, a heavy liquid was obtained beneath the water produced by the melted ice; this liquid consisted of methylene chloride, 35%; chloroform, 35%; carbon tetrachloride, 5%; chloroethanes, 20%. A portion of the product, amounting to about 14% of the total, remained soluble in the water, and consisted of methylene chloride, 61%; chloroform, 28%; carbon tetrachloride, 1.5%; and chloroethanes, 6%. Two hundred and fifty cubic feet of the natural gas yielded several gallons of the mixed chlorides.

DISCUSSION.

The CHAIRMAN welcomed the references made in the paper to problems awaiting solution which

might guide research chemists who were wanting to give their science a technical application. The importance of refractory materials to the carbonising industries was coming to receive recognition and a laboratory for this study was being specially staffed and equipped at the University of Leeds in connection with the Department of Coal Gas and Fuel Industries. The wide differences in properties between the ordinary silica brick and vitrified silica was a simple example of how much depended on other things than chemical composition and how much work lay before them. The author's reference to the use of the sulphur contained in coal as the source of the sulphur in ammonium sulphate called attention to one of the most important questions.

Mr. C. P. FINN remarked that the processes of carbonising coal for "town gas" on the one hand and for the production of metallurgical coke on the other had much in common and that any advance in either branch of the industry had its influence on the other. This being the case, he thought that the success of the modern continuous or semi-continuous vertical gas retort should stimulate coke oven constructors to produce a similar type of plant, with a sealed inlet for the coal and the utilisation to the full of the heat of the discharging coke, thus placing at the user's disposal a dry product. He knew that there were objections, viz., the absence of a "rest period" and the difficulty of charging compressed coal, but in his opinion these were not insuperable obstacles. Concerning the recovery of by-products he drew attention to methods proposed by Feld, Purves, and others for the fractional separation of tar products within the condensing and washing system. Referring to ammonia recovery, he was pleased to hear that Professor Cobb's recovery process would soon be working on the large scale with Mond gas. The possibilities of competition of synthetic ammonia processes, backed by large Continental syndicates, should stimulate research to obtain greater yields of ammonia from coal. The by-product coke oven plant of to-day was no longer a mere adjunct to a colliery as was the old bee-hive oven, but a complex chemical works using a raw material of unknown constitution. It was quite outside the scope of the average colliery manager and engineer, and required for its control men who combined a sound scientific training and the general experience gained only in a works. Such a man must not be a mere "handler of men," but able to direct his assistant staff in the prosecution of works research into the many problems that arise from time to time.

He was optimistic as to the further development of chemical manufacture on coking plants, as probably no other industry had at hand such sources of power and cheap, clean, and high quality fuel.

Mr. W. McD. MACKEY said that the author had mentioned many important points in connection with by-product coke oven practice, some of which had already engaged the serious attention of chemists. He had said nothing about low temperature carbonization, and this he (Mr. Mackey) thought was likely to prove a very fruitful field of research in the future; a low temperature coke for domestic use would soon be on the market in quantity, and he understood that it was only because of difficulties raised by the war that it was not already on the market. Mr. Mackey considered that the solution of the difficulty of smoky atmospheres in towns would be largely solved by the provision of a soft coke, clean to handle, and containing sufficient volatile matter to burn readily. He was doubtful if the recovery of sulphur from colliery refuse would be profitable. The mere handling of material with comparatively little sulphur in it was in itself a serious difficulty. As to coke breeze, his experience did

not agree with that of the author, viz., that it was difficult to market; and certainly he did not know of its being put on the dump. He was dubious as to the advantages of automatic quenchers. High pressure water under the direction of an intelligent workman he considered better. The point was to water so as to leave the coke warm enough to drive off the water remaining from the quenching; though in practice they might expect about 1.5% of moisture in well-quenched by-product coke.

Dr. L. GORDON PAUL asked how it was suggested to recover the carbon bisulphide.

Mr. HARMER said that the carbon bisulphide was usually recovered by fractionation from the crude benzol, and that much could be done by fractional separations at low temperatures.

Mr. FOXWELL said in reply that, as the Chairman had pointed out, the physical properties of the silica brick were very interesting. Quartz on heating changed into other crystalline forms, and about 80% of the free silica in a brick consisted of cristobalite. He suggested that in connection with salt corrosion it might be that only one of these crystalline forms was attacked. He had purposely not mentioned the fractional condensation of tar as this would require a complicated plant and highly skilled supervision. It seemed more economical to proceed as is done to-day.

With regard to the vertical oven, he remembered that in the early days of vertical retorts great trouble was experienced in connection with the refractory materials of which they were constructed. Probably similar trouble would be met with in connection with a vertical coke oven, and work on refractory materials must precede any successful attempt in this direction. The vertical oven would possibly be a sound proposition for uncompressed coals, but what of coals which required compressing? He was not in favour of low temperature carbonisation, since the tar produced, being mainly paraffinoid, would only be of use for fuel, and moreover the yield of sulphate of ammonia was very low as compared with that from the high temperature process. The consequence was that the solid fuel produced (intended for household consumption) would have to be sold at a price higher than that of coal if the process was to be a financial success. It was certainly his experience that coke breeze—by which he meant coke passing through, say, a 1 cm. mesh—was thrown away. Published figures dealing with a plant at an English gas works had shown that it was possible to run a coke breeze briquetting plant at a good profit. American coals, generally speaking, required more heat for their carbonisation than English coals.

Iron and Steel Institute.

The following are abstracts of some of the papers read at the meeting of the Iron and Steel Institute held on May 3rd and 4th:—

PROPERTIES OF THE REFRACTORY MATERIALS USED IN THE IRON AND STEEL INDUSTRY. By C. Johns.

Available materials. With the exception of carbon, and its compounds with silicon, which have a limited application, the available refractory substances are chiefly the oxides, SiO_2 , Al_2O_3 , CaO , MgO , Cr_2O_3 , or mixtures of these with oxides of iron, K_2O , Na_2O , and traces of other substances, regarded as impurities, some of which may function as catalysts. The materials available are therefore strictly limited; they never occur in a state of purity in nature. Their manufacture into refractory products involves in many cases grading, agglomeration or bonding, and final heating to a

temperature that varies according to the purpose for which the product is intended and the functions it has to perform. The problems that arise are not solved by a knowledge of the properties of the compounds mentioned; they are complicated by the presence of impurities and the varying nature of the bonding material employed. The final products, as delivered to the user, are always mineral aggregates, often of great complexity. They possess no fusion point, but rather a range during which softening, at first inappreciable, at last, with increasing temperature, causes the material to fail to perform its functions. The constituents have varying melting points, and during heating they invert and new phases appear. Some inversions, involving serious volume changes, should be completed during manufacture, but often are not. The temperatures required for such changes are rarely known, and even when they are known as a result of experiments under laboratory conditions, it does not follow that they apply to manufacturing processes. The most urgent need at present is for an expression, in terms of scientific precision, of the most successful practice in manufacturing the refractory products and of the physico-chemical changes which take place when they are used.

Tenacity and compressive strength at ordinary temperatures are valuable only in so far as they permit the refractory products to be transported and enable them to withstand the structural stresses to which they are exposed when used. It is when the material is exposed to high temperatures that the value of these properties becomes most important. The abrasion caused by the movement of solid substances while in contact with their heated surfaces is important, while the erosion caused by the passage of dust-laden gases at high velocities becomes serious in time. Little or nothing is known of the conditions that favour or retard abrasion and erosion. High tenacity, which in most cases would mean that of the bonding or of the most fusible constituent, is most probably the desired property. It is the surface exposed to the highest temperature which suffers, for it is the one that is in contact with the moving solids, liquids, or gases. Compressive strength is rarely a cause of failure, for the bulk of the refractory material is at a lower temperature than the face and therefore less affected. There is, however, urgent need for accurate determination of the two properties under discussion at wide ranges of temperature for the more important materials under both oxidising and reducing conditions.

Corrosion changes. Not less important than resistance to high temperature with concurrent abrasion and erosion is resistance to the corrosion caused by slags and gases. The effect of acid slags on basic refractories and of basic slags on acid refractories are familiar, and there is marked corrosion of the silica bricks in the gas ports and uptakes in open-hearth furnaces, due to the alternating passage of oxidising and reducing gases with the resulting formation of fusible silicates. A factor conducive to rapid corrosion in the last case is the absence of large particles of silica in the bricks employed and the presence of excessive pore spaces. Here again little has been published and few observations recorded. The effect of the alkalis found in certain coals on the refractories used in coke-oven construction is serious, and here too little is known as to the real nature of the destructive influences at work.

Volume changes. Apart from the fact that volume changes may cause disintegration, abnormal expansion causes structural difficulties, while contraction may be even more undesirable. In the case of coke-ovens the retention of gas-tight partitions is absolutely necessary, and this involves the use of a refractory material which does not undergo appreciable volume changes, i.e., a mixture of substances with volume changes of opposite

sign, viz., clay and silica. But while the contraction of the burnt clay is fairly regular with increased temperatures, quartz has an inversion point at which it becomes tridymite. In the presence of certain compounds this inversion takes place at a temperature lower than that at which coking is carried on. In their absence the inversion is retarded and does not take place until a temperature higher than that usual in coking practice is attained.

Heat conductivity. If the refractory materials used possess a fusion point or softening range higher than the maximum temperature to which they are exposed, it would in most instances be desirable that they should be non-conductors of heat, for radiation losses would then be at a minimum. More often the prevailing temperatures approach and sometimes exceed that at which fusion or softening occurs. In those cases it is necessary to encourage radiation from the surface farthest removed from the heated surface, in order to cause a steep temperature gradient from the heated to the cooler face. In special cases cooling devices are necessary to prevent the rapid destruction of the material employed. The melting of steel in crucibles and the coking of coal are instances where a refractory material with good heat conductivity is required.

Texture and porosity. The relative size of the grains employed, the extent of the surface exposed by the more resistant constituents to the others used as bond or matrix, are most important factors in contributing to the ability of the material to perform useful service. Another point of some importance is the influence of mass in promoting or retarding inversions. Some of these inversions take place almost instantly once the critical temperature has been reached, but with others marked hysteresis occurs. Porosity must always occur when the refractory material is composed of more than one constituent, and where their chief volume changes are dissimilar or occur at different temperatures. Little is known of the effect of porosity on the properties of refractory materials. That the pores encourage the deposition of extraneous substances in the interior of the bricks, and that they render the structure permeable to gases, is of course obvious.

Stresses caused by temperature changes. The stresses caused by temperature changes are due to the volume changes which take place during heating. If the refractory material happens to be a good conductor of heat these are not serious, unless one face is rapidly heated and the distortion produced exceeds the tenacity of the material. The remedy available is to avoid rapid temperature changes, and whenever possible to raise the temperature of the material during the burning stage of manufacture well above that at which the inversion to which the principal volume change is due should take place, and to hold it at that temperature long enough for the inversion to be completed. The "spalling" of magnesite bricks which sometimes occurs has been thus explained, and it is certain that the excessive expansion of silica bricks would be avoided if the manufacturer could ensure the completion of the quartz-tridymite inversion during burning. Despite the considerable advances in our knowledge of the inversions of silica made recently, their bearing on the problems that face the manufacturer is not yet sufficiently clear.

Need for further research. The first step is to prepare specifications for the most important refractory products expressed in terms capable of precise measurement or description, basing the specification on the best current practice. These specifications should be the starting point of systematic research which should cover, not only the problems that occur during manufacture, but the occurrence in nature and characteristics of the

raw materials. Their concentration and purification, proximate and ultimate analysis, mineralogical description and thermal analysis are all points on which additions to our present knowledge would be of great value. But the refractory materials are so complex, and the problems involved are so difficult of direct attack, that any contribution to our knowledge of the properties of the pure minerals, or of the impure aggregates which are used in practice, would be welcomed even if their immediate application did not happen to be possible.

The following schedule of the requirements of the iron and steel industry, indicating the most pressing problems affecting the use of refractory materials, is suggested:—*Coke-oven bricks.* Description as complete as possible of the foreign clays found suitable and of the British clays that resemble them. Investigations of the cause of failure of coke-oven bricks. Influence of texture and firing temperatures on their durability in service. *Blast-furnace bricks.* Tenacity at high temperatures. Causes of disintegration. Influence of texture and mineralogical character of original clays. Description of the available clays. *Carbon bricks.* Texture and bond. Influence of these on tenacity and crushing strength at high temperatures. *Magnesite bricks.* Texture and bond. Firing temperature. Thermal analyses of magnesite from various sources. Properties of the burnt brick. Thermal analyses with quenching from high temperatures. Substitution of dolomite for magnesite for brick making. *Silica bricks.* Texture, bond, and firing temperature. Mineralogical description of the fired brick. Thermal analyses of brick with quenching from high temperatures to determine actual constitution under working conditions. *Nozzles of casting ladles.* Cause of erosion. Influence of texture and firing temperature on resistance to erosion. Influence of casting temperatures and quality of steel on erosion. Use of new materials. *Chromite bricks.* *Bauxite bricks.* *Zirconia and other rare earths.* *Fused magnesia and lime.* Investigation of mode of occurrence of raw material in nature. Description and determination of properties of the pure minerals. Methods of concentration and purification. Bonding and preparation as refractory products. Properties of the finished product.

PENETRATION OF THE HARDENING EFFECT IN CHROMIUM- AND COPPER-STEELS. By L. Grenet.

Four chromium-steels containing C 0.31–0.59, Cr 1.46–1.82, and Cu 0.00–4.14%, and eleven chromium-nickel steels containing C 0.34–0.62, Cr 0.41–1.84, Ni 1.60–3.93, and Cu 0.00–4.0% were investigated. The transformation on heating occurred below 775° C. in every case; and the Brinell hardness of small pieces quenched from 790° C. was 600 and upwards. Copper was found to increase the depth of the hardening effect but to exert no other useful influence on the properties of the steels. The influence of copper was more limited than that of nickel; the chromium-nickel steels high in nickel became hardened by very slow cooling, but none of the chromium-copper steels possessed this property. By the use of copper, nickel, and chromium together, semi-hard steels were obtained which could be hardened by air-cooling in fairly large pieces and yet softened by the ordinary methods employed for carbon steel.—W. E. F. P.

STEEL INGOT DEFECTS. By J. N. Kilby.

The defects occurring in ingots up to 3 tons in weight are considered under the following headings. *Pipe.* Moulds wider at the top than at the bottom

are conducive to minimum pipe; and considerable economy is effected by the use of refractory feeder heads, even for ordinary steels. "*Ocluded slag*" in acid open-hearth steel results from oxide of iron formed during the melting of the charge or introduced by erratic feeding of ore; it may be minimised by melting the charge quickly under conditions producing a slag and bath of suitable composition and consistency. In the author's opinion, the whole charge should have an available silicon content of 2%, the difference between this figure and the silicon content of the pig iron and scrap being added in the form of slag. The use of limestone and the period at which it should be added are of the greatest importance in acid open-hearth practice; slags containing lime possess greater fluidity than those free from this constituent, and having also a higher silica content (62% as against 50%), absorb suspended particles of "slag" from the bath more readily. "*Lapping*," or folding on the surfaces of ingots may result from pouring bottom-cast steel at too low a temperature or speed. Contrary to the view held by many steel makers, the author is of opinion that cavities or splits in rolled or forged bars do not result from lapping in the ingots. The effects of spasmodic teeming, resulting from the use of a comparatively large nozzle in the ladle and a small number of ingots per bed, are often wrongly ascribed to lapping. *Fluxed fireclay.* All bottom-poured steel is liable to contain fluxed runner brick or partly fused pieces of fireclay jointing. The presence, in ingots, of extraneous matter of the latter kind may be minimised by the use of a suction ejector down each mould and a "trumpet" pipe immediately before casting. *Cracks.* In acid open-hearth ingots, are mainly cross-sectional and vertical and occur principally at the corners of square or octagonal ingots in the latter case. A chart is given showing the comparative margin of safety in casting ingots free from cracks under varying nozzle-sizes and capacities per bed; and tables showing (1) the teeming speeds at which a number of top-poured ingots of various sizes, free from cracks, were produced, and (2) the relative proportions of cracked bars from top- and bottom-poured ingots produced at various teeming speeds.—W. E. F. P.

CEMENTATION [OF IRON] BY GAS UNDER PRESSURE. By P. C. Langenberg.

Experiments on the carburisation of "Armco" iron (C 0.01%) by illuminating gas and acetylene at various temperatures and pressures were made in an electrically-heated pressure and vacuum tube-furnace of special design. The results are detailed in tables, curves, and micrographs. Owing to the deposition of carbon in the cooler parts of the tube, no carburisation was effected by illuminating gas at 900° or 1000° C. under atmospheric pressure; and for a similar reason the cementation of iron in acetylene at the same temperature and pressure occurred only when the flow of gas exceeded 2.75 litres per hr. In acetylene at atmospheric pressure, and under equilibrium conditions obtained by the use of carbon in the tube, the depth to which the iron was carburised in 4 hrs. at 980–985° C. increased from 1.25 to 1.75 mm. as the rate of flow of the gas increased from 0 to 3.25 litres per hr.; while at a constant rate of flow a sudden increase in carburisation occurred when the temperature was raised from 890 to 900° C., the region of the γ – β allotropic change in pure iron. With illuminating gas under similar equilibrium conditions, the rate of flow being 5 litres per hr. and the time of exposure 3 hrs., the following depths of carburisation were obtained:—0.3, 0.6, 1.0, and 1.6 mm. at 810°, 910°, 950°, and 1025° C., respectively, under

atmospheric pressure; 1.0, 1.0, 1.1, 1.25, 1.30, and 1.40 mm. at 910° C. under pressures of 25, 33, 45, 65, 90, and 115 lb. per sq. in., respectively; 0.5, 0.45, 0.45, and 0.45 mm. at 805°—810° C. under pressures of 40, 65, 90, and 115 lb. per sq. in., respectively; 1.8, 2.25, and 2.6 mm. at 990°—995° C. under pressures of 26, 45, and 75 lb. per sq. in., respectively. No carburisation was effected below 720° C. with either gas, and the γ - β points were found to mark a sharp break in the carburisation curves for both.—W. E. F. P.

CASE-HARDENING OF IRON BY BORON. By N. Tschischewsky.

A hole was drilled in each of two cubes of soft iron (C 0.12%) from the centre of one face to about the centre of the cube. The hole in one cube was filled with fine amorphous boron, the other with finely-powdered ferro-boron (B 19%). The holes were tightly closed by stoppers of the same kind of iron pressed home by hydraulic means. The specimens were heated for two hours to 950° C. in a silica tube evacuated with a mercury pump. They were then cut longitudinally and polished. The boron had penetrated to the depth of 1 mm. It was ascertained that cementation by ferro-boron is quicker than by amorphous boron. The hard, white surface layer consisted of compact boric pearlite having a twin crystal structure; the edges of the layer contained a sub-eutectic alloy of ferrite-pearlite, the ferrite containing the boron in solid solution. Case-hardening at a lower temperature gave an alloy containing less boron.—W. R. S.

DETERMINATION OF THE LINE SE IN THE IRON-CARBON DIAGRAM BY ETCHING SECTIONS AT HIGH TEMPERATURES IN VACUO. By N. Tschischewsky and N. Schulgin.

The preheating of sections of iron-carbon alloys, prior to etching by gaseous reagents, does not give trustworthy results owing to the decarburising action of the gases used. In the present experiments the sections were heated *in vacuo*, and chlorine was used as etching medium. Two points on the cementite line were thus determined, by studying photomicrographs of two alloys containing C 1.25 and 1.505% and heated to different temperatures at intervals of 10° to 15° C. The mean of the interval within which the disappearance of cementite in the chilled specimens was observed was taken as the transition point:—

C %	Interval.	Mean.
1.25	875°—890°	883° C.
1.505	1005°—1015°	1010° C.

The proximity of these points to the straight line between the points E and S in the iron-carbon equilibrium diagram justifies the supposition that the line SE is a straight line.—W. R. S.

INFLUENCE OF SURFACE TENSION UPON THE PROPERTIES OF METALS, ESPECIALLY IRON AND STEEL. By F. C. Thompson.

The author replies to criticisms directed against his theory correlating the properties of metals, especially the elastic limit, with the effect of surface tension, which is supposed to act at the crystal boundaries, or between the crystalline phase and the intercrystalline amorphous modification (this J., 1915, 620); the available evidence in favour of the theory is reviewed and extended.

—W. R. S.

NOTES ON SOME [STEEL] QUENCHING EXPERIMENTS. By L. H. Fry.

Two locomotive driving axles and a small test-piece were quenched in air, water, heavy and light oil, and different strengths of a cutting compound (mineralised lard oil and soft soap) dissolved in water. It was found that fairly accurate information as to the quenching properties of a medium (*i.e.*, cooling rate per sq. in. of surface) can be obtained with small objects. Regarding the physical properties of quenched steel, these are determined by the rate at which the heat is lost, not per unit of surface, but per unit of weight; the rate of quenching depends chiefly on the size of the object, less on the nature of the quenching medium. Hence the only scientific method of defining heat treatment is to give the rate of temperature loss over a given range; expressions such as "water-quenching" and "air-cooling" are quite indefinite.—W. R. S.

Industrial Notes.

CELLULOSE AND CHEMICAL INDUSTRY (1866—1916).

Abstract of a Lecture delivered at the Royal Institution on March 2, 1917.

BY C. F. CROSS.

The chemical industrial developments of cellulose are characteristic of the modern age, which in this section of technology dates from 1866. At this date the necessity of meeting the progressive consumption of paper by a supply of original raw cellulose material led to the introduction of esparto grass by Thos. Routledge, and to the investigation of wood material as the most massive form and source of cellulose. As the result of the pioneer work of an Anglo-Swedish group, of which the late C. D. Ekman was a prominent member, and for which his English collaborators (Messrs. Thomson, Bonar and Co., and George Fry, of Berwick-on-Tweed) supplied the means, the business organisation, and a considerable contribution to the technical and scientific basis of investigation, the wood pulp (cellulose) industry was launched.

It was considerably developed by the technical improvements introduced by our countryman, Edward Partington, now Lord Doverdale, who also brought to bear on the industry organising and business capabilities of a high order; the results, which have been cumulatively successful, are known to the world.

In these processes of resolving raw material into paper-maker's "pulp," the cellulose, as the chemically inert or non-reactive basis of the raw materials, resists the severe treatments required to attack the non-cellulose components. The esparto compound celluloses are resolved by alkaline treatment (caustic soda solution at 120°—130°), the wood substance (ligno-cellulose) by treatment with acid compounds (disulphides) in solution at 140°—160°.

The soluble by-products, derivatives of the non-cellulose complex, amounting in either case to 50 per cent. of the original raw material, are in effect waste products. In the case of the esparto they are burned incidentally to the recovery of the soda; but the "wood liquor" by-product is still in the main a waste, and a colossal one.

The "positive" chemical technology of cellulose is necessarily based upon its reactivity, and the industries which exploit the reaction changes of cellulose are of widely divergent character; those of Group A are based upon reactions of decompo-

sition; those of Group B are based upon the properties of synthetical derivatives.

Of Group A, the resolution of cellulose into sugar (dextrose) by acid hydrolysis is the basis (1) of a process for the preparation of industrial (ethyl) alcohol from wood, and more economically from wood wastes. According to our latest information, the technical difficulties presented by this apparently simple process have been so far overcome that the alcohol is produced on the large scale at a cost of 2½d. per gallon, exclusive of the small cost of the waste wood material. Under these most favourable conditions, however, the yield of alcohol is only 5 per cent. of the weight of the wood substance, or say 8 per cent. of its cellulose content, leaving therefore a very large item of final waste to the debit account of the chemist.

(2) Sawdust, or other wood waste, fused—i.e., heated at high temperatures—with the caustic alkalis is destructively oxidised, and the main product of the oxidation is oxalic acid; this process is in effect the main source of the acid, as an industrial product.

(3) Waste wood subjected to destructive distillation in closed retorts is resolved into gaseous and volatile liquid products, with a solid residue of charcoal or pseudo-carbon. The liquid products contain acetic acid, acetone, and methyl alcohol as chief constituents, and have been the main source of supply of these chemical individuals, which, as reagents especially, are indispensable in modern chemical industry.

In this direction, however, cellulose material and its wasteful treatment by destructive distillation are being supplanted by a direct and controlled synthesis from calcium carbide, acetylene being quantitatively transformed into acetaldehyde, and this into acetic acid. In this new industry the pioneers in this country are the British Cellulose and Chemical Manufacturing Company, Spondon, Derby.

(1) Cellulose treated in full contact with oxygen is burned with the familiar flame combustion; but from all the natural structural forms there is a residue of inorganic matter (ash) which when present in important proportion preserves the general structural details of the original. This intimate combination of cellulose with inorganic matter is a characteristic property of colloids of which cellulose is the prototype. It is the basis of innumerable processes incidental to the dyeing and colouring of cellulose fabrics and tissues. But the production of a combustion skeleton for utilisation as an industrial product is a modern and noteworthy realisation of a primary cellulose quality "strong even in death."

The familiar incandescent gas mantle is the skeleton of a textile material impregnated as such, or as we may say, "in the flesh," with colloidal thorium and cerium oxides, and afterwards cremated.

Of the cellulose industries of Group B, those (1) based on the nitric esters are of preponderating importance, for they include the production of the modern military explosives and they connote developments in pure and applied science peculiarly characteristic of the age. Cellulose nitrate not only fulfils the ideal of chemical effect, i.e., total conversion of solid into gaseous matter, at maximum increase of volume (or pressure), further increased by the temperature of combustion, but is a stable form of this high chemical potential, and further owing to its colloidal plastic properties can be moulded into any desired form and is therefore able to meet the most exacting specification of ballistic requirements. There is no doubt that mankind is directly indebted for its "smokeless" powders and the basis of the vast developments of modern military power to the pioneer work of Alfred Nobel and his collaborators.

The lower degrees of "nitration" of cellulose are represented by products which are the basis of "celluloid," and the celluloid industries connote the production of a large number of familiar objects both useful and ornamental, and a progressively increased production from the date of the pioneer work of the American inventor, Hyatt (1869). (See this J., 1914, 225.)

Celluloid realises a very high order of plasticity, and it is this structural potentiality which enables it to maintain its industrial leadership in spite of its disadvantages of high inflammability frequently and tragically manifested.

(2) The analogues of the nitric esters, are the acetic esters of cellulose derivatives, which are necessarily colloids with plastic capabilities, water-resistant as are the nitrates, and with a higher order of resistance to heat (unchanged at 200 °C.), and the ordinary inflammability of organic substances. Important uses of the cellulose acetates already established are: (a) in aeroplane construction, for treating to render taut and impermeable the textile fabric which constitutes the air-resistant surface of the wings; (b) in the form of film, as the "emulsion-film" support in photographic work, notably for the preparation of the continuous cinema picture; (c) for a varnish for metallic surfaces, and notably for electrical insulation and applications which depend upon exceptionally low inductive capacity.

In the above brief account of the cellulose nitrates and acetates there is the implicit suggestion of the production of artificial textile threads by drawing the solutions of these bodies through orifices of suitable form and dimensions such that after removal of the solvent liquid the re-solidified and structureless ester constitutes a cylinder of hyaline material of uniform diameter.

The industrial production of artificial threads, and notably of the "silk" or lustra cellulose, we owe to the pioneer enterprise and purposeful tenacity of a French technologist, H. de Chardonnet. But cellulose nitrate as *matière première* has many and obvious defects: hence the alternative plastic forms or derivatives of cellulose have progressively displaced the original industrial product, which had a brilliant career of success in the early years of this century.

There are three main rival processes of which the underlying principles are common. They are expressed in the stages or phases of the process:—

(1) Cellulose is transformed by reaction into a synthetic derivative—dissolved as such to an 8 per cent. solution (calculated as cellulose), filtered and continuously projected, or drawn through fine tubes or orifices, into a solidifying or setting medium.

(2) The thread as a unit filament (monofil, crin, crinole), or multiple group of twisted filaments (artificial silk), is a cellulose ester or other derivative, and is chemically treated to remove combined groups, or impurities as by-products of decomposing reactions; the thread substance is cellulose, reappearing as such after the cycle of changes.

The three cellulose derivatives on which these important industrial processes are based are: (1) The nitric esters; drawn or "spun," as ether-alcohol solution (Chardonnet process).

(2) The ammonia-soluble cellulose-hydrate-copper-hydroxide compounds (Cuprammonium process).

(3) The xanthic or sulpho-carbonic ester, synthesised in two stages: (a) mercerisation of the cellulose; (b) combination of the alkali cellulose with carbon bisulphide, and solution of the product in water (Viscose process).

Of these the Viscose process is now predominant by reason of its advantages, technical and economic. It will be noted that the material "elements" of the industry are cellulose, common salt, carbon and sulphur, than which no simpler terms could be devised, even as an *a priori* proposition.

Of other industrial applications of the Viscose process, the production of transparent film in continuous length is a variation only of the process above described, the liquid viscose being drawn through a controlled adjustable slit of 1.5 m. width, into a setting solution or precipitant, which converts it at once into the solid state, but retaining 80 per cent. of water. This hydrated product is purified by successive treatments, and is finally dehydrated and dried with a shrinkage of 33 per cent., the 1.5 m. of hydrated xanthate, as first precipitated, being reduced to a width of 1 m. in the finished cellulose film.

This is a noteworthy achievement in chemical engineering, and is entirely due to the inventive prescience of the personnel of the Société Française de la Viscose, especially to MM. L. Naudin and J. B. Brandenberger. It is a pleasant duty to recognise technical pioneer work of so high an order.

In addition to these main applications there are many other uses of the reactions involved in the Viscose cycle. Thus "mercerisation" of cellulose is an application of the interaction of cellulose (textiles) and caustic soda, to produce lustre effects and finishes upon cotton goods. The structural changes of yarns and cloths determined by these reactions were investigated by John Mercer at a period which long antedates our half-century of progress. To Mercer's anticipations there succeeded a long incubation period. A few discoveries of minor import in this field then revived interest in the major product; the alkali cellulose of the Viscose cycle and "mercerised goods" became a textile market of first note and importance.

DEVELOPMENT OF JAPANESE CHEMICAL INDUSTRIES.

Some of the recent developments of chemical industries in Japan are described by Prof. H. Nishida in the first issue of a new periodical, "The Chemical Technology," which is to be issued monthly (subscription price 3.36 yen per annum).

In regard to the manufacture of dyes, it is stated that many plants have been established since the outbreak of the war, in the endeavour to produce the 12,000,000 lb. of dyes required in Japan annually, but most of them have had to close owing to shortage of capital and lack of expert assistance. The Japan Dyestuff Manufacturing Co., which is subsidised by the Government, and to which reference has already been made (this J., 1915, 954; 1916, 37) has for some time past been working successfully, producing aniline oil and salt, phenol, Orange H., Benzo Purpurine 4B, Fast Red A, and Congo Red. A number of direct, basic, and sulphur colours will shortly be produced, and it is also intended to manufacture synthetic indigo. The Tokyo Gas Company and the Mitsui Mining Company have also met with considerable success, and are producing dyes on an industrial scale.

The manufacture of medicinal chemicals has also received a great deal of attention, and a number of compounds are being produced for the first time in Japan, including morphine hydrochloride, salicylic acid, bismuth compounds, atropine sulphate, chloroform, codeine, guaiacol, heroin, and tannin.

The wood distillation industry received a great impetus owing to the increased prices. Acetic acid manufacture had already been placed on a sound basis, and the works were able to extend their output to such an extent that they produced over 3,450,000 lb. in 1915, of which nearly 1,470,000 lb. was exported. Importations of calcium acetate from America having ceased during

1915, the manufacture of this product in Japan has increased considerably. Imports of formaldehyde into Japan amount normally to about 1,000,000 lb. annually, mostly from America and Germany; these supplies are not now available and steps are being taken to manufacture sufficient to fill the local demands, at any rate. The output of methyl alcohol has also been increased and the process of making it improved. Formerly only about 300,000 lb. was produced annually.

The consumption of glycerin in Japan amounts to about 1700 tons per annum, of which 1000 tons was imported, mainly from England, America, and Germany; several plants, one of them working under Government subsidy, have recently been erected, and it is expected that the supply will shortly meet the demand.

Japanese glass manufacturers have been doing greatly increased business, especially with India and Australia. The over-production which took place in the celluloid industry prior to the war has resulted in one of the manufacturing companies abandoning the production of celluloid and turning to the manufacture of nitrocellulose for military purposes; owing to the cessation of imports of celluloid from Germany, the recent supply has scarcely been adequate. A large expansion has also resulted in the paper making industry, consequent on the cutting off of imports; production during 1915 is stated to have amounted to 210,000 tons. Filter paper is now being manufactured in Japan. The difficulties experienced in obtaining an adequate supply of sulphite pulp are being overcome, and shortly Japan will be independent of raw materials for paper.

Prior to the war, phosphorus was imported into Japan to the extent of 70,000 lb. annually; only two Japanese factories produced it, and their output was only about 12,000 lb. The rise in prices following the outbreak of war caused a greatly increased production, which is now about 37,000 lb. annually, and is being enlarged rapidly. Potassium chlorate is another substance of which the greater part (3000 tons out of 4000 required) was formerly imported; several firms have taken up this manufacture since the outbreak of war and the former producers have increased their output, with the result that an over-production is feared in the future.

INDUSTRIAL AND SCIENTIFIC RESEARCH IN CANADA.

A statement has been issued by the Honorary Advisory Council on Industrial and Scientific Research which was appointed by the Dominion Government in December, 1916, to the effect that some forty projects, each bearing on vital phases of scientific conservation and development of Canada's natural resources, have been submitted to the Council. Each one is being carefully considered, with a view to applying the scientific and well-considered principles of technical research to the solution of the industrial problems of Canada, both for the present and for the future.

Some of the larger projects now in view include a comprehensive industrial census; the training and utilisation in industrial establishments of "efficiency experts"; the creation of technical laboratories at the great industrial centres to give free help to manufacturers in solving their problems; the utilisation and development of fuel resources, particularly those of the Prairie Provinces; and the preservation of the diminishing timber resources of Eastern Canada.

Industrial Census.—The Council will issue questionnaires to Canadian manufacturers, technical societies, Government Departments, and universities, asking for information with reference

to the laboratories and various other agencies of research now in operation in the Dominion; the men now engaged in or available for research work; the raw materials required for Canadian industries; the by-products produced but not at present utilised; and other information required in the development of the Council's work.

Establishment of Fellowships.—In order to provide a body of men who have been thoroughly trained in science and its application to industry, the Council will recommend the establishment of twenty or more studentships and fellowships in Canadian universities and technical schools. Arrangements will also be made by which, after graduating, men will be placed in one or other of the great manufacturing establishments, and they will thus be fitted to aid in the development of the industries of the Dominion.

Industrial Research Bureaux.—In order to furnish direct assistance to the manufacturing industries of Canada at once, the Council are recommending the establishment at certain of the great industrial centres of the Dominion, such as Toronto, Montreal, and Winnipeg, in co-operation with the Provincial Governments or other bodies, of industrial research bureaux, where a complete set of technical magazines and trade journals will be available, and where technical staffs, provided with suitable and properly equipped laboratories, will assist manufacturers in solving problems which present themselves in factories or works.

In addition to these broad general movements for the advancement of the industries of the Dominion, the Council have decided to examine carefully a number of specific projects which have been submitted to them, and which appear to give promise of yielding valuable results. They have also decided to recommend that work should be at once started with a view to the provision of an adequate supply of good fuel for the western plains, more especially in the Provinces of Saskatchewan and Manitoba. There are in the former Province large supplies of lignite, of comparatively little value for domestic or manufacturing purposes. The Council, however, believe that by a special treatment there may be produced from this lignite two grades of briquetted fuel, one similar in character to anthracite or hard coal, and the other resembling soft coal in general character; and that at the same time very valuable by-products may be secured.

WORKS ORGANISATION AND EFFICIENCY.

BY PROFESSOR W. RIPPER, D.ENG., D.SC.

Royal Society of Arts, May 9th, 1917.

In order to maintain a higher rate of wages than prevailed before the war, and to do so without injuring the employer and without the necessity of industrial strife between employer and employed, the only method is to increase the national output of wealth-producing goods and services, so that there may be more wealth to distribute than was the case before the war. To bring this about the following things at least will be necessary:—1. The continuance after the war of improved relations between employers and their workmen. 2. The introduction of improved organisation and methods in our factories and work-shops.

Already great changes in this direction have taken place. There has been an enormous improvement in our methods of working, as well as in the spirit of willingness to work together and to co-operate and associate, the effect of which has been to secure a rate of output exceeding anything ever before obtained. There is, however, the danger that after the war this spirit of co-operation will not continue, and that the subjects of dispute between Capital and Labour

will be so numerous as to make serious disputes more or less inevitable. In the past our commerce, trade, and manufacture have been conducted too much for the one object of profit only and without any regard whatever to human and neighbourly considerations.

It is encouraging to note the increasing recognition of the value of mutual discussion between the representatives of masters and men, not merely for the purpose of settling disputes, but for purposes of mutual helpfulness to clear up a difficult situation. It is better understood now than ever before that the interests of an employer and his workpeople have more in common than was formerly supposed.

Increased output after the war does not mean that our workers are to be called upon to work harder physically than they did before the war, but that there will be a demand for more brains, that inefficient methods and appliances must give place to better and more efficient methods, and, above all, that we must begin to organise our industries on a scale commensurate with the task which lies before us.

It is owing to the fact that businesses in this country are conducted on so small a scale that our costs per unit of output are so excessive, and that our manufacturers are handicapped by not being able to compete in price against larger organisations abroad. The methods of the small employer are not properly manufacturing methods, they are the methods of the manual worker, and as such, in some special industries where skilled craftsmanship is indispensable, they will still remain as a permanent factor of high-grade industry; but for trades in general that can be more profitably carried on on a large scale by means of repetition machine work, they will of necessity be superseded by the component specialist whose output is large and whose standing charges are relatively small. It is by means of manufacture by quantity and by special machinery that costs are reduced and business increased. To carry on business in any industry along the line above indicated there is need of a very much more whole-hearted attempt at association under some central or agreed control than has hitherto taken place.

Fortunately, great changes are taking place at the present moment in this direction. Firms in all sorts of industries all over the country are combining together for the purchase of their raw material, the sub-division of the processes involved in their particular department of trade, and the selling of their products in the home and foreign markets through a single organisation instead of by a multiplicity of small isolated and costly efforts of their own. They prefer to unite their efforts so as to be able to compete successfully with their foreign rivals rather than spend their substance in fighting each other at home.

The leading principle which must dominate modern manufacturing methods throughout is the elimination of waste—waste of time, waste of material, waste of effort, waste of health. To increase the scale of wages paid, drastic steps must be taken to reduce waste in all directions, and if a really earnest endeavour is made by both employers and workmen, each in their own way, in this direction, it will be quite possible to increase so greatly the wealth-producing power of all the trades in this country as to secure after the war an increased output of work sufficient to produce the increased rate of wages desired.

The prevention of waste is essentially a scientific problem, and it must be attacked by the scientific method. As a result of careful study of power plants with a view to discovering and removing sources of loss, the cost of the unit of power to-day is anything from one quarter to one-tenth of what it was fifty years ago.

The importance of a good system of costing as a means of efficient control of a business, and of discovering weak places in it, is more and more fully realised by manufacturers; such a system is in fact in these days indispensable. It must present comparative results showing the progress separately of the various departments, in order to discover the relative merits of their respective methods, and to discover also the effects of changes of methods. A good costing system intelligently handled points out the direction in which improvement is possible and necessary, and is a splendid instrument of efficiency.

Above all, there is a great demand for skilled and competent leadership and for organising and administrative ability. The demand of every branch of industry for men of scientific training and experience will be greater in the immediate future than ever before.

Finally the provision of trade training for apprentices, and of a continued education through part time for all boys up to the age of seventeen or eighteen, is now admitted to be a necessity.

The future of our industry must be something more than a mere fevered scramble for profit on the part of the employers or for wages on the part of the men. Trade and industry must be recognised as the natural healthful and normal means whereby the nation is able to express itself in useful service, and to realise itself in ever-improving quality of work, as distinguished from the increase of mere quantity.

Obituary.

LORD ALLERTON.

The Right Hon. Lord Allerton, F.R.S., died in London on April 4th, aged 77 years.

Born at Otley, Yorks., in 1810, William Lawies Jackson commenced at an early age to

learn his father's business—that of a leather merchant and tanner—and when his father died in 1857 he took entire control of the business, working it up with the greatest energy and spirit to the position which it occupied when, for private reasons, it was given up in 1912. During that period the firm of W. L. Jackson, Ltd., had become one of the best known in the leather trade, having a very large output. He was one of the originators of the Leeds Leather Fair and also for some years President of the Leeds Leather Trades Association, in addition to being a member of the Leather Industries Committee of Leeds University. He took a very keen interest in the latter institution, being a life governor and member of the Council, both before and after it had received university rank.

Jackson commenced his connection with public affairs at an early age; he was a member of the Leeds Council from 1869 to 1880, and was elected Mayor of Leeds in 1895. He sat in Parliament almost continuously from 1880 to 1902, being appointed Financial Secretary to the Treasury in 1886—an office which he held for about six years—and Chief Secretary for Ireland in 1891; he only retained the latter office for a few months, until the Government went out of office. He sat on a very large number of Royal Commissions and Government Committees, including the Royal Commission on Trade, the Census of Production Act Committee, and the Royal Commission appointed in 1891 to inquire into the coal supplies of the United Kingdom, of which he was Chairman.

He had been a member of this Society since 1893, and, on the occasion of the Annual Meeting at Leeds, in 1895, he conducted a party of the members through his works.

He was made a member of the Privy Council in 1890, and in 1902 was raised to the peerage, assuming the title of Baron Allerton of Chapel-Allerton.

Journal and Patent Literature.

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I.—GENERAL; PLANT; MACHINERY.

PATENTS.

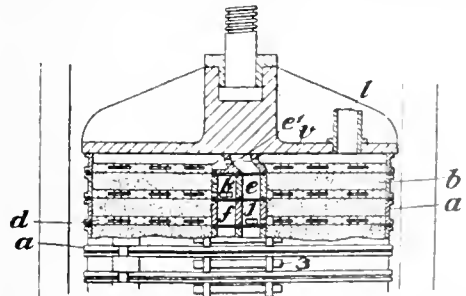
Loose material; Method of and means for the transference of—C. E. Blyth, Rugby, and L. Lister-Kaye, Southam. Eng. Pat. 104,775. Apr. 8 and Aug. 26, 1916. (Appl. Nos. 5188 and 12,086 of 1916.)

THE loose material is fed between two surfaces in yielding contact and moving in the same direction at a high velocity. In this way a momentum is given to the loose material, which is projected forward for a distance which varies with the velocity of the moving surfaces.—W. H. C.

Filter press. F. F. Briginshaw, London. Eng. Pat. 104,936. Mar. 29, 1916. (Appl. No. 4636 of 1916.)

A FILTER press is composed of a series of superposed horizontal filtering discs each mounted in its own frame. The frame comprises a ring, *a*, provided at its lower part with radial perforated

spokes, *d*, connected to a hollow central boss which is divided by a vertical partition into two compartments, *e* and *f*. A disc of wire gauze

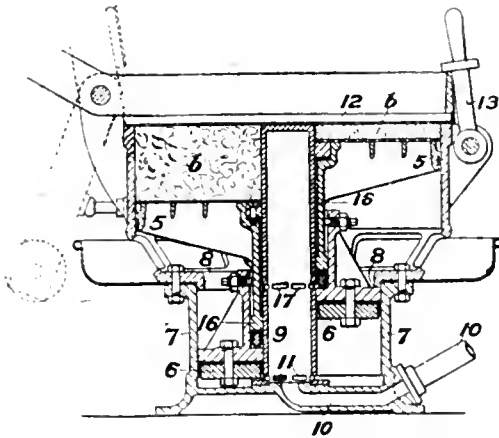


or a spirally wound wire is laid on the spokes and supports the filtering disc, *b*. Handles, *3*, are attached to the ring, *a*, to facilitate handling

the sections, a number of which are built up in a frame and maintained in position by a screwed press-head, *c*. The central bosses are perforated as at *j*, *k*, the perforations communicating with the spaces, *e* and *f*, in alternate discs. The liquid to be filtered is introduced by the pipe, *l*, and perforations, *e'*, into the column, *i*, so that it passes through the openings, *j*, and fills the alternate flat spaces between the discs. The liquid filters through the discs into the remaining alternate spaces, and thence through the openings, *k*, and conduit, *f*, to the outlet. In a modification, the spokes, *d*, are made of an inert metal attached to a light ring which is enclosed and supported by an outer ring of malleable iron or steel.—W. F. F.

Filler pulp cakes or discs for filler presses; Apparatus for compressing—F. F. Briginshaw, London. Eng. Pat. 105,323, Mar. 29, 1916. (Appl. No. 3551 of 1917.)

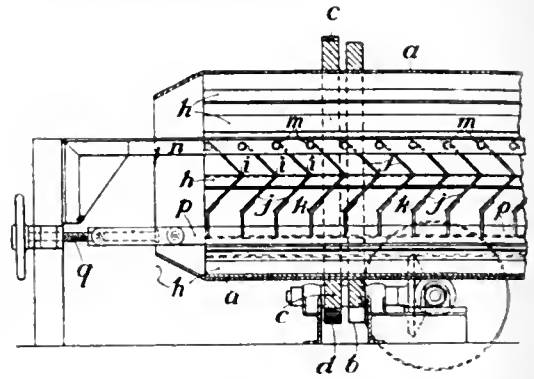
THE filter pulp cakes for use in the apparatus described in Eng. Pat. 104,936 (see preceding abstract) are made in the press illustrated. The pulp is placed in the space, *b*, above the perforated plate which is supported on the pressing table, 5. Pressure water is supplied through the pipe, 10,



and openings, 11, to the cylinder, 7, so that the annular ram, 6, and the smaller ram, 16, are raised together to compress the pulp against the cover, 12, which is locked by the catch, 13. After a predetermined compression, the main ram is stopped by the shoulder, 8, the cover, 12, is swung out of position, and pressure water passing through the openings, 17, forces up the smaller ram, 16, to raise the compressed cake so that the frame described in the prior patent may be placed upon it. The apparatus may be worked by a three-way valve in the pipe, 10, and the compressed air in the top of the column, 9, expedites the discharge of water. Alternatively, the smaller ram, 16, may be operated mechanically.—W. F. F.

Drying or roasting apparatus of the rotary chamber type. O. Elsworth, Newcastle-on-Tyne, Eng. Pat. 104,939, Mar. 30, 1916. (Appl. No. 4725 of 1916.)

A HORIZONTAL, cylindrical drying chamber, *a*, is provided with toothed rings, *c*, which are rotated with the cylinder by driving pinions, *d*. The material is fed into the cylinder at the left-hand end and is carried round by the channel-shaped carriers, *h*. Horizontal bars, *n*, pass through the cylinder and are supported independently of it, and bent plates, *j*, are pivoted to the bars at *m*. The material falls on to the plates and is progressively carried forward, and discharged at the



other end. The lower ends of the plates are pivoted to the bar, *p*, which may be moved longitudinally by the screw, *q*, so as to alter the inclination of the plates to modify the rate of feed of the material. In a modification, the upper part of the plates may be fixed and the lower segments pivoted at the points, *i*, so as to be capable of angular adjustment.—W. F. F.

Dryer. L. R. Jackson, Assignor to J. S. Schofield's Sons Co., Macon, Ga. U.S. Pat. 1,220,130, Mar. 20, 1917. Date of appl., Mar. 30, 1916.

THE shell of a cylindrical dryer is provided with openings covered by interior liner plates, the edges of which are overlapped by "flights" bolted to the shell. The openings of the cylinder allow material to drop through when any of the liner plates wear out.—W. H. C.

Drying apparatus for peat and the like. C. D. Jenkins, Assignor to Peat Coal, Ltd., Boston, Mass. U.S. Pat. 1,220,131, Mar. 20, 1917. Date of appl., May 1, 1915.

A NUMBER of air-jacketed cylinders are placed one above the other. The material to be dried is fed into the uppermost cylinder and passes down to the lowest, from which it is discharged, being moved forward by horizontal rakes which extend into each cylinder from a central vertical shaft. The teeth of the rakes work between teeth which extend upward from the floors of the chambers. Heated air is passed through the jackets, and means are provided for drawing off the vapour.—W. H. C.

Drying apparatus. C. H. Benedict, Chicago, Ill. U.S. Pat. 1,221,129, Apr. 3, 1917. Date of appl., Apr. 17, 1916.

A DRYING chamber having a heat-insulating covering is arranged in a pit having firebrick walls, and spaced from the walls. Waste gases from an adjoining furnace pass through the surrounding jacket to heat the chamber, and hot air is passed through the chamber from a hood over the furnace by a fan in the connecting conduit. An endless horizontal conveyor operates with its upper portion outside the chamber, so that articles may be placed thereon, and its lower portion within the chamber, moving in the opposite direction to the heated air.—W. F. F.

Dryer. R. Bernhard, Milwaukee, Wis., Assignor to Worthington Pump and Machinery Corporation. U.S. Pat. 1,221,412, Apr. 3, 1917. Date of appl., Sept. 5, 1914.

A HORIZONTAL, cylindrical, revolving casing is provided with transversely curved partitions extending for a part of its length and forming a flue and drying chambers. Each partition is composed of movable sections connected with the casing and having their ends approximately in line

with one another. Butt straps extend over the joints and are attached to one of the sections only, so as to permit relative movement.—W. F. F.

Drying kiln. P. W. Turner, Myndus, N. Mex. U.S. Pat. 1,221,776, Apr. 3, 1917. Date of appl., Sept. 20, 1915.

A DRYING kiln comprises a casing divided horizontally by heating pipes into a drying chamber above and a cold air chamber below. The air-supply flue for the lower chamber is provided with an automatic fan regulator, rotating in a transverse plane, and also with a baffle device. A larger discharge flue, in the top of the drying chamber, at the opposite end, is provided with a similar regulator and with a flared inlet.—W. F. F.

Stills and the like. British Dyes, Ltd., Huddersfield, A. T. Metcalf, Bradford, and W. Welch, Baildon, Yorks. Eng. Pat. 104,969, May 25, 1916. (Appl. No. 7409 of 1916.)

IN a still heated by horizontal steam pipes, a steam chest is fixed to the outside of one of the vertical walls, and divided into two parts by a vertical partition parallel to the wall of the still. Steam enters the outer compartment and passes into horizontal tubes fixed in the partition and extending through the wall of the still nearly to the opposite wall, the farther ends of the tubes being laterally perforated. The steam returns through concentric outer tubes which terminate in the wall of the still, so that the steam is discharged into the inner of the two compartments of the steam chest. The heating tubes thus resemble "field tubes," and are fixed at one end only, in plates which are slightly inclined, so that the tubes are also inclined and condensation water is discharged. Some of the inner tubes are shorter than others to equalise the heating, and the tubes are arranged in independent groups.—W. F. F.

*Chaff and other loosely aggregated materials; Apparatus for treating—*with steam, air, or other gases. W. R. Renshaw, Stoke-on-Trent, Eng. Pat. 105,096, Mar. 27, 1916. (Appl. No. 4525 of 1916.)

IN apparatus for treating or drying chaff or other loosely aggregated material with steam, hot air, or other gases, a steam ejector withdraws gas from the vessel containing the material, and forces it through a superheater, and thence, after addition of more steam, back to the vessel. A thermometer is provided on the inlet side of the superheater, and a thermometer, safety valve, and pressure and vacuum gauge on the other side of the superheater. Circulation is continued till the desired temperatures are reached. When treatment is finished the valves in the circulating system are closed and the heated air, gas, and steam withdrawn from the vessel by a water ejector connected to the pipe system between the vessel and the first valve.—W. F. F.

Annealing-furnaces. Regenerative furnace for annealing and like purposes. A. L. Stevens, Chicago, Ill. U.S. Pats. (A) 1,219,499 and (B) 1,219,500, Mar. 20, 1917. Date of appl., Sep. 10, 1912.

A REGENERATIVE annealing furnace has a series of combustion spaces formed by bridge walls spaced apart from the side walls of the heating chamber. In (A) a pair of regenerators is provided at one end, at about the level of the heating chamber, which is provided with a door at the opposite end. The regenerators are connected with two flues which pass below the heating chamber and are connected by other flues with each of the combustion spaces. In (B) separate regenerators are provided beneath and connected with each combustion space.—W. H. C.

Furnace. G. Rigg, Palmerton, Pa., and W. L. Coursen, New Rochelle, N.Y., Assignors to The New Jersey Zinc Co., New York, U.S. Pat. 1,220,789, Mar. 27, 1917. Date of appl., Apr. 19, 1916.

A FURNACE for roasting, calcining, and similar purposes is provided with a removable roof having a substantially flat bottom and a central feed opening. The roof is built up of a series of beams channelled for the reception of a cooling medium and provided at top and bottom with a series of inclines. The beams are spanned at the bottom by flat tiles resting on the inclines, and at the top by arched tiles, thus forming a series of combustion chambers. Means are provided for supplying a mixture of gas and air to the combustion chambers and for removing the products of combustion.—W. F. F.

Furnaces; Air-control system for [regenerative] —, W. H. Bradley, Pittsburgh, Pa. U.S. Pat. 1,222,519, Apr. 10, 1917. Date of appl., Feb. 29, 1916.

THE valve casings of a number of reversing regenerative furnaces are supplied with air by a blower which delivers it through a common main provided with a branch pipe for each valve casing. A control valve is provided in each branch pipe and is operated by a pressure-controlled device connected to the branch pipe between the valve and the furnace. An additional air inlet is provided in each valve casing, controlled by a valve operated manually.—W. F. F.

Refrigerating-machines. G. P. Carroll, Bridgeport, Conn. U.S. Pats. (A) 1,219,533 and (B) 1,219,534, Mar. 20, 1917. Date of appl., (A) Apr. 1, 1908, (B) Dec. 3, 1910. (B) Renewed Aug. 9, 1916.

THE claim is for a combination of a condenser, an evaporator, a coil in the chamber to be cooled, and a still to contain the absorbing liquid. The heating and cooling of the apparatus is automatically regulated (A) by thermostatic valves in the refrigerating chamber or (B) by means operated by the pressure of the refrigerant in the condenser.—W. H. C.

Condenser. G. P. Carroll, Bridgeport, Conn. U.S. Pat. 1,219,535, Mar. 20, 1917. Date of appl., Nov. 4, 1913.

A CONDENSER consists of a horizontal tank provided with an inlet and with an outlet at the bottom. A gas conduit enters the tank through the inlet, descends within the tank, and discharges near the bottom. A water conduit enters the tank near the bottom and leaves it at a higher place: it is formed of sections disposed horizontally within the tank and connected in series by other sections outside the tank. A water pipe leads from the outlet end of the water conduit, enters the gas conduit, traverses part of it longitudinally outside the tank, and then emerges from it.

Evaporator. R. J. Coach, Assignor to The Sub-Surface Vacuum Development Co., Cleveland, Ohio. U.S. Pat. 1,220,191, Mar. 27, 1917. Date of appl., Apr. 1, 1912.

THE liquid to be evaporated is contained in a shallow closed pan communicating through an aperture in the upper part of a partition with an adjacent air chamber to which suction is applied. The liquid is heated and agitated by steam pipes which can be moved vertically into and out of the liquid by a cranked shaft extending horizontally above the pan and connected by vertical rods to the steam pipes.—W. F. F.

Evaporating process and apparatus. F. G. Wheeler, Assignor to Bleach Process Co., Appleton, Wis. U.S. Pat. 1,222,340, Apr. 10, 1917. Date of appl., June 17, 1916.

A SOLUTE is removed from a solution, or from a

mixture of two solutions, by evaporating the solvent and crystallising the solute, and then circulating the solution so that at one point it flows upward into a vessel with a conical bottom. The reduction in velocity at the enlarged cross-section of the stream causes the crystals of solute to remain suspended at that point. The clear liquid above is withdrawn by a pipe at the top and treated again as often as desired. The process is applicable to the removal of sodium chloride from a solution containing also sodium hydroxide.

—W. F. F.

Chemical [mixing] apparatus. Z. Ostenberg, San Francisco, Cal., Assignor to International Cellulose Co., Reno, Nev., U.S. Pat. 1,220,778, Mar. 27, 1917. Date of appl., Feb. 7, 1916.

POWDERED material is discharged from a hopper by a screw conveyor into the top of a tall, vertical cylinder through which it is caused to fall in an annular stream by means of a conical spreader at the top. Liquid is sprayed from a central sprayer into the falling material, and the treated material is cooled in the lower half of the cylinder by an external cooling coil, and finally discharged by a screw conveyor. Means are also provided for simultaneously adding material to, and abstracting material from the mass in the cylinder.

—W. F. F.

Dehydrating apparatus [for air]. G. H. Benjamin, New York, U.S. Pat. 1,220,815, Mar. 27, 1917. Date of appl., Aug. 1, 1914.

AIR is drawn through a chamber in which brine is circulated, from an inlet at the bottom to an outlet at the top which is connected to a long horizontal casing provided with heating pipes connected at one end to a heater and at the other end to a chimney stack. The other end of the casing is connected to the suction side of the air circulating pump. The delivery side of the pump is connected to a second casing communicating along its length with a series of cells through which the air passes to another casing over the top of the cells and communicating with each of them, and thence to the chimney stack.—W. F. F.

Gas or mixture of gases: Method of separating certain constituents from a— L. Bradley, East Orange, N.J., and W. A. Schmidt, Los Angeles, Cal., Assignors to Research Corporation, New York, U.S. Pat. 1,221,505, Apr. 3, 1917. Date of appl., July 23, 1914.

A CONSTITUENT is separated from a gas or mixture of gases by injecting into it dust or other finely divided solid particles capable of reacting chemically or physically with the constituent and absorbing it. A cloud or mist is formed and is precipitated by subjecting the gas to the action of an electric field.—W. F. F.

Compressed-air washer. B. C. Donham, Glen Ridge, N.J., Assignor to Spray Engineering Co., Boston, Mass., U.S. Pat. 1,222,511, Apr. 10, 1917. Date of appl., Dec. 6, 1915.

COMPRESSED air is passed through a horizontal conduit, into which liquid is sprayed over the whole cross-section in different conditions of fineness, in the direction of movement of the air, so that the most finely-divided liquid is retained as moisture for the precipitation of foreign particles. Two separate sets of sprayers, one being provided with atomising screens, are used, with a liquid-removing device between them. The finely divided liquid is discharged from the last set of sprayers in diagonal paths toward the centre of the air stream.—W. F. F.

Electrostatic separator for inflammable materials. J. Kraus, Brunswick, Germany, U.S. Pat. 1,222,505, Apr. 10, 1917. Date of appl., Oct. 27, 1914. SEE Eng. Pat. 26,802 of 1913; this J., 1914, 681.

IIA.—FUEL; GAS; MINERAL OILS AND WAXES.

Coal; Gasification of—without residue [except of ash]. A. Naumann, Chem.-Zeit., 1917, 41, 6—8.

THE method of converting coal directly into heating gas, by-products, and ash, as covered by the patents of the Dellwik-Fleischer Wassergases, and E. Dolensky (this J., 1911, 585; 1915, 268; and 1917, 380), is described and its compulsory adoption (in Germany) under State control suggested. It is urged that district stations be installed and conducted in the public interest, and that private consumption of solid fuel be prohibited. The gas, which has been named "tri-gas," is a mixture of water-gas and illuminating gas with, in special cases, a small proportion of producer gas, and results with an experimental installation show that it has a high calorific value. The process may be regulated by adjusting temperature and steam supply so that the best results, as regards yield of gas, tar, or ammonia, are obtained with any kind of fuel, and is claimed to be highly economical.

—F. SOBX.

Coke gasification; Economy of— J. E. Enright, Gas J., 1917, 138, 185—186.

RESULTS obtained from the carburetted hydrogen plant at Tralee, Ireland, over a period of ten months, are as follows. Carburetted hydrogen gas made, 15,225,100 cub. ft.; coke used, including boiler fuel and stand-by plant, 363 tons, 9 cwt.; tar used in plant, 10,197 gallons; wages, £128 12s. 6d., working out at an average cost of 9d. per 1000 cub. ft. into the holder. During the same period 1357 tons of coal, at an average cost per ton of 55s., was carbonised, giving, 14,885,900 cub. ft. of gas. Thus 363 tons of coke yielded more gas than 1357 tons of coal. The working of the plant has been most satisfactory, important economies having been effected in renewal, repair, and maintenance of retorts, number of stokers required, and other incidental expenses. The plant can be operated by one man. With regard to the distribution and consumption of the mixed gas, a burner adjustment for a 50% gas has been found suitable for any mixture between this and carburetted hydrogen gas alone. Carbon monoxide can be kept well below 18% and the mixed gas varies between 475 and 500 B.Th.U., but a variation between 400 and 500 B.Th.U. causes no trouble after adjusting the burners or stoves for the mixed gas. In gas engine trials it was found that the B.H.P. was not affected by the variation of the B.Th.U., the consumption of gas being in inverse proportion to the latter. The consumption of gas in fires and stoves works out similarly, whilst with the incandescence mantle the 400 B.Th.U. gas has been found as economical and efficient as the richer gas.—J. E. C.

Wood in gas making. Gas J., 1917, 138, 191

RESULTS of experiments at Romorantin Gas Works in the distillation of fir and oak for gas making are as follows. The wood was distilled, unmixed with coal, in retorts, 10 ft. x 25 ins. x 14 ins., in quantity to yield from 10 to 20% of the make of gas from coal. Each charge was about 100 kilos. of fir or 120 kilos. of oak, yielding about 25 cb. m. (900 cub. ft.) of gas. Costs are given as:—Fir, 40 frs. per ton; labour, 4 frs.; furnace coke, 17.5 frs.; total, 61.5 frs. Net cost (deducting 50 frs.

from sale of 10 hectolitres of charcoal), 11.5 frs. Oak. 58.5 frs. per ton; labour, 4 frs.; coke, 17.5 frs.; net cost, 10 frs. The charcoal sells readily, the weight per hectolitre being 15 kilos. in the case of fir and 18 kilos. in that of oak.—J. E. C.

Gas washing [for benzol and toluol]: analysis of products; control of stills. A. Edwards. Yorkshire Junior Gas Assoc., Apr., 1917. Gas J., 1917, 138, 187—191. (See this J., 1916, 587.)

In gas washing by oil it is necessary to determine the quantity of oil required per ton of coal. There is a dividing line in regard to the amount of oil used below which economy in steam is more than balanced by loss of benzol, and above which increasing recovery of benzol is more than balanced by increasing steam and water cooling demands, and this point must be determined for the particular plant and conditions. Some conditions affecting this point are:—(a) Quantity of benzol in the gas. (b) Type of washer. (c) Temperature of oil. (d) Cost and pressure of steam. (e) Cost of water. In coking installations 100 galls. of wash oil per ton of coal is commonly regarded as representing the best point, but it is not certain that the conditions in coking installations are the best or comparable with average gas-works conditions. In coking installations the tower scrubber is used in most cases, whilst gas works have adopted mechanical washers of the rotary or centrifugal type. As against the extra cost of the tower scrubber with its filling may be set the running costs, maintenance, and power costs of the mechanical scrubbers. There are three ways of considering the efficiency of a gas-washing plant. First there is the volumetric efficiency, the proportion of benzol recovered to the total quantity present. Secondly, the "constitutional" efficiency, due to the method of applying the washing liquid, and a constant for the particular method employed. Thirdly, the "mechanical" efficiency, represented by the comparison of the theoretical minimum volume of oil to ensure equilibrium between gas and oil with the actual volume found necessary. For maximum efficiency the flows of gas and oil should take place on the counter-current principle through a series of saturations increasing by very small stages. In tower scrubbers this is only obtained if the washing medium travels evenly and progressively over the surface of the packing material. In rotary washers the action is divided into definite steps according to the number of sections. The proportion of benzene in the wash-oil in equilibrium with benzene vapour in the gas can be determined for any particular temperature, and from the data thus obtained the theoretical amount of wash-oil required for absorption can be calculated. If the wash oil is passed through a single chamber, equilibrium is attained when 50% of the vapour is absorbed, and with washing systems of two, four, and eight chambers the volumetric efficiencies will be 75, 87, and 93% respectively. Town gas of 500 B.Th.U. net calorific value, from horizontal and inclined retorts, contains usually 0.8% by volume of benzene vapour, corresponding to a partial pressure of 6.1 mm. of mercury, and requiring under summer temperatures a circulation of 48.8 to 56 gallons of wash oil per ton of coal. The benzene concentration in the wash-oil in equilibrium with 0.8% benzene vapour in the gas varies from 9.8% at 5° C. to 3.05% at 30° C. Experience with an eight-chamber washer points to the use of 1.1 to 1.5 times the theoretical quantity of wash oil, the practical circulation for 0.8% benzene in the gas at a temperature of 25° C. being 53 to 73 gallons per 10,000 cub. ft. The cost of steam is usually about half the total cost of recovery. Efficient practical working may be maintained by: (1) Measuring the wash oil used, preferably

by a V-notch weir; (2) indicating the amount of hydrocarbon vapours extracted, e.g., by means of a couple of jet photometers with scales constructed by direct experiment; (3) indicating the volume of steam used in the still; (4) periodical tests of the crude benzol; (5) examination of wash oil before and after the still; (6) determination of viscosity of wash oil. Where crude benzol is made and sold on the usual basis of 65%, a complete analysis is not necessary, unless the proportion of paraffin is objected to, but where the crude material is rectified, analysis plays an important part. The author gives a scheme for the analysis of crude benzol based on the methods of Spielmann, Colman, and on his own boiling-point method (this J., 1915, 168; 1916, 396, 587). The following is an average of 5 analyses of crude benzol: benzene, 54.07; toluene, 15.00; solvent naphtha (up to 160° C.), 4.98; creosote, 16.65; unsaturated hydrocarbons, 8.16; carbon bisulphide, 0.30; paraffins (up to 139° C.), 0.80%. These figures are for the ultimate proportions present and do not give any indication of the distribution of the paraffins. The latter are important to-day since their presence in benzene and toluene intended for the manufacture of explosives is objectionable. The full scheme of operations for the analysis of a crude benzol is somewhat involved, and the author gives a simpler method of following the working of a primary still at the different stages. In testing the wash oil before and after the still, 4000 c.c. is distilled to 240° C. in a metal still provided with a jacket. Water is separated and recorded, and the distillate redistilled to 160° C. through a column. This represents the total benzol, toluol, and solvent naphtha. In working up to fairly pure products it is advisable to make free use of the dephlegmator, returning down the column up to four times as much as is permitted to pass into the condenser.—J. E. C.

Concrete; Destruction of — by gas liquor. E. Ott. Chem.-Zeit., 1917, 41, 161.

A GAS LIQUOR tank of armoured concrete showed signs of leaking. The liquid which escaped contained ammonia, free and fixed, much calcium, and as acid radicle thiosulphuric and thiocyanic acids but no hydrogen, sulphide or sulphuric or hydrochloric acids. The ammonium salts in the liquor had attacked the free lime in the concrete, forming soluble calcium salts. Coating the inside of the tank with materials such as tar is only partly effective, as it is difficult to avoid the development of cracks. A suitable lining to the tank is to be preferred—lead, iron, or glass being suggested. Zinc is not a suitable material. Where iron is used, it is recommended to keep the atmosphere of the tank free from air and so avoid rusting. For this purpose coal gas is recommended.—H. J. H.

Lignite gas oils; Oxidation of — and of similar substances by ozone. C. Harries, R. Koetschau, and E. Fonrobert. Chem.-Zeit., 1917, 41, 117—119.

THE object of the experiments was the production of fatty acids from the unsaturated portion of the heavier gas oils from the distillation of Halle lignite (Webau). The oil boiled at 125°—220° C. under 10 mm. pressure. It was light brown, viscid, with disagreeable smell, and had a flash point of 125° C. The iodine value was 50—60. Similar results were found on ozonising shale oils. Ozonised oxygen was passed through a train of vessels containing the oil until the latter had increased in weight by 10%. Formic acid and formaldehyde were carried forward and condensed. The oil now contained an ozonide which was decomposed by steam. An excess of potash was added and steam again blown through. A potash soap was thus produced. This was purified by extraction with benzene and again ozonised, when

its colour improved. By a further treatment with steam any ozonide formed was decomposed and the soap was then concentrated by vacuum evaporation. The soap is stated to have given good results in the leather industry. By an adequate ozonisation all the unsaturated compounds were removed from the oil, and a paraffinoid residue of high quality remained. The chemistry of the process has not been thoroughly worked out, but the unsaturated compounds of the oil are believed to have conjugated double bonds, perhaps at the end of a chain. Trials on a works scale gave results similar to those in the laboratory.—H. J. H.

Montan wax and its behaviour on distillation. J. Marcusson and H. Smelkus. *Chem.-Zeit.*, 1917, 41, 129—136, 150—151.

THERE are three kinds of montan wax in commerce, viz., crude wax or bitumen, distilled wax, and refined wax. Crude montan wax is obtained by the extraction of dried lignite with benzene—a good sample of lignite containing 10—20% of available bitumen. Fischer and Glud (this J., 1916, 1901) have shown that the yield can be increased from 11% to 25% by working at 260° C. and 6 atm. pressure, but the residue cannot be briquetted as is normally possible. The crude waxes differ widely according to the source, Thuringian lignites yielding a brittle wax (m. pt. 80°—90° C.), while Bohemian lignites give a viscid liquid. Montan wax resembles beeswax in its resistance to saponification, and like the latter, is free from glycerides, consisting essentially of esters of monohydric alcohols and free acids of high molecular weight. The difficulty of saponification leads to some uncertainty as to the chemical nature of the unsaponifiable portion and this is discussed in detail. Solvents, e.g., alcohol and benzene, extract from the crude wax a resinous portion, the properties of which are described. A better separation of the resin from the wax can be effected by the use of liquid sulphur dioxide as employed by Fischer and Glud. On the other hand the extraction with benzene under pressure, already referred to, leads to an increased contamination of the true wax with resin. Many attempts at a chemical purification of crude wax have been made to obtain without distillation a product suitable for candle manufacture, but without success. The origin of montan wax is a subject of discussion. The authors hold that both vegetable waxes and resins have been involved, the proportions depending on the nature of the parent plants. Distillation of crude wax under atmospheric pressure leads to considerable decomposition. This is considerably reduced by working under diminished pressure and especially with superheated steam at 250° C. After further purification of the product by treatment with benzene, pressing, and decolorisation, a white crystalline product (m. pt. 70°—80° C.) results, containing mainly montanic acid, $C_{29}H_{58}O_2$. The yield in this process is stated as being only 30%. An examination of the distillation product led to the following conclusions as to the causes of loss of yield:—1. Decomposition of resinous and sulphur compounds during distillation. 2. Splitting of the wax esters into free fatty acids and unsaturated hydrocarbons. 3. Formation of ketones by union of two molecules of fatty acid and splitting off of water and carbon dioxide. 4. Formation of a pitchy residue. While crude wax is strongly optically active, distilled and refined montan wax is inactive. The activity is due to the resinous part of the crude material. (See also this J., 1909, 878, 991; 1916, 917.)—H. J. H.

Determination of free alkali in petroleum soaps. Charitschkov. See XII.

PATENTS.

Briquetting machine. J. F. Lovejoy, New Rochelle, N.Y., Assignor to A. Stein, New York. U.S. Pat. 1,221,878, Apr. 10, 1917. Date of appl., Apr. 9, 1913.

A MACHINE for briquetting powdered coal consists of a pair of rotary drums revolving in opposite directions. The drums are provided with radial pockets, fitted with plungers. As the point of tangency approaches, suitably arranged cam tracks bring about a compressing movement of the plungers. Means are provided for feeding the powdered fuel into the pockets of one of these barrels, partially compressing the fuel to carry it to the tangential region, and afterwards ejecting the fully compressed briquette.—J. E. C.

Binder [for briquettes, from sulphite-pulp waste lyes]. L. H. Woddrop, Arcola, N.J., Assignor to Robeson Process Co., New York. U.S. Pat. 1,221,259, Apr. 3, 1917. Date of appl., Dec. 4, 1916.

THE composition consists of an intimate mixture of bituminous coal, dried sulphite waste liquor, bituminous matter, such as pitch, and an inert granular material, such as sand.—J. F. B.

Gas producers. G. H. Isley, Assignor to Morgan Construction Co., Worcester, Mass. U.S. Pat. 1,221,055, Apr. 3, 1917. Date of appl., June 30, 1913.

A GAS producer comprises a fuel section and a fuel-feeding mechanism, with means for causing relative rotation between the two. The feeding mechanism is disposed eccentrically to the fuel section and consists of a hopper and a shelf, the hopper feeding the shelf and a rotary member forcing the fuel over the edges of the latter.—J. E. C.

Hydrogen or a mixture of hydrogen and carbon monoxide; Manufacture of—. C. B. Tully, Westminster. Eng. Pat. 16,932 of 1915; date of appl., July 3, 1916.

IN the lower part of a cylindrical apparatus is a combustion chamber in which a reducing gas is made by blowing air, or air and steam, into incandescent fuel. This chamber extends upwards into a fuel supply chamber, which is surrounded at its lower part by a reaction chamber containing iron ore in direct communication with the combustion chamber by means of holes and passages. Surrounding the upper part of the fuel supply chamber is a steam superheating chamber through which the oxidised gases pass, and which is provided with a valve-controlled outlet. After the iron ore has been reduced, the supply of reducing gas is cut off, the outlet pipe is closed, and steam is admitted through a pipe at the top of the apparatus; this passes through the superheater and over the iron, the hydrogen being either tapped through a pipe just below the reaction chamber or passed through the incandescent fuel and led away through a pipe at the bottom of it. Steam or liquid hydrocarbon may be injected directly into the combustion chamber at a point situated between it and the reaction chamber. Air may be admitted at the bottom of the superheater to burn the carbon monoxide, and the heat of combustion utilised to maintain the temperature.—E. H. T.

Combustible liquids; Treatment of—. C. White and C. F. Killar, London. Eng. Pat. 105,256, Apr. 1, 1916. (Appl. No. 4824 of 1916.)

AN inflammable substance for use as fuel for internal combustion engines is made by dissolving a gaseous hydrocarbon (preferably acetylene) and petrol in a mineral oil hydrocarbon fraction, the latter being preferably a petroleum fraction having sp. gr. 0.775 to 0.780, b.pt. about 150° to 230° C., and flash point 79° F. (26° C.). Liquids

such as ether, alcohol, or acetone may be added to retain the gaseous hydrocarbon in solution.
—J. E. C.

Mineral oils; Treating — to increase the yield of light-gravity oils. D. T. Day, Washington, D.C. U.S. Pat. 1,221,698, Apr. 3, 1917. Date of appl., May 3, 1913. Renewed Feb. 23, 1917.

HEAVY oils, such as gas oil or other distillates having a higher boiling point than gasoline, are subjected to distillation at a cracking temperature and at a pressure greater than the atmospheric pressure. Sulphur or sulphur compounds are added at intervals to facilitate the cracking of the heavier oils. Hydrogen-carrying gas or vapour may also be added and the mixed vapours passed through porous contact substances or a catalytic agent.—J. E. C.

Petroleum; Obtaining products from — by decomposition of component hydrocarbons. H. P. Chamberlain, Buffalo, N.Y., Assignor to Standard Oil Co. of New York. U.S. Pat. 1,221,790, Apr. 3, 1917. Date of appl., Oct. 20, 1913.

CRUDE petroleum is distilled until the distillate contains more than 10% by vol. of hydrocarbons having a viscosity ranging between 70 and 170 seconds at 100° F. (38° C.), and from this point the distillate is collected separately up to the point at which it is no longer free from still wax or other matters of sticky character. The collected product (heavy paraffin) is then distilled at decomposing temperatures under a pressure of not less than 30 lb. per sq.in.—J. E. C.

Hydrocarbons; Method and apparatus for fractionating —. L. E. Hirt, Charleston, W. Va. U.S. Pat. 1,222,402, Apr. 10, 1917. Date of appl., July 21, 1915.

OIL, mixed with steam, is subjected to the action of an electric arc in a closed chamber. Steam is decomposed and the liberated hydrogen reacts with the oil forming a compound therewith. The pressure in the chamber is controlled during the operation, and the oil vapours produced are withdrawn and condensed.—J. E. C.

Reactive products from paraffin hydrocarbons; Preparation of —. H. Zerning, Berlin-Halensee. Ger. Pat. 295,594, May 5, 1915.

PARAFFIN hydrocarbons and water are sprayed into a system of tubes, of which the first section is heated to about 300° C., the next to about 500° C., and the last to about 700° C., the most favourable excess pressure being 0.2 atmos. Highly reactive products are obtained, which can be readily oxidised, nitrated, sulphonated, etc. For example, the product from high-boiling American petroleum yields with sulphuric acid bodies resembling shellac, with nitric acid and potassium permanganate oils with a pleasant odour, and by simple nitration products which can be used in the manufacture of explosives.—F. Sr.

Expressing liquid from materials; Apparatus for —. Process for expressing liquid from peat. J. W. Hinchley, London. U.S. Pats. 1,222,209 and 1,222,210, Apr. 10, 1917. Date of appl., Sept. 25, 1916.

SEE Eng. Pats. 101,782 and 3998 of 1915; this J., 1916, 1254.

Drying apparatus for peat and the like. U.S. Pat. 1,220,131. See I.

Method of and apparatus for producing sulphate of ammonia. Eng. Pat. 104,155. See VII.

Manufacture of a non-volatile unsaturated hydrocarbon from petroleum. U.S. Pat. 1,220,821. See XIII.

Manufacture of alcohols [fusel oil substitute, from gasoline]. U.S. Pat. 1,221,667. See XX.

IIb.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

[Tungsten] crystals (crystalline wire for incandescence lamps); Manufacture of filiform —, by the method of J. Pintsch A.-G. W. Böttger, Deutsche Bunsen-Ges., Dec., 1916. Chem.-Zeit., 1917, 41, 10.

FILAMENTS prepared from a mixture of tungsten and thorium oxide by extrusion are found from an examination of etched specimens to consist of numerous crystals which are flexible in themselves but allow of great brittleness in the filament at points of mutual juncture. Relatively long crystals are obtained by very intimately incorporating the oxide with the metal, and suitable crystallisation is induced in filaments made with the aid of a binding agent, by extrusion, by causing these to travel through a zone heated to 2400°—2600° C., at a rate which is less than the rate of crystallisation. Filaments thus treated, unlike drawn filaments, do not undergo recrystallisation, even after 1000 hours of incandescence, and crystalline wire, although in the cold softer than drawn wire, becomes rigid at high temperatures.
—F. SODN.

PATENT.

Heat; Process of generating —. W. Thomas and A. E. Mainwaring, Nanaimo, British Columbia. U.S. Pat. 1,221,627, Apr. 3, 1917. Date of appl., Sept. 17, 1914. Renewed Dec. 14, 1916.

A BODY of fuel is coked or charred, and the rich hydrocarbon vapours and gases are withdrawn by means of air at a high pressure and injected at separate localised points into the body of incandescent coke, and into a combustion chamber above the coke. This brings about perfect combustion of the fuel and gases, and causes the mineral matter to be reduced to separate masses of clinker.—J. E. C.

III.—TAR AND TAR PRODUCTS.

Phthalic acid; Salts of —. J. B. Ekeley and C. Banta. J. Amer. Chem. Soc., 1917, 39, 759—768.

THE preparation and composition of a number of phthalates, already described in literature, was verified and the following new salts were prepared: lithium phthalate, $\text{Li}_2\text{C}_8\text{H}_4\text{O}_4$, glucinum (beryllium) phthalate, $\text{BeC}_8\text{H}_4\text{O}_4 \cdot \text{H}_2\text{O}$, manganese phthalate, $\text{MnC}_8\text{H}_4\text{O}_4$, basic ferric phthalate, $\text{Fe}(\text{C}_8\text{H}_4\text{O}_4)(\text{OH}) \cdot 2\text{H}_2\text{O}$, cobalt phthalate, $\text{CoC}_8\text{H}_4\text{O}_4 \cdot 2\text{H}_2\text{O}$, nickel phthalate, $\text{NiC}_8\text{H}_4\text{O}_4 \cdot 2\text{H}_2\text{O}$, acid cerium phthalate, $\text{Ce}(\text{C}_8\text{H}_4\text{O}_4)_3$, mercuric phthalate, $\text{HgC}_8\text{H}_4\text{O}_4 \cdot \text{H}_2\text{O}$, mercurous phthalate, $\text{Hg}_2\text{C}_8\text{H}_4\text{O}_4 \cdot 2\text{H}_2\text{O}$, thorium phthalate, $\text{Th}(\text{C}_8\text{H}_4\text{O}_4)_3 \cdot 5\text{H}_2\text{O}$, and uranyl phthalate, $\text{UO}_2\text{C}_8\text{H}_4\text{O}_4 \cdot 2\text{H}_2\text{O}$. The solubility of these salts apparently bears no relation to the atomic weight of the metallic element present. For instance, the glucinum and nickel salts are very soluble, whilst the lithium and cobalt salts are only slightly soluble; the lead salt is insoluble whilst the thorium salt is moderately soluble. The best method of preparing the salts is by acting on the respective carbonates with phthalic acid solution. A number of the salts were decomposed under varying conditions of temperature and pressure; only traces of anthraquinone were obtained, the main products of the decompositions being resinous matter, phthalic anhydride, and benzophenone, the latter often in large quantity.—W. P. S.

Gas washing [for benzol and toluol]: analysis of products: control of still. Edwards. See IIA.

Potassium persulphate as a reagent in organic chemistry. Datta and Sen. See XX.

PATENTS.

Tar: Distillation of—. B. E. D. Kilburn. London. From Sulzer Frères Soc. Anon., Winterthur, Switzerland. Eng. Pat. 105,198. Sept. 11, 1916. (Appl. No. 12,837 of 1916.)

TAR is distilled in a horizontal drum, the whole of the external surface of which is exposed to the heating gases. The tar from the bottom of the drum is continuously removed by means of one scoop of a series carried on a rotating shaft and deposited on the inner wall of the drum, and is removed therefrom by the next scoop in the series. —F. W. A.

2-Aminoanthraquinone and its derivatives: Production of—. Farbenfabr. vorm. F. Bayer und Co. Ger. Pat. 295,621. Dec. 21, 1912.

2-AMINOANTHRAQUINONE and its derivatives are obtained by heating 2-chloroanthraquinone, or such of its derivatives as do not contain a strongly negative substituent (e.g., carboxyl, halogen, nitro- or sulpho-groups) in the *ortho* position to the chlorine atom, with aqueous ammonia under pressure, either with or without copper or copper salts. —F. Sp.

3-Nitrocarbazole and its halogen derivatives: Production of—. Act.-Ges. f. Anilinfabr. Ger. Pat. 295,817. Nov. 6, 1912.

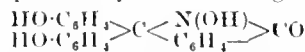
3-NITROCARBAZOLE and its halogen derivatives are obtained by treating carbazole or its halogen substitution products with about two molecules of nitric acid of 10% concentration. —F. Sp.

Purification of trade waste effluents [from benzol purification]. Eng. Pat. 104,999. See XIXB.

IV.—COLOURING MATTERS AND DYES.

Phthaleins: New class of—. *Mixed phthaleins formed by heating p-hydroxybenzoyl-o-benzoic acid with phenols.* W. R. Orndorff and R. R. Murray. J. Amer. Chem. Soc., 1917, 39, 679—697.

THE condensation of phenol and phthalic anhydride to give phenolphthalein is considered to take place in two stages, *p*-hydroxybenzoyl-*o*-benzoic acid being the intermediate product. The quantitative formation of *p*-hydroxybenzoyl-*o*-benzoic acid and *p*-aminophenol from phenolphthalein-oxime is explained by the following structure:—



Phenolphthalein and several mixed phthaleins have been synthesised from *p*-hydroxybenzoyl-*o*-benzoic acid. —F. W. A.

Potassium persulphate as a reagent in organic chemistry. Datta and Sen. See XX.

PATENTS.

Sulphide dyestuffs. G. H. Frank. Leeds. Eng. Pat. 105,118. Apr. 3, 1916. (Appl. No. 4817 of 1916.)

NITRO or nitroso derivatives of yacca gum (from *Xanthorrhoea arborea* or *X. hastilis*) or of Congo resin (from *Hymenaea verrucosa* or *Copaifera copallina*) or azo compounds of yacca gum (see following abstract) are fused with alkali sulphides or polysulphides. —F. W. A.

Azo dyestuffs. G. H. Frank. Leeds. Eng. Pat. 105,119. Apr. 3, 1916. (Appl. No. 4848 of 1916.)

YACCA gum (from *Xanthorrhoea arborea* or *X. hastilis*) is combined with diazo or tetrazo compounds, e.g., with diazotised sulphanilic acid in alkaline solution. The product dyes animal fibres yellow shades which may be after-treated with mordants. —F. W. A.

Colouring materials [sulphide dyestuffs]: Method for preparing black—. H. R. Vidal, Asnières, France. Eng. Pat. 105,162. June 26, 1916. (Appl. No. 8988 of 1916.)

BLACK dyestuffs are produced by heating *p*-aminophenol or *p*-amino-*o*- or *m*-cresol with half its weight of resorcinol or *m*-phenylenediamine in the presence of sulphur in such a manner that the vapours produced are condensed and the condensed material flows back into the apparatus. —F. W. A.

Azo dyestuffs: Manufacture of chromium compounds of—containing groups able to be chromated. G. Engi, F. Straub, and A. Grob, Assignors to Soc. Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,221,819. Apr. 10, 1917. Date of appl., July 6, 1916.

Azo dyestuffs containing groups able to combine with chromium are treated with a hot solution of a chromite. —F. W. A.

Dye composition. E. O'N. Macdonald, St. Regis Falls, N.Y. U.S. Pat. 1,222,433. Apr. 10, 1917. Date of appl., Dec. 11, 1916.

A COLOURING matter which dyes wool and silk generally brown shades of good fastness to light and washing, is obtained by extracting the autumnal coloured leaves of a hardwood tree, e.g., brown maple leaves. —F. W. A.

Acyl derivatives of 2.5.7-aminonaphtholsulphonic acid: Production of—. Chem. Fabr. Griesheim-Elektron. Ger. Pat. 295,767. Feb. 5, 1914.

ACYL derivatives of 2.5.7-aminonaphtholsulphonic acid are produced by condensing 2.3-hydroxynaphthoic acid halides, or their *O*-acetyl compounds, with 2.5.7-aminonaphtholsulphonic acid. The products have strong affinity for cotton and silk. 2.3-Hydroxynaphthoyl-2-amino-5-naphthol-7-sulphonic acid gives in alkaline solution the typical yellow colour of the 2.3-hydroxynaphthoic acid arylamino alkali salts. It combines with two molecules of diazo compounds, and is absorbed by cotton from alkaline solutions and by silk from acetic acid solutions. Valuable colours fast to washing are obtained by treating the fabrics with diazo compounds. —F. Sp.

[Azo] dyestuffs: Manufacture of chromium compounds of—. O. Imray, London. From Soc. of Chem. Ind. in Basle, Switzerland. Eng. Pat. 104,045. Mar. 13, 1916. (Appl. No. 3729 of 1916.)

SEE U.S. Pat. 1,221,849 of 1917; preceding.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Marine fibre. D. C. Winterbottom. Dept. of Chem., S. Australia. Bull. No. 4, 1917, pp. 1—36.

MARINE fibre is the resistant skeleton of the leaf sheath of *Posidonia australis*, a sea plant growing in the shallow waters of certain parts of the Australian coast, especially in Spencer's Gulf. The workable beds of fibre attain an average depth of 7 ft., with a yield of about 6 lb. of fibre per cub. yd., and the deposits aggregate approximately 240 sq. miles, with a total estimated yield of

4,600,000 tons. The fibre occurs under a top deposit, 12—18 ins. thick, of living plant; the shallow-draught dredges first clear away this top growth and then collect the commercial fibre for purification. The development work has been conducted by three companies using slightly different methods, and a full description of the development plant in each case is given. The removal of loose impurities (sand, shells, etc.) is effected at sea on the dredge, but in all cases the final cleansing is done on shore, either by crushing and dusting the crude material in the damp or dry state or else, more satisfactorily, by repeated mechanical washings with fresh water. The use of fresh water, however, would be excluded if any large industry were developed and it would be necessary to put on the market a product cleaned with sea water. Much valuable information has been accumulated and the main lines of future development have been determined, but the industry is not yet on a remunerative basis. Marine fibre varies in length of staple from 2 to 8 ins., and the thickness shows extreme variations of 0.02—0.15 mm. It is a brittle fibre and the coarser elements are stiff, like horsehair. It cannot be worked successfully, like jute, on long-fibre combing machinery, but can be carded, though with considerable loss on carding machinery. It can be spun in admixture with jute, and can be batched with the lower grades of wool, for which purpose it is well adapted. Marine fibre has been used for insulation purposes with excellent results and has proved superior to asbestos and charcoal and almost as efficient as wool. For paper making purposes the ultimate fibre would appear to be quite suitable, having a length of 0.02—0.05 in., but the chemical properties of the raw fibre are such that the usual processes of treatment have but little effect. The raw fibre, as might be expected from the conditions of its occurrence, is extraordinarily resistant to rot and chemical hydrolysis; it is a lignocellulose of strongly pronounced type and yields only to the process of chlorination; the percentage of cellulose, 63.6, is relatively low. It is estimated that on an output of 4260 tons per annum, with present methods, the raw dry fibre could be delivered at a European port at a cost of £16 15s. to £19 per ton.—J. F. B.

Paper-yarns in 1916. W. Massot. Z. angew. Chem., 1917, 30, 96—97.

IN recent years the use of paper yarns of 1—5 mm. diam. in the cable industry has largely increased, chiefly as a partial or complete substitute for jute as a packing between the lead sheath and the iron armour of the cables, for which purpose the paper yarns are specially impregnated before spinning. In the coating of lead-sheathed cables with waterproof composition, also, the winding of paper yarn serves as well as the old jute yarn winding, since it adheres better to the lead sheath and blends with the composition to form a perfectly flexible and waterproof covering. Paper yarns spun from parchment paper are used for weaving driving belts for light machines up to about 8 H.P., in widths of 30—155 mm. and thicknesses of 5 and 7.5 mm. The yarns are spun, impregnated, wound on spools, and the fabrics woven from them are stitched together to the required thickness. The effect of treatment with various chemicals has been studied. A solution of aluminium acetate partially neutralised with sodium carbonate imparts a somewhat harsh feel but causes no cohesion of the threads; subsequent treatment in soap solution produces a flexible damp feel and prevents the absorption of water, but does not appreciably improve the strength after immersion in water. Gelatin solution mixed with neutralised aluminium acetate cements some of the threads together and causes a decrease in strength of 17%

but reduces the loss of strength in the wet state. Gelatin mixed with formaldehyde imparts a milder feel and does not cement the threads; in this case the decrease of strength is only 8%, but the loss of strength in the wet state is not reduced to so great an extent. Treatment with 1% tannin solution gives a soft, pliable feel and increases the strength by 49%, and also has a favourable influence on the strength in the wet state. Tannin solution fixed with gelatin gives a hard, string-like feel, increases the strength by 25%, and reduces the loss of strength on wetting to only 15%. Tannin solution fixed with neutralised aluminium acetate gives a strong, elastic feel, the strength is increased by 44%, and the loss of strength in the wet state is 22%. Weaker tannin solutions have a correspondingly weaker effect. Paper yarns come into the market containing a considerable excess of moisture as a residue from the spinning process; this is not necessarily a drawback because the moisture imparts a flexibility favourable to the working up of the yarn into finished goods. The average of a large number of analyses showed a total moisture (natural and excess) of about 38%; the highest value found was 65%. Pinagel (Monatsschr. Text. Ind., 1916, 31, 146) has proposed, as a result of his investigations, that an addition of 14.66% to the dry weight be taken as the basis for the calculation of the commercial weight of paper yarns.—J. F. B.

Methyl alcohol and acetone as by-products of the soda pulp industry. J. C. Lawrence. Met. and Chem. Eng., 1917, 16, 416—417. (See also this J., 1917, 383.)

RINMAN'S process for the distillation of the spent soda liquors with lime is described in its application to esparto liquors. The concentrated black lye is mixed with lime and the mass spread on trays in layers of predetermined thickness. Distillation is carried out in a furnace similar to that employed for the destructive distillation of calcium acetate, the vapours being withdrawn at the coldest part of the furnace and the reaction being assisted by the introduction of superheated steam between the trays so as to sweep the entire length of the retort. The working temperature suitable for maximum yields is 255°—300° C. One of the most interesting products is contained in the "tar." This is esparto wax, which may be separated in a crude state by fractional condensation. A pre-condenser maintained at approximately 200° C. separates the wax from the lighter fractions of the tar; the middle oils are collected in a second condenser at 110° C. and the aqueous vapour containing acetone, alcohol, and ammonia passes through an absorber containing sulphuric acid into the final condenser. The wax is drained and pressed, the ammonium sulphate liquor is evaporated, and the aqueous distillate is rectified, without attempting to separate pure acetone, and sold as "methyl-acetone" or "alcohol-ketone" as a solvent. The following yields are recorded, but on a theoretical basis they should be capable of being increased by 50—75%:—Aqueous distillate, 42.2%; wax and oils, 6.0%; ammonia, 0.3%; residue, 40.7% as black ash only; gas, 10.8%, all calculated on the weight of actual liquor without lime. The spirit content of the aqueous distillate is 5.24%, containing 70% of methyl alcohol and 30% of acetone, ketones, and aldehydes. Of the oily products, 39.2% is condensed at 200° C., as "wax"; 56.5% at 110° C., as "middle oils," and 4.3% passes over as "light oils" with the aqueous distillate.—J. F. B.

Cellulose and chemical industry. Cross. See p. 531.

Action of ozone on organic compounds. [Degradation of sericin by ozone.] Harries and others. See XX.

PATENTS.

Cotton waste; Method of treating — H. S. Landell, Philadelphia, Pa., Assignor to Anglo-American Cotton Products Corporation, New York. U.S. Pat. 1,222,422, Apr. 10, 1917. Date of appl., Sept. 14, 1915.

BOILING caustic soda is circulated through a body of cotton waste; the material is washed and acid is circulated through it. The washed material is subsequently agitated and shredded in the upper portion of a body of water so as to allow the foreign impurities to settle out in the quiescent portion of the water. The sediment is drawn off and the material drained and dried.—J. F. B.

Fabrics and other flexible materials; Impregnating compositions for proofing — L. C. Wooldridge and A. Fox, London. Eng. Pat. 105,137, May 4, 1916. (Appl. No. 6420 of 1916.)

FOR proofing fabrics, e.g., balloon fabrics or wearing apparel, the following composition is employed: pyroxylin, 4 oz., is dissolved in a mixture of 75 fl. oz. of ether and 25 fl. oz. of alcohol. Celluloid, 1½ oz., is added to the solution and when thoroughly dissolved, the mixture is filtered. To the filtrate are added Canada balsam, 13 fl. oz., and castor oil, 9 fl. oz., in which 2 oz. of pure rubber has previously been dissolved.—J. F. B.

Canvas fabrics and the like; Waterproofing and rot-proofing composition for — A. Maltman, Barrhead. Eng. Pat. 104,986, June 21, 1916. (Appl. No. 8724 of 1916.)

A KHAKI-COLOURED proofing composition for canvas fabrics is composed of a mixture of Archangel or other tar, 28 lb., cutch, 7 lb., and cuprammonium solution, 140 galls. The cuprammonium solution contains 1.5% of copper dissolved in ammonia solution of sp. gr. 0.940; the tar, previously mixed with a little strong ammonia solution, is thoroughly incorporated with it in a mixing machine, forming a copper-tar soap, and the cutch then added to develop the colour.

—J. F. B.

Cellulosic materials; Chemical treatment of — M. A. Adam, London. Eng. Pat. 17,846, Dec. 21, 1915.

CELLULOSIC material, e.g., sawdust, wood-waste, or mechanical wood pulp of long fibre, is ground with water to which has been added a hydrolysing acid or bisulphite lye, to form a pulp containing about 90% of water. The pulp is subjected to hydrolysis in a continuous regenerative digester similar to that used for wet carbonising peat, described in Eng. Pat. 17,427 of 1912 (this J., 1913, 1099), the rate of flow through the heating portion of the digester being regulated so that the pulp remains for 30–40 mins. at the predetermined digestion temperature, e.g., 150° C.; the pulp is then caused to transmit a portion of its heat to the incoming fresh material, so that the digested pulp is discharged at a temperature suitable for filtration, e.g., 80–95° C. The liquid is separated from the solid material also in a continuous manner, e.g., by means of an endless travelling web combined with suction-boxes and press-rolls. The process is applicable to the manufacture of chemical wood pulp from ground wood and to the production of alcohol from the hydrolysed material.—J. F. B.

Fibrous material [waste paper]; Process and apparatus for separating — from impurities and recovering the fibres. N. V. Neo-Cellulose Maatschappij, Rotterdam, Holland. Eng. Pat. 104,952, Apr. 25, 1916. (Appl. No. 5938 of 1916.) Under Int. Conv., Apr. 1, 1916.

THE disintegrated fibrous material suspended in liquid is discharged on to the inner surface of a

rotating drum designed to impart a rotational and progressive movement to the material by means of conveyor blades depending from the axis. The feed end of the cylinder may have solid walls, but the remainder is constructed of wire gauze in order to drain away the liquid, and after the material has assumed the form of a rolling coherent mass with progressive movement, sprays of washing liquid are directed on this mass at a high velocity from an axial supply pipe, the liquid percolating away at a low velocity. External sprays are fitted above the upper portion of the drum to keep the meshes clear of deposit.—J. F. B.

Vulcanised fibre [leather substitute]; Treatment of — T. Oye, Christiania, Norway. Eng. Pat. 105,033, Oct. 6, 1916. (Appl. No. 14,234 of 1916.)

PLATES of hard vulcanised fibre, 1–6 mm. thick, are steeped in a solution of zinc chloride (1:5), dried in the air, impregnated with an emulsion of water and oil at 20–50° C. and subsequently with an animal or vegetable oil at a low temperature. The excess of oil is wiped off and the plates dipped in a bath of melted paraffin wax or in a solution of water-glass. The treated plates are flexible and capable of being used as a substitute for sole-leather.—J. F. B.

Pulp digesters; Sampling device for — P. S. Tuttle, Johnsonburg, Pa. U.S. Pat. 1,222,249, Apr. 10, 1917. Date of appl., July 31, 1916.

Fur; Process for treating — W. P. Braun, Brooklyn, N.Y., U.S.A. Eng. Pat. 105,508, Oct. 10, 1916. (Appl. No. 14,408 of 1916.)

SEE U.S. Pat. 1,215,246 of 1917; this J., 1917, 334.

Binder [for briquettes, from sulphite-pulp waste lyes]. U.S. Pat. 1,221,250. See 11A.

Process for pickling metal articles. U.S. Pat. 1,221,735. See X.

Fermentation of sulphite waste liquor. U.S. Pat. 1,221,058. See XVIII.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

PATENTS.

Dyeing yarn in the form of skeins; Machine for — B. E. D. Kilburn, London. From Sulzer Frères Soc. Anon., Winterthur, Switzerland. Eng. Pat. 105,015, Aug. 12, 1916. (Appl. No. 11,423 of 1916.)

IN a machine for dyeing yarn in the form of skeins in small quantities, the yarn reel is not itself eccentrically mounted, but is driven by an eccentric or cam or by means of friction or toothed wheels in such a manner that it is given a periodical movement in a vertical plane without lateral movement and is also rotated first in one direction and then in the other, to ensure all the portions of the yarn skeins being dipped for the same length of time, at a speed which varies continually during each period to prevent the yarn from tangling. The combination of the two motions has for its object a temporary loosening of the skein layers, which results in satisfactory penetration being attained.—F. W. A.

Warp printing machines. J. Zimmermann, Philadelphia, Pa., U.S.A. Eng. Pat. 104,953, Apr. 25, 1916. (Appl. No. 5939 of 1916.)

IN warp printing machines of the type in which the warp threads are situated above the printing rolls, pattern-controlled impression members being pro-

vided for bringing the warp threads into contact with the rolls, the printing rolls are partially submerged in the colouring matter and a device is provided for evenly distributing the colouring matter regardless of any inequality in the surface of the printing rolls.—F. W. A.

Warp threads; Apparatus for washing — after printing. J. Zimmermann, Philadelphia, Pa., U.S.A. Eng. Pat. 105,209, Apr. 25, 1916. (Appl. No. 17,205 of 1916.)

AN apparatus for washing warp threads after printing and/or steaming consists of a number of independent washing pans with intermittently operated means for immersing the threads, consisting of arms normally disposed over the threads and movable into engagement with them, jets for directing a blast of air against the threads, to remove surface water, and a drying chamber. Owing to their course of travel through the pans being constantly changed, thorough washing of the threads is facilitated.—F. W. A.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Sulphuric acid; Application of the Komarowsky reaction as a test of purity of concentrated —. Mitt. aus dem Lab. der Schweiz. Alkoholverwaltung. Chem.-Zeit., 1917, 41, 132.

SULPHURIC acid sold as "pure for analysis" is commonly unsatisfactory for the testing of alcohol for higher alcohols by the Komarowsky reaction on account of the presence of organic matter. It is suggested that this reaction should be applied in selecting acid to be used in laboratories for the testing of wines and spirits, and that acids not giving a negative result should be rejected. The specification of the reaction in Switzerland is as follows:—10 c.c. of spirit is placed in a stoppered flask of 100—150 c.c. capacity, and 1 c.c. of a 1% solution of salicylic aldehyde in purest alcohol and 20 c.c. of pure sulphuric acid are added. The whole is mixed by shaking. Pure reagents give only a light yellow colour. Organic impurities in the acid cause a dark yellow to brown colour and oxides of nitrogen a pink colour. The sulphuric acid can be purified by heating it with 0.2—0.3 gm. potassium bichromate per kilo. of acid.

—H. J. H.

Sulphuric acid; Determination of small amounts of free — in presence of sulphates. E. Vulquin and M. Entat. Ann. Chim. Analyt., 1917, 22, 61—66.

VERY small quantities (0.0004 gm.) of free sulphuric acid can be determined in presence of sulphates, of organic acids, and of inorganic and organic salts, by measuring the fall of potential between a normal calomel electrode and a polarised platinum electrode placed in the solution, at intervals during the neutralisation of the acid with a standardised baryta solution. A curve is plotted co-ordinating the amounts of baryta added with the differences of potential recorded, and the complete neutralisation of the free acid is indicated on the curve by a sudden change of direction. The platinum electrode is sealed in a glass tube filled with mercury and is rotated by means of a small electric motor at the rate of 100—300 revolutions per minute. The calomel electrode is placed in a separate vessel, and communication between the solutions is effected by means of a tube with two rectangular bends filled with starch paste saturated with potassium nitrate. The polarising

current should not exceed 1.2×10^{-4} amp. and the E.M.F. is found by Poggendorff's compensation method with an Ostwald capillary electrometer. As the volume of solution should be as far as possible constant, the solutions should be concentrated, and the baryta added from a 1 c.c. or 5 c.c. burette. Trial determinations on solutions containing 0.0041—0.0073 gm. of free sulphuric acid, and on a solution containing 0.00565 gm. of acid in presence of acetic acid, calcium sulphate, magnesium sulphate, potassium chloride, and potassium nitrate, gave very accurate results.

—E. H. T.

Oxalic acid; Titration of — with alkalis and ammonia in presence of methyl orange. G. Bruhns. Chem.-Zeit., 1917, 41, 189.

OXALIC acid can be determined directly by adding alkali until it is nearly neutral, then introducing at least an equivalent of calcium chloride (or of certain other neutral metallic salts), whereby calcium oxalate is precipitated and hydrochloric acid set free, and finishing the titration in presence of methyl orange. Other organic acids, e.g., tartaric and citric acids, may be determined in a similar way. In the presence of calcium chloride, oxalic acid and ammonia solutions can be titrated directly, loss of ammonia being prevented by adding to the *N/10* solution, a solution of borax containing 35—40 grms. per litre. This method has been used successfully for nine years. Similarly, oxalic acid and borax solutions can be accurately titrated when calcium chloride is added just before the neutral point has been reached. Correct results are also obtainable when oxalic acid solutions are titrated in presence of phenolphthalein, provided that distilled water perfectly free from carbon dioxide be employed. Many years' experience has shown that oxalic acid crystals remain perfectly stable for a very long time. On one occasion very small crystals were maintained for several days in open vessels at 30°—32° C. without any perceptible change in weight.—E. H. T.

Hydrochloroplatinic acid; Preparation of — by means of hydrogen peroxide. P. Rudnick and R. D. Cooke. J. Amer. Chem. Soc., 1917, 39, 633—635.

PLATINUM black, if it has not been ignited, dissolves readily in concentrated hydrochloric acid in the presence of hydrogen peroxide, yielding hydrochloroplatinic acid which is entirely free from nitro-compounds and from hydrochloroplatinous acid, both of which affect its value as a reagent. It is necessary to regulate the addition of the peroxide to avoid frothing.—W. H. P.

Ammonia; Synthesis of —. H. Le Chatelier. Comptes rend., 1917, 164, 588—590.

THE fact that ammonia could be synthesised by heating nitrogen and hydrogen together under pressure was discovered by the author in 1901, but owing to a nearly fatal explosion the investigation was abandoned. Seven years later, the work was resumed by Haber, who brought it to a successful issue. This research (and others) was undertaken with the object of convincing chemists of the great possibilities that would attend the application of thermo-dynamical principles to chemical change, and the possible industrial application of the discovery was covered by a patent (Fr. Pat. 313,950, Sept. 2, 1904) which, however, was allowed to lapse. According to it, ammonia was produced by heating nitrogen and hydrogen, with or without the addition of hydrocarbons, under pressure and to a temperature above a dull red heat, in the presence or absence of spongy platinum or of finely divided iron.—E. H. T.

Bleaching powder; Manufacture of— in chambers or with mechanical apparatus. E. Schütz. *Chem.-Zeit.*, 1917, 41, 137—140.

THE question of the relative merits of absorption chambers and mechanical apparatus has recently been put to the test in many new installations. The only important sources of the chlorine are the electrolytic product which contains about 99% Cl and that derived from the Deacon process which contains an average of 8% by volume of the halogen. The chamber process is the less healthy for the workers, requires rather more labour, and demands much more space than its rival which, in its turn, necessitates a more skilled supervision. For a plant to produce 20 tons (metric) of bleaching power in 24 hours, at least four chambers are required, one-half being filled while the other half is being emptied; for the working of this 6 men and 1 boy are necessary. A mechanical plant of the same capacity would consist of 10 units each composed of 8 superimposed cylinders, and require the labour of 5 men and 1 boy (subsidiary operations, as, e.g., the slaking of the lime, are not included, being the same for both processes). To produce the above yield the chambers would cover an area of at least 2400 sq. m., the mechanical plant about 250 sq. m. The capital cost is probably somewhat in favour of the mechanical method. The modern absorption chamber is made of lead mounted on a wooden framework, after the manner of the sulphuric acid chamber, and is about 7 ft. high. The floor is made of lead covered with flag-stones set in asphalt, the joints being made with a cement of litharge and glycerin. The walls, up to a height of 50 cm., are faced with granite slabs joined together with the same material. The chlorine is introduced through earthenware socket-pipes and where a number of chambers are used, a high chimney must be provided for the exit-gases. With electrolytic chlorine, the passage of the gas into the chamber has to be assisted by a ventilator-fan, made of lead or earthenware and preferably faced with ebonite. The mechanical apparatus is made of cast-iron covered with acid-resisting material. The most common form contains 8 cylinders of such a diameter that a maximum of 2—2.4 tons of product can be obtained in 24 hours. The mechanical means of conveying the lime through the cylinders have been improved, the blades now being made of stronger material and fixed to a four-edged shaft by a kind of bayonet attachment. The cylinders require cleaning out once daily. A satisfactory mechanical method of filling the upper cylinders has yet to be found. It is essential that the chlorine be dry and as free as possible from other gases, particularly from carbon dioxide. Electrolytic chlorine contains much more of the latter than the gas supplied by Deacon's process; its amount must be reduced to a maximum of 2% for the chamber method and must not exceed a few tenths of 1 per cent. for the mechanical plant. The careful adjustment of the ratio of chlorine to air is of the first importance in the mechanical process, and this is not easy when the electrolytic gas is used; in this case the mixed gases may contain from 10—12% of chlorine, and it is advisable to mix the gases in a special mixing chamber. The current of gases passing through the cylinders must be regular and of constant composition, and a second ventilator-fan should be installed between the cylinders and the chimney. Attempts to free the gaseous mixture from water by cooling to 0°C. have not been an economic success, hence it is still dried by contact with 92—93% sulphuric acid in a leaden tower. For a yield of 20 tons per 24 hours, a tower measuring 9—10 × 2 m. is required. The acid is used continuously until its concentration is reduced to 58°—59° B. (sp. gr.

1.67—1.69), and the water-content of the gas is gauged from the temperature in the tower. Moist chlorine is particularly objectionable in the mechanical apparatus as it leads to a rise in temperature and decomposition of the bleaching powder. The lime is slaked in a mechanical apparatus and allowed to cool for several days before it is sifted and used in the plant. It should contain about 5—6% of free water for use in the cylinders, and 1% when destined for the chambers. With efficient working, the waste gases should not contain more than 0.1% of chlorine, and their temperature should not exceed 38°—42°C. When electrolytic chlorine is used, its content of carbon dioxide must be regularly determined, the gasometric method with stannous chloride solution being preferred. The finished product should contain about 40% of available chlorine, thus allowing for a loss of 1% during transit and a loss of 1—1.5% owing to formation of calcium chloride, which is particularly noticeable in the mechanical method. The view is expressed that the mechanical apparatus will in time entirely supersede the absorption chamber.—E. H. T.

Hypochlorite; Conversion of— into chlorate in alkaline solution. F. Förster and P. Dolch. *Deutsche Bunsen-Ges.*, Dec., 1916. *Chem.-Zeit.*, 1917, 41, 10.

AN experimental study of the conversion of sodium hypochlorite into sodium chlorate in alkaline solution showed that two successive reactions are involved:—(1) $2\text{NaClO} = \text{NaClO}_2 + \text{NaCl}$, and (2) $\text{NaClO} + \text{NaClO}_2 = \text{NaCl} + \text{NaClO}_3$. Only a small proportion of chlorite was detected in the solution, but this is accounted for by the relatively high velocity constant of the second reaction, which is 26—35 times that of the first. In acid solution (e.g., with an excess of chlorine) it is supposed that chlorate is formed directly, according to the equation, $\text{NaClO} + 2\text{HClO} = \text{NaClO}_3 + 2\text{HCl}$, which explains the more rapid conversion experienced under these conditions. No chlorite was formed during the electrolytic production of chlorate from pure chloride solution, and added chlorite was quickly converted into chlorate by anodic oxidation.—F. SODN.

Perchlorate; Electrolytic formation of—. E. L. Mack. *J. Phys. Chem.*, 1917, 21, 238—264.

THE formation of perchlorate by the electrolysis of chlorate is generally regarded as a secondary action following the liberation of the chloric acid anion as expressed by the equation:— $2\text{ClO}_2' + \text{H}_2\text{O} = \text{HClO}_4 + \text{HClO}_2$. An alternative theory that the formation of perchlorate arises from the direct addition of oxygen to the chlorate is more in accordance with the following observed phenomena:—Through the operation of over-voltage the potential necessary to separate oxygen in the free condition depends on the material of the anode. With an iron anode, it was found that the formation of perchlorate begins at a potential far below that required for the liberation of oxygen, and nearly as far below that commonly assigned for the discharge of ClO_2' . The high efficiency in the formation of perchlorate when a strong neutral chlorate solution is electrolysed with a platinum anode is due to the high concentration of atomic oxygen which follows from the high overvoltage. On lowering the current density, the efficiency falls in proportion to the diminution of the overvoltage. If the temperature is raised the current efficiency decreases markedly, which is in accordance with the view that the concentration of active oxygen present at the anode is dependent on the state of the reaction, $2\text{O}_1 = \text{O}_2$, which increases in velocity with increased temperature. It was also found that the inhibiting effect of high temperature

can be overcome by an increase in the current density. With an alkaline solution, the current efficiency falls off rapidly owing to the discharge potential for oxygen on platinum being lower in alkaline than in acid solutions, thus leading to a lower concentration of active oxygen. On starting the electrolysis both the potential of the anode and the efficiency are somewhat below their normal values, which would be expected from the fact that the measurements of anodic overvoltage indicate a low concentration of active oxygen during the first few moments of oxygen discharge. The decrease in anodic efficiency on substituting an anode of platinised platinum for one of polished platinum agrees with the view that at a given current density, the concentration of active oxygen at a platinised anode is less than with the smooth metal. In general, any factor which tends to lower the concentration of active oxygen at the electrode affects unfavourably the formation of perchlorate. The oxidation of chlorate to perchlorate can be brought about chemically by heating the solid with silver oxide or to a small degree in aqueous solution by persulphuric acid, ozone, hydrogen peroxide in acid solution, and by oxygen which has been activated by ultra-violet light, thus supporting the view that the electrochemical formation of perchlorate is the result of direct oxidation.—J. N. P.

Potash salts, original liquors, and end liquors: The bromine contents of German —. L. W. Winkler. *Z. angew. Chem.*, 1917, **30**, 95–96.

THE German potash liquors contain considerable quantities of bromine, amounting to 7.492 grms. for Stassfurt, 5.398 for Mecklenburg, and 3.691 for Hainleite, per litre in original liquors of approximately 1.3 sp. gr. The end-liquors from Stassfurt contain 3.850 grms., mother-liquors from Alsace sylvinite 4.907, and end-liquors from Sondershausen 2.865 grms. per litre. The percentages of bromine in the commercial potash salts show considerable variations: bischofite and tachhydrite from Vienenburg are the richest, with 0.467% and 0.438% respectively; carnallite shows 0.143–0.356%, sylvinite 0.117–0.300%, and sylvinite 0.085–0.331%; "Hartsalz" contains only 0.027–0.052%, and langbeinite only 0.016%. Br.—J. F. B.

Sodium sulphite: Effect of various substances on the photochemical oxidation of solutions of —. J. H. Mathews and M. E. Weeks. *J. Amer. Chem. Soc.*, 1917, **39**, 635–646.

THE authors have studied the phenomenon of negative catalysis, using ultra-violet light from a quartz mercury-vapour lamp. In their apparatus the reaction was rapid, a 0.2 N solution of sodium sulphite being completely oxidised in three hours. All the organic substances used as catalysts had an inhibiting effect, that of urea, however, being very slight. The most marked effects were obtained with pyridine (5 c.c. per litre), benzaldehyde (5 drops per litre), and quinine sulphate (0.001 N), while methyl and ethyl acetates (5 c.c. per litre), phenol (0.001 N), quinol (0.001 N), and sucrose (0.025 N) were less effective. The effect produced by glycerol (5 drops per litre) was only small, although this substance is a powerful inhibitor of the oxidation in ordinary light. Copper sulphate, which is a powerful positive catalyst in ordinary light, is practically without effect in ultra violet light.—W. H. P.

Lead: Attempt to separate the isotopic forms of — by fractional crystallisation. T. W. Richards and N. F. Hall. *J. Amer. Chem. Soc.*, 1917, **39**, 531–541.

ABOUT 1 kilo. of radioactive lead from Australian carnotite, which, from measurements of the β -ray

activity, was inferred to contain about one part of ordinary lead to 3 of radium G, and an amount of radium D of the order of 10^{-7} part, was converted into the nitrate and repeatedly crystallised from aqueous solution. After a thousand fractionations, samples were taken from the most soluble and least soluble fractions respectively, carefully purified, and used for determinations of the atomic weight of the lead. The average atomic weights obtained for lead from opposite ends of the fractionation were 206.422 and 206.409 respectively, or a difference of only 6 parts in 100,000. On the assumption that the atomic weights of radium G and lead are 206.0 and 207.2, it follows that no change in the relative concentration of the isotopes greater than 1.1% had been effected by 900 crystallisations. The change in the relative concentration of radium D produced by the fractionations was also within the same limits.—J. N. P.

Supplies of Sicilian sulphur. See page 523.

Action of magnesium on aqueous solutions. Getman. See X.

Potassium persulphate as a reagent in organic chemistry. Datta and Sen. See XX.

New applications of thymolphthalein and naphtholphthalein, including rapid methods for analysing limestone and ammonium salts. Moir. See XXIII.

Differential iodimetry. II. Titration of chromic acid in the presence of ferric iron, and analysis of chromite. Barnebey. *III. Determination of the available oxygen in soluble and precipitated oxidised forms of manganese.* Barnebey and Hawes. See XXIII.

PATENTS.

Hydrochloric acid; Manufacture of —. J. B. Garner and H. D. Clayton, Pittsburgh, Pa., Assignors to Metals Research Co., New York. U.S. Pat. 1,220,411, Mar. 27, 1917. Date of appl., Mar. 4, 1915.

A MIXTURE of moist hydrogen and chlorine, in the volumetric ratio of about 50:35, is heated to a temperature not below 340° C. in the presence of wood charcoal, and the hydrogen chloride produced is absorbed in water.—E. H. T.

Sulphuric acid; Manufacture of —. W. J. Kee, jun., Kansas City, Kans., and U. Wedge, Ardmore, Pa. U.S. Pat. 1,220,752, Mar. 27, 1917. Date of appl., Aug. 8, 1914.

IN the manufacture of sulphuric acid by the chamber process, the mixed sulphur dioxide and oxygen are exposed to an electric discharge after leaving the Glover tower and before entering the lead chamber, or at other points between the Glover and Gay-Lussac towers. By subjecting the nitrogen oxides as they are formed at the temperature of the electric arc to sulphuric acid at a temperature suitable for their absorption, their reversion to nitrogen and oxygen is prevented.—E. H. T.

Ammonia; Manufacture of —. A. Classen, Aachen, Germany. Eng. Pat. 14,055, Oct. 4, 1915.

NITROGEN and hydrogen are subjected to the simultaneous action of silent and spark electric discharges in presence of catalysts, e.g., metals and metallic alloys, supported on carriers of an acidic nature. Silica, prepared from water-glass, is well suited for this purpose, as it readily adsorbs colloidal metals such as gold, platinum, metals of the platinum and iron groups, as well as their alloys. The efficiency of the catalyst is improved by the presence of a protective colloid, e.g., gelatose. The mixed gases are passed over the catalyst between two electrodes, one being a good

conductor, like copper, and the other a bad conductor, like glass or porcelain. The latter may be immersed in cold water and may concentrically surround the former, the contact material being in the intervening space. The temperature may range from 25° C. to 90° C. according to the conditions, and the pressure may be normal or increased.—E. H. T.

Sulphate of ammonia; Method of, and apparatus for, producing —. Riter-Conley Manufacturing Co., Leedsdale, Pa., U.S.A., Assignees of H. A. Carpenter, Sewickley, Pa., U.S.A. Eng. Pat. 104,155, Mar. 17, 1916. (Appl. No. 4000 of 1916.) Under Int. Conv., Feb. 15, 1916.

COAL gas is passed into a saturator containing sulphuric acid kept at uniform temperature, volume, and concentration, and as it emerges its heat is utilised to control the temperature of the incoming gas. The separated sulphate, as it is withdrawn, is washed by meeting a counter-current of water, which is then used to maintain the volume of the liquid in the saturator. The sulphate is removed by an endless bucket conveyor mounted on a rotating support and adapted to remove material from different parts of the accumulation. Connected with the saturator is a second vessel provided with a pump by means of which acid is forced into the first vessel below the liquid surface, and the acid is kept in circulation; the strong acid required to maintain the acidity of the bath is supplied to this auxiliary vessel. By means of electrical and mechanical devices the movements of a float or hydrometer in the auxiliary vessel are made to control the supply of water and of strong acid and thus ensure the level and the acidity of the liquid in the saturator remaining constant.—E. H. T.

Ammonium chloride; Preparation of —. H. Precht, Hanover, Ger. Pat. 295,509, June 23, 1915.

AMMONIUM magnesium chloride or magnesium chloride is decomposed in aqueous solution with an excess of ammonia, the precipitated magnesium hydroxide filtered off, and the filtrate again treated with ammonia, the operations of filtering and introducing ammonia into the filtrate being repeated until a sufficient yield of ammonium chloride is obtained. With magnesium chloride, 70-80% is decomposed after the second precipitation. The double salt may also be decomposed by treating with a large excess of ammonia in a closed apparatus, under pressure.—F. SODN.

Nitric oxide; Production of — in internal combustion engines. E. C. R. Marks, London, From E. Wuest, Saarbrücken, Germany. Eng. Pat. 104,734, Mar. 15, 1916. (Appl. No. 3878 of 1916.)

THE conditions of chemical efficiency in the internal combustion engine are very different from those determining thermal efficiency. The rapidity of combustion of the gases is accelerated by preheating them, and the higher the temperature of the charge the more rapid the fall of temperature afterwards. The mixed oxygen and nitrogen are agitated energetically during compression by passing a jet of gas, steam, or air at high velocity, and preferably under pressure, into the combustion chamber; and the residual gases are eliminated quickly by a current of warm or cold air.—E. H. T.

Aluminium carbide; Art of producing —. M. Barnett and L. Burgess, New York. U.S. Pat. 1,219,797, Mar. 20, 1917. Date of appl., Dec. 18, 1916.

ALUMINA and carbon are heated together in an electric furnace to a temperature below that of the electric arc but not below 2000° C. The

amount of carbon used is in excess of that required to reduce the alumina to metal, e.g., 1 part of carbon to 2 parts of alumina.—E. H. T.

Silicides and borides of tungsten; Manufacture of —. E. Wedekind, Strassburg, and J. Pintsch A.-G., Berlin. Ger. Pat. 295,547, Nov. 23, 1913. Addition to Ger. Pat. 294,267 of 1913 (this J., 1916, 1156).

THE components are compressed into rods and subjected to electrical resistance heating in a vacuum. The rods may be held in the furnace between clips which are connected with a source of current at not less than 100-130 volts. The resistance of the rods, at first fairly high, suddenly falls, and the reaction sets in with incandescence.—F. SODN.

Air; Process and apparatus for liquefying atmospheric — and separating it into its constituents, oxygen and nitrogen. J. F. Place, Glen Ridge, N.J., U.S.A. Eng. Pat. 105,106, Mar. 29, 1916. (Appl. No. 4633 of 1916.)

TWO portions of the air are compressed to different degrees, one to a pressure much higher than its critical pressure and the other substantially to its critical pressure. The air at the higher tension is then cooled in accordance with the Joule-Thomson formula, by reducing its pressure in successive steps through a throttled valve, the liquefied air, as produced, being caused to descend by gravity through and in rectifying contact with an ascending column of cold gaseous air, from some external source. The heat of compression, the carbon dioxide, and most of the moisture must be removed from the compressed air before the release of pressure takes place, and the expanded air is then employed to cool and liquefy the other portion of air compressed to a lower degree. A pressure of 200 atmospheres is employed for the high tension air, and one of 40 atmospheres for the remaining air.—J. B. C. K.

[Sulphuric acid] chambers; Density-regulator for the atomising of water under pressure and of steam in lead —. L. Santa, Turin, Italy. U.S. Pat. 1,221,913, Apr. 10, 1917. Date of appl., Aug. 21, 1913.

SEE Fr. Pat. 461,641 of 1913; this J., 1914, 199.

Alkaline haloids; Electrolysis of —. K. Ochs, Charlottenburg, Assignor to Siemens und Halske A.-G., Berlin, Germany. U.S. Pat. 1,222,239, Apr. 10, 1917. Date of appl., Aug. 26, 1913.

SEE Eng. Pat. 18,102 of 1913; this J., 1914, 23.

Evaporating process and apparatus. U.S. Pat. 1,222,340. See I.

Manufacture of hydrogen or a mixture of hydrogen and carbon monoxide. Eng. Pat. 16,932. See 11A.

Manufacture of carbon black and hydrogen. U.S. Pat. 1,220,391. See XIII.

VIII.—GLASS; CERAMICS.

Fireclays; Do — contain halloysite or clayite? J. W. Mellor. Trans. Ceram. Soc., 1916-17, 16, 73-84.

A CRITICISM of a hypothesis by Le Chatelier in 1887 and by J. W. Gregory and D. P. McDonald in 1910 that sedimentary clays and particularly Glenboig fireclays contain amorphous halloysite. The author gives the heating curves of crystalline kaolinite, fireclay, halloysite, silicic acid, allophane, and pyrophyllite and shows that halloysite and

kaolinite are readily distinguishable by this means, as halloysite has no critical point at 500° C. The heating curve of halloysite is not characteristic, since allophane and several other hydrated alumina-silica minerals (which are probably mixtures of colloidal alumina and colloidal silica) give similar curves. It is concluded that the dominant mineral in Glenboig fireclay is clayite—a colloidal form of kaolinite. The same is true of Stourbridge, Lancashire, and most other fireclays and also of Devon and Dorset ball clays, though in ball clays there is also evidence of some kaolinite.

—A. B. S.

Fireclay and similar articles; New process of manufacturing — B. J. Allen. Trans. Ceram. Soc., 1916—17, 16, 134—157.

CASTING large or thick-walled articles made of fireclay has not hitherto been wholly satisfactory. If the slip is poured into a mould with two plaster faces, the centre of the casting is seldom solid, whilst if a liner of cast clay is fixed in a mould and the final form is cast around it, a laminated structure is produced. These objections are overcome by surrounding a simple one-face plaster mould with an iron case and removing the air between the mould and casing. This enables the filtering power of the mould to be increased to an almost unlimited extent, and a deposit of clay of any reasonable thickness can be obtained. The deposit is homogeneous, without any hard skin and soft core; it is in closer contact with the mould than when no suction is used, and the danger of collapse is eliminated, as the low pressure may be maintained until the article is hard and self-supporting. When one part of the article is required to be thicker than another, the space between the case and the mould is increased and *vice versa*. Illustrations and brief descriptions of this method of casting large vessels, glass-house pots—both open and covered—chemical ware, condensing worms, and insulators are given. "Electro-deposition" of flint, clay, plumbago, etc., is suggested for making tubes. The material, made into a slip with a little caustic soda, is allowed to flow through a mould encased in type metal and with a brass rod running through its centre. An electric current is then passed through the slip, using the case and rod as electrodes. The material is deposited and water flows away. A combination of the two preceding processes suitable for the production of plumbago crucibles and muffles, carborundum articles, etc., is also described. In using this, to make two-necked jars, the metal case surrounding the mould forms one electrode and the other is formed by a suspended, perforated metal tube inserted through each neck. The mould is kept full of slip and on passing the current, the suspended material migrates to the case and the water accumulates around the suspended tubes and may be siphoned off through insulated pipes which are used to carry the current to the suspended electrodes. When the deposit is sufficiently thick, the remainder of the slip is siphoned off, and a vacuum is created between the mould and the outer case, to extract the remaining liquid. The density of the deposit may be increased by employing a higher voltage. The reversal of the current may be used to release the material from the mould. When a dense slip is used, the plaster mould and vacuum are unnecessary and a simple metal mould will suffice.—A. B. S.

Furnace linings [for the iron and steel industry]; Acid and basic — J. E. Foster. Trans. Ceram. Soc., 1916—17, 16, 24—39.

REFRACTORY materials are used in constructing blast furnaces, puddling furnaces, cupolas, Bessemer (acid) converters, basic converters, open hearth, electric, and crucible furnaces. The bricks and

blocks used for such purposes should be infusible at 1400° C., becoming hard and dense, but somewhat porous; they should resist chemical reagents, show only a small change in volume at 1100° C., and be unaffected by temperature changes. *Fireclay furnace bricks* are made of a mixture of lean and plastic clay and grog, which is ground, tempered, and then ground wet in a pan-mill. The clay is shaped by hand in wooden or iron moulds or in hand-presses, or it may be pressed hydraulically. The bricks are partially dried by steam or hot air and are then re-pressed. When fully dried, they are burned up to cones 14—16 (1410°—1460° C.), about a week being required. *Silicious furnace bricks* are made of ganister, quartz, flint, and quartzite (sandstone), with or without a proportion of old bricks and a bond of milk of lime, fireclay, or iron oxide. The materials are ground and tempered in a wet pan-mill and are shaped in iron or wooden moulds or in a power-driven press. The bricks are dried and then burned in round kilns up to 1400°—1600° C., from 7 to 10 days being required. The cooling must be slow above 700° C. or the bricks will crack. *Magnesia furnace bricks* are made of selected, calcined magnesite which is ground to 0.1 in. and treated in a similar manner to silica, though the burning temperature reaches cone 18—30 (1500°—1670° C.). *Chrome bricks* are made of low-grade chromite. They cannot safely be used above 1500° C. on account of disintegration. They are used chiefly as a buffer between magnesia bricks and the bottom of the furnace. The ore is crushed in a stone-breaker, then ground in an edge-runner and finally in a tube-mill, the bond being added previous to the final milling. The bricks are made in power-driven presses, dried, and burned in chamber kilns at cone 12 (1350° C.). They swell if burned too rapidly. A classification of furnace bricks according to their refractoriness, porosity, tensile strength, and resistance to crushing and to slag is suggested.

—A. B. S.

[Pottery] frits; Effect of water on — during wet grinding. J. W. Mellor. Trans. Ceram. Soc., 1916—17, 16, 67—68.

WHEN a certain alkali-lime-boric frit was heated in the usual manner, it developed blisters. These were found to be due to 5.41% of water which entered into combination on grinding the frit in a wet state. When dry ground, this frit gave no trouble. B. Moore had previously noticed this phenomenon with other frits containing alkali.

—A. B. S.

[Lime-] earthenware; Manufacture of cheap — A. Teichfeld. Trans. Ceram. Soc., 1916—17, 16, 1—15.

THE author describes the manufacture of earthenware containing lime in Russian Poland and South Western Russia, and suggests its production in England as a means of meeting German competition in the cheaper kinds of pottery. The earthenware is made of Vistula sand 11—42 parts, Kieff kaolin 27 parts, Donetz ball clay 27—56 parts, and a very pure limestone from S.W. Poland 6 parts. Part of the Russian ball clay may be replaced by a silicious ball clay from Meissen; this prevents crazing. To the ball clays, a little soda and a large quantity of water are added, and the mixture is blunged and then passed through an 80's lawn. The sand and limestone are ground in a tube-mill for 16 hours and all the materials are then mixed. The resulting slip is passed through a 120's lawn and an electro-magnetic machine and is then used for casting, or it is flocculated by the addition of calcium chloride solution. The articles are shaped in the ordinary manner and are burned in saggers in down-draught ovens to about cone 3a (1140° C.)

in 15–18 hours. The biscuit ware is then dipped in a plumbiferous borocalcite glaze corresponding to the formula: $(\text{PbO } 0.342, \text{CaO } 0.378, \text{Na}_2\text{O } 0.135, \text{K}_2\text{O } 0.145) \text{Al}_2\text{O}_3 \text{ } 0.218 (\text{SiO}_2 \text{ } 2.68, \text{B}_2\text{O}_3 \text{ } 0.28)$. Of this glaze, 48% is in the form of a frit. The glaze is fired at cone 1a (1100 °C.) in 12–15 hrs. The finished ware is about 10% lighter than English earthenware and is cheaper to produce.—A. B. S.

Porcelain; Electrical — L. E. Barringer. Met. and Chem. Eng., 1917, 16, 433–436.

PORCELAIN has superseded other materials for the insulation of overhead lines and purposes where high weather-resistant insulation is required. It has a high dielectric strength, and a $\frac{1}{4}$ in. thickness will usually not puncture under 70,000 volts, or a $\frac{1}{2}$ in. thickness under 100,000 volts. The dielectric strength begins to fall at 100° C., and at 300° C. the insulation is very poor. Electrical porcelain has sp. gr. 2.4 and coefficient of expansion 0.000004 per 1° C.; the crushing strength averages 20,000 lb. per sq. in. and the tensile strength 900–1800. Porcelain, however, is deficient in toughness and does not withstand sudden shock or impact or even vibration. There is also little or no resistance to sudden changes of temperature; it has no flexibility and cannot be used in moving elements subject to bending or torsional strain. There is also the drawback that metal parts cannot be embedded or moulded into place on account of the necessity for firing. The materials used for the manufacture of electrical porcelain are china clay, ball clay, feldspar, and silica. The clays possess the advantage of plasticity, but when used alone, a porous mass or "body" is obtained unless the firing heat is so excessive that fusion or distortion occurs. Feldspar is used as a flux to give a dense vitrified body at a moderate temperature, and flint as a stabiliser to extend the vitrifying range and to prevent distortion within a narrow temperature range. Between 600° and 900° C. the clay loses its combined water; at about 1200° C. the feldspar fuses and the clay begins to dissociate with formation of sillimanite; at a higher temperature the quartz is slowly attacked and finally dissolved in the feldspar at 1400° C. The ware is classified according to the dry or wet processes. Dry process porcelain is formed in steel dies and is used for low-voltage insulation, being more porous and of lower dielectric strength than the wet process ware; dry process porcelain will absorb 1% of water when immersed, whereas the wet process porcelain absorbs only 0.25%. The process of drying and burning electrical porcelain is much the same as for any other type of porcelain, but the old bottle-shaped potters' kiln is uneconomical. A continuous kiln is described which saves about 50% of the fuel-cost. It consists of a straight tunnel, 197 ft. long, with fixed firing zone somewhat nearer the discharge end than the entrance. The ware is placed on cars and moved through the firing zone to the cooling end. At the firing zone there are grates on either side. The combustion chamber is separated from the main tunnel by a narrow wall and the gases are passed through tuyères before entering the main tunnel. Air for combustion is preheated by passing through holes at the discharge end and coming in contact with the cars of goods cooling off. Just before reaching the firing zone part of the air is deflected beneath the grates and another part is directed into the main tunnel at the firing zone to complete the combustion of the gases from the fire-boxes; it then passes on towards the entrance to heat the incoming cars. The firing temperature is 1300°–1400° C. and the temperature at the chimney only 200°–220° C.

—J. F. B.

Discolorations in the manufacture of pottery and bricks. B. Moore and J. W. Mellor. Trans. Ceram. Soc., 1916–17, 16, 58–66.

THE work of Seger, Sosman and Merwin, Brongniart, Jackson and Hopwood, Orton and others is reviewed, and the reddening of buff and white bodies is attributed to the formation of free ferric oxide, alumina, and silica on heating clays. At a later stage in the burning, these oxides dissolve in the molten fluxes forming bluish-grey or pale green colours under reducing conditions and pale yellow under oxidising ones. The red discoloration is attributed to free ferric oxide. The discoloration known as *la maladie jaune* or *jaune de cuisson* in hard porcelain is produced by oxidising conditions in the first stages of burning, followed later by reducing ones. Some of the ferric compounds are reduced to ferrous oxide which readily fluxes; at the same time there is an increase in the volume of the gases formed when hydrocarbon gases act as reducing agents, and the ware is thereby blistered. Blue and brown discolorations in bone china are probably due to the formation of ferrous phosphate by reducing gases, as a result of deficiency of alkalis in the body, and by carbon in the bone ash. A brown discoloration may also be caused by the action of chlorides on iron compounds in the body resulting in the formation of the vapour of ferric chloride, which is later converted into red ferric oxide.—A. B. S.

Dressler tunnel oven and its application to the heat treatment of [pottery and] steel. C. Dressler. Trans. Ceram. Soc., 1916–17, 16, 171–188.

IN the Dressler oven the weight of coal used is only 6% of that of clay goods burned at 1000° C., and 8% when burning at 1200° C.; these are the best results achieved industrially in burning clay products. In annealing steel at 850°–1000° C., the metal must be heated without being oxidised. In a modification of the Dressler kiln, this is accomplished by making the structure air-tight, with double, air-tight doors at each end, and filling it with an inert gas. All air required for the combustion of the gas is passed through two tubes fixed longitudinally in the cooling part of the kiln. A small amount of air enters the kiln with each car, but the oxygen in it is not sufficient to do any appreciable harm to the steel. It is claimed that both for clay products and steel, this kiln is economical in fuel and working charges, and that the temperature and atmosphere in it are under complete and easy control. (See also this J., 1916, 539.)—A. B. S.

Firing temperature of a [pottery] body; Possibility of determining the — from the microscopic appearance. J. W. Mellor. Trans. Ceram. Soc., 1916–17, 16, 71–72.

A CRITICISM of Technol. Paper 80 of U.S. Bureau of Standards (this J., 1916, 1220) in which A. Klein claims that (i) it is possible to estimate the burning temperature of porcelain bodies from the way in which sillimanite crystals are developed, and (ii) that the time of burning is less important than the temperature. According to Klein, needles of sillimanite are formed in pottery bodies only to a very slight extent between 1250° and 1275° C. and not at all at lower temperatures, whilst they are formed in abundance only at temperatures above 1300° C. It is now pointed out that Heath and Mellor showed in 1907 (this J., 1909, 474) that sillimanite crystals can develop abundantly in bodies which have never reached 1200° C. The facts indicate that by extending the time of firing similar results can be obtained as at a higher temperature when the time is abbreviated. Moreover, sillimanite crystals develop more freely in certain mixtures than in others, and this fact still further invalidates Klein's claim.—A. B. S.

Temperature measurements in clay works practice. J. W. Cobb. Trans. Ceram. Soc., 1916—17, 16, 118—120.

For temperatures between 50° and 450° C., a mercury thermometer filled with nitrogen under pressure may be used. For 450°—1400° C., a thermo-couple of platinum and platinum-rhodium with recorder is recommended. For temperatures above 1400° C., a Fery radiation pyrometer or an optical pyrometer depending on the brightness of a lamp filament altering with varying resistance should be used. To control heating where the effect of time, temperature, and kiln atmosphere have all to be indicated, Watkin's recorders, Seger cones, Holdcroft thermoscopes, Wedgwood's pyrometer, and Buller's rings are used. Seger cones are usually too small for works use, being fragile, difficult to see when in use, and liable to be unduly affected by accidental heat waves. They are preferably replaced by a larger wedge made of the same material, the top of the wedge being half the size of the bottom.—A. B. S.

Properties of the refractory materials used in the iron and steel industry. Johns. See page 528.

PATENTS.

Glass working machines. British Thomson-Houston Co., Ltd., London. From General Electric Co., Schenectady, N.Y., U.S.A. Eng. Pat. 105,285, June 15, 1916. (Appl. No. 8453 of 1916.) (See also Eng. Pat. 17,602 of 1913; this J., 1914, 831.)

AN apparatus for drawing glass rod and tubing comprises a receptacle containing molten glass, with a number of gripping devices which travel up and down above the container and draw the molten glass into rod. An adjustable chilling device, arranged near the working level of the glass, comprises a hollow ring, on which a cylindrical shield is supported, on the inner surface of which, and communicating with the ring, a cooling pipe is closely coiled. The gripping devices automatically lower the chilling arrangement as the working level of the glass descends. Cutters are mounted in the path of the grippers and actuated by them to cut the rod into sections, and mechanism is arranged in the path of the grippers to receive these sections when the grippers are released, and a sprocket and chain mechanism, engaged by the grippers, causes one complete to-and-fro movement of the delivery mechanism to deliver sections to a depository.—W. C. H.

[Clay] articles; Process for drying — and apparatus for accomplishing the same. F. A. Second. Assignor to A. P. Paterson and C. H. Peters, St. John, New Brunswick. U.S. Pat. 1,221,383, Apr. 3, 1917. Date of appl., Nov. 17, 1915.

CLAY articles are placed in a closed casing, through which currents of air, having a temperature artificially reduced to about 39.2° F. (4° C.), are circulated until the temperature of the clay is thus artificially reduced. The temperature of the currents of air is then substantially raised, and the circulation of these in the casing continued, whereby moisture is removed from the surface of the clay and from the casing.—W. C. H.

Clay pots or crucibles; Method of making —. H. K. Hitchcock, Tarentum, Pa. U.S. Pat. 1,221,450, Apr. 3, 1917. Date of appl., July 28, 1913.

THE method consists in enclosing a shaped, hollow, moist blank within an air-tight, impervious mould, with its entire outer surface in contact with the mould, and subjecting the hollow inner surface of the blank to a partial vacuum, whereby it is freed from air bubbles, or occluded gas, and excess moisture. The entire inner surface of the blank is then subjected to uniform yielding pressure to compact it equally

throughout, and the blank allowed to remain under pressure until it becomes homogeneous.

—W. C. H.

Grinding and cutting wheels and analogous contrivances; Grinding surfaces of —. W. W. Jenkins, Torquay. Eng. Pat. 105,296, July 14, 1916. (Appl. No. 9932 of 1916.)

THE grinding and abrading surface of grinding wheels is composed of the following ingredients, by weight: 16 parts of fine carborundum, 1 part of coarse carborundum, 1 part of steel "crystals" or "grits" (angular fragments of a specially hard steel), all intimately mixed and bound together with 6 parts of shellac or the like.—W. C. H.

IX.—BUILDING MATERIALS.

Magnesite bricks; Spalling of —. J. W. Mellor. Trans. Ceram. Soc., 1916—17, 16, 85—100.

FITZGERALD (this J., 1912, 337) has stated that the spalling of magnesite bricks is due to their great shrinkage (accompanied by a corresponding increase in the specific gravity) when heated. Lightly calcined or α -magnesia has a sp. gr. of 3.2 or 3.3, but the crystalline or fully shrunk β -magnesia has a sp. gr. of 3.65; that of the natural mineral (periclase) is 3.5—3.75. Some powdered commercial magnesite bricks had a sp. gr. of 3.44, and assuming the maximum to be 3.7, such bricks correspond to a mixture of 40.5% of the dense magnesia and 59.5% of the unconverted form, and may contract 7%. Bricks with a sufficiently high sp. gr. do not spall, as the change in volume on further heating is too small to set up serious strains. The speed of conversion from α - into β -magnesia at 1300° C. is relatively slow, but is more rapid at higher temperatures, though different types of magnesite each have their specific rate of conversion. To prevent spalling, the material must not merely be heated to a suitable temperature; it must be maintained at that temperature until a sufficient amount of conversion has occurred. Spalling is attributed to (i) shrinkage caused by conversion of α - into β -magnesia, (ii) shrinkage caused by the closing of the pores in highly porous bricks. Bricks which are not sufficiently porous will probably crack or "dunt" with abrupt changes in temperature. The remedies for spalling are to heat the bricks sufficiently long to secure sufficient β -magnesia being formed, and to keep the porosity of the bricks reasonably low.—A. B. S.

Zirconia; Use of — as a refractory material. J. A. Audley. Trans. Ceram. Soc., 1916—17, 16, 121—133.

A BRIEF outline of the occurrence, properties, and uses of zirconia, is given. Baddeleyite (82—94% ZrO_2) from Brazil is the chief source of zirconia, but zircon ($ZrSiO_4$) from monazite sand, etc., is sometimes used. Zirconia has a hardness of 6.5, sp. gr. 4.4—6, grey colour, light yellow streak, very low electrical and thermal conductivity, and high melting point (nearly 2000° C.). It can be melted in an electric furnace (360 amps., 70 volts). It is insoluble in acids, except hydrofluoric acid, and resists fused cyanides and alkalis, but is easily attacked by fusion with potassium bisulphate and fluorides. Bricks made of crude baddeleyite bonded with clay will resist a temperature of 1650° C., if previously burned to a higher temperature; otherwise they crack. Superior bricks are made by extracting the iron oxide from the crude ore with dilute sulphuric or hydrochloric acid. The use of zirconia for muffles, retorts, and tubes was patented by Pyhal in 1904 and for crucibles by the Heraeus Co. in 1906. More recently it has been used for lamp filaments and for lining electric furnaces. Several more recent German patents are mentioned, as is also the work of Podszus (this J., 1917, 217). Ruff and Lauschie

(this J., 1917, 85) found that marketed zirconia articles usually contain so much clay or silica that they cannot be used owing to softening at 1800° C. or to their porosity being above 15%. Beryllia, alumina, thoria, and yttria are suitable bonds if not more than 1% is used; silica and magnesia are less satisfactory on account of their volatilisation at 2000° C. Crucibles made of calcined zirconia with one of the foregoing bonds acquire a crystalline structure at 2200° C., but keep their shape at 2400° C. unless the heating is irregular. They are more compact and harder than clay crucibles, but zirconium carbides form and they cannot be used more than three times. Crucibles made of raw zirconia blistered below 2000° C. and were excessively porous. Well-made crucibles lose weight by reduction of zirconia to lower oxides and formation of carbides, by volatilisation of added oxides, and sublimation of the zirconia. They fall to pieces on prolonged heating at 2200° C. owing to change of texture and formation of oxidation and reduction products; the use of 6% of alumina prevents this.—A. B. S.

Destruction of concrete by gas liquor. Ott. See IIA.

Acid and basic furnace linings [for the iron and steel industry]. Foster. See VIII.

PATENTS.

Cement or composition; Bituminous — and method of making the same. R. Illema, Glasgow. Eng. Pat. 105,202, Oct. 12, 1916. (Appl. No. 14,484 of 1916.)

ABOUT 3 parts by weight of clay is mixed with 3 parts of water and added to 5 parts of bitumen or pitch which has been rendered fluid by heat. The mixture is thoroughly stirred until emulsified, the heat applied being kept low enough to avoid evaporating the moisture from the mixture. The finished moist and plastic composition can be rendered fluid, without the aid of heat, merely by the addition of water.—W. C. H.

Cement [; Refractory —]. F. W. Sperr, jun., and R. J. Montgomery. Assignors to H. Koppers Co., Pittsburgh, Pa. U.S. Pat. 1,221,618, Apr. 3, 1917. Date of appl., Mar. 7, 1916.

THE cement mixture is composed of approximately 25% of fireclay, 35% of silica, 35% of silica bats, and 5% of felspar.—W. C. H.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Chromium; Determination of — in ferro-chromium, steel, and slags by the permanganate method. P. Koch. Chem.-Zeit., 1917, 41, 61.

FROM 0.2 to 0.3 gm. of the finely divided material is weighed into a porcelain crucible, 1 gm. of sodium peroxide added, and the mixture fused by heating carefully with a small flame, or on a sand bath, so as to avoid too high a temperature. When cold, the product is extracted in a beaker with a litre of boiling water, which is then boiled for a further half hour to decompose the hydrogen peroxide. The solution is acidified with sulphuric acid to dissolve the ferric oxide and a measured excess of ferrous sulphate solution is added, when the yellow colour of the chromic acid changes to that of green chromium sulphate, and the excess of ferrous sulphate is titrated with permanganate solution. The end point, which is indicated by the disappearance of the green colour due to ferrous salt, is best observed by diluting the solution with water to 2 litres. The red colour of the permanganate is masked by the complementary colour of the chromium salt. The titration of all chromium solutions requires to be conducted rapidly. The analysis of chromium alloys by

liberation of iodine by chromic acid and titration with thiosulphate gives an erroneously high value for the chromium through the presence of other compounds which liberate iodine. If the fusion with sodium peroxide is made in a nickel crucible, the solution must be freed from particles of nickel and nickel oxide by filtration before acidifying. An alternative method, applicable to the estimation of chromium in steels, consists in dissolving 1 gm. of the metal in dilute sulphuric acid, oxidising with saturated potassium permanganate solution until the red colour of the latter persists on continued boiling, adding 10 to 20 c.c. of manganese sulphate solution, filtering from the separated manganese dioxide, and then adding standard ferrous sulphate solution and titrating with potassium permanganate. With slags containing manganese, 3 to 5 grms. is well mixed with 20 to 40 grms. of sodium peroxide and heated in a crucible of nickel, iron, or copper until disintegration of the slag is complete, the product is extracted with hot water, boiled, and the residue containing manganese dioxide and the oxides of silicon and iron is filtered off. The small quantity of manganese which is held in solution as manganate and permanganate is decomposed as before by boiling the acidified solution with a few c.c. of manganese sulphide, and the solution is filtered, and the chromium estimated by adding ferrous sulphate and titrating back with potassium permanganate or N/10 potassium chromate or bichromate.—J. N. P.

Galvanised iron; Stripping and analysis of —. G. W. Heise and A. Clemente. Philippine J. Sci., 1916, 11, 135—146.

THE separation of zinc from galvanised iron for the purpose of analysis and recovery of the metal, was examined by taking samples cut from a sheet which analysis had shown to be approximately uniform in composition, and immersing in a reagent for definite intervals or until no further loss in weight occurred. With acetic acid, cadmium nitrate, ammoniacal copper sulphate, cobalt acetate, and chromium nitrate, the action was very slow, whilst with lead acetate, either alone or in presence of acetic acid or sodium hydroxide, with cobalt acetate or nitrate in presence of ammonia, with sodium bisulphate (concentrated), and with boiling sodium peroxide, the reaction was rapid and gave a quantitative separation of the zinc from the iron. Good results were also obtained with 2% sulphuric acid solution containing a little arsenic trioxide, which has an inhibitive effect on the solution of the iron, with phosphoric acid (25% by vol.), and with hydrochloric acid (sp. gr. 1.19). In these cases removal of the zinc is characterised by an effervescence which ceases entirely when the iron of the base is reached. Phosphoric acid reacts slowly, but the stripped iron can be left immersed for a long time without appreciable loss. With hydrochloric acid the loss in weight was less than 0.002 gm. after 30 minutes' additional immersion. The experiments with metallic salts gave an indication of the changes in the potential of zinc and iron which occur in different liquids and, together with the character of the metallic deposit, which in some cases is crystalline and adherent, and in others loose and spongy, determine the progress of the solution. The separation of zinc by using the sample as anode in alkaline or acid solutions is sufficiently complete and clean-cut to serve as a rapid and accurate method of analysis. The solutions used were saturated potassium chlorate or nitrate, 30% sodium nitrate, 20% chromium nitrate, or 20% potassium or sodium hydroxide. With a voltage of 3 and a current density of 15—25 amps. per sq. dm. the zinc was completely removed in a few minutes. Except with an electrolyte of chromium nitrate,

there was no noticeable action on the iron base on continued passage of the current. Though the presence of iron could always be shown in the solution after the zinc had been removed, the constancy of the results recorded for the thickness of the coating, and the constancy of the amount of iron removed in the different trials, indicated that the metal was derived from the layer of zinc-iron alloy formed when iron is galvanised by the hot process. The separation of zinc from galvanised iron was also brought about satisfactorily by arranging a plate 3.8 cm. square as cathode in a sulphuric acid solution (20% by vol.) and passing a current of 0.75 to 1.7 amp. Iron from the surface alloy was dissolved but no metal from the iron base, and the separation was complete in a few minutes.—J. N. P.

Galvanised iron; Testing of — J. C. Witt. Philippine J. Sci., 1916, 11, 147—165.

AN examination was made of the different methods which have been introduced for the estimation of zinc on galvanised iron. On account of the non-uniformity of the coating, which was found to lead to variations amounting to 12.3% in the thickness of the coating on different parts of a plate, it was found desirable that estimations should be made with samples at least 15 cm. \times 15 cm. square. The use of sodium hydroxide as a solvent for the zinc is unsatisfactory. The method in most general use measures the time necessary for removal of the zinc by immersion in neutral copper sulphate solution, but has the disadvantage that the zinc does not dissolve at a constant rate since the coating is not homogeneous and the zinc-iron alloys in the lower layers are less electro-positive than the pure zinc. A misleading result is thus given by the fact that alloyed iron diminishes the rate of solution of the zinc in the copper sulphate, but increases its rate of corrosion when exposed to the atmosphere. The zinc layer can be removed by means of neutral lead acetate, but in order to remove the alloy layers, it is necessary to use a large excess of the lead salt. More uniform and complete removal of the zinc is obtained by hydrochloric acid solution, preferably of a concentration of 19.5% acid (sp. gr. 1.098 at 15° C.). The temperature should not exceed 45° C. during the reaction. The plate is immersed until effervescence ceases, then washed, dried, and weighed. Comparative estimations showed that the amount of iron dissolved by the hydrochloric acid solution was constant in different determinations and slightly greater than that removed by lead acetate solution, on account of incomplete solution of the zinc-iron alloys with the latter solvent. On treating galvanised sheets with a solution of hydrochloric acid (10.5%) it was found that during the first minute the amount of iron which passed into solution was 0.65% of the total metal dissolved and could be accounted for by the initial contamination of the molten zinc used for galvanising. After 3 mins. 91.2% of the total zinc and 24.2% of the total alloyed iron was dissolved. During the next 3 mins. 8.22% more of the zinc and 65.38% more of the iron dissolved. During the following 4 mins. only 0.53% of the zinc and 10.42% of the iron was dissolved. The large increase in the ratio of iron to zinc dissolved in the later stages would indicate that in addition to alloys like FeZn₃ and FeZn₇, there may be a series high in iron and low in zinc such as Fe₂Zn and Fe₁₁Zn. During the dissolving of the outer coating of almost pure zinc, the curve showing the relation of the rate of solution with time is nearly a straight line which bends very sharply when the layer of alloy is reached. An estimation of the duration of this first period and the amount of iron dissolved gives a measure of the purity of the outside coating of zinc and the thickness of the layer, which are the two factors determining the capacity of the sheet to withstand corrosion.—J. N. P.

Galvanised-iron roofing in the Philippines. A. S. Argüelles. Philip. J. Sci., 1916, 11, 177—181.

THE greater durability of old in comparison to modern galvanised iron sheets was found to be due to the increased thickness of the zinc coating with the former. A minimum of 2.5 oz. of zinc per square foot is necessary for satisfactory service in the Philippines. The amount of lead found in the zinc, which was in all cases below 1%, was approximately the same in old and modern sheets, and probably insufficient to affect adversely the durability. Small amounts of chlorides derived from the fluxes used in the hot bath were in all cases found in the metal. The iron dissolved by 3% sulphuric acid, assumed to represent the iron alloyed with zinc, bore approximately the same ratio to the total zinc in both old and modern sheets. The advanced corrosion of sheets newly arrived or after being kept in storage in the Philippines, is attributed to the influence of moisture either through actual contact with water or through the presence of damp air.—J. N. P.

Tin plate; Detinning and analysis of — G. W. Heise and A. Clemente. Philipp. J. Sci., 1916, 11, 191—199.

AN investigation was made of the different methods of analysing tinned iron plates. By dissolving the tin in hydrochloric acid and titrating with iodine, a mean value of 0.089 oz. of tin per sq. foot of surface was obtained. By the method of repeated immersion in boiling sodium peroxide solution, followed by acidifying with sulphuric acid, a higher average value of 0.105 oz. per sq. foot was obtained, the difference representing the amount of iron removed with the tin. That this iron was part of the alloy and not due to attack on the base was shown by the fact that there was no further loss in weight on subsequent treatment with sodium peroxide. The most rapid and accurate method of determination was found to consist in arranging a section of tin plate, 5 cm. \times 5 cm. square, as anode in a 30% sodium nitrate solution and electrolysis with a current of 0.7 amp. The tin is completely removed within 10 mins., and the iron of the alloy is left in the bath and can be readily determined by recovering as ferric hydroxide, while the iron of the base is left unattacked. An average value of 0.105 oz. tin per sq. foot was obtained by this method. Accurate results are also obtained by the use of lead acetate in presence of sodium or potassium hydroxide, when the tin is rapidly dissolved and lead deposited in a spongy condition. After immersion for 5 mins., the average value found was 0.098 oz. tin per sq. foot, and after 3 days, 0.105 oz. Lead nitrate in neutral or acetic acid solution has no action on tin plate. Chromium, aluminium, and copper salts in presence of alkali have a similar solvent action on tin, though the solution is slower and less complete than with sodium plumbite. Concentrated nitric acid will remove tin without attacking the iron base. Estimates of the iron present as alloy in the tin coatings in the samples analysed gave a value of about 15% of the weight of tin.—J. N. P.

Zinc extraction; Physical-chemical conditions of metallurgical — Bodenstein. Deutsche Bunsen-Ges., Dec., 1916. Chem.-Zeit., 1917, 41, 9.

DETERMINATIONS of the equilibrium pressure attained in the decomposition of zinc oxide by carbon (both in the form of ignited wood charcoal and of Acheson graphite) at temperatures ranging from 596° to 795° C. showed that equilibrium was established very slowly, and the main equilibrium is complicated by the presence of carbon dioxide and of zinc as a liquid phase. Even at atmospheric pressure the reaction may be made to yield zinc in the liquid state, but the reaction velocity is too small to admit of technical application.—F. SODN.

Antimony; Methods of recovering—from its ores by volatilisation processes. J. A. DeCew. Canadian Soc. Civil Eng., Mar. 15, 1917. Met. and Chem. Eng., 1917, 16, 441.

IN the manufacture of antimony trioxide from sulphide ores by the combustion process, the gases passing from the zone of combustion to the condensing chamber slowly deposit the antimony oxide in the form of white fume. The problem of obtaining complete combustion of the ore presents many difficulties, since satisfactory conditions exist only in a limited part of the furnace and difficulty may arise through fusion or through distillation of unoxidised ore. In practice a large excess of air, about five times the theoretical quantity, has to be employed. This is when treating an ore averaging 10% of metal and when 4% of coke is mixed with the ore; the coke however, could be more advantageously applied to heating the air supply. With a stack furnace relatively deep and not too large in diameter, good results may be obtained; the area should increase with the depth so that in case of fusion the ore would not be held up by the side walls. The condensation of the white fume is a difficult operation; antimony trioxide boils at 1550° C. but is molten at a red heat, so that any oxide which separates above 750° C. appears as liquid particles, solidifying to a dense mass more difficult to reduce to metal than the snow-like deposits formed at lower temperatures. The particles of fume condensing below the fusion point are so minute that they exhibit Brownian movement, exert osmotic pressure, resist the effect of gravity, and possess properties analogous to those of colloidal particles in an aqueous medium. Each particle is surrounded by a layer of air or gas and shows electro-repulsion due to similar electric charges, so that when the oxide finally settles the density of the powder is extremely low. The volume of air being very large, a very large condensing area is necessary to reduce the velocity of the gases sufficiently to allow the oxide to settle. Every effort must be made to cool the gases as rapidly as possible, but the use of water sprays or scrubbers is of little value, as the particles tend to repel water and are wetted only with difficulty; moreover antimony trioxide which has been wetted and dried has a lower market value than the dry condensed fume. In view of the conditions above stated, there is a demand for some system of condensation and settling other than by gravity, and attention is drawn to the possibility of separating the minute solid particles from the moving gases by the application of centrifugal force, which has been employed at an intensity of 40,000 times that of gravity for the separation of colloidal solutions (see this J., 1917, 375). An apparatus is illustrated which has been designed for the application of the Cottrell system of high voltage electric discharge to the separation of the trioxide fume, and there is every reason to expect an improved recovery and a more densely packed product by this treatment. If arsenic be present in the ore, a portion of the arsenious oxide enters into combination with the antimony oxide to form an antimonate and cannot be extracted by washing with caustic alkali. The antimonate is decomposed by heating to a high temperature and a process of fractional distillation of the oxides might successfully be employed. A furnace for the reduction of antimony oxide to metal is illustrated. The question of the effect of the presence of arsenic in the metal is discussed; the two elements are so closely allied that for many requirements they serve the same purpose. Alloys of antimony and arsenic are more brittle than pure antimony but when used for hardening other metals they are equivalent. Antimony containing 2–3% of arsenic cannot be purified by distillation of the latter in absence of air, because the pressure

of diffusion is just about sufficient to counteract the pressure of the arsenic vapour. When fused in presence of air the antimony is burned off at about the same rate as the arsenic. One of the chief uses for antimony trioxide is in the manufacture of enamel ware; the tetroxide is useless for this, owing to its infusibility; the commercial product is tested for its solubility in acids as a measure of its fusibility and freedom from tetroxide. The presence of small quantities of arsenious oxide would appear to be non-detrimental and increases the fusibility and ease of working.—J. F. B.

Babbitt metal; Analysis of— J. C. Witt. Philippine J. Sci., 1916, 11, 169–175.

IN the analysis of anti-friction alloys containing Pb 50 to 90%, Sb 10–15%, Sn 0–5%, and Cu 0–1%, the estimation of antimony and tin is made by heating in an Erlenmeyer flask 0.2–1 gm. of the alloy with strong sulphuric acid until thoroughly decomposed. After cooling, water and hydrochloric acid are added and the solution is boiled to expel all the sulphur dioxide. Antimony is then estimated by titrating rapidly with standardised potassium permanganate. Tin is estimated by adding 1 gm. of steel turnings to the hydrochloric acid solution, and, after excluding air by maintaining an atmosphere of carbon dioxide, the solution is boiled until all the steel is dissolved, when, after quickly cooling, while still excluding air, starch solution is added and the solution titrated with N/10 iodine. Lead is estimated by dissolving the alloy in nitric acid, adding excess of sulphuric acid, allowing the lead sulphate precipitate to settle, filtering, and washing with sulphuric acid solution, dissolving in hot ammonium acetate solution, and titrating with standardised ammonium molybdate, using tannic acid as an outside indicator. The solution must be almost boiling at the beginning of the titration to ensure complete precipitation of the lead. Copper, which is present in these alloys only in small amounts, is estimated colorimetrically with ammonia, using as a standard of comparison, a babbitt alloy of known copper content. Iron may be determined as ferric oxide in the filtrate from the lead sulphate after removing any remaining lead with hydrogen sulphide, and zinc may be determined in the filtrate from the iron.—J. N. P.

Magnesium; Action of—on aqueous solutions. F. H. Getman. J. Amer. Chem. Soc., 1917, 39, 596–601.

MAGNESIUM, in the form of wire containing 99.6% Mg, or powder as obtained by distillation *in vacuo*, was added to a N/10 solution of potassium chloride which formed the electrolyte of a cell containing, as one pole, a standard calomel electrode, and as the second electrode, platinum surrounded by an atmosphere of hydrogen. The E.M.F. of this element is determined by the concentration of hydrogen ions, and with carefully purified materials was initially 0.33 volt. On the introduction of magnesium, the formation of hydroxyl ions following from the reaction, $\text{Mg} + 2\text{H}_2\text{O} \rightarrow \text{Mg}(\text{OH})_2 + \text{H}_2$, caused a proportionate decrease of the hydrogen ions, and the resulting change of potential gave a measure of the extent of the reaction and enabled its progress with time to be observed. A comparison of magnesium wire with the purer distilled metal showed a larger initial reduction of the hydrogen ions with the latter in accordance with the greater surface exposed, though with time the E.M.F. in the two cases tended to approach the same limiting value, indicating that the small amount of impurity present in the magnesium wire did not exert any appreciable influence on the reaction between the metal and the saline solution. A

comparison of the curves showing the change of the E.M.F. with time was made with the volume of hydrogen evolved on exposure of magnesium to a number of different salt solutions for measured intervals. With the exception of ammonium chloride, which gave an abnormally large evolution of hydrogen and hydrogen ion concentration through the slight hydrolysis of the salt in aqueous solution, the salts of univalent and divalent metals gave curves for the E.M.F. of similar form but, in each case, with differences in both the initial E.M.F., indicating the concentration of the hydrogen ions before adding the magnesium, and in the limiting values reached after an interval of about 80 minutes. With an electrolyte of ammonium chloride, variable E.M.F.'s were first obtained through liberation of some ammonia by the current of hydrogen, leaving the solution acid. It was accordingly found necessary first to pass the hydrogen through wash-bottles containing a solution of this salt so as to establish equilibrium with the displaced ammonia before admitting to the electrode. With an acid electrolyte, or a salt like aluminium chloride which yields free acid, complete neutralisation by the magnesium was attained after a few hours, and thereafter the curve followed the normal course. With alkaline electrolytes, including those in which alkali was formed by hydrolysis of salts of weak acids, such as sodium carbonate and tetraborate, a marked depression of the hydrogen ion concentration was obtained, but no change occurred with time nor with the introduction of magnesium. With non-electrolytes such as sucrose, mannitol, and urea, the concentration of the hydrogen ions was depressed by magnesium to nearly the same extent as with solutions of many of the neutral salts, yet the volume of hydrogen evolved was hardly greater than when magnesium is immersed in pure water alone, thus indicating that the accelerating influence of a dissolved salt on the reaction between magnesium and water is to be ascribed to a catalytic influence of the ions of the salt rather than of the non-ionised molecules. —J. N. P.

Properties of the refractory materials used in the iron and steel industry. Johns. See page 528.

Penetration of the burdening effect in chromium- and copper-steels. Grenet. See page 530.

Steel ingot defects. Kilby. See page 530.

Cementation [of iron] by gas under pressure. Langenberg. See page 530.

Case-hardening of iron by boron. Tschischewsky. See page 531.

Determination of the line SE in the iron-carbon diagram. Tschischewsky and Schulgin. See page 531.

Influence of surface tension upon the properties of metals, especially iron and steel. Thompson. See page 531.

Notes on some [steel] quenching experiments. Fry. See page 531.

Manufacture of filiform [tungsten] crystals (crystal-line wire for incandescence lamps). Böttger. See 11B.

Acid and basic furnace linings [for the iron and steel industry]. Foster. See VIII.

Dressler tunnel oven and its application to the heat treatment of [pottery and] steel. Dressler. See VIII.

Protective colloids. Cydonia [quince] seed as protective colloid. Colloidal silver, gold, mercury, and platinum. Gutbier and Wagner. See XX.

Differential iodimetry. II. Titration of chromic acid in the presence of ferric iron, and analysis of chromite. Barnebey. III. *Determination of the available oxygen in soluble and precipitated oxidised forms of manganese.* Barnebey and Hawes. See XXIII.

PATENTS.

Ferrophosphorus: Process of making — J. J. Gray, jun., Rockdale, Tenn. U.S. Pat. 1,220,416. Mar. 27, 1917. Date of appl. Dec. 28, 1916.

A CHARGE of iron ore, phosphate rock, fluxing materials, and carbon is heated in a blast furnace, the lower part of which is maintained at above 2000° F. (about 1090° C.), and the upper zone at not above 700° F. (390° C.). At the higher temperature the phosphate is reduced by the free carbon, and the liberated phosphorus reduces the iron ore as it descends through the furnace, and combines with the iron. To prevent the occurrence of a "dirty hearth," the furnace is charged at intervals with ferruginous material, phosphate rock, silica, and an excess of carbon. When this is smelted, a charge of iron ore, basic material, and carbon is immediately added. —E. H. T.

Ferromanganese: Manufacture of — in the blast furnace, using manganese ores rich in oxygen. F. Lange, Essen-Bredney. Ger. Pat. 295,549. Nov. 27, 1915.

THE finely powdered ore, which may be mixed with finely powdered coal and limestone, is blown into the furnace through the tuyères. Wear and tear due to excessive heat in the upper part of the furnace is thereby prevented, and the high oxygen content of the ore is utilised in the fusion zone, whilst the proportion of carbon dioxide in the exit gases is reduced. —F. SODN.

Crucible furnaces. F. S. Wigley, Birmingham. Eng. Pat. 105,116. May 25 and Dec. 13, 1916. (Appl. Nos. 7434 and 17,882 of 1916.)

A CRUCIBLE furnace has a firebar frame so fixed into the brickwork as to allow an up-draught of air around it, and also an auxiliary frame, which supports the firebrick lining and forms lateral air inlet openings above the firebars. The upper surface of the firebar frame is narrow and has rounded edges to prevent coke from resting immediately underneath the auxiliary frame. The latter is cast with supporting blocks projecting downwards, while the firebar frame is cast with similar blocks on its upper surface, to maintain the auxiliary frame at the proper height above the firebar frame. —W. R. S.

Furnace-hearth: Method of making — J. H. Gray, New York. U.S. Pat. 1,220,839. Mar. 27, 1917. Date of appl. Jan. 23, 1914.

A FURNACE hearth is made of magnesite or the like by heating the material *in situ* in the furnace to a temperature at which it becomes electrically conducting, and then forming an electric arc from an electrode to the material so that it is heated to a pasty condition, when it can be moulded to the desired shape. —W. F. F.

[Ore roasting] furnace. W. W. Whitton, Oakland, Cal. U.S. Pat. 1,222,251. Apr. 10, 1917. Date of appl. June 21, 1916.

THE heating chamber of the furnace contains vertical retort tubes, each traversed by a central perforated pipe. The upper ends of the retorts are held in a frame with rectangular openings, by means of plates forming a closure around each retort. An ore bin surrounds the upper open ends of the retorts, to permit a continuous delivery of ore. A receiving plate is mounted a certain distance below the lower open ends of the retorts, where the roasted ore is removed without disturbing the perforated pipes. The latter are connected to a condenser below the receiving plate. —W. R. S.

Brass borings, turnings, and the like; Separation and extraction of dust and iron from—W. Sowden, Leeds, Eng. Pat. 105,171, July 21, 1916. (Appl. No. 10,275 of 1916.)

THE apparatus comprises a hopper connected by a rotating worm conveyor with a separating chamber in which an upward air blast separates the dust from the heavier material; the chamber contains reciprocating electro-magnets, each of which when in its inner position attracts the particles of iron, and when in its outer position is demagnetised so that the iron drops into a discharge shoot. The magnets may be disposed in opposite pairs, the reciprocating movement of which is controlled from a main shaft which also drives the feed worm shaft.—W. R. S.

Speller; Condenser for redistilling—J. G. Granberg, Beckemeyer, Ill. U.S. Pat. 1,221,015, Apr. 3, 1917. Date of appl., Dec. 8, 1916.

THE end of the earthenware receiver, which makes close contact with the retort, is provided with a bridge which closes the lower part of the opening. To prevent leakage at the junction of the retort and receiver, the end of the condenser is flanged inwards. The closed end of the receiver is provided with an opening, fitted with an earthenware plug, for the purpose of withdrawing the charge.—J. N. P.

Zinc; Chemical primer for—J. H. Gravell, Philadelphia, Pa. U.S. Pat. 1,221,016, Apr. 3, 1917. Date of appl., July 22, 1916.

A MIXTURE used for producing a coating on zinc consists of nitric acid and phosphoric acid dissolved in a solvent, e.g., water, which itself has no action on the metal.—J. N. P.

Metals; Production of—of improved quality [in a combined blast- and electric-furnace]—H. M. Chance, Philadelphia, Pa. U.S. Pat. 1,221,139, Apr. 3, 1917. Date of appl., June 12, 1916.

THE ore is mixed with the necessary fuel and fluxes and charged into a blast furnace where a preliminary smelting is effected by means of an air blast. After separation of the metal and slag has occurred, further heating is effected by the passage of an electric current, which is admitted by pole pieces connected respectively with the slag and with the molten metal.—J. N. P.

Metal-plating [galvanising]; Method of—E. L. Watrous, Des Moines, Iowa, Assignor to E. L. Watrous Galvanizing Co. U.S. Pat. 1,221,397, Apr. 3, 1917. Date of appl., May 3, 1909. Renewed Feb. 26, 1917.

SMALL iron articles are placed loosely in a receptacle having perforated sides, which is then immersed in a bath of molten zinc and allowed to remain until the zinc alloys with the surface metal. The receptacle is then transferred to a rotary support and subjected to centrifugal action while maintaining a uniform temperature, so as to throw off the excess of zinc and produce a smooth, uniform coating.—J. N. P.

Metals; Cleaning—and preventing them from corroding—J. H. Gravell, Philadelphia, Pa. U.S. Pat. (A) 1,221,141 and (B) 1,221,142, Apr. 3, 1917. Dates of appl., Nov. 15, and Dec. 26, 1916.

STEEL is cleaned and prevented from rusting by treating it with an aqueous solution of calcium phosphate and (A) sulphuric acid or (B) sodium bisulphate, so as to form calcium hydrogen phosphate; manganese dioxide may also be added to the solution.—J. N. P.

Metal articles; Process for pickling—A. F. Hoffman and W. M. Parkin, Pittsburgh, Pa. U.S. Pat. 1,221,735, Apr. 3, 1917. Date of appl., Dec. 5, 1916.

THE articles are immersed in an acid bath to which is added a small quantity of waste sulphite liquor, which has been freed from sulphites by precipitating with a basic calcium compound and filtering off the precipitate.—W. R. S.

Alloy—H. S. Cooper, Assignor to The Cooper Co., Cleveland, Ohio. U.S. Pat. 1,221,769, Apr. 3, 1917. Date of appl., Oct. 30, 1916.

A SELF-HARDENING alloy for cutting tools consists mainly of nickel, or nickel and cobalt, together with from 2 to 10% zirconium, and with a "small amount" (not more than 35%) of one or more of the metals of the chromium group.—J. N. P.

Alloys; Process of producing—I. Ladoff, Wilkinsburg, Pa., Assignor to W. D. Edmonds, Boonville, N.Y. U.S. Pat. 1,221,873, Apr. 10, 1917. Date of appl., Oct. 12, 1915.

THE oxides of the constituent metals of the desired alloy are mixed with an oxygen compound, the reduction temperature of which is lower than that of one of the oxides, and the charge is then subjected in a reducing atmosphere to a temperature below the melting points of the metals, but sufficiently high and maintained sufficiently long to bring about the reduction of the oxides. An oxygen compound of arsenic is specified as suitable for carrying out the reaction.—J. B. C. K.

Alloys; Method of making—I. Ladoff, Wilkinsburg, Pa., Assignor to W. D. Edmonds, Boonville, N.Y. U.S. Pat. 1,221,874, Apr. 10, 1917. Date of appl., Feb. 25, 1916.

OXIDES of tungsten, chromium, and vanadium are mixed with a ferro-metal or its oxide in the proportions necessary to produce a ferro-alloy containing not less than 50% of alloying metals, and the mass is then heated and reduced to the metallic state at a temperature below that of the melting points of the respective metals. The reduced mass is then melted in a molten bath of another ferro-metal, to obtain a high-speed tool-steel.—J. B. C. K.

Aluminium-soldering compound—C. A. Stewart, Carson City, Nev. U.S. Pat. 1,222,158, Apr. 10, 1917. Date of appl., May 13, 1916.

THE solder contains tin 69.07, lead 28.77, zinc 1.41, and silver 0.72%.—W. R. S.

Sintering fine oxide ore and metallurgical products; Process for—H. Bittmann, Frankfurt, Germany, Assignor to Dwight and Lloyd Sintering Co., New York. U.S. Pat. 1,221,962, Apr. 10, 1917. Date of appl., July 16, 1914.

AIR is passed in an upward direction through a layer of ignited carbonaceous fuel to bring it to a state of active combustion, and a layer of the ore or other material under treatment is then deposited on the fuel layer, the passage of air being continued. By the action of the heat and the carbon oxides generated by the combustion of the fuel, the oxide particles in the ore layer are caused to agglomerate, thin, coherent, sintered masses, suitable for blast-furnace treatment, being produced.

Ores; Process of desulphurising—H. F. Wierum, Upper Montclair, N.J., Assignor to The Sulphur Syndicate, Ltd., London. U.S. Pat. 1,222,252, Apr. 10, 1917. Date of appl., Sept. 15, 1913. Renewed Sept. 15, 1916.

PYRRHOTITE or other sulphide ores or mattes are powdered and mixed with carbonaceous fuel; the mixture is heated, while being agitated, to 700°–900° C. by a direct flame, in presence of sufficient steam to decompose any carbon oxy-

sulphide formed, the sulphur distilling in the free state. The treatment is continued until all the fuel has burned away.—W. R. S.

Briquetting metal-cuttings; Method of and means for—Campbells and Hunter, Ltd., and C. Korte, Leeds. Eng. Pat. 105,245, Jan. 3, 1916. (Appl. No. 1 of 1916.)

Furnaces; Tilting—S. W. Price, London. Eng. Pat. 105,381, Apr. 7, 1916. (Appl. No. 5139 of 1916.)

XI.—ELECTRO-CHEMISTRY.

Conversion of hypochlorite into chlorate in alkaline solution. Forster and Dolch. See VII.

Electrolytic formation of perchlorate Mack. See VII.

New process of manufacturing fireclay and similar articles. Allen. See VIII.

Electrical porcelain. Barringer. See VIII.

PATENTS.

Method and apparatus for fractionating hydrocarbons. U.S. Pat. 1,222,402. See IIa.

Manufacture of ammonia. Eng. Pat. 14,055. See VII.

Manufacture of silicides and borides of tungsten. Ger. Pat. 295,547. See VII.

Apparatus for electrically sterilising foods. Eng. Pat. 101,804. See XIXa.

XII.—FATS; OILS; WAXES.

Petroleum soaps; Determination of free alkali in—K. Charitschkov, Nephthanoje Djelo, 1916, No. 13. Chem.-Zeit., 1917, 41, Rep., 102.

THE aqueous solution of the soap is treated with copper sulphate or ferrous ammonium sulphate, the naphthenic acid salt dissolved in petroleum spirit, and the residue of iron oxide or copper oxide determined, and calculated into the corresponding amount of free alkali. The method is also suitable for the examination of soaps in general. —C. A. M.

Oxidation of lignite gas oils and of similar substances by ozone. Harries and others. See IIa.

The Duclaux method for determination of volatile fatty acids. Upson and others. See XX.

The Duclaux method for volatile fatty acids. Lamb. See XX.

PATENTS.

Fatty oils; Treatment of residues obtained in refining—E. I. du Pont de Nemours and Co., Wilmington, Del., U.S.A., Assignees of J. Stewart, Philadelphia, U.S.A. Eng. Pat. 101,959, Mar. 25, 1916. (Appl. No. 4435 of 1916.) Under Int. Conv., Oct. 27, 1915.

THE residues or "foots" obtained in refining oils with alkali are treated with an acid salt such as sodium bisulphate or a solution of an acid salt such as nitre cake. The addition promotes the separation of the aqueous layer, and the separated oil is of lighter colour.—C. A. M.

Manufacture of a non-saponifiable unsaturated hydrocarbon oil from a drying oil. U.S. Pat. 1,220,820. See XIII.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Colophony; Ammonium soaps of—L. Paul, Seifenfabr., 1916, 36, 545—546, 567—569. J. Chem. Soc., 1917, 112, i., 214—216. (See this J., 1915, 1062; 1916, 478.)

AN alcoholic solution of colophony solidifies to a stiff jelly when poured into dilute ammonia. Larger quantities of the jelly are conveniently prepared by grinding γ -pinic acid with distilled water and treatment with ammonia in excess. The ammonium soap thus prepared greatly resembles the γ -sodium resin soap. Both form additive compounds with petroleum (compare this J., 1915, 1153). Aqueous solutions of both resin soaps can be boiled without decomposition; on the other hand, decomposition is always observed with the γ -ammonium soap if this has been prepared with relatively little ammonia. If a concentrated alcoholic solution of colophony is poured into very dilute aqueous ammonia, a solution is obtained which deposits some resinous matter on boiling, and forms a milky emulsion, from which unchanged γ -pinic acid, m. pt. 74°—76° C., is obtained by filtration or by treatment with hydrochloric acid. α -Pinic acid, m. pt. 101°—103° C., is formed by addition of hydrochloric acid to the filtrate. Similar precipitates, m. pt. about 98° C., are obtained when preserved colophony powder ("KS") is treated with ammonia. γ -Pinic acid ("KS"-acid) does not invariably melt at 76° C., but often between 85° and 88° C. A resin acid, m. pt. 85°—87° C., is obtained from the calcium salts contained in the filtrate from the precipitation of γ -sodium resin soap by water containing calcium as well as by decomposition of the non-gelatinised ammonium soap. Further, γ -pinic acid, m. pt. 85°—87° C., is obtained from γ -sodium resin soap by means of ether. The higher m. pt. is attributed to the entrance of calcium into the resin and its non-removal by hydrochloric acid. A transparent piece of colophony yields the sodium resin soap with sodium hydroxide, from which γ -pinic acid, m. pt. 75°—76.5° C., can be separated. If the latter is washed with much conductivity water the m. pt. rises to 85°—87° C. Further, a substance, m. pt. 85°—87° C., was obtained in the investigation of a two and a-half years old specimen of γ -pinic acid, which, in contrast to the former substance, was soluble in water. γ -Pinic acid gradually becomes transformed into α -pinic acid. Similarly, in the course of time, α -pinic acid is converted into β -pinic acid, m. pt. 122°—123° C. The autoxidation of colophony is to be compared with the conversion of α -pinic acid into the β -compound. This is shown not only by the crumbling of colophony to powder (consisting chiefly of β -pinic acid), but also by the fact that α -pinic acid, m. pt. 100°—105° C., passes within a short period into the β -compound. The α - and β -acids can be separated by the ammonia method, since the ammonium salt of the α -acid is readily decomposed, whilst the β compound shows little or no instability. γ -Pinic acid, the m. pt. of which had risen from 74°—77° C. to above 100° C. during two and a-half years, was stirred with water and ammonia, when a separation of γ -ammonium resin soap was not observed. Before being boiled, the solution deposited considerable quantities (18 grms. from 35 grms.) of a plastic mass (Kpl), m. pt. 95°—98° C. The filtrate was treated with hydrochloric acid and the precipitate dissolved in conductivity water. Hydrochloric acid precipitated β -pinic acid, m. pt. about 120° C., from the extracts, so that the substance directly precipitated with ammonia is to be regarded as fairly pure β -pinic acid. Colophony is similarly decomposed with separation of "Kpl." In the "Kpl.-substance" a resinous matter intermediate between α - and γ -pinic acids is present (in addition to α -acid),

which possibly represents the first product of transformation. Colophony which had been treated with nitric acid showed the same decomposition when treated with ammonia and boiled: the filtrate also contained β -pinic acid, the latter being characterised by its solubility in water and the formation of fluorescent, resin-like solutions. Colophony is changed in a few hours by nitric acid in the same manner as by exposure to air for years. This transformation of colophony is attributed to the action of colloidal contained water. On the other hand, colophony can decompose owing to loss of water. Whereas sylvic acid is formed by the action of cold alcohol, hot alcohol causes the formation of γ -abietic acid. Resinous substances may be classified into those soluble in petroleum (γ -pinic acid, sylvic acid, γ -abietic acid) and those insoluble in petroleum (Kpl. α - and β -pinic acids), but the classification is not final.

Action of ozone on organic compounds [resins]. Harries and others. See XX.

PATENTS.

Agitating the liquid contents of tanks for coating [with paint] or treating by dipping; Means for —, C. G. Heywood, Chislehurst, Kent, and F. G. Kidd, London. Eng. Pat. 105,138, May 6, 1916. (Appl. No. 6552 of 1916.)

IN a tank for coating or treating articles by dipping, the liquid mixture, e.g., paint, is kept uniformly mixed by the movement of a submerged horizontal foraminous or perforated screen. The screen may be raised and lowered synchronously with the articles dipped, and this movement may be combined with alternating horizontal movements. Alternatively mixing may be effected by angular oscillation of the screen. The movements may be produced by suspending the screen from rotating eccentrics, or the screen may be fixed and the tank movable. Means may also be attached to the screen for producing whirling currents of liquids. The screen may be formed of two superposed perforated plates, which may be relatively adjusted to place the perforations wholly or partly out of register. Alternatively the screen may be composed of adjustable pivoted slats which may be arranged in oppositely inclined groups.—W. F. F.

Carbon-black and hydrogen; Manufacture of —, R. F. Bacon, B. T. Brooks, and H. Clark, Assignors to Gulf Refining Co., Pittsburgh, Pa. U.S. Pat. 1,229,391, Mar. 27, 1917. Date of appl., July 9, 1911.

A JET of liquid hydrocarbon is injected into a zone of sufficiently high temperature to decompose the hydrocarbon into its elementary constituents, which are then continuously removed from the zone by the force of the gas pressure developed, while the carbon-black is still suspended in the hydrogen and in such condition that when it subsides it will have a deep black lustre.—C. A. M.

Pigment. H. A. Gardner, Washington, D.C. U.S. Pat. 1,220,973, Mar. 27, 1917. Date of appl., Feb. 18, 1915.

BARIUM phosphate or other substantially insoluble metallic phosphate is incorporated with zinc sulphide or other insoluble metallic sulphide to form a pigment.—C. A. M.

Hydrocarbon oil; Manufacture of a non-saponifiable unsaturated — from a drying oil. Manufacture of a non-volatile unsaturated hydrocarbon from petroleum. B. T. Brooks and F. W. Padgett, Assignors to Gulf Refining Co., Pittsburgh, Pa. U.S. Pats. (A) 1,220,820 and (B) 1,220,821, Mar. 27, 1917. Date of appl., Aug. 10, 1911.

(A) CARBON dioxide is split off from the free fatty

acids of linseed or other drying oil, leaving an unsaturated hydrocarbon which forms a good film on drying, and is a valuable substitute for linseed oil. (B) A fraction of petroleum oil boiling above about 250° C. is chlorinated sufficiently to obtain dichlorinated compounds of the constituent hydrocarbons, and the latter are heated *in vacuo* to between about 350° and 500° C., in the presence of barium chloride or other catalyst, whereby hydrochloric acid is split off, and a non-volatile unsaturated hydrocarbon drying oil is left.—C. A. M.

Phenols and formaldehyde; Process for obtaining hard products of condensation of —, K. Tarassoff, Moscow, and P. Shestakoff, Petrograd. Eng. Pat. 101,887, Jan. 19, 1916. (Appl. No. 893 of 1916.)

PHENOLS and formaldehyde or its polymers are mixed with oil of turpentine or other liquid terpene products, or with coal or wood tar, or non-phenolic oils obtained in the distillation of coal tar, and the mixture is polymerised or condensed e.g., as described in Eng. Pats. 21,566 and 1921 of 1908 (this J., 1909, 374, 148). The initial stage of the process is carried out at temperatures below the boiling point of the mixture, and in the presence of alkalis, ammonia, or organic bases. The resulting product has good dielectric properties and is not affected by various chemical agents. (See also Eng. Pat. 2122 of 1908; this J., 1909, 252.)—C. A. M.

Preparation of reactive products [shellac substitute] from paraffin hydrocarbons. Ger. Pat. 295,591. See IIA.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Rubber from Eucommia ulmoides. Oliver, A. F. Sievers, J. Amer. Chem. Soc., 1917, 39, 725—731. ETHER readily extracts about 2% of caoutchouc from the bark of *Eucommia ulmoides*; after the solvent has been evaporated, the residue of caoutchouc is slowly soluble in ether (requiring about 10 hours) and also in toluene, chloroform, carbon bisulphide, turpentine oil, carbon tetrachloride, and gasoline, but is insoluble in alcohol. Its rate of solubility in these solvents is slightly different from those of specimens of raw rubber from Ceylon and Siam, respectively.—W. P. S.

Action of ozone on organic compounds [rubber resins]. Harries and others. See XX.

PATENT.

Rubber composition and process for the manufacture thereof. C. Paechetti, Milan, Italy. Eng. Pat. 105,026, Sep. 5, 1916. (Appl. No. 12,538 of 1916.)

A COMPOSITION of rubber or the like is mixed with small lengths of horse hair, hogshair, or bristles, the length of the hairs being about 3 to 4 mm., and the mixture is then vulcanised, to obtain a non-slipping material suitable for belts, pneumatic tyres, and packing rings for steam and water pipes. Preferably the hair is freed from fat prior to admixture with the rubber, etc.—C. A. M.

XV.—LEATHER; BONE; HORN; GLUE.

Wattle bark industry of Natal. Bull. Imp. Inst., 1916, 14, 599—601. (See this J., 1916, 1165.)

THE production of wattle bark in Natal was 1,300,000 cwts. in 1913, corresponding to 2,350,000 cwts. of the green, undried bark. Of this 811,000 cwts. (value £325,000) was imported into the United Kingdom for re-export and home use. Whilst the total production of Natal has naturally

declined since 1913, the quantity used in the United Kingdom has increased remarkably. The most important recent development of the industry has been in the production in Natal of tanning extract. Several patents have been granted, one factory is erected and others are in course of construction. In full work, these factories will be able to deal with two-thirds of the total output of bark. In one of the patented processes the bark is simultaneously crushed between bronze rollers and extracted with hot water. In another the dried or green bark is first finely chopped, then crushed between bronze rollers, and subsequently extracted in large leaching vats. The spent bark is used as fuel.—F. C. T.

Industrial development in United Provinces, India. [Babul pods as tanning material.] Bull. Imp. Inst., 1916, 14, 612—615.

THE Board of Industries recently established in the United Provinces has issued several memoranda on native products and industries, of which one deals with babul (*Acacia arabica*) pods as a tanning material. The difficulty which has hindered the use of these pods for tanning in India has been the great liability of the liquors to fermentation. Experiments made in the technical laboratories of the Department of Industries, United Provinces, have shown that the fermentation can be stopped by boiling the liquors, by keeping them at a low temperature, or by the use of antiseptics such as phenazole or carbolic acid. Phenazole is alkaline, but quite effective if slightly acidified with acetic acid: 0.25% or more should be used, calculated on the tanning material; rather more carbolic acid is necessary. While the fermentation of untreated liquors is quite rapid at 65° F. (18° C.), very little takes place at 50° F. (10° C.), and it is probable that babul liquors would be quite suitable for use in the winter months in India.—F. C. T.

Paper yarns. [Treatment with tanning materials.] Massot. See V.

PATENTS.

Bark extracts: Process for obtaining —. D. C. Reynolds. Philadelphia, Pa. U.S. Pat. 1,220,557, Mar. 27, 1917. Date of appl. June 22, 1914.

THE bark is boiled with water, the extract separated from the spent bark and boiled with more fresh bark, and the concentrated extract heated and sprayed through relatively dry air to evaporate part of the water.—C. A. M.

Products adapted to precipitate glue or like substances: Manufacture of —. A. Römer. Stuttgart. Assignor to Deutsch-Koloniale Gerb- und Farbstoff-Ges., Karlsruhe, Germany. U.S. Pat. 1,222,033, Apr. 10, 1917. Date of appl. July 6, 1914.

SEE Fr. Pat. 471,921 of 1914: this J., 1915, 438.

Treatment of vulcanised fibre [leather substitute]. Eng. Pat. 105,033. See V.

XVI.—SOILS; FERTILISERS.

Soils and fertilisers: The organic nitrogen compounds of —. E. C. Lathrop. J. Franklin Inst., 1917, 183, 465—498. (See this J., 1915, 293; 1916, 1167.)

DETERMINATIONS of the amide nitrogen in a mixture of soil and dried blood (this J., 1916, 1167) showed that the amount increased slightly during the second and third days of the experiment, but decreased by about 70% from the third to the fifth day, indicating that practically all of it was

split off from the dried blood proteins in five days. The initial increase was probably due to the synthetic action of micro-organisms, and the protoplasmic proteins produced by them are far more stable than the protein of dried blood. The nitrogenous organic compounds so far isolated from soils are chiefly primary protein decomposition products. Nitrogen metabolism in plants in so far resembles the metabolism in animals that organic nitrogen compounds are synthesised from pre-existing complex nitrogenous matter: this fact and the related one, that soil organisms are influenced by such compounds, are of great agricultural importance. Recent analyses of cottonseed meal, tankage, and blood meal show that their organic nitrogen content is very similar to that of dried blood, hence it is probable that their decomposition products in the soil are also similar. The principle of the manufacture of processed fertilisers is the same as that of the rendering available of the nitrogenous organic matter of the soil, *viz.*, the partial or complete hydrolysis of proteins; and in general the fertilising effect is proportional to the extent of hydrolysis. Any method which seeks to determine the availability of the nitrogen in an organic fertiliser by measuring the ammonification which takes place in a given time under biological conditions, must be incomplete if it fails to take into account the intermediate products produced by partial hydrolysis.—E. H. T.

Plants: Influence of certain organic substances on the development of —. I. G. Clamian and C. Ravenna. Atti R. Accad. Lincei, 1917, [v], 26, i., 3—7. J. Chem. Soc., 1917, 112, i., 244—245.

THE accessory substances of vegetable organisms, such as glucosides, alkaloids, colouring matters other than chlorophyll, etc., are regarded by some authorities as reserve food materials and by others as excretory products. The authors, who favour the former view, have investigated the influence of certain of these substances on the development of plants. When an organic compound is introduced into an adult plant either by way of the roots or by inoculation into the stem, no apparent external change is produced, provided that the nature and amount of the substance are such that the plant remains alive. The germination of beans and maize on cotton-wool is almost completely inhibited by watering with 0.1% mandelonitrile solution, whereas when an amygdalin solution of corresponding concentration (0.55%) is used, all the seeds germinate like those treated with water. If, however, the mandelonitrile is first administered some days after germination, the plants develop, although comparatively slowly, the height attained being less and the root-growth not so marked; on the other hand, the stems are thicker and the plants more robust, since they are able to live through the winter, whilst those provided with complete nutriment dry up in October. That these plants treated with mandelonitrile are nourished at the expense of the nitrogen of this compound whilst the benzaldehyde undergoes oxidation or other transformation, is shown by the absence of hydrocyanic acid or benzaldehyde, even after the extract of the plant has been treated with emulsin. Hydrocyanic acid in 0.1% concentration retards or prevents the germination of beans and maize, and those plants (about 30%) which grow very soon die. Nicotine tartrate solution containing 0.1% of the alkaloid behaves similarly towards the seeds, and even when it is first applied subsequently to the germination, the plants grow slowly and abnormally. Strychnine tartrate of similar concentration has no apparent influence on the germination of the seeds, but the plants dry up after a few days. The action of caffeine or morphine is similar to that of strychnine.

Soil protozoa and soil sterilisation; Review of investigations in —. N. Kopeloff and D. A. Coleman. *Soil Sci.* 1917, 3, 197—269.

PATENTS

Soil: Method of sterilising — for tobacco-plant beds, etc. W. T. Young and J. Chapman, Allensville, Ky. U.S. Pat. 1,222,253, Apr. 10, 1917. Date of appl., Feb. 19, 1917.

THE bed is divided into sections, unslaked lime is piled on the soil at the centre of each section, the lime is saturated with water, the surface soil scraped over the slaking lime to form a mound, and the latter levelled after slaking is completed. —W. R. S.

Phosphates; Process for producing citrate-soluble —. J. G. Lipman, New Brunswick, N.J. U.S. Pat. 1,222,012, Apr. 10, 1917. Date of appl., Feb. 17, 1916.

FINELY-GROUND phosphate rock is mixed with finely-divided sulphur and fertile soil, whereby the sulphur is oxidised by bacterial action, and the resulting acid acts on the phosphate rock, producing soluble phosphates. Rotted manure and water may also be added to the mixture to increase the bacterial activity, and accelerate the oxidation of the sulphur. The following proportions are given:—Phosphate rock 10, sulphur 1 to 1, manure 5 to 10, and fertile soil 5 to 20 parts.

—J. B. C. K.

Fertiliser (made from calcium nitrate and urea). Badische Anilin u. Soda-Fabr. Ger. Pat. 295,548, Apr. 29, 1915.

DOUBLE compounds of calcium nitrate and urea, prepared, for example, by intimately mixing the respective constituents in the molecular proportion, 1:4, and drying the resulting paste, are claimed as fertilisers. The products are non-hygroscopic.—F. SONN.

Fertiliser; New compound for use as a — and method of fertilising. J. Y. Johnson, London. From Badische Anilin u. Soda-Fabr., Ludwigshafen, Germany. Eng. Pat. 103,722, Mar. 6, 1916. (Appl. No. 3345 of 1916.)

SEE Ger. Pat. 295,548 of 1915; preceding.

Fertiliser from peat; Process of making —. J. J. A. de Whalley, Lee, Assignor to The Molassine Co., Ltd., East Greenwich, U.S. Pat. 1,221,979, Apr. 10, 1917. Date of appl., Mar. 2, 1916.

SEE Eng. Pats. 14,487 and 17,818 of 1915; this J., 1916, 1168.

XVII.—SUGARS; STARCHES; GUMS.

Saponin in extracted beetroot. Andriik. Böhm. Zeits. Zuckerind. 1917, 41, 343. Chem.-Zeit., 1917, 41, Rep., 103.

EXTRACTED beetroot slices as obtained from the factories contain when dried below 100° C. about 1.4% of saponin (about 0.1% of the fresh beetroot). It is present in combined form, but can be obtained in pure condition by hydrolysis for 24 hours in the cold with 50% alcohol and 4% of sodium hydroxide, or with 96% alcohol in presence of 2 to 4% of sulphuric acid, or more rapidly by boiling for 2 mins. with the alcoholic acid.—C. A. M.

Ketohexose; Thiobarbituric acid as a reagent for —. G. P. Plaisance. J. Biol. Chem., 1917, 29, 207—208.

THE hexoses are more readily converted into hydroxymethylfurfural than are the aldoses, and the test proposed depends on the detection of the

hydroxymethylfurfural by means of the orange-coloured precipitate which it yields with thiobarbituric acid in hydrochloric acid solution. The substance to be tested is boiled with 12% hydrochloric acid, the solution then cooled, and a few drops of thiobarbituric acid solution (in 12% hydrochloric acid) are added. If a ketohexose was present originally, an orange-coloured precipitate forms gradually. Aldoses may yield a yellow solution with the test, but a precipitate is not formed.—W. P. S.

Starches; Determination of gelatinisation temperatures of — by means of an electrically heated chamber on the microscope stage. A. W. Dox and G. W. Roark, jun. J. Amer. Chem. Soc., 1917, 39, 742—745.

THE heating device employed is a "No. 8, electric incubator for the microscope stage," especially adjusted for temperatures up to 80° C. A piece of asbestos board inserted between the stage and the heating chamber will prevent considerable loss of heat. A small amount of the starch to be tested is placed on a cover glass, moistened with a drop of water, and the cover glass is placed over the depression in a hanging-drop slide; the latter is then supported on two short rods at the bottom of the chamber, which has been heated previously to 60° C., a mica cover, provided with a hole for the objective, is placed in position, and the temperature is increased slowly until anisotropy disappears in all the grains that are large enough to show the characteristic shape and markings. This operation serves as a preliminary orientation. The test is then repeated, starting 5° below the previously noted gelatinising temperature and increasing the temperature at the rate of 1° C. per min. The gelatinising temperature will be found to be slightly below that observed in the preliminary test. The use of a short thermometer is recommended, and owing to variations in the temperature at different parts of the chamber, a correcting factor is found by determining the melting points of such substances as palmitic acid, phthalide, or azobenzene, under the same conditions that prevailed during the gelatinisation tests; the correction will usually be about —3.8° C. The gelatinisation points of the starches from 13 varieties of maize were found to vary from 64.1° to 71.1° C., but concordant results were obtained for each variety.—W. P. S.

Invertase action; Kinetics of —. J. M. Nelson and W. C. Vosburgh. J. Amer. Chem. Soc., 1917, 39, 790—811.

THE velocity of the inversion of sucrose by invertase is directly proportional to the concentration of the invertase and is nearly independent of the concentration of the sugar solution; in the case of very dilute sucrose solutions, however, the velocity increases with an increase of the concentration of the sugar up to 5 grms. per 100 c.c. Experimental results obtained agree with the view that the reaction is a two-phase one and contradict the claim that the kinetics of invertase action conform to the unimolecular law for homogeneous reactions. Adsorption is one of the controlling factors of the kinetics of the action. The inversion of sucrose by invertase is a different type of heterogeneous catalytic reaction from the dissociation of stibine into antimony and hydrogen in the presence of metallic antimony, and the dissociation of molecular hydrogen into atomic hydrogen in the presence of heated metals. (See also Henri, this J., 1906, 131.)—W. P. S.

Constitution and technical importance of pectins. Ehrlich. See XIXa.

Isomer of glucuronic acid. Suarez. See XIXa.

Occurrence of mellitic acid. Von Lippmann. See XXIV.

PATENT.

Aqueous solutions [e.g. massecuite]; Method of evaporating —. R. U. Bunker, Yonkers, N.Y. U.S. Pat. 1,221,022, Apr. 3, 1917. Date of appl., Dec. 8, 1913.

AN aqueous solution, e.g., massecuite, is evaporated in a series of four vacuum chambers. The material is boiled successively in three of the chambers having progressively higher temperatures and lower vacua, and finally in the fourth chamber in which the temperature is lower than in the third. Each chamber is divided into a number of pockets having a vapour space in common, and the charges of material in the pockets, after concentration, are withdrawn separately and transferred to pockets in the next vacuum chamber of the series. The vapour from each chamber is passed into the next chamber, with the exception that the fourth chamber is next to the last in order of progression of the vapour. —W. F. F.

XVIII.—FERMENTATION INDUSTRIES.

Wine; Chemical equilibrium between tartaric acid and dipotassium tartrate as basis for the de-acidification of — with this salt. T. Paul. Z. Elektrochem., 1917, 23, 65—86. (See also this J., 1915, 1159; 1916, 134.)

THE author has studied, from the standpoint of electrolytic dissociation, the reactions involved in the treatment of acid wines with dipotassium tartrate to precipitate excessive amounts of tartaric acid as monopotassium salt (tartar), a treatment first proposed by Liebig, but since undeservedly neglected. The solubility of monopotassium tartrate at 18° C. was found to be 4.903 grms. per litre (of solvent) in pure water, and 3.58, 2.94, and 2.57 grms. per litre in water containing 5, 8, and 10 grms. of alcohol per 100 c.c. One per cent. solutions of tartaric acid in water and in dilute alcohol were treated with dipotassium tartrate in quantities ranging from 0 to the full equivalent of the acid present, and the equilibria produced were accounted for satisfactorily in terms of the known laws of electrolytic dissociation. Small quantities of the dipotassium salt, insufficient to produce any precipitation of tartar, had no effect on the acidity determined by titration, but larger quantities reduced the acidity to an extent proportional to the amount of tartar precipitated. The concentration of hydrogen ions, however, fell to about half its original value on addition of only one-tenth of the amount of dipotassium salt equivalent to the tartaric acid present, and was still further reduced by larger amounts of the salt. Addition of dipotassium tartrate to natural wines of excessive acidity produced substantially similar results, though the fall in the concentration of hydrogen ions was more nearly proportional to the quantity of added salt than in the experiments mentioned above. This method of treating acid wines has less effect on their constitution than the use of calcium carbonate (see this J., 1916, 134). It does not introduce a foreign substance into the wine, nor does it raise the ash- or extract-content appreciably, for the greater part of the added salt is again removed in the form of tartar. If added in the form of a saturated solution, the dipotassium salt immediately exerts its full effect in reducing the concentration of hydrogen ions (on which the acid flavour of the wine depends), although the tartar formed may not begin to separate for some time; the separation is, however, usually complete within 24 hours. The treatment may therefore be simply carried out by adding a saturated solution of dipotassium tartrate in small quantities until the desired alteration of flavour is attained, and then leaving the wine to stand until the tartar separates. —J. H. L.

Wines; White "casse" of —. Fonzes-Diacon. Comptes rend., 1917, 164, 650—652. (See this J., 1917, 468.)

TREATMENT with citric acid does not always prevent the appearance of white casse in wines; the maximum amount which may be added in France is 0.5 gm. per litre, but for some wines manufactured with the aid of sulphurous solutions of ammonium phosphate, 2 grms. of citric acid per litre has been found insufficient. Another method of treatment, now illegal, consists in adding oxalic acid or potassium oxalate. Part of the lime present is thus precipitated, but some oxalic acid always remains in solution and this appears so to influence the equilibrium in solution as to prevent the separation of ferric phosphate.

—J. H. L.

Application of the Komarowsky reaction as a test of purity of concentrated sulphuric acid. See VII.

Vitamine content of brewers' yeast. Seidell. See XIXA.

PATENT.

Sulphite waste liquor; Fermentation of —. A. V. Jernberg, Tidaholm, Sweden. U.S. Pat. 1,221,058, Apr. 3, 1917. Date of appl., Feb. 6, 1917.

SULPHITE waste liquor is prepared for fermentation by the addition of a neutralising agent and a suitable quantity of calcium cyanamide, previously treated with water or steam, corresponding to the need of nitrogen and the acidity of the lye.

—J. F. B.

XIXA.—FOODS.

Butter; Method of preserving —. T. Paul. Chem.-Zeit., 1917, 41, 74—75.

THE butter is melted at 40° to 45° C. and the fat separated, and while still warm stirred with salt (30 grms. per lb. of fat) which has been strongly heated and then cooled to about 45° C. The vessel is allowed to stand for 2 to 3 hours in a warm place so that the fat remains fluid, and the mixture is meanwhile frequently stirred. It is then filtered through cotton wool in a hot water funnel, and the filtered fat is placed in bottles, which should be filled to within 1 to 2 cm. of the stopper, and kept in the dark in a cool place. To reproduce the butter, the fat is melted at about 40° C., and 85 parts by weight is vigorously shaken with 15 parts of fresh milk for 2 to 3 mins., and the emulsion is rapidly cooled by means of ice-water. Butter fat thus preserved will keep for at least a year. —C. A. M.

Calcium in blood and milk; Rapid method for determining —. H. Lyman. J. Biol. Chem., 1917, 29, 169—178.

FIVE c.c. of blood, or the same quantity of a mixture of 10 c.c. of milk and 190 c.c. of water, is mixed with 15 c.c. of a 6.5% solution of trichloroacetic acid, the mixture is filtered, 10 c.c. of the filtrate is neutralised with ammonia, and a slight excess of dilute nitric acid is added, followed by oxalic acid and sodium acetate. After 18 hours, the precipitated calcium oxalate is separated by centrifugal action, washed with ammonium oxalate solution, dissolved in a very small quantity of nitric acid, the solution mixed with an excess of ammonium stearate solution, and the turbidity produced compared in a nephelometer with that given under similar conditions by a known amount of calcium oxalate dissolved in nitric acid. —W. P. S.

Casein; Solubility of — in dilute sodium chloride solutions. S. Ryd. Z. Elektrochem., 1917, 23, 19—23.

WHEN pure casein is dissolved in standardised sodium hydroxide solution, and standard hydro-

chloric acid then added, after the free alkali has been neutralised the sodium caseinate is decomposed, yielding free casein and sodium chloride. The separation of the casein produces an opalescence before actual precipitation takes place. If, owing to the presence of dissolved sodium chloride, an excess of casein is dissolved, the opalescence is observed before the neutral point, as given by phenolphthalein, is reached (*i.e.*, before all the caseinate has been decomposed by the acid); if the amount of dissolved casein is deficient, then more acid than corresponds to the alkali used must be added to cause the opalescence. This is the principle of a method described for tracing the effect of sodium chloride upon the solubility of casein in water. The titration is performed in a closed cylindrical jar provided with a tightly-fitting cork through which pass a mechanical stirrer, a thermometer, and the prolongations of the jets of two burettes containing respectively the acid and the alkali. Experimenting with sodium chloride solutions of 22 different concentrations, it was found that the solubility rose rapidly with the concentration of the chloride up to 0.115 gm.-mol. per litre, and that above this concentration it fell, at first rapidly, then more slowly, and finally tended to remain constant.—E. H. T.

Canned meat; Sterilisation of —, A. Kossowicz. *Chem.-Zeit.*, 1917, **41**, 211—213.

MEAT packed in tins of 250 c.c. capacity ought to be sterilised for at least an hour, of which not less than 45 mins. should be at a temperature of 120° to 127.5° C., corresponding to a pressure of 1 to 1½ atmos. A pressure of 1 atmos., corresponding to about 120° C., would be sufficient, but it is necessary in practice to make allowance for possible unobserved reduction of the steam pressure, especially when several autoclaves are working simultaneously, and it is therefore advisable to use a pressure of 1½ atmos. At 1½ atmos. the meat often becomes too soft and too readily disintegrated. In the case of larger or smaller tins the duration of the sterilisation is correspondingly varied in accordance with the results of experiments. The empty tins should be tested for pinholes under water at a pressure of 3 atmos., and then washed in running hot and cold water. After sterilisation they are wiped free from fat, etc., immediately after removal from the autoclaves, and are then set aside for observation, before packing, for at least 14 days at 20° to 30° C. At temperatures below 20° C., the observation period must be extended to 4 to 8 weeks. After the removal of blown tins, etc., the remainder is cleaned, coated with a thin film of vaseline as a protection against rust, and packed.—C. A. M.

Oat kernel; Nature of the dietary deficiencies of the —, E. V. McCollum, N. Simmonds, and W. Pitz. *J. Biol. Chem.*, 1917, **29**, 311—351.

FEEDING experiments on rats were made with oat kernels and purified food principles. It was found that the oat kernel contained proteins of a poorer quality than those of maize and wheat kernels. These proteins were not supplemented very satisfactorily by the addition of casein, but gelatin in about equal quantity gave very good results. The hulled oat kernel does not induce growth, but with addition of butter fat causes a slow increase. The addition of a single food principle such as protein, inorganic salts, etc., does not induce growth, but the addition of two principles does so, provided one of them is a salt mixture. The oat kernel causes injury to animals when their diet is of such a kind as to lower their vitality.—J. H. J.

Cottonseed as food; Use of —, T. B. Osborne and L. B. Mendel. *J. Biol. Chem.*, 1917, **29**, 289—317.

FEEDING experiments were made on white rats

with cottonseed meal and flour, both when used as the sole protein in the diet and when used in small quantity to supplement less efficient proteins. In all cases satisfactory growth of the animals took place. Cottonseed kernels were, however, unsatisfactory, due to the presence of a constituent which was either directly poisonous or else so unpalatable as to cause the animals to refuse to eat the food. The injurious constituent could be extracted by ether, and the extracted kernels, and kernels which had been steamed for some hours, proved satisfactory foods. Cottonseed oil was harmless.—J. H. J.

Inositolphosphoric acids of cottonseed meal. J. B. Rafter. *J. Amer. Chem. Soc.*, 1917, **39**, 777—789.

AN inositolphosphoric acid corresponding in composition with inositoltriphosphoric acid, $C_6H_6(OH)_3(H_2PO_4)_3$, was isolated from certain samples of cottonseed meal, but this compound does not appear to be a constant constituent of the meal. From other samples of the meal an inositolphosphoric acid was separated which corresponded in composition with inositolpentaphosphoric acid, $C_6H_6(OH)(H_2PO_4)_5$, or equally well with the acid, $C_{12}H_{43}O_{12}P_9$; in view of the theoretical possibility of the existence of the pentaphosphoric acid, it appears best to ascribe to it the former formula. (See also this J., 1915, 630.)—W. P. S.

Vitamine content of brewers' yeast. A. Seidell. *J. Biol. Chem.*, 1917, **29**, 145—151.

ASSUMING that all the nitrogen contained in fullers' earth which has been shaken with the filtrate from autolysed yeast is derived from vitamine, the maximum quantity of the latter which can be present in the original filtrate is 0.18 gm. per 100 c.c. In the case of pigeons, the vitamine deficiency of an exclusive diet of polished rice is just replaced by daily doses of 1 c.c. of the clear filtrate from autolysed brewers' yeast; equivalent doses of freshly-pressed yeast do not replace the vitamine deficiency of polished rice, and the autolytic process appears, therefore, to influence favourably the activity of the vitamine of brewers' yeast.—W. P. S.

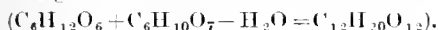
Arginine in proteins; Method for accurately estimating —, B. C. P. Jansen. *Chem. Weekblad*, 1917, **14**, 125—129. *J. Chem. Soc.*, 1917, 112, ii, 184.

ARGININE can be estimated quantitatively in proteins by the action of arginase and urease on the hydrolysed product after elimination of the ammonia. The arginase decomposes the arginine, with formation of an equimolecular proportion of urea, which is converted by the urease into ammonium carbonate.

Pectins; Constitution and technical importance of —, F. Ehrlich. *Chem.-Zeit.*, 1917, **41**, 197—200. (See also Schryver and Haynes, this J., 1917, 517.)

"CRUDE pectin" may be separated from the residual cellular membrane of the beetroot after expression of the juice and washing. It consists of two constituents which can be readily separated. One of these is a kevo-rotatory araban, $[\alpha]_D = -171$ to -121 , which when boiled with dilute organic acids yields dextro-rotatory *l*-arabinose. Since the araban is readily soluble in water, and is not precipitated by lime or lead acetate, it must pass into the syrups and molasses in the sugar factories, and probably contributes to the apparent losses of sugar as indicated by the polarisation tests. The other and main constituent of the crude pectin is a dextro-rotatory calcium-magnesium salt of pectic acid, and has the same properties as that isolated from the crude pectins of apricots and of orange peel. It contains about 6% of ash.

and has a specific rotation of $[\alpha]_D = +150$ to $+155$. On adding alcohol and hydrochloric acid to its aqueous solution the free pectic acid is precipitated as a powder, which when washed with alcohol and ether and dried at 100°C . still contains about 0.1 to 0.6% of ash, and has a composition, calculated on the ash-free substance, of C, 43.70; H, 5.45; and O, 50.85%. It contains about 9% of methoxyl, behaves as a weak acid, and has a specific rotation of about $[\alpha]_D = +220$. Pure pectic acid thus separated from different kinds of vegetable substances was free from pentoses, though it gave the pentose reactions with orcinol and resorcinol and yielded a considerable amount of furtural when distilled with hydrochloric acid. On oxidation with nitric acid it yielded up to 50% of mucic acid, attributable to the presence of galactose. The solution gave Tollens' naphthoresorcinol reaction for glucuronic acid. Hydrolysis of the pectic acid with acids and alkalis showed that it contained a compound of *d*-galactose with an isomer of glucuronic acid, *d*-galacturonic acid (see Suarez, following abstract). By restricted hydrolysis with 0.5 to 1% oxalic acid solution, a dextro-rotatory galactose-galacturonic acid,



was obtained. This is an amorphous monobasic acid which is soluble in water, gives the orcinol and naphthoresorcinol reactions, and yields much mucic acid on oxidation. Complete hydrolysis of pectic acid is best effected by boiling with oxalic acid solution under pressure (130 to 140 $^\circ\text{C}$). On treating pure pectic acid with an excess of sodium hydroxide solution, a gelatinous deposit of a sodium salt is obtained, and by treating this with hydrochloric acid a nearly insoluble acid with very high specific rotation, $[\alpha]_D = +270$, is obtained, which appears to be formed by the elimination of 3 mols. of water from 1 mol. of *d*-galacturonic acid: $4\text{C}_6\text{H}_{10}\text{O}_7 - 3\text{H}_2\text{O} = \text{C}_{24}\text{H}_{34}\text{O}_{25}$. For this acid, which contains four free hydroxyl groups, the name of *d*-tetragalacturonic acid is suggested. It gives all the colour reactions of the pentoses and glucuronic acid, and yields 70%, or more, of its weight of mucic acid on oxidation. When hydrolysed with dilute oxalic acid under pressure, it yields a new stereoisomeric *d*-glucuronic acid, — *d*-galacturonic acid—which gives all the typical reactions of glucuronic acid, such as reduction of Fehling's solution in the cold. Unlike glucuronic acid, it forms crystalline phenylhydrazine derivatives, and readily soluble compounds with alkaloids, such as the cinchonine salt, which crystallises in rhombic needles (m. pt. 158°C) and has $[\alpha]_D = +134$. These results indicate that the natural pectin of vegetable cell membranes must be regarded as the calcium-magnesium salt of a complex anhydro-arabino-galactose-methoxytetragalacturonic acid. With regard to the utilisation of pectin, it is pointed out that the dry cellular membrane of the beetroot contains up to 25 or 30% of crude pectin, and that there would be no difficulty in associating its production with the manufacture of sugar. Pectin substances are suitable for fodder, and it may be possible to treat crude pectin by hydrolysis or otherwise in such a way as to render at least the galactose group available for human food.

—C. A. M.

Glucuronic acid [from lemons]: An isomer of —. M. L. Suarez, Chem.-Zeit., 1917, 41, 87.

The expressed pulp of lemons was finely divided, washed with cold water until the washings no longer reduced Fehling's solution, and 1 kilo. of the pressed mass heated for $1\frac{1}{2}$ hours in an autoclave at 120°C . with 5 kilos. of water containing 10 grms. of sulphuric acid, and then again pressed. The yellow filtrate was boiled with barium carbonate, filtered from barium sulphate, and con-

centrated to 300 c.c. under reduced pressure. The precipitate which formed was removed, the residual solution was poured into 2 litres of absolute alcohol, and the resulting precipitate was separated and purified by reprecipitation with alcohol from an aqueous solution. It was a pale-yellow non-hygroscopic powder, with a composition corresponding with the formula, $\text{Ba}(\text{C}_6\text{H}_5\text{O}_7)_2$. Its aqueous solution was dextro-rotatory, had a strong reducing action, and gave the reactions of glucuronic acid with Tollens' naphthoresorcinol reagent, and with phloroglucinol and orcinol, but it was not possible to obtain the *p*-bromophenylhydrazine compound nor to prepare from it the anhydride of glucuronic acid, whilst oxidation by Thierfelder's method yielded mucic acid. This new acid, isomeric with glucuronic acid, did not yield a definite osazone with phenylhydrazine.

—C. A. M.

Lichens and their characteristic constituents. Hesse. See XX.

Separation and determination of butyric acid in biological products. Phelps and Palmer. See XX.

PATENTS.

Emulsions [for margarine]: Preparation of —. S. H. Blichfeldt, Southall, Middlesex, Eng. Pat. 104,899, Mar. 17, 1916. (Appl. No. 1017 of 1916.)

AN aqueous vehicle for use in the manufacture of a concentrated fatty emulsion to be used for the production of margarine, is obtained from linseed. The seed, or the outer coating or cortex of the seed, is treated with 100 parts of hot or boiling water to 1—5 parts of seed, a "ropy" solution of the mucous material in the cortex being obtained. The water used may be slightly alkaline. The margarine may be prepared by the use of this solution according to the methods described in Eng. Pats. 23,653 and 25,245 of 1913 and 18,048 of 1914 (this J., 1911, 1167 and 1218). —W. F. F.

Milk; Method of treating —. C. H. Campbell, Assignor to Borden's Condensed Milk Co., New York, U.S. Pat. 1,221,024, Apr. 3, 1917. Date of appl., July 25, 1913.

A BODY of milk is maintained at a temperature above normal by a rigid heated surface in contact with it. The adhering thickening milk is wiped from the heated surface periodically at frequent intervals, and returned to the body of milk, so that it is prevented from coagulating, burning, or exposure to the air, and heat transference from the heated surface is facilitated. —W. F. F.

Sterilising foods; Apparatus for electrically —. J. Haussen, Christiania, Norway. Eng. Pat. 101,801, Oct. 12, 1916. (Appl. No. 11,521 of 1916.) Under Int. Conv., Oct. 12, 1915.

THE apparatus, which is specially adapted for the sterilisation of split cod, consists of an inclined channel into which the fish are fed from a hopper and down which they pass between metal contact plates in the floor and spring projections from the top of the channel. The springs are attached to a metal shaft which crosses the channel and is electrically connected to an induction coil, to which the plates in the floor of the channel are also connected. An alternating current of high voltage is sent through the coil. —J. H. J.

XIXB.—WATER PURIFICATION; SANITATION.

Magnesium: Titration of — [in water analysis]. F. W. Brucknüller, J. Amer. Chem. Soc., 1917, 39, 610—615.

THE estimation of magnesium in water analysis can be effected satisfactorily by the following

methods in the solution remaining after precipitation of the calcium: (a) The solution is evaporated to dryness, and ammonium salts decomposed by heating. The residue is dissolved in a small volume of water, acidified with hydrochloric acid, and after filtering, made slightly alkaline with ammonia. Microcosmic salt solution is slowly added to the cold solution, with stirring, and after the precipitate has formed, a quantity of ammonia solution equal to one-third of the total volume added, is introduced, and the solution allowed to stand 18 hours. The precipitate is filtered off with the aid of suction and washed with 25 c.c. of alcohol. After transferring with hot water to a beaker, a known excess of $N/10$ hydrochloric acid is added and the excess titrated back with $N/10$ sodium hydroxide using methyl orange as indicator. (b) The solution is entirely freed from ammonium salts by evaporation and ignition, the residue dissolved in a small quantity of hydrochloric acid, and the solution filtered. The solution is cooled, made alkaline with ammonia, which is free from ammonium salts, and an excess of 10 c.c. added. A 10–20% excess of sodium arsenate is added slowly and with vigorous stirring which is continued for about 10 minutes after no further precipitation has taken place. The solution is allowed to stand in a cool place to allow the precipitate of magnesium ammonium arsenate to settle, and, after filtering and washing with 3% ammonia water, the precipitate is dissolved in hot water, and 10 c.c. of concentrated hydrochloric acid and 0.3 gm. potassium iodide added for every 100 c.c. of liquid. The liberated iodine is titrated with $N/10$ thiosulphate. (c) The precipitate of magnesium ammonium arsenate obtained as in (b), after washing with dilute ammonia, is dissolved in hot water and the solution transferred to an Erlenmeyer flask fitted with a trap. An excess of potassium iodide and 10 c.c. of sulphuric acid (1:1) are added and the whole boiled rapidly until iodine vapours are no longer visible. While still hot, the trace of iodine remaining is destroyed with sulphurous acid and the whole cooled quickly. The acid solution is neutralised with $N/10$ sodium hydroxide, using phenolphthalein as indicator, and adding from time to time a solution of sodium phosphate. When titration is complete, the volume of phosphate solution added should be equal to one-half the volume of the iodine solution. The total volume should be about 250 c.c., and if greater than this more phosphate must be added in proportion to keep the hydrogen ion concentration at the right value. The arsenious acid is titrated as usual with $N/10$ iodine. For every 100 c.c. of $N/10$ iodine, 11 grms. of $\text{Na}_2\text{HPO}_4 \cdot 12\text{H}_2\text{O}$ is necessary in a volume of 250 c.c. to keep the ratio $\text{Na}_2\text{HPO}_4/\text{NaH}_2\text{PO}_4 = 2$ at the end point, which ensures a hydrogen ion concentration of 10^{-7} .

—J. N. P.

Polable water for military purposes. A. Vila. J. Pharm. Chim., 1917, 15, 277–282.

THE author describes a simple apparatus for use in treating water by means of hypochlorite, the amount of reagent supplied being regulated automatically according to the flow of the water.

Disinfecting power of complex organic mercury compounds. III. Mercurised phenols. W. Schrauth and W. Schoeller. Z. Hyg. Infektkrankh., 1916, 82, 279–288. J. Chem. Soc., 1917, 112, i., 241–242.

THE results previously obtained by the authors with the substitution products of sodium *o*-hydroxymercuribenzoate, $\text{HO} \cdot \text{Hg} \cdot \text{C}_6\text{H}_4 \cdot \text{CO}_2\text{Na}$ (this J., 1912, 297), indicate that the disinfecting power would be increased by the substitution of the less acidic phenolic hydroxyl for the carboxyl group.

Experiments have now been performed with two mercurised phenols, and also with substances which contain, in addition to one or two hydroxymercuri-groups, halogen, alkyl, or methoxy-groups. The previous observations have been confirmed in all cases, and the influence of the position of the substituent in the benzene nucleus has been investigated. It has been further observed that the relative positions of the hydroxymercuri- and phenolic groups are important. Considerable differences in the disinfecting power of the three isomeric mercurised cresols have been noticed; the *m*-derivative is most potent, whilst sodium *o*-hydroxymercuriphenoxide is more active than the isomeric para-compound. In the case of sodium dihydroxymercuriphenoxide (providol), the entrance of a second hydroxymercuri-group into the benzene nucleus considerably increases the disinfecting power. The substances were prepared by treating the phenol with mercuric acetate in alcoholic solution; the recrystallised products were dissolved in the calculated amount of sodium hydroxide and diluted with water to the required mercury content. Among the preparations examined, sodium *o*-chlorohydroxymercuriphenoxide and sodium dihydroxymercuriphenoxide have been found particularly active. Their practical importance is increased by the fact that their disinfecting power, in contrast to that of all previously investigated compounds, is not diminished in the presence of soap, and that they are permanently unchanged in soaps which consist chiefly of the sodium salts of saturated fatty acids. Medical preparations of this kind (apidol- and providol-soap) keep well.

New applications of thymolphthalein and naphtholphthalein [in determination of true neutrality in waters]. Moir. See XXIII.

PATENTS. •

Water softening and purifying apparatus. W. Paterson, London. Eng. Pat. 104,919, Mar. 22, 1916. (Appl. No. 4280 of 1916.)

THE apparatus is especially suitable as a small plant for domestic use. It consists of a closed tank on which is supported a smaller closed tank containing the measuring and reagent-adding apparatus. The two tanks are connected by an opening through which the water, to which the reagent has been added, passes into the larger tank. The exit from the large tank is by means of a submerged pipe with a valve controlled by a ball float. The pipe passes upwards to the purified water tank situated at a higher level; a float in this tank controls a valve on the raw water supply pipe entering the measuring apparatus. As the water in the large tank accumulates, the air above it is compressed, and when the water rises to a certain level, the valve on the exit pipe is opened and the water rises in the exit pipe and enters the purified water tank. For the addition of the reagent, a small vessel is provided on the top of the reagent tank, with openings to the air and the reagent tank. In another form of the apparatus, the raw water pipe has a valve which is connected with the air space in the large tank, the pressure in this space closing the valve at a fixed point. The exit pipe, at its termination in the purified water tank, is provided with a ball float valve, actuated by alterations of the level of the water in the tank.—J. H. J.

Softening water: Apparatus for —. L. D. Kinzig, Dayton, Ohio. Assignor to Optenberg Iron Works, Sheboygan, Wis. U.S. Pat. 1,220,129, Mar. 27, 1917. Date of appl., July 10, 1916.

THE addition of the reagent is controlled by a tank of water containing a float connected to the discharge pipe from the tank. This pipe has a

restricted opening at its inlet end and is kept by the float at a fixed distance below the level of the water, which is thus discharged at a uniform rate. The float is connected also to the discharge pipe of the reagent tank which is kept at the surface of the reagent and is lowered in unison with the discharge from the control tank.—J. H. J.

Trade waste effluents [from benzol purification]: Purification of —. J. T. Sheard, Sheffield. Eng. Pat. 104,999, July 8, 1916. (Appl. No. 9636 of 1916.)

THE process is applicable to the waste liquid from a benzene rectification still. The waste is made alkaline if necessary, 0.5–1% of alum in solution is added to it, and the mixture well agitated. It is then passed into a settling tank, and when clear, the water is run off through a pipe in the side. The bottom of the tank slopes to an outlet, through which the sludge is withdrawn.—J. H. J.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Digitalis leaves: New reaction for the water-soluble, active glucoside from —. F. Wratschko. Z. allg. Oesterr. Apoth.-Ver., 1916, 54, 263. J. Chem. Soc., 1917, 112, ii., 182.

A FEW c.c. of orcinol-hydrochloric acid reagent (0.2 gm. of orcinol, 100 c.c. of concentrated hydrochloric acid, 4 drops of ferric chloride solution) are heated to boiling, a few drops of the liquid under investigation are added, and the mixture is shaken. A green to blue colour develops, or, at greater concentration, a dark precipitate is formed. The solution is treated with an equal volume of water and shaken with amyl alcohol, whereby the latter is coloured green to dark blue; in the course of a few hours, this colour changes to a more stable lilac to carmine-red tint. The intensity of the colour is dependent on the "digoside" content of the liquid under investigation. The reaction is very sensitive. In the rare case in which the presence of free pentoses is considered possible, a preliminary extraction of the active glucoside with chloroform is necessary; the chloroform is removed, the residue dissolved in alcohol, and the solution tested as described. *Strophanthus* tincture and the aqueous and chloroform extracts of *Strophanthus* seeds also show this reaction.

Narcotic and anæsthetic drugs: Tests for certain —. E. H. Hankin. Indian J. Med. Research, 1916, 4, 237–255. J. Chem. Soc., 1917, 112, ii., 184.

COLOUR reactions of a large number of alkaloids, narcotic substances, etc., are recorded, and more particularly those given by cycloform, β -eucaine, orthoform, nirvanine, anæsthesine, novocaine, holocaine, acaine, stovaine, and alypine. Nitric acid gives a yellow coloration with cycloform, reddish-brown with holocaine, and brownish-black with acaine. Alypine, cocaine, tropacocaine, and α -eucaine yield red crystals when their solutions are mixed with alum solution and the mixtures added to potassium permanganate crystals on a microscope slide; β -eucaine and stovaine form red, oily drops with this reagent. Most of the substances give a white precipitate when treated with Fehling's solution. Reactions with sulphuric acid and potassium iodate, sulphuric acid and hexamethylenetetramine, and with bromine are also described.

Emodin: Identification of drugs containing —. G. D. Beal and R. Okey. J. Amer. Chem. Soc., 1917, 39, 716–725.

CASCARA, RUMEX, RHUBARB, FRANGULA, SENNA, and

ALOES are the best known members of the group of drugs which contain some derivative of a methylanthraquinone, such as emodin, chrysophanic acid, or their isomers, or glucosides yielding these compounds on hydrolysis, and the following scheme is suggested for the identification of these drugs. The drug is extracted with boiling 50% alcohol and the alcoholic solution is divided into three portions: one of these is extracted with benzene, then with amyl alcohol; another portion is extracted with ether, and the third portion is reserved. A portion of the benzene extract is shaken with ammonia, when the formation of a deep violet-red coloration and precipitate indicates the presence of rhubarb. The benzene solution of rhubarb gives a yellow precipitate with lead acetate, which turns red when treated with an alkali, whilst the precipitates obtained from other drugs remain white. A portion of the amyl alcohol extract when shaken with concentrated ammonia exhibits a red coloration and a green fluorescence in the presence of aloes or of freshly-prepared cascara extract. If the red coloration is obtained, another portion of the amyl alcohol extract is treated with mercurous nitrate solution; a red coloration indicates aloes, and this may be confirmed by the copper sulphate, hydrogen peroxide, and borax tests. The presence or absence of cascara may be ascertained by evaporating a portion of the benzene or amyl alcohol extract, nitrating the residue, and treating the product with stannous chloride; cascara gives a deep red coloration, aloes a yellow-brown. The presence of senna is indicated by the formation of a red coloration when a portion of the ether extract of the drug is shaken with saturated nickel acetate solution. If the solution retains its green colour and gives a green precipitate when treated with potassium hydroxide, rumex is present, but the ethereal and aqueous layers must be well mixed when the alkali is added to render this test trustworthy. If the mixture with potassium hydroxide results in the formation of a violet precipitate, the presence of senna is indicated, whilst with rhubarb or frangula it will be red-violet, and with cascara dark orange-red. Rhubarb and frangula give orange coloured solutions before the alkali is added, and the ethereal layer, after the addition of the alkali, becomes colourless except in the presence of rhubarb. If the above tests do not give conclusive evidence as to the composition of the drug, a portion of the ether extract is nitrated, then reduced with stannous chloride, and kept at 100°C. Senna gives a green residue, aloes a brown one, cascara red, and rumex, rhubarb, and frangula violet-red residues. The residue from phenolphthalein, should this be present, is lemon yellow. If these residues are washed with water and then treated with sodium hypochlorite, the senna residue alone yields a red coloration, the others turning yellow. Phenolphthalein gives a red coloration when the extracts are treated with ammonia or other alkali, but this coloration disappears when 30% sodium hydroxide is added, whilst the colorations given by anthraquinone derivatives are not affected by concentrated alkali solution.—W. P. S.

Cignolin as a remedy for psoriasis. P. G. Unna. Dermatol. Wochenschr., 1916, 62, No. 6—8. Chem.-Zeit., 1917, 41, Rep., 99.

CIGNOLIN (1,8-dihydroxyanthranol) has a much more energetic action upon the skin than its 3-methyl derivative, chrysarobin. The dihydroxy derivatives, chrysarobin and cignolin, are both greatly superior in this respect to anthranol and 2-hydroxyanthranol. The reduced compounds, dihydroanthracene, dihydroanthranol, and oxanthrone, are inactive against psoriasis.—C. A. M.

Lichens and their characteristic constituents: Contribution to the knowledge of —. O. Hesse, J. prakt. Chem., 1916, 94, 227–270.

SEVERAL varieties of lichens have been examined, chiefly by extraction with ether or other solvents, and small quantities of characteristic acids have been isolated. From *Evernia furfuracea* var. *olivetorina* were obtained about 0.25% of atranorin, 2% of olivetoric acid, and very small quantities of olivoric and apolivoric acids. From *Parmelia saxatilis* var. *refriga* were obtained 0.2% of usnetic acid and 6.4% of parmatic (saxatilis) acid. From the variety *omphalodes* the same acids were extracted, also lobaric acid, the lactone of usnetic acid. From *Peltusaria communis*, var. *rufifusa*, a bitter-tasting lichen, salicic acid was the principal constituent isolated. *Cetraria nivalis* from Norway yielded on extraction with ether 1.8% of *l*-usnic acid and a new acid, nivalic acid. The carbohydrates of this lichen have been studied and 11% of carbohydrates readily soluble in hot water, consisting of about one-fourth of lichenin and three-fourths of a new carbohydrate, *l*-lichenidin, were obtained. Lichenin, $C_{12}H_{16}O_8$, melts at about 275° C. with decomposition and is optically inactive in aqueous alkaline solution; on hydrolysis it yields only dextrose. Lichenin has the composition of a disaccharide and in borax solution shows $[\alpha]_D^{20} = +68$; it also yields only dextrose on hydrolysis. *Cetraria islandica* (Iceland moss) yields on extraction with ether proto-a-lichesteric acid, which when subjected to a temperature higher than 45° C. is converted more or less into α -lichesteric acid, $C_{12}H_{16}O_8$, m. pt. 124° C., which again is converted into dilichesteric acid. From Iceland moss there is extracted by acetone the potassium salt of fumaroprotocetraric acid, which is readily split up into acid potassium fumarate and cetraric acid; the latter does not occur in the free state. The cold-water soluble carbohydrates of Iceland moss include, lichenin, *d*-lichenidin, $[\alpha]_D^{20} = +15.1$, and lichenoin, $C_{12}H_{16}O_{10}$, $[\alpha]_D^{20} = +202.7$, which on hydrolysis yields dextrose and a carbohydrate, $C_{12}H_{16}O_8$, which gives a crystalline derivative with barium hydroxide. On boiling with water and a little sodium carbonate the lichen loses about 61%, and the residue is largely hydrolysable by dilute acid, yielding mainly dextrose, some galactose, and a very little mannose.—J. F. B.

Heart lecithin: Nitrogenous hydrolysis products of —. C. G. MacArthur, F. G. Norbury, and W. G. Karr, J. Amer. Chem. Soc., 1917, 39, 768–777.

HEART lecithin is possibly identical with brain lecithin, since the two contain about the same amounts of main constituents. On hydrolysis, heart lecithin yields about 12% of its nitrogen in a form insoluble in water; about 50% of the soluble nitrogen is present as choline and the remainder as amino-ethyl alcohol. Traces of ammonia and amino-acids found in the hydrolysed solution are probably derived from impurities and are not part of the lecithin molecule. (See also Parrish and MacArthur, this J., 1916, 556.)

—W. P. S.

Amines and their derivatives: Certain products of the action of formaldehyde and a bisulphite on aromatic —. Action of alkalis and acids on sodium *p*-phenetidinomethanesulphonate. R. Lepetit, Atti R. Accad. Lincei, 1917, [v], 26, i., 126–132, 172–171. J. Chem. Soc., 1917, 112, i., 197–199.

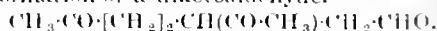
THE action of dilute sodium hydroxide solution on sodium *p*-phenetidinomethanesulphonate (neuralteine) (Eng. Pat. 24,389 of 1908; this J., 1909, 490) has been investigated, and it was found that the reaction proceeds quantitatively according to the equation: $2C_{12}H_{13}O-C_6H_4-NH-CH_2-SO_3Na$

$+ 2NaOH = (C_{12}H_{13}O-C_6H_4-NH)_2CH_2 + CH_2O + H_2O + 2Na_2SO_3$. Other arylaminomethanesulphonates undergo the same reaction, which represents a good general method for preparing imides. If pure methanesulphonates are used, the di-imides are obtained in a pure state, but on recrystallisation the melting point becomes lowered, owing to decomposition. The action of boiling dilute hydrochloric acid on *p*-phenetidinomethanesulphonic acid yields *p*-phenetidine hydrochloride and a substance which crystallises in pale yellow, shining needles, and is the hydrochloride of a sulphur-free base, $C_{18}H_{20}O_2N_2$, m.pt. 140° C., exhibiting anæsthetic properties. When *p*-phenetidinomethanesulphonic acid is boiled with water alone, sulphur dioxide and formaldehyde are evolved, the residual product being the *p*-phenetidinomethanesulphonate of the above base.

$C_{18}H_{20}O_2N_2 \cdot C_{12}H_{13}O-C_6H_4-NH-CH_2-SO_3H$, which crystallises in white needles, m.pt. 160–161° C., and exerts a pronounced and moderately persistent anæsthetic action.

Ozone: Action of — on organic compounds. C. Harries, H. Neresheimer, H. von Splawa-Neyman, R. V. Stanford, and E. Paulsen, Chem. Zentr., 1916, ii., 991–995. J. Chem. Soc., 1917, 112, i., 211–211.

Action of ozone on certain terpenes (see also this J., 1916, 707).—The action of ozone on *d*-limonene in carbon tetrachloride solution leads to the formation of a solid diozonide, which when dissolved in ethyl acetate leaves a small residue, probably consisting of oxozonide; the latter passes after some time into the di-ozonide of formula $C_{10}H_{16}O_6$. This substance forms a white mass, m.pt. 60–65° C., $[\alpha]_D^{20} = -9.32$, in chloroform solution, which decomposes violently at about 85° C. Short treatment with boiling water or dilute acetic acid transforms the ozonide into a keto-ozonide, $C_{10}H_{14}O_4$, which is a syrup; protracted treatment with boiling water leads to the formation of a diketozonide.



Oxidation of the ozonide by chromic acid in acetic acid solution at 50–60° C. leads to the formation of β -diacetylvaleric acid. In addition to the fairly stable normal ozonides, the ketones yield highly explosive ozonide peroxides. A mixture of normal ozonide and ozonide peroxide, a yellow explosive liquid, is formed by ozonising pulegone in chloroform solution, which is converted by water into β -methyladipic acid. The latter substance, $n_D^{20} = +2.5$ (in 33% aqueous solution, *l*, 1), is also obtained by evaporation of the chloroform solution of the mixture. A solution of carvone in carbon tetrachloride is converted by ozone into the oily carvonediozonide, which, when further ozonised in the same solvent, yields carvonediozonide peroxide, an unstable, yellow syrup, which explodes after a few hours in a freezing mixture, more rapidly on contact with ice-water, and within thirty to thirty-five seconds after mixture with water at 40° C. Formaldehyde is formed during the explosion, together with an oil, $C_9H_{12}O_3$, which in all probability is the diketozonide. Total decomposition of the diozonide by steam yields 3-acetylglutaric acid (or its ketodilactone), which is also formed from the diketozonide and boiling water.

Aldehyde from pinene (see this J., 1909, 440).—Pinonaldehyde, $C_{10}H_{16}O_2$, is a pale yellow oil, b.pt. 115–125° C., sp. gr. at 19.4° C. 1.022, $n_D^{20} = 1.46867$; $n_D^{25} = 1.46531$; $[\alpha]_D^{20} = +14.67$. It is readily volatile with steam, reduces cold silver and Fehling's solutions, and is oxidised by air with formation of pinonic acid. It is readily changed by acids and alkalis or by gentle heating. Pinonic acid, obtained by oxidation of the aldehyde with aqueous potassium

permanganate, is an oil, b.pt. 180° — 185° C. at 12 mm., $[\alpha]_D^{20} = +3.9^{\circ}$ in chloroform solution. The crystalline semicarbazone, $C_{11}H_{15}O_3N_3$, has m. pt. 204° C. Nopinone, pleasant-smelling oil, $[\alpha]_D^{20} = -45^{\circ}$ (semicarbazone, m. pt. 167° C.; benzylidene derivative, m. pt. 106 — 107° C.) is obtained by oxidising the previously described (*loc. cit.*) oil (obtained by fusion of pineneozonide) with permanganate.

Degradation of sericin by ozone.—When sericin is ozonised in aqueous solution, the products of fission only account for 65% of the original material. The sole uniform product which is formed is a polypeptide, which, after purification by repeated solution in water and precipitation with methyl alcohol, has $[\alpha]_D^{20} = -60.1^{\circ}$, C = 43.9%, H = 5.85%, N = 17.5%. Determinations of molecular weight lead to the formula $C_{29}H_{48}O_{16}N_{10}$. Hydrolysis of the polypeptide by acids yielded: CO_2 , 8.8%; NH_4Cl , 9.2%; glycine, about 0.5%; alanine, about 1%; valine (or leucine), about 0.3%; serine, 13.1%; aspartic acid, 0.25%; glutamic acid, 0.25%; lysine, 0.35%; and, in addition, arginine. The phenyl group contained in sericin cannot be recognised among the products of ozonisation.

Action of ozone on resins.—A fundamental difference exists between the ozonides of caoutchouc and dammar resin, since the latter is insoluble in carbon tetrachloride and not explosive. Decomposition with water leads to the formation of only a small quantity of acid, the main substance being a solid product, insoluble in water. Since other resins behave similarly to dammar resin, it is possible to establish the presence of resins in rubber by ozonisation in carbon tetrachloride solution, and the operation may be made quantitative, since the resin is quantitatively converted into the ozonide. The ozonide obtained by direct solution and ozonisation of dammar resin was not uniform, and the resin was therefore subjected to a preliminary treatment with acetic acid and precipitation with water. All the resins investigated yielded solid ozonides, the melting points of which lay between 53° and 81° C. The solubility of the ozonides was less than that of the resins; they are very sparingly soluble in light petroleum, slightly so in carbon tetrachloride, and yield clear solutions in alcohol, ethyl acetate, acetone, and acetic acid. The cleavage products are almost insoluble in light petroleum, slightly soluble in carbon tetrachloride, soluble in alcohol, ethyl acetate, acetone, and acetic acid, and, for the most part, in chloroform. A definite phytosterol- or isocholesterol-reaction is not given by the resins, ozonides, or their cleavage products. The iodine values of the ozonides, cleavage products, and resins are 126—285, 112—238, and 5—152, respectively. The ozonides have C = 47—61%; H = 6—11%; the cleavage products, C = 60.8—69%; H = 8—10%. The resins may be classified in the following groups: (i.) Dammar, mastic, sandarac; (ii.) brown and pale dammar copal, recent and fossil kauri copal; (iii.) rubber resin and guttapercha resin; (iv.) French colophonium, American resin, Mark B. elemi, and galipot. The solubilities of dammar, mastic, and sandarac are very different, those of their ozonides and cleavage products closely similar. From 82 to 83% of dammar resin is soluble in acetic acid; the residue after solution in light petroleum and precipitation with acetic acid, forms a white, amorphous mass, m. pt. 211° C., which probably consists of a hydrocarbon, $(C_{10}H_{16})_{15}$. The solubilities of the resins, ozonides, and cleavage products of the two dammar copals are approximately the same, and this is also true for the kauri copals. The melting points of the ozonides are 64° and 68° , 53° and 51° C. respectively; and of the resins, 154° and 158° , 92° and 119° C. respectively. Acid values, 198 and 201, 131 and 126 respectively. The solu-

bilities of the resins, ozonides, and cleavage products of the members of the third group show almost exact agreement. Melting points of ozonides, 63 and 70° ; of cleavage products, 92° and 87° C. The resins, ozonides, and cleavage products of group IV, also show marked analogies with respect to solubility, etc.

Potassium persulphate as a reagent in organic chemistry. R. L. Datta and J. N. Sen, J. Amer. Chem. Soc., 1917, 39, 747—750.

QUINOL (hydroquinone) is oxidised by neutral potassium persulphate, in the cold, with the formation of quinhydrone; aniline gives a good yield of Aniline Black, and *o*-toluidine is oxidised quantitatively to *o*-Toluidine Black. Acetanilide, when heated for some time with concentrated potassium persulphate solution, yields quinone, and acetic acid is liberated; benzanilide gives a small quantity of quinone after 24 hours' contact with persulphate and in this case benzoic acid is set free. Acetamide, propionamide, and butyramide are hydrolysed when boiled with potassium persulphate solution, the corresponding acids being formed. Allyl alcohol is readily oxidised by persulphate, the chief product being acrolein.—W. P. S.

Methyl salicylate: Method for the examination of —, A. R. Albright, J. Amer. Chem. Soc., 1917, 39, 820—825.

THE following method is described for the detection of small quantities of such substances as phenol, *p*-hydroxybenzoic acid, etc., in methyl salicylate; it depends on the fact that in a mixture of two substances having different refractive indices, one of the substances, if isometric, may be rendered practically invisible by immersing the mixture in a liquid having the same refractive index as that substance, whilst the other substance will stand out in more or less sharp relief. In the case of methyl salicylate, the sample is treated with an excess of benzoyl chloride, the mixture is agitated thoroughly and rendered alkaline from time to time with dilute potassium hydroxide solution until the reaction is complete. The salicylate and all phenolic substances present are thus converted into the same crystalline derivatives (benzoates). The resulting crystalline precipitate is collected, washed with water, dried, and recrystallised from warm alcohol. The crystals thus obtained are then mounted in a solution having a refractive index equal to that of benzoyl methyl salicylate (1.658); the mounting solution used is an aqueous solution of mercuric potassium iodide diluted or concentrated until it has the required refractive index. If the slide is now examined under the microscope, the benzoyl methyl salicylate tends to become invisible, leaving the other compounds, if present, in clear view. Using this method, the author has detected the presence of phenol in both natural and synthetic wintergreen and sweet birch oils; methyl *p*-hydroxybenzoate was also found in synthetic wintergreen oil.—W. P. S.

Butyric acid in biological products: Separation and determination of —, I. K. Phelps and H. E. Palmer, J. Biol. Chem., 1917, 29, 199—205.

THE process described depends on the insolubility of quinine formate and quinine acetate, and on the solubility of quinine butyrate in carbon tetrachloride. Briefly, the solution containing the three acids is neutralised with barium hydroxide solution, a quantity of quinine sulphate sufficient to precipitate the barium is added, the barium sulphate is separated by filtration, and the filtrate is evaporated under reduced pressure; the residue obtained is then extracted with carbon tetrachloride and the quinine butyrate recovered by

evaporating the solvent. From 89.7 to 100.5% of the butyric acid present is found by the process. The solubilities of quinine butyrate and quinine propionate are so nearly alike that only a partial separation of these two salts can be effected, but the propionate may be separated readily from the formate. The m. pts. and solubilities of the quinine salts mentioned are as follows:—

	M. pt. °C.	Solubility in carbon tetrachloride.
Quinine formate.....	110.0—113.0	1 in 16,000
„ acetate.....	124.0—126.0	1 in 2,000
„ propionate ..	110.5—111.0	1 in 450
„ butyrate.....	77.5	1 in 25
„ sulphate.....	214.0	1 in 40,000

—W. P. S.

Volatile fatty acids: The Duclaux method for the determination of—F. W. Upson, H. M. Plum, and J. E. Schott. *J. Amer. Chem. Soc.*, 1917, **39**, 731—742. (See also this J., 1917, 236, 519.)

CRITICAL examination of this method showed that unavoidable variations in experimental results are sufficient to render it untrustworthy. When more than two acids are present in a mixture, the results may be calculated equally well in terms of one, two, three, or more acids. Small amounts of acids may be distributed between the acids next higher and lower in the series. The method is considered to be unsound theoretically, and not suitable for determining the composition of unknown mixtures of fatty acids.—W. P. S.

Volatile fatty acids: The Duclaux method for—A. R. Lamb. *J. Amer. Chem. Soc.*, 1917, **39**, 746—747.

WHEN applied to pure formic, acetic, and propionic acids, this method yielded reliable results, provided that the experimental conditions were kept as uniform as possible. An electric hot plate was used as the source of heat, the 200 c.c. short-necked distillation flask was connected by a short bent tube to the condenser, and the flask was surrounded by an asbestos jacket. The water used was free from carbon dioxide, but it was found necessary to apply corrections for the carbon dioxide absorbed during the distillation. In the author's opinion, it is impracticable to attempt to determine more than two or three acids in the same mixture, and he considers that the unsatisfactory results obtained by Upson, Plum, and Schott (see preceding abstract) were due to impurities in the acids used, and to avoidable experimental variations.—W. P. S.

[Organic] acids: Identification of—H. J. A. Lyman and E. E. Reid. *J. Amer. Chem. Soc.*, 1917, **39**, 701—711.

IN addition to *p*-nitrobenzyl bromide (this J., 1917, 236), the chloride and iodide may also be used in the preparation of *p*-nitrobenzyl esters. The results suggest that it may be preferable to use the iodide instead of the bromide for dibasic acids.

—F. W. A.

Aldehydes: Identification of aliphatic—C. Harries and K. Oppenheim. *Chem. Zentr.*, 1916, ii., 991. *J. Chem. Soc.*, 1917, **112**, i., 210—211.

THE general reactions for aldehydes have been examined for a series of aliphatic aldehydes. It has been found that the semicarbazones of the lower aldehydes can only be induced to crystallise with great difficulty, whereas the higher aldehydes immediately yield crystalline products. Conversely, the nitrophenylhydrazones of the higher aldehydes are oily, those of the lower members

being crystalline. All the aldehydes investigated gave good results with diphenylmethanedimethyldihydrazine. Unsatisfactory results were obtained in attempting to apply Angeli's reaction (action of benzenesulphohydroxamic acid and conversion of the hydroxamic acids formed into their copper salts) to the exact characterisation of aldehydes. The physical and chemical characters of a number of aliphatic aldehydes and their derivatives are given.

Catalytic hydrogenation of organic compounds by base metals at ordinary temperatures. The removal of halogen from organic halogen derivatives. C. Kelber. *Ber.*, 1917, **50**, 305—310. (See this J., 1916, 382, 1130.)

PALLADIUM has been used for the displacement of halogens from organic compounds, and it has been found that the reaction in presence of palladised calcium carbonate proceeds so completely that the hydrogenation process may be used as a quantitative method for the determination of halogens. Equally satisfactory results may be obtained with nickel catalysts and in this case it is not necessary to recover the catalyst. A special shaking-tube has been designed for the use of this method for analytical purposes. This vessel is easily filled with the catalyst and the halogen derivative can be added subsequently; any contact of the liquid and catalyst with rubber connections is avoided and the product of the reaction can be quantitatively removed. The catalyst is prepared by heating basic nickel carbonate in a current of hydrogen at 310°—320° C., cooling, and passing a current of carbon dioxide over the material. The catalyst may be kept for a long time in closed vessels. For each determination, 3 grms. of the catalyst is placed in the reaction tube, shaken with water or dilute alcohol and 0.5—1.0 gm. of alkali hydroxide in presence of hydrogen until no more of the gas is absorbed, and the substance to be analysed is then sucked in and the funnel rinsed. Shaking is continued for some time after the reaction with the hydrogen is complete, the nickel is filtered off and washed, and the halogen in the liquid determined either gravimetrically or by titration. In the case of amino compounds or compounds which form precipitates with silver, the organic by-products should be shaken out with ether before making the halogen determination.—J. F. B.

Organo-metallic arsenic compounds; Activation of the therapeutic actions of quinine and mercury by—A. Gautier. *Comptes rend.*, 1917, **164**, 590—592.

THE efficacy of adding organo-metallic arsenic compounds, in particular of sodium dimethyl arsinate, to quinine in the treatment of malaria, as outlined by the author several years ago, has been confirmed recently by Ravaut and Kerdrel, who used injections of arsenol-enzyme supplemented by the usual dose of quinine in the treatment of the disease in Algeria. The subcutaneous injection of very small amounts of quinine and not more than 5—10 grms. of sodium dimethylarsinate, 8—10 hours before a probable attack, is advised; and the action of this specific in promoting the activity of the phagocytes has been verified experimentally. The association of organically combined arsenic with mercury has been equally successful as a remedy for syphilis.—E. H. T.

Mercuric salicylate and its isomers; Determination of mercury in basic—H. Lajoux. *J. Pharm. Chim.*, 1917, **15**, 241—246.

THE gravimetric determination of mercury in these complex salts (see this J., 1915, 733) is carried out by dissolving about 0.25 gm. of the salt and 1—1.5 gm. of potassium cyanide in 25 c.c.

of water. The solution is boiled, saturated with hydrochloric acid, diluted to 150 c.c., and then saturated with hydrogen sulphide. The resulting precipitate is weighed on a tared filter paper. For volumetric determination of the mercury, it is necessary first to destroy the organic complex and this, though possible, is tedious. If about 0.2 gm. of the salt is dissolved in 10 c.c. of *N*/10 potassium cyanide, the solution, after adding 10 c.c. of ammonia and about 1 c.c. of *N*/10 potassium iodide, may be titrated with *N*/10 silver nitrate. This leads, however, to results which show that only half the mercury has reacted with the potassium cyanide. If the result is multiplied by 2 the method is quite as satisfactory for determination of mercury not only in the salicylate but also in the *m*- and *p*-hydroxybenzoates. The commercial salt rarely contains more than 57% of mercury, while the formula requires 59.52%.—W. H. P.

Colloids; Protective—. *Cydonia* [quince] seed as protective colloid. Colloidal silver, gold, mercury, and platinum. A. Gutbier and A. Wagner. *Kolloid Zeits.*, 1916, 19, 280—302. *J. Chem. Soc.*, 1917, 112, ii., 168—169.

THE action of quince seed extract as a protective colloid has been examined in experiments with silver sols prepared by the reduction of silver nitrate by hydrazine hydrate in presence of the organic colloid. By dialysing the resulting colloidal silver solution and evaporating at low temperature or precipitating by the addition of alcohol, solid substances have been obtained containing about 20% of silver, which dissolve completely in water. Reversible colloids of the same kind were also obtained by the action of sunlight on silver nitrate solutions in presence of the quince seed extract. The coagulation of these protected silver sols by the action of various electrolytes has been examined, and the results indicate that the coagulating power diminishes in the order: sulphuric acid, sodium chloride, sodium carbonate, sodium hydroxide. Solid substances which contain up to 50% of gold and are completely soluble in water, may be obtained by the reduction of gold chloride by hydrazine hydrate in presence of quince seed extract. The protective action of the organic colloid on the gold sols is very pronounced. The protective action of quince seed extract on colloidal solutions of mercury prepared by the action of hydrazine hydrate on mercuric chloride is not very marked. If, however, sodium hydrosulphite is used as the reducing agent, much more stable solutions are obtained, and by dialysing and evaporating or precipitating with alcohol, solid colloids containing up to about 20% of metallic mercury have been prepared which are partly soluble in water. Platinum sols, prepared by the reducing action of hydrazine hydrate on platinum chloride in presence of quince seed extract, yield, on dialysing and evaporating or precipitating by the addition of alcohol, solid colloidal substances which contain as much as 25% of platinum. These colloids are readily soluble in warm water. As in the case of silver, gold, and mercury, the protective action of quince seed extract on colloidal platinum is strongly marked.

Salts of phthalic acid. Ekeley and Banta. See III.

Titration of oxalic acid with alkalis and ammonia in presence of methyl orange. Bruhns. See VII.

An isomer of glucuronic acid [from lemons]. Suarez. See XIXA.

Disinfecting power of complex organic mercury compounds. III. *Mercurised phenols.* Schoeller and Schrauth. See XIXB.

Applications of a new reagent for separating ammonia. I. *Colorimetric determination of ammonia in urine.* Folin and Bell. See XXIII.

PATENTS.

Ether: Process and apparatus for the continuous production of—. E. Barbet et Fils et Cie., Paris. Eng. Pat. 100,406, May 2, 1916. (Appl. No. 6289 of 1916.) Under Int. Conv., May 5, 1915.

IN a continuous process for the production of ether by treating alcohol with sulphuric acid, the acid and alcohol are kept in contact until the alcohol is entirely absorbed, and the ethylsulphuric acid so formed is partially decomposed by heat in a separate part of the apparatus. The ether set free is collected, and the acid is brought into contact with a fresh supply of alcohol. Apparatus for carrying out the process consists of a plate tower down which the acid trickles against an ascending stream of alcohol previously vaporised in a tubular heater heated by steam. From the bottom of the tower, the ethylsulphuric acid passes to a "tubular emulsifying apparatus," where it ascends lead pipes surrounded by steam jackets. The bubbles of ether vapour emulsify the acid liquid and are led off from the top of the emulsifier, while the liquid partially freed from ether is returned to the plate tower. The latter may be replaced by a cylinder packed with suitable material, and the emulsifier may be placed above the cylinder in the interior of a large cylindrical boiler, so that the acid leaving the top of the emulsifier passes down the peripheral space, and enters again at the bottom of the packed cylinder with the fresh alcohol.—F. Sp.

Alcohols [fuel oil substitute]: Manufacture of— [from gasoline]. B. T. Brooks and H. Essex, Assignors to Gulf Refining Co., Pittsburgh, Pa. U.S. Pat. 1,221,667, Apr. 3, 1917. Date of appl., Mar. 22, 1916.

HIGH-BOILING monohydric alcohols are produced by heating the corresponding chlorinated hydrocarbons, e.g., monochlorinated gasoline, with methyl alcohol and a formate under pressure at 140° C. to 190° C.—F. Sp.

Ethylene: Manufacture of— from acetylene. W. Traube, Berlin. Ger. Pat. 295,976, Nov. 22, 1914. Addition to Ger. Pat. 287,565 (see this J., 1916, 112).

THE process described in the principal patent is modified by using less than the theoretical amount of chromous salt, and regenerating it with reducing agents from the chromic salt produced. *Example.*—4 parts of crystalline chromic chloride, 20 parts of 25% hydrochloric acid, and 4 parts of zinc are shaken with 0.4 part by weight of acetylene under pressure. Ethylene and hydrogen are produced, and can be separated in the usual manner. Other chromium salts may be employed, and the concentration of the hydrochloric acid may be diminished.—F. Sp.

Ketones: Preparation of—. G. Schicht A.-G., and A. Grün, Aussig, Ger. Pat. 295,657, Sept. 8, 1914. Under Int. Conv., Sept. 20, 1913.

KETONES are produced by heating monocarboxylic acids of b. pt. above 300° C., in the liquid state, to temperatures not greatly exceeding 300° C., with small quantities of ketone-producing catalysts, e.g., finely divided metals, oxides, silicates, or silicic acid. Mixtures of catalysts, or catalysts deposited on finely divided carriers, or on filtering material, may be employed. In consequence of the relatively low temperature of the reaction and the absence of energetic reagents, the yield is practically quantitative. Stearic acid yields stearone, (C₁₇H₃₃)₂CO, m. pt. 87° C. Commercial

stearine of m. pt. 54° C. yields a mixture of stearone, palmitone, and stearopalmitone melting at 75° C.—F. Sp.

Ethyl triacetylglutamate: Process of making—K. Zimmermann, Elberfeld, Germany, Assignor to Synthetic Patents Co., New York. U.S. Pat. 1,222,315, Apr. 10, 1917. Date of appl., Jan. 5, 1911. SEE Ger. Pat. 279,958 of 1913; this J., 1915, 452.

Preparation of reactive products from paraffin hydrocarbons. Ger. Pat. 295,591. See IIX.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

Effect of various substances on the photochemical oxidation of solutions of sodium sulphite. Mathews and Weeks. See VII.

PATENT.

Photographic film; Sensitizer—J. E. Brandenberger, Assignor to Soc. "La Cellophane," Paris. U.S. Pat. 1,221,825, Apr. 10, 1917. Date of appl., Feb. 21, 1915.

SEE Eng. Pat. 2411 of 1915; this J., 1915, 983.

XXII.—EXPLOSIVES; MATCHES.

Azides: Sensitiveness of—L. Wöhler and F. Martin. Z. angew. Chem., 1917, 30, 33—39.

VARYING definite weights, up to 0.02 gram, of different azides, in a micro-crystalline form, were compressed to a constant degree in the form of pellets. A steel cylinder insulated on the outside with thick asbestos was heated in a bath of Wood's metal. After the temperature, which was measured directly at the base of the cylinder, had become constant, the pellet was admitted through an opening in the asbestos lid and the time required for detonation noticed. Beginning with 0.005 gram, of the substance, the temperature necessary to cause detonation after a given interval fell in every case with increasing quantity of material, until with from 0.01 to 0.02 gram, a limiting value was reached above which the detonation temperature was independent of the mass of the material. The development of the explosion wave from a comparatively slow reaction requires a definite interval which becomes shorter with increasing temperature and with the constant of the reaction velocity. Conversely, with a shorter period of heating, a higher temperature is necessary to initiate detonation than with a long period, as has been shown in the ignition of methane-air mixtures. With a small quantity of the azide, complete decomposition by slow chemical change might follow at the temperature employed, whereas at a higher temperature or with a larger mass at the lower temperature the decomposition would lead to detonation. The fact that the limiting temperature is already reached with a weight of 0.01 gram, in the case of azides indicates a very high speed in the velocity of the decomposition which leads to detonation. With mercury fulminate, the detonation temperature did not fall so soon to a constant value with increasing mass, indicating that in this case the initial decomposition takes place more slowly and is accompanied by a larger loss through slow chemical change. With azides and fulminates of the different metals, the following values, arranged in order of sensitiveness, were obtained as the temperatures (°C.) at which 0.02 gram, of the substance detonated after an interval of 5 seconds. Azides: cobalt, 118°; barium, 152°; calcium, 158°; strontium, 169°; copper, 174°; nickel, 200°; manganese, 205°; lithium, 245°;

mercury, 281°; zinc, 289°; cadmium, 291°; silver, 297°; lead, 327°; thallium, 329°. Fulminates: thallium, 120°; silver, 170°; copper, 205°; mercury, 215°; cadmium, 215°; sodium, 215°; potassium, 225°. The temperatures of detonation are obviously not determined by the heat of decomposition as this is greatest in the case of the azides of silver, cadmium, and lead. The azides of metals of low atomic weight have lower temperatures of detonation than those of high atomic weight, in accordance with the view that the heavier molecule needs a higher temperature to acquire the velocity necessary for detonation. Differences were also observed in the manner of decomposition, from lithium azide, which gave a very violent detonation, to the azides of sodium, potassium, and thallium, which exploded without developing true detonation. More uniformity is shown with the fulminates, which, with the exception of thallium, have all detonating temperatures in the neighbourhood of 200° C. The hygroscopicity of the azides of metals of low atomic weight was found to be much higher than with those of high atomic weight. Sensitiveness to shock was measured by the falling weight method. The compound, in amounts varying from 0.01 to 0.05 gram, was compressed in a brass cap case of definite cross-section and covered with a disc of copper or tin, over which was placed a hardened steel block which received the impact of the falling weight. With the exception of the azides of strontium and barium, which only exploded with production of flame, and the azides of lithium, sodium, and potassium, which could not be made to explode at all by percussion, the compounds examined all detonated, violently on receiving sufficient impact. A very large influence was in most cases found to be exerted by the thickness of the layer. The sensitiveness of the azides of silver, lead, and mercury increased with the thickness of the layer, that of cadmium was almost constant, those of copper, manganese, zinc, and thallium diminished in sensitiveness with increasing thickness, and those of nickel, cobalt, calcium, barium, and strontium increased to a maximum value with 0.02 gram, and then the sensitiveness diminished. Apart from this large influence of the thickness, which gives a misleading high figure of insensitiveness in the case of thick layers of the azides of copper, nickel, cobalt, and barium, a general parallelism was observed between the sensitiveness to heat and to percussion, and as with the temperature of detonation, no relation was apparent between sensitiveness to percussion and the heat of decomposition. The sensitiveness to percussion of thin layers of the azides was found to be a measure also of their responsiveness to friction, which determines the instability of the material in filling caps and during compression and shaking. In this respect, as shown in the percussion measurements, the azides of copper, nickel, and cobalt are the most unstable, and those of silver, cadmium, zinc, and thallium much more stable. The sensitiveness of thin layers of copper azide is encountered in copper detonator tubes. The increased sensitiveness of thick layers of lead and mercury azides accords with the property shown by large crystals of spontaneous detonation. The instability of mixtures of crystalline and liquid nitroglycerin may be due to an analogous effect of the influence of the thickness of the layers of liquid enclosed between the crystalline faces. Greater regularity was obtained in the measurements on percussion with fulminates, the sensitiveness being always greatest with the thinnest layers. The parallelism between temperature of detonation and sensitiveness to percussion is closer with fulminates than with azides. Thallium fulminate is the most easily detonated by heat and is the most sensitive to percussion.—J. N. P.

PATENTS.

Smokeless powder and process of making same.
J. M. Brown, Johnson City, Tenn. U.S. Pat.
1,222,065, Apr. 10, 1917. Date of appl. Mar. 4, 1915.
SEE Fr. Pat. 473,384 of 1915; this J., 1916, 1181.

Preparation of reactive products from paraffin hydrocarbons. Ger. Pat. 295,594. See IIa.

XXIII.—ANALYSIS.

Nephelometer-colorimeter; An improved —, P.
A. Kober. J. Biol. Chem., 1917, 29, 155–168.

In the instrument described, the usual rack and pinion movement for raising the cups or plungers is replaced by a screw movement, the scale is removable, and dark cloth curtains are not used. The glass plungers and the nephelometric and colorimetric cups are made in one piece without cemented joints, and have optically clear bottoms. A convenient support is provided for keeping the eye steady and always at the same point. The lamp house has adjustable reflectors so that the amounts of light reaching both sides of the colorimetric field may be equally adjusted.—W. P. S.

Colloid-chemical phenomenon as indicator in quantitative analysis. J. F. Sacher. Koll. Zeits., 1916, 19, 276–277. J. Chem. Soc., 1917, 112, ii., 180.

In the estimation of lead by titration with a solution of ammonium molybdate, the supernatant liquid is turbid so long as the reaction is incomplete, but this turbidity disappears suddenly at the end-point. The turbidity is due to colloidal lead molybdate, and the coagulation of this serves to indicate the end-point. In practice, the solution of lead, acidified with acetic acid, is heated at 70°–80° C., and the progress of the titration is determined by removing a drop of the solution and observing its optical condition. The end-point is independent of the quantity of acetic acid present, and the method is to be preferred to the older procedure in which tannin is used as indicator.

Thymolphthalein and naphtholphthalein [in the determination of true neutrality in waters]; New applications of —, including rapid methods for analysing limestone and ammonium salts. J. Moir. J. Chem., Met., and Min. Soc., S. Africa, 1917, 17, 129–132.

THE insensitiveness of thymolphthalein to traces of alkali, particularly at the boil, has been utilised in the determination of lime and magnesia in limestone: 0.5 to 0.75 grm. of sample, free from grit, is mixed with about 10 c.c. of 2 N hydrochloric acid, the mixture heated on the water-bath for 20 mins., the turbid liquid diluted to about 20 c.c., and titrated with N/2 caustic soda (free from carbonate) using a 0.02% methyl red solution in dilute alcohol as indicator: the combined acid-equivalent of the lime and magnesia is thus obtained. After diluting to 50 c.c. and raising to the boil for one minute, 3 c.c. of 1% thymolphthalein solution in 60–70% alcohol, and then sufficient N/2 caustic soda to give a dark blue solution are added, the mixture boiled for one minute to coagulate the precipitated magnesia, and the blue suspension titrated until yellow with N/2 hydrochloric acid; in this manner the magnesia content is determined, and the lime may be obtained by difference. A correction should be made in case an appreciable amount of phosphate is present. The results agree closely with those found by the ordinary method.

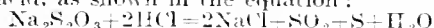
In analysing the ammonium salts of strong acids, the solution, previously neutralised to methyl red if necessary, is titrated at the boil with N/5 caustic soda in presence of a small quantity of a saturated

solution of thymolphthalein in 50% alcohol until the deep blue to green colour reappears and withstands boiling for 20 secs.

The true neutrality of water is determined by using as mixed indicators methyl red and α -naphtholphthalein, which are much more delicate than methyl orange and phenolphthalein, and will detect 0.1 part sulphuric acid and 0.2 part calcium hydroxide per 100,000. In presence of more than 0.4 part acid per 100,000, the colour is violet-rose; 0.2 part acid, salmon-orange; neutral, straw-yellow; 0.2 part alkali, citrine-green; over 0.4 part alkali, deep bluish-green. Neutral red, rosolic acid, or alizarin may be used in place of methyl red.—F. W. A.

Iodine; Titration of — with thiosulphate. R. Kempf. Z. angew. Chem., 1917, 30, 71–72.

In the titration of an iodine solution by thiosulphate in presence of free acid, a certain error arises by a reaction between the thiosulphate and the acid, as shown in the equation:



The reaction is made possible by the greater rate of diffusion of acid than of iodine into the layer of thiosulphate admitted to the solution. The sulphur dioxide formed neutralises subsequently two equivalents of iodine, whereas this quantity of iodine would react with two molecules of thiosulphate in the more rapid reaction producing tetrathionate. The reaction with the acid can be observed by the production of an opalescence due to sulphur, and can be minimised by avoiding a large excess of acid, by efficient stirring during the titration, and by running the thiosulphate from the burette slowly in drops. In the presence of alkali a still greater error is caused by the direct oxidation to sulphate brought about by iodine in an alkaline solution.—J. N. P.

Iodimetry; Differential —. II. Titration of chromic acid in the presence of ferric iron and the analysis of chromite. O. L. Barnebey. J. Amer. Chem. Soc., 1917, 39, 604–606. (See also this J., 1916, 358.)

THE reaction between potassium iodide and chromic acid proceeds to the exclusion of any effect from ferric iron in the presence of phosphoric acid, which converts the iron into a soluble acid phosphate. It is necessary to adjust the concentration of the phosphoric acid, as if the acid used is too strong, ferric iron reacts with the iodide, and if too weak the liberation of iodine by the chromic acid is too slow. When allowing three minutes for the reaction, the minimum acidity required for a concentration of iodide equal to N/10, was found to be 2.5 N. The estimation of chromium in presence of iron in an aqueous solution is conducted by making just alkaline with sodium hydroxide, adding solid sodium peroxide in slight excess, and boiling for a few minutes to decompose the excess of sodium peroxide. In the analysis of chromite, the sample is fused with sodium peroxide in a porcelain or silver crucible, extracted with water, and the excess of peroxide removed by boiling. In either case phosphoric acid is then added until the iron phosphate is completely dissolved and the solution has an acidity of about 3 N. 10 c.c. of N/1 iodide is then added for each 100 c.c. of solution and the liberated iodine titrated with standardised thiosulphate. Comparative determinations made in presence of, and after removal of, the iron by filtration gave results in close agreement.—J. N. P.

Iodimetry; Differential —. III. Determination of the available oxygen in soluble and precipitated oxidised forms of manganese. O. L. Barnebey and W. C. Hawes. J. Amer. Chem. Soc., 1917, 39, 607–610.

USE is made of the inappreciable rate of reaction

of ferric iron with iodide when in dilute phosphoric acid solution as a means of estimating manganese, through the liberation of iodine from an iodide by the oxidised manganese salt. It was found that potassium permanganate in presence of iron can be titrated accurately by the liberation of iodine in phosphoric acid solution. Samples of manganese dioxide in the form of Weldon mud, and as obtained by the reduction of potassium permanganate, and by precipitation from manganese salts by hydrogen peroxide, chlorate, and hypochlorite, were dried at 105° C., and weighed samples treated with 10 c.c. of $N/1$ iodide and 10 c.c. of 2 N phosphoric acid. The solutions were agitated gently until the reaction was complete and then titrated with thiosulphate, with results which agreed closely with the estimations made by Bunsen's distillation method. A direct estimation can in some cases be made with natural manganese ores by treating the finely ground material with 10 c.c. of $N/1$ iodide and 10 c.c. of 2 N phosphoric acid, then diluting to 100 c.c., allowing to react for 10 minutes, and titrating. Some samples of pyrolusite which contained a considerable amount of iron oxide were found, however, to be attacked with difficulty and could not be analysed successfully by this method.

—J. N. P.

Ammonia; Applications of a new reagent for the separation of —. 1. *Colorimetric determination of ammonia in urine.* O. Folin and R. D. Bell. *J. Biol. Chem.*, 1917, 29, 329–335.

THE reagent used is an artificial sodium zeolite, known commercially as permutit, in powder of 60–80-mesh fineness. About 2 grms. of the powder is placed in a 200 c.c. flask, 5 c.c. of water added, and then 1 or 2 c.c. of urine or 5 c.c. of diluted urine. The flask is rinsed down with a little water and shaken gently for 5 mins. The powder is then washed down from the sides of the flask with 25–40 c.c. of water, allowed to settle, and the liquid decanted. After another washing and decantation, a little water is added to the flask and 5 c.c. of caustic soda (10%), the contents are mixed and water is added until the flask is three-quarters full; it is then shaken and 10 c.c. of Nessler solution is added and mixed. After standing 10 mins., the contents are made up to the mark with water, and the colour compared with that given by a standard solution of ammonia treated with 5 c.c. of caustic soda in the same way. The reagent may be recovered and used over again, after washing with dilute acetic acid and drying.—J. H. J.

Gas washing [for benzol and toluol]: analysis of products; control of still. Edwards. See VIIA.

Application of the Komarowsky reaction as a test of purity of concentrated sulphuric acid. See VII.

Determination of small amounts of free sulphuric acid in presence of sulphates. Vulquin and Entat. See VII.

Titration of oxalic acid with alkalis and ammonia in presence of methyl orange. Bruhns. See VII.

Temperature measurements in clay works practice. Cobb. See VIII.

Determination of chromium in ferrochromium, steel, and slags by the permanganate method. Koch. See X.

Stripping and analysis of galvanised iron. Heise and Clemente. See X.

Testing of galvanised iron. Witt. See X.

Detinning and analysis of tin plate. Heise and Clemente. See X.

Analysis of Babbitt metal. Witt. See X.

Determination of free alkali in petroleum soaps. Charitschkov. See XII.

Thiobarbituric acid as a reagent for ketohexoses. Plaisance. See XVII.

Determination of gelatinisation temperatures of starches by means of an electrically heated chamber on the microscope stage. Dox and Roark, jun. See XVII.

Rapid method for determining calcium in blood and milk. Lyman. See XIXA.

Method for accurately estimating arginine in proteins. Jansen. See XIXA.

Titration of magnesium [in water analysis]. Bruckmiller. See XIXB.

New reaction for the water-soluble active glucoside of digitalis leaves. Wratschko. See XX.

Tests for certain narcotic and anæsthetic drugs. Hankin. See XX.

Identification of drugs containing emodin. Beal and Okey. See XX.

Method for the examination of methyl salicylate. Albright. See XX.

Separation and determination of butyric acid in biological products. Phelps and Palmer. See XX.

The Duclaux method for the determination of volatile fatty acids. Upson and others. See XX.

The Duclaux method for volatile fatty acids. Lamb. See XX.

Identification of [organic] acids. Lyman and Reid. See XX.

Identification of aliphatic aldehydes. Harries and Oppenheim. See XX.

Catalytic hydrogenation of organic compounds by base metals at ordinary temperatures. Removal of halogens from organic halogen derivatives. Kelber. See XX.

Determination of mercury in basic mercuric salicylate and its isomers. Lajoux. See XX.

XXIV.—MISCELLANEOUS ABSTRACTS.

Mellitic acid; The occurrence of —. E. O. von Lippmann. *Ber.*, 1917, 50, 236–238.

THE presence of mellitic acid has previously been recorded in a black, humus-like deposit formed by the gradual decomposition of pure sugar solutions under factory conditions (this J., 1895, 375). A similar instance has again been observed in the case of a very loose, nearly dry, coal-like, lustrous deposit found on dismantling an old copper pipe. Extraction of the powdered deposit with alcohol yielded crystals of fine white needles of mellitic acid, melting at 200° C. with decomposition. The acid was characterised by its crystalline barium salt, insoluble in water and alcohol, occurring as fine needles having the formula $C_{12}O_{12}Ba_3 + 3H_2O$. Another case of the formation of mellitic acid was observed in a heap of ordinary lignite (brown coal) on which a barrow-load of alumina sludge had accidentally been overturned two years previously. Under the sludge in the middle of the coal was a board which had been broken so as to form an angle and in the hollow space below the board was found a bunch of yellow crystals, the size of nuts, which were identified as "honey-stone," $C_{12}O_{12}Al_2 + 18H_2O$.—J. F. B.

Official Notices.

ANNUAL GENERAL MEETING, 1917.

In accordance with the provisions of By-law 64, notice is hereby given that the Annual General Meeting will be held in The University Buildings, Edmund Street, Birmingham, at 10.30 a.m. on Wednesday, July 18th, 1917. A programme of the proceedings is inserted loose in this issue.

In accordance with the provisions of By-law 24, those members whose names are printed in *italics* in the List of Council will retire from their respective offices at the forthcoming Annual Meeting.

Prof. Henry Louis has been nominated to the office of President under By-law 20; Dr. Charles Carpenter has been nominated Vice-President under By-law 20; Mr. John Gray, Mr. A. R. Ling, Prof. R. F. Ruttan, and Mr. J. T. Wood have been nominated Vice-Presidents under By-law 21.

Mr. A. G. Bloxam, Mr. W. J. Rees, Mr. Edwin Thompson, and Prof. James Walker have been nominated to fill the four vacancies among Ordinary Members of Council, under By-law 25. No ballot will be required.

J. P. LONGSTAFF,
Secretary.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY.

The first volume of these reports is now ready. As the issue is strictly limited, those who desire to obtain copies are advised to apply for them without delay. The price is 3s. to members and 5/6 to non-members, including postage.

IMPERIAL MINERAL RESOURCES BUREAU.

By direction of the War Cabinet, the Minister of Munitions has made arrangements for the appointment of an inter-departmental Committee to prepare a scheme for the establishment in London of an Imperial Mineral Resources Bureau to collect information in regard to the mineral resources and metal requirements of the Empire, and to advise what action, if any, may appear desirable to enable such resources to be developed and made available to meet requirements.

The Committee consists of the following gentlemen:—Sir James Stevenson, Bart. (Chairman), Mr. C. L. Budd, Sir A. Duckham, K.C.B., Professor W. R. Dunstan, C.M.G., Mr. C. W. Fielding, Mr. J. E. N. Green, Right Hon. Lord Islington, G.C.M.G., Mr. L. J. Kershaw, C.I.E., Sir T. Mackenzie, K.C.M.G., Hon. Sir G. H. Perley, K.C.M.G., Mr. W. S. Robinson, Right Hon. W. P. Schreiner, C.M.G., K.C. The Secretary to the Committee is Mr. Oswald C. Allen, and all communications on the subject should be addressed to him at the Ministry of Munitions, Whitehall Place, S.W.1.

INTERPRETATIONS OF EXPORT PROHIBITIONS.

The following interpretations of prohibitions of export from the United Kingdom have been issued by the Director of the War Trade Department, 4, Central Buildings, Westminster, S.W.1 (P.=Prohibited, N.P.=Not prohibited to any port or destination except in Sweden):—

Alcohol in which microscopic slides or laboratory specimens are packed, N.P. Aniline dye, manufactured articles containing not more than 3% of, as the only prohibited ingredient, N.P. Argols, crude (used in the making of tartaric acid), P. Blast-furnace tar, P. Bradford sewer grease, P. Capsicum essence made from chillie fruit, P. Carboic acid and formaldehyde B. & W. mixture known as "liquid resin," P. Carboic acid in preparations containing not more than 1% extractable crystals as the only prohibited ingredient, N.P. Carbon brushes, P. Cardamoms, P. Chloroform, P. Clay, diatomite, N.P. Copper scale (or copper pickle dust), P. Cutch, P. Ether, ozonic, P. Firebricks and fireclay forming integral parts of manufactured goods not otherwise prohibited, N.P. Flint, powdered, N.P. German silver, P. Glycerin in toilet and other preparations containing not more than 1% as the only prohibited ingredient, N.P. Hard lead, P. Incandescent mantle rings (magnesia), P. Lamp black, N.P. Manganese dioxide or black oxide of manganese, P. Naphtha, wood, P. Nickel silver, P. Perfumed spirits, N.P. Pyrometers, P. Rectified spirits of wine, P. Tartar emetic, P. Terebene, P. Tin foil, P. Umber (a coloured earth), N.P. Vaseline P. Vulcanising compound, composed of rubber, litharge, and sulphur, P.

EXPORT PROHIBITIONS.

The Supplement to the "Board of Trade Journal" of 31st May contains complete lists of articles which, according to the latest information received by the Board of Trade, are prohibited to be exported from Denmark, France (including Algeria), Italy, Japan, and the Netherlands. The Supplement also contains the list of articles (complete to date) which are prohibited to be exported from the United Kingdom.

EXPORTS TO SWITZERLAND.

The May 31st issue of the "Board of Trade Journal" contains, on pages 179—196, a list, corrected to May 19th, of articles in respect of which licences for export to Switzerland are only granted if the goods are consigned to the Société Suisse de Surveillance Economique, showing also those which are allowed to benefit under the special system for small parcels.

NORWAY: PROHIBITED EXPORTS.

The exportation of the following articles from Norway has been prohibited:—Calcium chloride, Carboic acid, Coal pitch, Creosol, crude, Dégras, Formalin, Hydrochloric acid, Sodium sulphate, calcined and crystallised.

SWEDEN: PROHIBITED EXPORTS.

The exportation of the following articles from Sweden has been prohibited as from the 20th May:—Asphalt lac and "zapon" lac, Asphalt, manufactures of, not specially mentioned in the Swedish Customs Tariff, with or without admixture of sand, gravel, textile waste or the like, and even if combined with other material, Carborundum (carbide of silicon) and other carbides not specially mentioned in the Swedish Customs Tariff, Celluloid, celloidin, galalith, ambroin, eburin and other

similar artificial plastic materials, not specially mentioned in the Swedish Customs Tariff. Cement, Portland, ordinary grey, white, or coloured, ground or not, and slag cement, trass and other varieties of cement used for building purposes. Chrome acetate. Disinfectants, not specially mentioned in the Swedish Customs Tariff, containing soap or soft soap, such as lysol and creolin. Formalin in aqueous solution. Formic acid and lactic acid. Fusel oil. Insulating compositions (for protection against heat or cold), dry or liquid, consisting of two or more mineral substances, such as asbestos, kieselsuhr, asphalt clay, or cement, with or without admixture of cotton fibres, animal hair or the like, or consisting of one mineral material with admixture of such materials; also manufactures of the compositions specified, such as slabs, segments, and other shaped pieces. Mercury and mercury alloys (amalgams). Oxalic acid, and oxalates of potassium, sodium, and ammonium. Paints, even if dry, prepared with base other than oil (such as with albumen or casein), and colours not specially mentioned in the Swedish Customs Tariff. Quillaia bark. Resin in lumps, or powdered, also turpentine and other natural balsams, including liquid resin, such as sulphate resin and crude pine and fir resin. Tar distillation products—benzol, carbolic acid, cresol, naphthalene, creosote oil, carbolineum, and the like, also carbolic lime. Tartar and seignette salts and other tartrates of potassium, sodium, and ammonium. Vegetable waxes (carnauba, palm, and other). Vulcanised fibre and other chemically prepared fibre board in plates or sheets (leaves). Vulcanised fibre in tubes or rods.

RESTRICTIONS ON DEALING IN SULPHURIC ACID.

The Minister of Munitions has issued an Order, under date 29th May, to the following effect:—

1. No person shall as on and from 11th June, 1917, until further notice, manufacture sulphuric acid except under a licence issued by or under the authority of the Minister of Munitions and in accordance with the terms and conditions of such licence as to the quantities to be manufactured or otherwise.

2. No person manufacturing sulphuric acid shall as on and from 11th June, until further notice, use during any one calendar month more than ten tons in all of 95% sulphuric acid (or its equivalent in acid of other strengths) for the purpose of all other manufactures, trades and businesses carried on by him except under and in accordance with the terms and conditions of a licence issued by or under the authority of the Minister of Munitions.

3. No person shall as on and from 30th May, until further notice, supply sulphuric acid (including waste sulphuric acid) to any person except under and in accordance with the terms and conditions of a licence issued by or under the authority of the Minister of Munitions. Provided that no licence shall be required to supply not more than 56 lb. of 95% sulphuric acid (or its equivalent in acid of other strengths) to any person during any one calendar month. And provided also that any sulphuric acid supplied

subsequently to the date of this Order, in pursuance of written directions or requests given or made by or on behalf of the Minister of Munitions previously to the date of this Order shall unless and until such written directions or requests are cancelled or withdrawn be deemed to have been supplied under a licence issued under the authority of the Minister of Munitions within the meaning of this Order.

4. As on and from 29th May until further notice, no manufacturer of sulphuric acid, or agent of such a manufacturer, shall charge or receive in payment for any sulphuric acid supplied by or through him a price exceeding the maximum price specified in the schedule to this Order for sulphuric acid of the description and strength supplied. Provided that the maximum prices specified in the schedule hereto shall not apply to—(a) Sulphuric acid supplied to persons outside the United Kingdom under export licences; (b) sulphuric acid manufactured outside the United Kingdom; (c) sulphuric acid made wholly from brimstone; (d) sulphuric acid specially purified for laboratory purposes.

5. All persons engaged in producing, manufacturing, selling, distributing or storing sulphuric acid (including waste acid), or in any manufacture, trade or business in which the same is used, shall make such returns with regard to their businesses as may from time to time be required by or under the authority of the Minister of Munitions.

6. For the purpose of this Order the expression sulphuric acid shall include sulphuric acid of all strengths up to 100% H_2SO_4 , but shall not include acid containing free SO_3 (commonly called oleum or fuming sulphuric acid).

NOTE.—All applications in reference to this Order (including applications for licences) should be addressed to the Director of Acid Supplies, Ministry of Munitions, Department of Explosives Supply, Storey's Gate, Westminster, S.W.1.

SCHEDULE.

Maximum prices for sulphuric acid.

1. *Weak acid, i.e., acid of all strengths up to and including 90% H_2SO_4 .*

Maximum price per ton.

Class A.	Arsenical acid	78s.
Class B.	Non-arsenical or de-arsenicated acid.	85s.

For acid of 140° Tw. at 60° F., with an increase or reduction of 5d. in respect of each complete degree Twaddell by which the specific gravity is more or less than 140° Tw. at 60° F.

For acid of 144° Tw. at 60° F., with an increase or reduction of 6d. in respect of each complete degree Twaddell by which the specific gravity is more or less than 144° Tw. at 60° F.

2. *Concentrated acid, i.e., acid of all strengths over 90% H_2SO_4 .*

Maximum price per ton.

Monohydrate (H_2SO_4) content of acid.	Class C.		Class D.	
	Arsenical acid.		De-arsenicated or non-arsenical acid.	
Over 90 and up to 91	£	s. d.	£	s. d.
.. 91 .. 92	5	3 0	5	13 0
.. 92 .. 93	5	9 0	5	19 0
.. 93 .. 93½	6	1 0	6	5 0
.. 93½ .. 94	6	4 0	6	11 0
.. 94 .. 94½	6	7 0	6	17 0
.. 94½ .. 95	6	10 0	7	0 0
.. 95 .. 95½	6	15 0	7	5 0
.. 95½ .. 96	7	0 0	7	10 0

Over 96 in both classes, an addition of 1s. per ton for each complete one-tenth of one per cent. of additional monohydrate.

Packages.

All the above maximum prices are for acid delivered into tank wagon, tank cart or tank barge at makers' works.

When the acid maker supplies the railway tank wagons he shall be entitled to make a further charge of not more than 5s. per ton for hire of such wagons. When the acid maker supplies the acid in his own drums he shall be entitled to make a further charge of not more than 10s. per ton for filling and hire of drums. When drums are supplied by the purchaser a charge of 2s. per ton may be made to cover the cost of filling. When the acid is supplied in the acid maker's own carboys he shall be entitled to make a further charge of £1 per ton for filling and hire of carboys. When carboys are supplied by the purchaser a charge of 5s. per ton may be made by the acid maker to cover the cost of filling.

Extra carriage.

In cases where a maker of sulphuric acid has, in order to supply his customers, to purchase supplies of acid from a third party, it will be permissible for him, in so far as this is a departure from his normal procedure, to charge to his customers any extra cost of carriage thereby incurred.

Birmingham Section.

Meeting held at White Horse Hotel, Birmingham, on Thursday, March 29th, 1917.

MR. HARRY SILVESTER IN THE CHAIR.

THE USE OF NITRE CAKE AS A SUBSTITUTE FOR SULPHURIC ACID IN THE PICKLING OF ANNEALED BRASS.

BY H. W. BROWNSDON, M.Sc., Ph.D.

Under present abnormal conditions, the quantity of sulphuric acid used for the pickling of annealed brass must run into several hundred tons per week. Difficulty in obtaining raw material and labour, coupled with the increased demand of sulphuric acid for other purposes, has resulted in an extended application of nitre cake solutions in place of dilute sulphuric acid for the pickling of annealed brass.

As a pickling agent, nitre cake solution is inferior to sulphuric acid and under certain conditions its use leads to very unsatisfactory results. For this reason, the subject of this communication is of more than passing interest to those who have to deal with the rapid pickling and cleaning of large quantities of annealed brass.

The two products controlling the success or otherwise of the process, are the nitre cake and the annealed brass.

Nitre cake is essentially crude acid sodium sulphate, and whilst the latter in the pure anhydrous state contains theoretically 40.8% of sulphuric acid, the free acid found in nitre cake may vary from 5 to 30%. It is evident that where difficulty may be experienced in obtaining satisfactory results with nitre cake poor in free acid, complete satisfaction may be given with better qualities, and in purchasing a by-product of this nature for pickling purposes a minimum content of free acid should be specified. In the Midlands there is no difficulty in obtaining nitre cake showing 25 to 28% of free acid calculated as sulphuric. Nitre cake invariably contains small quantities of free nitric acid which, however, from a pickling point of view are negligible.

For pickling, the nitre cake solution should be of such strength as to show 3 to 5% of sulphuric acid on titration, and for reasons which may be considered later, there is no advantage to be gained in using solutions of higher acid concentration.

Whilst nitre cake is a variable product, annealed brass from a pickling point of view may be even more so. According to the conditions of annealing, it may be clean, practically free from superficial oxides and of a brassy lustre, or it may be dirty, black in colour and badly stained through oxidation and contact with injurious furnace gases. Given clean work, nitre cake solutions replace dilute sulphuric acid quite efficiently, but with dirty work the difference is much more marked, and nitre cake solutions, even under the most favourable conditions, may fail to pickle the work satisfactorily. In the latter case the use of nitre cake in place of sulphuric acid becomes a serious handicap and deterrent to rapid production, especially when manufacture consists of a sequence of mechanical operations between each of which the product has to be annealed, pickled, and cleaned. It is little consolation for the manufacturer to know that his troubles lie in his annealing furnaces, for he cannot equip himself with furnaces of new type in order to overcome difficulties of pickling, and it is left to him to see that the nitre cake solution is used under the most favourable conditions possible for efficient pickling. Much may be done on the following lines in this direction.

(a) The nitre cake solution should be as hot as possible.

(b) Its acid content should be tested frequently and maintained at 3 to 5% by the addition of nitre cake.

(c) The hot annealed products may be quenched in water, whereby much scale is mechanically loosened and readily recovered prior to pickling.

(d) The hot annealed work may be placed direct into the nitre cake solution. The pickle can thus be maintained at a high temperature without auxiliary steam heating.

(e) Oxidising agents such as ferric salts, bichromates, or persulphates may be added to the pickle. Their addition stimulates the solvent action of the nitre cake solution, but their action is not constant and in many cases the price is prohibitive.

(f) Electrochemical aid might be sought by using a low voltage current, making the lead lining of the vat the cathode and the work to be pickled the anode.

(g) The movement of the work in the pickle or the agitation of the pickle during pickling.

The difficulties met with in the successful use of nitre cake solution can only be overcome in a satisfactory manner by, in the first instance, paying close attention to the conditions governing the annealing, so as to obtain the annealed brass as clean as possible, and secondly, by using the nitre cake solution under conditions which will most strongly stimulate its pickling activity.

The comparative sluggishness of nitre cake solution as compared with dilute sulphuric acid of equal acidity may be theorised upon in the light of the ionic dissociation of chemical substances when in aqueous solution. That the solvent power of an acid is reduced by the addition of a quantity of neutral salt of the same acid is a fact made use of in several analytical separations by precipitation.

It is quite likely, however, that the action of pickle is not simply solvent, as between oxide film and acid. In the case of annealed brass being immersed in an acid pickle, all the elements are present for electrochemical action, and the difference in potential arising between the metal and the oxides may produce minute local currents

which may aid or deter the solvent action of the pickle according to the nature of the free ions present in the pickle, which then becomes the electrolyte.

From the point of view of economy in future developments, at present ruling prices of £1 per ton for sulphuric acid and nitre cake at £1 per ton, there is not much to choose, but the economy of metal which would result from the more general use of muffles annealing bright or clean would be considerable, and if the use of nitre cake forces us to pay more attention to economical annealing conditions, it will have achieved indirectly some good purpose.

DISCUSSION.

Mr. F. H. ALCOCK said that nitre cake frequently contained considerable quantities of nitric acid, and it was not justifiable to consider the free acidity as due entirely to sulphuric acid. The use of an ammonium salt has been advocated to improve the working of the pickling material. He agreed that the higher the temperature the better the result, owing to the removal of the nitric acid.

Mr. E. KILBURN SCOTT said that the common method of dissolving the nitre cake was to throw the material into the "bosh," and to make the solution in a spare bosh. The importance of using steam in these boshes could scarcely be exaggerated, and yet the number of firms using steam was small. The agitation of the boshes was essential for work on tubes; there was a certain agitation when the tubes were lifted out and put back again, but continued agitation could be maintained by rockers. Much of the waste of metal and acid was due to men being engaged on piece work, and requiring a strong solution in the morning.

Mr. C. LEIGH agreed as to the utility of nitre cake, which, he said, was often condemned because the sulphate was not washed out sufficiently. The difficulty was that the picklers would not keep the boshes clean. His difficulty had been to get nitre cake containing sufficient sulphuric acid.

The CHAIRMAN said that nitre cake contained little acid: he had found never more than 17%, and as low as 5%. He had known it take half-an-hour to remove any trace of oxide from a piece of sheet steel. He could not understand why the large amount of sulphate of iron which was obtained could not be directly used for the manufacture of sulphuric acid. He agreed that the agitation of the bosh increased the efficiency of the pickle.

Dr. BROWNSDON, in reply, said that 25% of acid was obtained from nitre cake on titration. The oxidation products of brass were deceptive; zinc oxide predominated even in the presence of black scale. In spent pickle the zinc percentage was in higher ratio. An effective way of dealing with the cake was in tubs in the solid form.

Liverpool Section.

Meeting held at the University on Friday, January 26th, 1917.

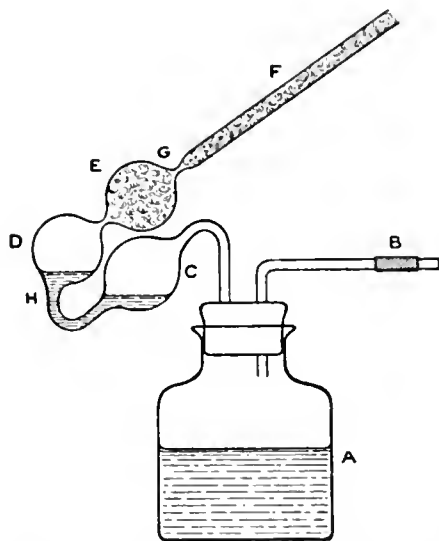
MR. JOHN GRAY IN THE CHAIR.

APPLICATION OF THE GUTZEIT TEST TO WORKS' DETERMINATIONS OF ARSENIC.

BY C. HOLLINS, B.Sc.

The apparatus described below, which is a modification of that used by Bird (Chem. and

Drug., 1901, 600; see also Sanger and Black, this J., 1907, 1115), has been found very useful for determining the quality of dearsenicated vitriols. It is also applicable to estimation of arsenic in phosphates, phosphoric acid, and other substances containing only small quantities of arsenic.



As shown in the diagram, A is a wide-mouthed bottle of about 100 c.c. capacity, fitted with a two-holed rubber bung. B is a glass tube bent at right angles and stoppered by rubber tube and glass rod. B is used for clearing out the gas after an unfinished experiment. It also enables the washing apparatus to stand conveniently when the bung is removed from the bottle. B may be replaced by a small tap-funnel if desired.

The washing bulbs, C, D, and E, are blown on a piece of glass tubing 4—5 mm. internal diameter. The diameter of each is about 2 cm. C and D contain a little lead acetate solution (10—20%). E is tightly packed with glass wool, which is wetted with the lead acetate solution. The tube is constricted between bulbs, D and E, to facilitate the packing of E. A constriction at H produces regular bubbling. F, 10 cm. long, carries the mercuric chloride paper strip, which is supported by the constriction, G. G also serves to direct the flow of gas. The paper must be shielded from too bright daylight by a cardboard cover placed over F—a piece of thermometer case is convenient—or F may be painted black. F is inclined at about 45° to the vertical. This results in more satisfactory stains than a vertical tube and permits of a faster evolution of gas without undue lengthening of the stain. Apparently there is no advantage in making F horizontal.

Mercuric chloride paper. Thin Michallet drawing paper is cut into sheets of convenient size and soaked in water (in a photographic developing dish) until limp. The water is drained off and replaced by 1% mercuric chloride solution in which the paper is kept moving for half an hour. The sheets are then drained and dried in a steam oven separately. They must not be unduly exposed to bright daylight. When dry the sheets are cut into strips about 4½ in. long and of uniform width (2—3 mm.). The strips are kept in the dark in a test-tube fitted with a rubber bung. They are reliable for two or three months.

Standard stains:—A standard arsenic solution containing 0.001 mgrm. As_2O_3 per c.c. is used. (This may be made from N/10 sodium arsenite

by diluting 20·21 c.c. to 1 litre and further diluting 10 c.c. of this to 1 litre.)

In the bottle are placed x c.c. of standard arsenic solution, $40-x$ c.c. of water, and 2 c.c. of pure arsenic-free sulphuric acid. A strip of mercuric chloride paper is placed in position, 3—4 grms. of pure arsenic-free zinc added to the liquid, and the bung at once replaced. By the judicious admixture of a little zinc which has been previously used, the rate of evolution of the stream of gas may be kept regularly at 2—4 bubbles per second.

After half an hour the stain is complete. The standard is transferred to a bulb tube containing phosphorus pentoxide (kept in the bulb by a stopper of cotton wool), and the tube is sealed off. Convenient standard stains are those corresponding to 0·001, 0·002, 0·005, 0·010, 0·015, 0·020, 0·025, 0·030, 0·040 and 0·050 mgrm. As_2O_3 . The stains blacken quickly in direct sunlight and should be exposed as little as possible to daylight. With ordinary care a set of standard stains will be reliable for about three months. The sensitiveness of a new batch of paper must always be tested by preparing two or three standards from it.

Determination of arsenic in de-arsenicated vitriol. In the bottle are placed 40 c.c. of water, a measured volume of the vitriol (0·5 to 2 c.c.), and enough pure arsenic-free sulphuric acid to make up the total acid to 2 c.c. at 168° Tw. Three drops of stannous chloride solution (arsenic-free) are added to reduce arsenic compounds, the paper strip is placed in the tube, and 3—4 grms. arsenic-free zinc added as before. After half an hour the stain is compared with the standard stains, and its value estimated in micromilligrams As_2O_3 , and expressed as parts As_2O_3 per million of acid.

If by reason of too large a volume of lead acetate solution in the bulbs the paper strip becomes wet, the experiment is spoiled. The tube, F, should be dried when necessary by means of a screw of filter paper. Too vigorous reaction produces a long stain. The best stains are produced when the gas comes off at about 2 bubbles per second.

The most accurate results with 1% mercuric chloride paper are given by stains between 7 and 20 micromilligrams. The accuracy attained is within 5%. With stains of 35 or less there is no loss of arsenic hydride. This was proved by taking varying amounts of a de-arsenicated vitriol. The results with stains of 40, 32, 24, 16, and 8 micromilligrams were identical. In other experiments mercuric chloride paper was fastened across the top of tube, F, in addition to the strip in its usual position. No stain was visible at the top of the tube, even on development with concentrated hydrochloric acid. Under certain conditions of dilution appreciable quantities of hydrogen sulphide are produced during the reaction. The experiment is quite reliable, however, unless enough hydrogen sulphide is formed to blacken the glass wool.

The time occupied by a single determination is less than 35 minutes. With a dozen sets of apparatus twelve determinations are easily made in 45 to 50 minutes. On 1 c.c. of concentrated vitriol or two grams of other substances the range of the test is 0·3 to 27 parts per million.

A stain which is otherwise invisible may be developed by touching the paper with a drop of concentrated hydrochloric acid. A stain which is just visible on development represents about 0·05 micromilligram of As_2O_3 .

Many experiments have been made with paper of different qualities and weights. Thin filter paper can be made most sensitive but is less convenient to handle than the Michallet drawing paper. The sensitiveness is decreased by using a stronger solution of mercuric chloride. It does not increase on dilution beyond 0·5%.

Prepared with 1% solution is nearly three times as sensitive as that prepared with a saturated solution.

The apparatus is easily cleaned by rinsing under the tap. A little concentrated nitric acid removes all lead sulphide and sulphate, but all trace of nitric acid must afterwards be washed out with water. The lead acetate solution requires renewal after about a dozen experiments.

The method was primarily devised for works determinations on de-arsenicated vitriol and for this it has proved itself eminently satisfactory. It is quite applicable, however, to other substances, such as phosphates and phosphoric acid, containing small quantities of arsenic. The time necessary for completion of the stain varies for different substances.

The apparatus and also strips of mercuric chloride paper are supplied by Messrs. Towers of Widnes.

In conclusion I should like to express my thanks to the United Alkali Co. of Widnes, in whose laboratories most of my experiments have been performed, and to the Ministry of Munitions for permission to publish this paper.

Newcastle Section.

*Meeting held at Bolbec Hall on Wednesday,
April 25th, 1917.*

MR. H. PEILE IN THE CHAIR.

FUSED SILICA.

BY DR. FRANK BOTTOMLEY.

Numerous attempts to fuse and work quartz or other forms of silica have been made during the last seventy years. In 1839 a French experimenter, Gaudin, fused quartz into a pasty condition with an oxy-hydrogen blowpipe, and similar experiments were also made about 1878 by another French worker, Gautier.

The first practical results were, however, obtained by Boys, who devised an ingenious method of making very fine filaments by shooting off lumps of silica from a softened quartz crystal by means of a crossbow; these filaments were employed in delicate electrical instruments, as for example for suspending the mirror in galvanometers. Other early workers in the field were Dufur and Le Chatelier and the firm of Schott and Genossen in Jena who exhibited a quartz lens in the Paris Exhibition of 1900. The experiments up to this date were, however, chiefly of academic interest.

In 1901 Shenstone read a paper before the Royal Institution, in London, giving the result of his experiments in working quartz by means of an oxy-hydrogen blowpipe, and gave details of a practical method of producing articles of fused quartz from rock crystal. Shenstone's method consisted in fusing a number of small fragments of crystal together to form a rough rod by means of an oxy-hydrogen blowpipe, and this rod was heated and drawn out into a thick thread. A number of these threads were bound together round a thick platinum wire and the individual rods fused together so as to form a tube. This tube was then drawn out, closed at one end, and shaped by blowing as is done in working glass, except that the quartz has practically to be worked in the blowpipe flame itself. Shenstone exhibited many articles which showed great manipulative skill in their manufacture.

At the fifth International Congress of Applied Chemistry in 1903, Dr. Heraeus read a paper on fused quartz, giving the results of his experiments

in fusing this material and producing articles of transparent silica. He also exhibited a very fine collection of apparatus manufactured in the workshop of Siebert & Kuhn, Cassel. The method employed by Heraeus was also chiefly a blowpipe one, though he made use of an iridium tube which I believe was heated electrically for the preliminary preparation of his raw material.

The methods of both Shenstone and Heraeus were developed commercially, the former by the Silica Syndicate of London and the latter by his own firm, W. C. Heraeus, of Hanau, though the methods now employed by these firms probably differ altogether from the somewhat crude methods which had to be adopted to begin with.

The methods which I have described so far are so expensive that large scale working was out of the question on account of the high price of pure rock crystal and the cost of using the oxy-hydrogen blowpipe. The attention of workers was therefore turned to the possibility of fusing silver sand, which contains over 99% silica, and to the adoption of electrical methods for fusing the material.

In 1902 Dr. Hutton read a paper before the American Electro-Chemical Society, in which he described some experiments in making tubes by fusing sand or particles of rock crystal. The material was piled round a central core and fused either by passing a current through the core or by playing an arc flame over the surface of the granulated material. The core was removed after the mass had cooled and a rough tube obtained.

In the same year Elihu Thomson in the United States took out a patent for making articles of fused quartz. By his process a core of the shape of the article required was embedded in sand and current passed through it till the sand had fused so as to take the shape of the core. The core was removed when the fused quartz was cold. Sometimes it had to be bored or burnt out.

About the same time Ruhstrat in Germany took out a patent for a very similar method of working. These methods, however, were of very limited application and did not lead to any practical result.

The chief difficulties in fusing quartz are due, firstly to its very high melting point, secondly, to the fact that the melting point and vaporising temperatures lie very close together, and thirdly, because there is no material sufficiently refractory to act as the containing vessel in which it can be fused, nearly all materials reacting with silica at the fusion temperature.

Heraeus in Germany has taken out a patent for the use of zirconia vessels for fusing quartz, but such vessels are not to be had at the present time in sizes which would be useful for practical working.

Before leaving the history of development of the manufacture of quartz, for the sake of historical accuracy I would like to refer to a statement which has been made in the German and Continental Press. The founder of the Deutsche Quarz Gesellschaft, Dr. Voelker, read a paper before the Dutch Chemical Society, at Nymegen in 1910, in which he claimed that a German firm, Ludwig Bolle und Co., which consisted of himself and Ludwig Bolle, had succeeded independently in 1904 in fusing sand. The facts of the case are the following: Ludwig Bolle und Co. was a firm engaged in exploiting certain electrical heating apparatus and furnaces but not in the manufacture of quartz, but for a short time they took up the sale of articles of fused silica manufactured at Wallsend. This arrangement lasted only a short time owing to financial difficulties and their firm went into liquidation. Dr. Voelker then became very much interested in quartz and spent several years in experimental work. His earliest patents were taken out in 1907 but were not of practical value; it was only in 1910 that the Deutsche

Quarz Ges. commenced to manufacture quartz by a process which led to patent litigation that ended disastrously for the German firm. I should not have referred to this matter but for the fact that it has been common practice for the Germans to claim priority for many new developments to which they are not entitled.

In the first experiments which we carried out at Wallsend in 1903, attempts were made to obtain a mass of molten quartz or sand in a liquid state and to work it much in the same way as glass is worked, but we very soon discovered that this was out of the question.

Although it is very difficult to get silica really fluid, it can be got into a plastic condition much more readily, and after a large amount of experimental work had been done, methods were evolved for working it in this condition.

The type of furnace employed is an electrical resistance one, the heating core or resistance consisting of plates, tubes, or rods of carbon or graphite. The limits within which such furnaces can be worked are exceedingly narrow because the temperature at which silica reacts with carbon to form carborundum is very close to the temperature required for working silica. The electric furnace, however, renders it possible to control the temperature of fusion, as accurate measurements are relatively easy.

In the manufacture of tubes or pipes the starting point is a hollow cylinder of plastic silica; this is formed by fusing a mass of sand round a central core through which the current is passed. The size of the cylinder is of course decided by the amount of electrical energy passed through the core and the length of time the heating is continued. As soon as the hollow cylinder has been formed the heating core is withdrawn from the centre of the mass, which can then be removed from the furnace and drawn into tubing. If a moulded article such as a pipe is required, the hollow plastic cylinder is closed at one end by mechanical pressure and a refractory nozzle, to which a source of compressed air is attached, pressed into the other end; the fused mass is then placed in the mould and expanded with compressed air till it assumes the required shape. The weight of fused material which can be worked at the present time exceeds 200 lb., and it is interesting to compare this with the small blowpipe pieces which were made by Shenstone and Heraeus in 1902. The temperature required for fusing silica is between 1800° and 2000° C. In the plastic condition it is extremely ductile and can be drawn out like glass in lengths of 90 to 100 feet.

The material made by the process I have described is rough on the outside, but small laboratory ware is subjected to a further process of grinding and finally glazing by melting the surface. This may be done electrically or by an oxy-hydrogen blowpipe.

Unfortunately owing to the extreme viscosity of plastic silica it is very difficult to remove the fine air bubbles which are found mixed with and contained in sand, and this has so far prevented the material made from sand from being entirely transparent, though very great improvements have been, and are still being, made in this direction. The lustrous appearance of some of the material is due to reflection from the included air.

The specific gravity of fused silica made from sand is 2.07 as compared with 2.2 for the material made from rock crystal. The coefficient of expansion of the two materials is practically the same, viz., 52×10^{-6} . A rod 1 metre long heated from 0° to 1000° C. expands 0.5 mm.

The properties of fused silica are now generally well known. Fused silica is unattacked by practically all acids except hydrofluoric acid and phosphoric acid above 400° C., and at the same time on account of the very small coefficient of expansion it is able to resist extreme changes of

temperature without cracking. These properties make it of great value for the manufacture of chemical plant.

At the outbreak of war there was a serious shortage of refractory and acid-proof material, which was very largely stoneware imported from Germany. Fused silica was to some extent able to make good the deficiency, and I am glad to say that in this respect it has played a considerable part in equipping the numerous factories which have been erected for ourselves and our Allies for the manufacture of explosives, especially in connection with the concentration of sulphuric acid and the condensation of nitric acid. For example, a large proportion of the nitric acid plants in this country have been fitted with Vitreosil condensers and conduit pipes, and we have also been able to supply our Allies with such plants.

Nitric acid plant.

A typical arrangement of the nitric acid plant is shown in Fig. 1. The cast-iron retort is connected by a silica socket pipe, A, with the range of silica conduit pipes, B, C, D, to the collecting piece, E; the branch pipes, F, lead the gases from E to the coils, G (only one shown), cooled by a water spray, where the main part of the condensation takes place. The residual nitrous gases pass out through H into the usual absorber, while the condensed nitric acid flows down the vertical pipe into a U tube, K, immersed in a small tank where cold water is circulated; thus the whole of the acid comes off at a low, uniform temperature. The cooled nitric acid flows off through the swan-neck pipe. A hydrometer floats in the exit side of the U tube, K. A very important feature in the design of the above plant is that all the joints have the socket below and vertical to protect the jointing cement, and prevent leakage of liquid or gas. A sightpiece in the small exit pipe allows the attendant to note the quantity and colour of the run of nitric acid.

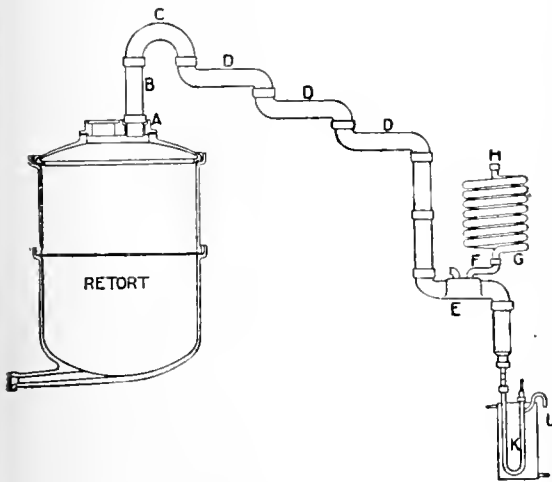


FIG. 1.

With a retort of dimensions about 10 ft. deep and 7 ft. diameter this plant is capable of working off a charge of 2 tons of nitrate of soda, with its equivalent of sulphuric acid, in 8–10 hours. In this particular case the conduit pipes, A to E, are 8 in. internal diameter, and lead into four coils each 2½ in. diameter and 60 ft. long.

An alternative arrangement to the coils G (fig. 2) is a system of S pipes, four tiers of 4 in. diameter pipes having the same condensing surface as the above-described system of coils. These pipes are cooled by a spray of cold water, the same means being used for cooling the condensed acid.

Both these forms are extensively used, and give excellent results. The silica pipes and connections are comparatively light, simplifying the structural supports (not shown in the diagram). The whole of the pipes from C may be water-cooled without fear of breaking.

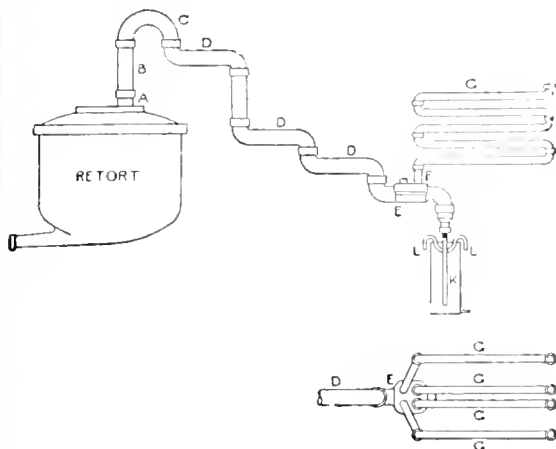


FIG. 2.

The condensing arrangements described above, being on the reflux principle, have the advantage of converting the greater part of the nitrous acid into nitric acid, and so increasing the yield of nitric acid, which thus contains the minimum amount of nitrous acid. This feature is absent from most other systems.

Concentration of sulphuric acid.

For the concentration of sulphuric acid the cascade system has been adopted in many of the largest factories, as on account of its simplicity of construction, ease in repairs, and continuity of working it presents great advantages. Fig. 3 (p. 580) shows one of the latest forms of cascade concentrating plants which has been adopted.

The sulphuric acid to be dealt with may be (a) pure, (b) de-arsenicated vitriol, or (c) waste acid from nitrating processes. These different qualities and strengths involve some changes in treatment, but in general the weak acid runs through a series of beakers, where the preliminary heating and some concentration take place; very little fume is given off in this portion. From the beakers the acid flows through pipes into a series of basins, where the concentration is completed; a good deal of fume is given off here, consequently this portion is covered, and the fume led into suitable condensing scrubbers, a slight vacuum preventing the escape of fumes into the air. The concentrated acid flows through a series of coolers. All the parts in contact with the acid are of silica.

A unit plant consisting of four rows, each row having 15 beakers and 25 basins, will yield 10 tons of concentrated sulphuric acid per 24 hours, with a fuel consumption of 20 per cent. on the acid produced. The silica-beaker arrangement of preheater has been found to be much more efficient than any form of open-tray system hitherto in use, having particularly the advantage over a lead preheater in that there is no danger of overheating and consequent failure of the lead.

The above figures of output relate to ordinary chamber or de-arsenicated acid of 100° or 110° Tw.—say 60% or 65% H_2SO_4 —concentrated to acid of 94.5 to 95.5%.

On the above plan the resulting acid is not contaminated by fire gases or from contact with any metal. The course of the fire gases is contraindicated to that of the acid. Fans are not necessary if a good chimney draught is available.

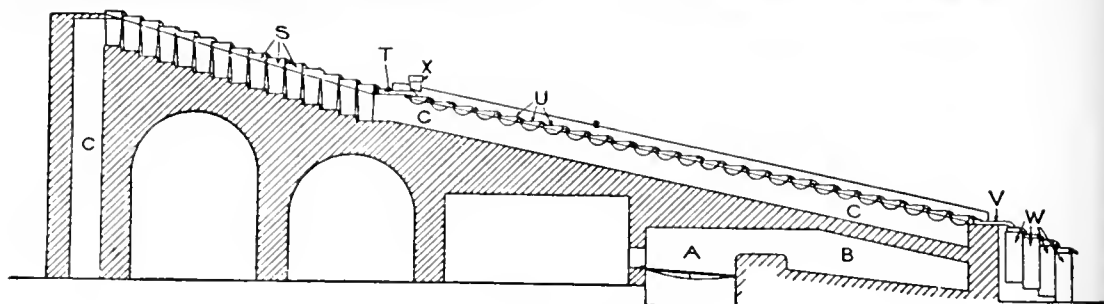


FIG. 3.

Denitration of mixed acid.

One other use in explosives factories which may be mentioned is the denitration of mixed acid from the manufacture of trinitrotoluol. This waste acid contains about 4 to 5% HNO_2 and HNO_3 , and it is advisable to separate these acids before concentrating the sulphuric acid. The operation is performed by running the waste acid down a tower, B (Fig. 4), packed with suitable material. A steam jet, S, is led into the base of this tower, carrying steam at about 50 or 60 lb. pressure, preferably slightly superheated, so as not to weaken unnecessarily the resulting sulphuric acid. The action of the steam is to separate the nitric and nitrous acids from the sulphuric acid, whence they are led from the top of the tower, D, through the pipe, E, into the receiver, F, thence through H into the coil, K, the outlet being led into the usual absorber. The condensed nitric acid flows through the outlet pipe, G. The denitrated sulphuric acid flows from the lead dish, A, to be pumped up to the concentrators. The plant as described, with a tower consisting of four pipes each 2 ft. 6 in. long by 2 in. diameter, is capable of dealing with about 10 tons of waste acid from T.N.T. manufacture per 24 hours.

In addition to the uses described above, there are many others for the material in the chemical and other industries, such as condenser pipes in the manufacture of hydrochloric acid and as basins, etc., for concentrating phosphoric acid, but to put it generally, fused silica is of value in all cases in which heat-resisting and acid-proof qualities are of importance.

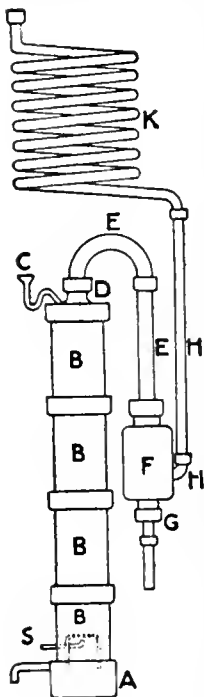


FIG. 4.

Fused silica is already being

largely used for electric heating apparatus, and on account of its valuable insulating properties which are retained at relatively high temperatures, and to the fact that it is not hygroscopic in the same way as glass and china, it makes a very efficient insulator.

In conclusion I may say that as this is an entirely new process which is still in the stage of development, there is no doubt that the manufacture will continue to expand as regards size and variety of product and also as regards the sphere of useful application.

DISCUSSION.

The CHAIRMAN asked whether the joints in silica apparatus could be, or were, ground, and whether any difficulty was found in making joints.

Prof. H. LOUIS asked what was the silica content of the sand used, and said that sand containing 98.8% of silica could be obtained in the Midlands.

Mr. A. TROBRIDGE congratulated the Thermal Syndicate on the quality of their ware, and said he had yet to find a breakage in the silica parts of his nitric acid plant.

Dr. F. BOTTOMLEY, in reply, stated that grinding joints was not necessary, as a proper cement would keep them quite tight. The sand used contained about 99.7% silica. A suitable putty for joints consisted of 40 pts. of asbestos small, 8 pts. asbestos fibre, 10 pts. by weight of whiting, a little tallow, and the balance boiled linseed oil.

Industrial Notes.

JOINT COMMITTEE OF TECHNICAL ORGANISATIONS (ONTARIO BRANCH).

In the Annual Report for 1916-17 of the Joint Committee of Technical Organisations (Ontario Branch), of which Mr. Alfred Burton, of Toronto, is Chairman, it is stated that at a meeting of the executive officers of the various technical and scientific societies, instructions and associations of Ontario, held on the 28th December, 1916, in the rooms of the Engineers' Club, Toronto, a scheme was formulated for the creation of a Joint Committee of Technical Organisations, to consist of one representative from each society, institution, or organisation. These representatives were duly elected, and constitute the first Joint Committee. To facilitate prompt action an Executive Committee of five was named by the Joint Committee.

According to the by-laws, the aims and objects of the committee are "to devise ways and means by which engineers and other technical men may, as a result of their special training and experience, render assistance in the development and government of our Dominions. The immediate aim shall be to evolve a plan whereby such of these men as are unable to go to the front, may be used for war purposes at home in such a manner as their special technical training may make them most valuable." One of the by-laws also gave

power to the Joint Committee to elect "such other technical men, not exceeding five in number, as in their judgment could assist in carrying forward the work of the committee."

The question of organising similar committees in other provinces of the Dominion was immediately taken up with the various technical bodies in those provinces, and the idea has received hearty and, for the most part, enthusiastic support, so much so that joint committees have already been formed or are in process of formation in almost all of the provinces. The logical sequence, it is believed, will be the formation of a Dominion-wide Committee to give united expression to the aims and objects of the various joint committees.

One of the first activities of the Joint Committee, designed to form a basis of future operations, was to take a man-power census of all the members included under the plan of organisation. This necessitated, first of all, the compilation of a list including all the members of the various bodies—some 2500 in all. Cards were prepared and mailed to the last known address of every engineer and technical man in Ontario, and most of these have been returned. The information obtained by this means has been carefully filed, so that there is now available a systematic classification of the technical men of the province, together with their qualifications and special training and experience.

The attention of Government boards and commissions, engaged in carrying on the various phases of the war, has been drawn to the formation of the Joint Committee, as it was felt that it could be of assistance to them in many ways. Without exception, these bodies have expressed themselves as deeply appreciative of the value of such an organisation of technical men, and the committee is in close touch with the Imperial Munitions Board, the Honorary Advisory Council for Scientific and Industrial Research, the Department of Militia and Defence, and the Soldiers' Aid Commission. Other departments of the Government will be approached as time and opportunity offer.

The members of the committee have also interested themselves as a body in the question of the establishment of industrial research bureaux or laboratories at various points in Canada, for the purpose of co-relating more intimately the world of pure science with the world of commerce. The best method of procedure to further their aims is at present under consideration.

The committee has consented to act in conjunction with the Canadian Manufacturers' Association in obtaining information for the Advisory Council as to the present extent of, and resources for, research work at various points in the province. A questionnaire to fulfill this purpose has been prepared and is being sent to all manufacturers. A special sub-committee has been appointed to look after this part of the Joint Committee's activities.

Sub-committees have also been appointed to keep in touch with other activities undertaken, as follows:—*Imperial Munitions.* The sub-committee having this in charge is keeping in close touch with the Imperial Munitions Board, supplying technical men required by the board in munitions work, obtaining information as to materials required for war purposes, and giving other useful and special information. *Inventions.* This sub-committee has already passed upon a number of inventions submitted to us by the Imperial Munitions Board. *Recruiting.* The endeavours of the recruiting sub-committee have been chiefly along the line of improving the status of the ordinary sapper, whose work corresponds at least in importance to that of lieutenant in the infantry, though his status is merely that of a private. It

is also felt that something should be done to discourage or prevent technical men from enlisting in regular infantry battalions, where their special technical training is liable to be entirely lost to the Empire. *Returned soldiers.* This sub-committee has undertaken to follow up certain suggestions whereby plans might be put into effect for providing vocational training to returned soldiers, to assist them in adapting themselves, as their abilities may permit, to occupy better positions in life. Other plans are also being considered along similar practical lines. *Finance.* The finance sub-committee has gathered in sufficient voluntary subscriptions to enable the necessary expenses to be met to date and also to provide for the fitting out of an office. *Lists.* The lists sub-committee has been appointed to keep the lists up to date. *Classification.* The classification sub-committee has worked out and put into effect a very thorough and comprehensive card index system, which enables the secretary to place his finger immediately on any information required. *Suggestions.* Finally, a sub-committee has been named to initiate of itself, or receive from others, and report upon, suggestions of any nature pertaining to the activities, present or future, of the committee.

SOCIETY OF GLASS TECHNOLOGY.

At a meeting of the above Society held in the rooms of the Institute of Chemistry, Russell Square, London, on May 16th, Professor Herbert Jackson, F.R.S., gave a succinct account of the excellent work accomplished in glass research since 1911 at the instigation of the Institute and the Ministry of Munitions. One outcome of that work had been the placing of at least fifty new batch formulæ at the disposal of glass manufacturers, to experiment with, to adopt, and to improve. Amongst the most important formulæ available might be mentioned batches for (1) resistant and ordinary chemical ware; (2) soft glass for lamp work; (3) combustion tubing; (4) various types of glasses for X-ray work; (5) opal glasses; (6) thermometer glasses; (7) optical glasses. To show the widespread nature of the researches already carried out upon glass he mentioned that the effect of almost every known element had been tried and that many glasses with interesting properties were now available both for present and post-war use.

By fostering research in many directions and by the admission of science in its most advanced form into their industry, glass manufacturers had ensured its progress in the future. The outlook for the future was most encouraging and promising, for numerous interesting problems were needing attention whilst new ideas and new methods all required testing. The glass industry was a striking example of the co-ordination of the manufacturer and scientist at its best.

The lecturer then passed on to the properties of glass, dealing first of all with the relation between hardness and temperature of casting, and leading up to brittleness and the amorphous nature of glass. The causes of crystallisation were pointed out and the analogy between well-known crystallisation phenomena in pure chemistry and in actual glass manufacture was emphasised. In particular the necessity for homogeneity was commented upon. Given good homogeneity many of the problems of annealing, and faulty metal, would automatically disappear. The lecture concluded by the recounting of many new facts dealing with opal glasses and colour in glass, whilst lines on which research could be carried out were indicated.

BENZENE AND TOLUENE FROM PETROLEUM.

In view of the statements and claims that have been made in connection with the Rittman or "vapour-phase" process of producing benzene and toluene from petroleum oils, it is instructive to read an account of actual results on a commercial scale, by a chemist who has been in a position to judge the merits of the process. In the issue of the *Oil, Paint and Drug Reporter* for May 7th, Andrew Bender, chief chemist of the Carnegie Plant, Aetna Chemical Co., gives a short history of the working of this process by the Aetna Explosives Co. (which invested over £100,000 in the process), from the beginning until the plant was shut down last year. During this time many variations in size and kind of furnace tubes, pressure, temperature, method of heating, kind of oil used, and rate of oil feed were tried. During the last six months of operation, an average of 8500 gallons of oil per day was passed through the furnaces. The cracked oil contained an average of only 3% of benzene and 2½% of toluene on the oil used, and only about half of these quantities could be separated in a state of sufficient purity for profitable use.

The heavy oil obtained from the furnaces, containing considerable amounts of carbon, was allowed to settle and then distilled up to 175°C. The distillate was first freed from the relatively large amounts of sulphur dioxide and then separated into fractions corresponding to "heads," "crude benzol," "intermediates," "crude toluol," and "residue." The crude benzol and crude toluol fractions contained unusually large amounts of unsaturated hydrocarbons, which were removed by washing with sulphuric acid, after which the oils were washed with caustic soda and further rectified in stills of the Badger type. The presence of paraffin hydrocarbons having boiling points very near to those of benzene and toluene, respectively, rendered it impossible to produce high grade benzol or toluol, the best obtained being from 89 to 93% after repeated distillations. Some of the benzol was used for denaturing alcohol and some for conversion into phenol, whilst further quantities were blended with high-grade benzols. The toluene also was so contaminated with paraffins that it was useless for the manufacture of trinitrotoluene.

The cost of producing benzene and toluene by this process was far in excess of the high prices reached during 1915, and the author concludes from his experience that no possible cracking process could produce benzene or toluene at prices to compete with those at which these hydrocarbons were sold by Germany before the war.

INDIAN CHEMICAL TRADE IN 1915-16.

The annual "Review of the Trade of India," covering the twelve months ending March 31st, 1916, has just been issued as a blue-book [Cd. 8561].

From this report it appears that "chemicals, drugs, and medicines" is one of the few headings under which the imports show an appreciable improvement, the total value having increased from £1,368,000 in 1914-15 to £1,792,000; increases are noted in all the chemicals specified excepting caustic soda, potassium cyanide, and sulphuric acid. Imports of sulphuric acid only

amounted to 257 tons, against 1231 tons in the previous year and 3197 tons in 1913-14. Imports of coal, coke, and patent fuel fell to less than one-third of the imports in 1914-15. Coal-tar dyes also showed heavy decreases (91% in weight and 63% in value). Decreases are also noted in imports of metals and oils (mineral and vegetable), and increases in salt and sugar.

Sugar imports reached 515,000 tons, against 128,096 tons in 1914-15. The production of raw sugar is estimated to have been 2,636,000 tons in 1915-16, on an area of 2,375,000 acres, an increase of 7% in yield compared with the preceding year.

The amount of saltpetre produced in India increased from 15,500 tons in 1914 to 18,098 tons in 1915. Exports, of which about 80% went to the United Kingdom, amounted to 20,702 tons in 1915-16, an increase of 4303 tons over 1914-15. Increases are recorded both in the production and exports of coal, the figures for the year being 17,103,932 tons and 805,290 tons respectively.

Exports of indigo increased by 24,800 cwt. to 41,912 cwt., valued at £1,386,000; the quantity exported has not been exceeded since 1901. About three-fourths was sent to the United Kingdom, whilst the bulk of the remainder went to the United States and Egypt. The total area under indigo in 1915-16 was 311,300 acres—more than double that in the preceding year—and the yield of dye was estimated at 39,900 cwt. against 25,200 cwt. The first forecast for 1916-17 estimates a production of 75,200 cwt. on an area of 625,900 acres.

India is the principal source of supply of lac, and exports in the year under review amounted to 417,000 cwt., valued at £1,145,000. The quantity exported is the highest recorded for five years, but the prices continue to fall, the average having been £2 11s. 10d. per cwt., against £2 18s. 5d. in 1911-15. About 65% of the exports were to the United States and nearly 25% to the United Kingdom.

Exports of oil cake (all kinds) amounted to 150,282 tons, value £757,000; animal bones, fish manures and guano, and other manures totalled 60,178 tons, valued at £296,000.

The total exports of metals and ores were valued at £1,457,000. Exports of manganese ore amounted to 472,563 tons, value £554,000, and of tungsten ore 2787 tons, value £357,000; 80% of the manganese ore and over 90% of the tungsten ore was sent to the United Kingdom. It is estimated that the output of tungsten ore from Burma will reach 4000 to 5000 tons per annum. Exports of lead increased from 6518 tons in 1914-15 to 10,818 tons.

Oil-seeds generally experienced a considerable decrease in exports, the total value falling from £9,670,000 in 1914-15 to £6,582,000; increases were recorded, however, in ground nuts, mustard seed, and castor seed. Exports of vegetable oils and oil cakes increased in most instances, though decreases are reported in sesame oil, and in linseed and rape seed cakes (grouped together). Abnormally large exports of castor oil to the United Kingdom and of coconut oil to the United States are shown. The production of mineral oils, mostly in Burma, increased from 259 million to 287 million gallons, and exports from 26 to 28 millions; over 25,000,000 gallons of the exports consisted of benzine, petrol, and other motor spirit.

Exports of opium declined from 10,856 chests, value £1,176,000, to 8786 chests, value £980,000 (chest = 140 lb.). Of other exports, the following may be noted:—Raw rubber, £814,000; paraffin wax, £542,000; coal, £192,000.

Obituary.

PETER MACEWAN.

Peter MacEwan, Editor of the *Chemist and Druggist*, died suddenly at Highgate on May 16th, aged sixty.

Born at Lochee, Forfarshire, in 1856, he was trained as a pharmacist and followed that profession until 1885, when he joined the

editorial staff of the *Chemist and Druggist*, becoming Editor in 1899, a position he has filled with conspicuous success. He contributed a large number of papers on pharmaceutical subjects to various Associations and Journals, and was the author of several books, including the well-known works, "The Art of Dispensing" and "Pharmaceutical Formulas"; the latter was first produced in 1898 and has passed through nine editions.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each, to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.

United States.—1s. each, to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—Patent number, date, name of patentee, and title of invention.

French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56 Rue Ferou 8 Paris (3e.) Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

Geysers, hot springs, etc.; Commercial utilisation of.—R. M. Gabrié. *Comptes rend.*, 1917, 164, 729—731.

ATTENTION is directed to the large amounts of energy which might be obtained from the natural steam jets and hot springs found in many countries. Since the temperature increases rapidly with depth, borings in the neighbourhood of hot springs would probably yield unlimited quantities of steam.—W. P. S.

Experiments with paper tubes. Rudeloff. *See V.*

PATENTS.

Drying apparatus. A. Sommermeyer, Berlin. Eng. Pat. 105,190, Aug. 26, 1916. (Appl. No. 12,098 of 1916.)

THE material is placed in a drum and is subjected to the disintegrating action of a rotary system of internally heated ribbed tubes.—W. H. C.

Dehydrating or drying apparatus. G. F. Humphrey, and Alliance Vegetable Co., Ltd., London. Eng. Pat. 105,626, Apr. 20, 1916. (Appl. No. 5825 of 1916.)

A PAIR of drying chambers are built back to back with air heating chambers above and below, so arranged that the air can be passed through both heating chambers and drying chambers in series or through either or both heating chambers and one drying chamber. The drying chambers are provided with superposed shelves on which the material to be dried is placed. The shelves are either arranged so as to leave a tapering air space at each end from which the air passes between the shelves in parallel; or they are perforated and the air is passed through all the shelves in series.—W. H. C.

Drying materials in vacuo; Means applicable for use in.—M. W. Blyth and T. V. Miles, Sheffield. Eng. Pat. 105,647, May 11, 1916. (Appl. No. 6770 of 1916.)

MATERIAL to be dried *in vacuo* is placed on shelves in a vessel provided with a cover which fits into an annular channel round the edge of the vessel. The channel contains paraffin wax, and a pipe is embedded in it so that the wax may be melted by passing steam through the pipe. The cover is placed in position and cold water passed through the pipe to solidify the wax and seal the cover. A number of such vessels are placed in a tank containing water heated by steam coils, and the

vessels are connected to a common pipe which is connected to an exhaust pump. The apparatus is specially applicable to the drying of guncotton.

—W. F. F.

Drying materials; Method of and apparatus for.—G. B. Damon, Belvidere, N.J., Assignor to Allis-Chalmers Manufacturing Co., Milwaukee, Wis. U.S. Pat. 1,222,079, Apr. 10, 1917. Date of appl., Aug. 2, 1915.

HOT gas from a producer, together with the material to be treated, is passed along the inner tube of a concentric rotary drying cylinder; the gas is then burned and the products of combustion used to complete the drying.—W. H. C.

Dryer; Mechanical rotary.—W. E. Prindle, Assignor to Buckeye Drier Co., London, Ohio. U.S. Pat. 1,222,211, Apr. 10, 1917. Date of appl., Aug. 5, 1915.

THE dryer consists of an inclined rotating cylinder through which the material is passed in the opposite direction to the heated products of combustion from a furnace. The latter enter the lower or discharge end of the cylinder through a fixed concentric pipe which extends some distance into the cylinder and serves to prevent direct contact between the material and the hot gases after the former has become nearly dry. A short screw conveyor is arranged on the inside of the rotating cylinder just before the open end of the inner pipe, to prevent the material from being thrown into the latter. The heated gases are withdrawn from the feed end of the cylinder by a fan.—W. H. C.

Agitator for dryers. J. Sorensen, Brooklyn, N.Y. U.S. Pat. 1,222,691, Apr. 17, 1917. Date of appl., Aug. 28, 1916.

SETS of relatively short scraping blades are mounted on a shaft within a drum, one set of blades being oppositely faced with respect to the other set. The blades can be simultaneously reciprocated longitudinally, and alternate blades rotated in opposite directions.—W. H. C.

Drying apparatus for asbestos or other material. J. N. Bourque, Thetford Mines, Quebec, U.S. Pat. 1,222,811, Apr. 17, 1917. Date of appl., Feb. 5, 1916.

THE material enters the top of a tower provided with inclined baffles on opposite sides alternately so as to retard the passage of the material. The lower part of the tower is connected with the inlet of a drying kiln, which comprises a rotating shell slightly inclined to the horizontal, and having

on its inner surface projecting longitudinal ribs carrying curved plates, forming a conveying worm which distributes the material in the kiln and conveys it slowly from the upper to the lower end. The lower end of the kiln is connected to the outlet of a furnace, and the hot gases pass over the material in the kiln and tower in the opposite direction, so that the material in traversing the tower is partly dried and preheated. The gases escape at the top of the tower through an outlet other than the inlet for the material.—W. F. F.

Dehydrator. C. Biesel, El Paso, Tex. U.S. Pat. 1,223,245, Apr. 17, 1917. Date of appl., Jan. 17, 1916.

A rotary drum has an annular peripheral space divided by partitions into separate chambers. The outer surface of the drum is covered with suitable screening material, and the chambers are separately connected to a valve on the shaft at one end of the drum. The valve consists of a rotary part which rotates with the shaft, and a fixed part which slides on the shaft and is pressed against the rotary part by a spring. As the drum rotates the valve puts the chambers successively into communication with means for producing suction or pressure.—W. H. C.

Drying chamber for liquid, fluid, and moist materials. W. Loebel, Leipzig. Ger. Pat. 295,799, Oct. 23, 1914.

The material is sprayed into a wide chamber on both sides of which, along the entire length, are air-suction chambers provided with filters, communicating with the lower part of the spraying chamber. Along the bottom of the chamber travelling bands are arranged on both sides and a roof-shaped ridge along the middle, so that the precipitated dry material is delivered from the filters and the ridge on to the travelling bands, which carry it outside before it has time to re-absorb moisture.—J. F. B.

Drying apparatus with moving wire band. A. Schultze, Dresden. Ger. Pat. 296,054, July 30, 1915.

The air jets in a drying apparatus through which the material is carried by a wire band, are so situated that they form a sharp angle in a direction opposed to that in which the material is travelling and overlap each other in the middle. The arrangement of the air jets has the effect of driving the lighter material towards the middle of the wire band but not of blowing it off on the other side. The accumulation of the material towards the middle of the band might impede the drying of that part, but the overlapping of the jets provides for a double supply of air at the middle.—J. F. B.

Drying drum. E. Peters, Charlottenburg. Ger. Pat. 296,834, Aug. 10, 1913.

The interior of the drum is divided into numerous compartments, e.g., by means of radial and annular partitions and with radial guide-plates, the inclination of which to the radial partitions can be adjusted so as to control the distribution of the material within the drum.—C. A. M.

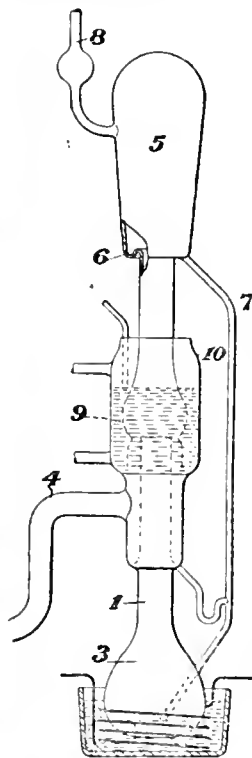
Transference of heat between liquids and vapours or gases; Devices for the —. R. Sawyer and A. C. Ilston, Worthing. Eng. Pat. 105,127, Apr. 8, 1916. (Appl. No. 5191 of 1916.)

A HEAT-EXCHANGING device is formed of three concentric tubes. For example, water flows in one direction through the inner annular space, and is heated by steam which flows in the opposite

direction through the outer annular space. A rod may be used in place of the innermost tube.

—W. H. C.

High vacuum; Method of and means for obtaining —. The British-Thomson-Houston Co., Ltd. London. From General Electric Co., Schenectady, N.Y., U.S.A. Eng. Pat. 105,357, Mar. 10 1916. (Appl. No. 3603 of 1916.)



IN a device for obtaining high vacua in bulbs for incandescence electric lamps, mercury vapour rectifiers, X-ray tubes, and the like, the vessel to be evacuated is connected to the pipe, 4, and mercury is evaporated in the bulb, 3. A jet of mercury vapour issuing from the tube, 1, carries gas from the tube, 4, with it, and passes to the condensing chamber, 5. Condensed mercury collects in the chamber, 6, and returns to the bulb, 3, by the pipe, 7. Back flow of mercury vapour through the pipe, 4, is prevented by surrounding the enlargement, 9, with a condensing jacket, 10. The gas in the chamber, 5, is withdrawn by an exhaust pump attached to the pipe, 8. Aniline, chloroform, or water may be used in place of mercury.—W. F. F.

Ball-mills. W. Everitt and Co., Ltd., and W. Everitt, Southall, Middlesex. Eng. Pat. 105,614, Apr. 19, 1916. (Appl. No. 5742 of 1916.)

IN a ball-mill with cylindrical wall, the internal surface of the wall has longitudinal ribs formed integrally with the wall itself so as to increase the play of the balls.—W. H. C.

Pulveriser; Centrifugal —. H. Adams, Stamford, Conn. U.S. Pat. 1,221,952, Apr. 10, 1917. Date of appl., Apr. 6, 1914. Renewed Oct. 21, 1916.

Two horizontal, rotary discs are spaced apart, and have series of annular ribs of triangular cross-section mounted on their opposed faces. The material to be ground is fed through an opening in the upper disc on to the lower disc.—W. H. C.

Grinding-mill. D. Cole, Tucson, Ariz. U.S. Pat. 1,222,184, Apr. 10, 1917. Date of appl., Apr. 28, 1913.

THE material to be ground is fed through one of the hollow axial shafts of a rotary grinding chamber and, after being ground, flows along with the water to a sorting chamber, which forms an extension of, and rotates with, the grinding chamber. The finely ground material flows away with the water through the other hollow axial

shaft, and the larger pieces, which separate in the sorting chamber, are returned to the grinding chamber by a screw-conveyor fixed within the sorting chamber.—W. H. C.

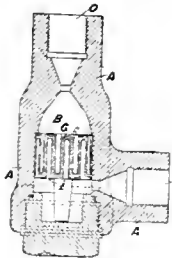
Separator for grinding-mills. W. J. Price, Dixon, Ill. U.S. Pat. 1,223,612, Apr. 24, 1917. Date of appl., May 11, 1916.

THE material from the grinding-mill is delivered to the apex of a cone fixed within a vertical cylindrical casing having conical ends. A current of air is directed against the cone and carries the finer particles upwards to the fine material outlet at the apex of the upper conical end. This outlet is connected to a suitable means of creating suction and has an adjustable conical deflector, suspended below, which serves to collect any coarse particles carried upward by the air current, and to return them through an opening in the apex of the retarding cone below. The coarser particles gravitate to an outlet at the apex of the lower conical end of the casing.—W. H. C.

Straining liquids [e.g., oil fuel for internal combustion engines]; Apparatus for— Cammell Laird and Co., Ltd., Birkenhead, and G. J. Carter, Bromborough, Cheshire. Eng. Pat. 105,630, Apr. 25, 1916. (Appl. No. 5882 of 1916.)

THE apparatus is particularly suitable for straining oil for internal combustion (e.g., Diesel) engines and the like. A cylindrical plug, B, fitting in a casing, A, is provided with a series of fine transverse peripheral triangular grooves, G, about 60

to the inch. Passage-ways, *i*, are cut longitudinally in the periphery of the plug, extending from one end nearly to the other, and alternate passage-ways, *o*, are similarly cut from the opposite end of the plug. Oil entering at I, passes into the passages, *i*, through the grooves, G, to the passages, *o*, and thence to the outlet, O. Two or more strainers may be used in series or parallel, and when in series, the first may have coarser grooves. The grooves may alternatively be formed in a conical or plane surface. In a modification, the inlet and outlet passages, *i* and *o*, each extend halfway along the plug, and intermediate parallel recesses, *l*, closed at the ends, are provided between them, the effect being that of two plugs in series. In another modification, the plug is hollow with a diametral partition forming inlet and outlet chambers. Transverse circular grooves are cut eccentrically alternately on opposite sides of the partition, so as to cut through the wall on one side but not on the other side of the partition alternately. Fine spiral grooves, corresponding to G, are cut in the outside of the plug. The liquid passes from the circular transverse grooves communicating with the inlet chamber, through the fine spiral grooves, to the transverse grooves communicating with the outlet chamber.—W. F. F.



Liquid sprayers or atomisers. T. Andrew, Heaton Moor, Cheshire. Eng. Pat. 105,687, July 25, 1916. (Appl. No. 10,467 of 1916.)

IN atomising or spraying apparatus in which liquid and compressed air are used, a valve is provided for automatically cutting off the liquid supply when the air falls below a predetermined pressure. A piston or lift valve, closed by a spring or weight, is placed in the liquid-supply pipe, and carries a piston or diaphragm on its spindle, to which the compressed air is admitted by a branch pipe so as to lift the valve against

the action of the spring or weight at a predetermined pressure. Another valve of this type may be arranged to open when the air pressure falls below a predetermined amount and thus drain the liquid from the pipes.—W. F. F.

Cloth for filter-presses. H. H. Hanson, Boston, Mass., Assignor to Berlin Mills Co., Berlin, N.H. U.S. Pat. 1,222,100, Apr. 10, 1917. Date of appl., July 8, 1916.

THE cloth is woven from threads of suitable textile material which are impregnated with indiarubber to render the cloth resistant to the action of caustic alkalis.—W. H. C.

Filter; Renewable— Dr. North Kommandit-Ges., Hannover. Ger. Pat. 296,715, Mar. 23, 1915.

THE filtering medium consists of silicon carbide (carborundum), which has been made into a paste with water or other binding agent and ignited. It is then left as a porous mass, which is not attacked by acids and can be repeatedly purified by ignition. It is particularly suitable for the filtration of strong acids, and, in the heated condition, as a filter and vaporiser for volatile oils, etc. The impurities left in the filter can be removed by burning, or by washing with a suitable liquid.—C. A. M.

Regenerative furnaces. H. E. Smythe, Assignor to S. R. Smythe Co., Pittsburgh, Pa. U.S. Pat. 1,222,699, Apr. 17, 1917. Date of appl., May 15, 1915.

THE furnace is provided with regenerators below the sole and with a preliminary combustion chamber at the side of the regenerator chamber. Gas is supplied to the preliminary combustion chamber and burned by partly-regenerated air, and the resulting products of combustion are delivered to the furnace chamber proper, where they are intimately mixed with fully-regenerated air and the combustion is completed.—W. H. C.

Kiln. J. A. Reams, Assignor to W. J. Parrish, Richmond, Va. U.S. Pat. 1,223,732, Apr. 24, 1917. Date of appl., Sept. 20, 1916.

AN open-ended tunnel kiln is divided into a series of zones connected by flues. Air is passed laterally across the kiln in the zone at the exit end, thence back across the tunnel in the form of products of combustion, thence again across the tunnel in another zone, and finally across the tunnel in a zone at the inlet end.—A. B. S.

Gas and other fluids; Apparatus for separating vapour from— L. C. Frohrieß, Pittsburgh, Pa. U.S. Pat. 1,222,751, Apr. 17, 1917. Date of appl., July 19, 1916.

A VERTICAL cylindrical chamber is provided with an inlet and an outlet opposite one another about midway of its height. A vertical baffle-plate, with a series of inclined troughs on one side and perforations between the troughs, is placed opposite the inlet with the troughs facing the latter. A travelling belt of fibrous absorbent material moves vertically closely behind the baffle-plate, being carried by an endless chain which passes over two sprocket wheels. A non-perforated baffle-plate is placed behind the belt. The belt is longer than the chain and the slack portion passes between a pair of rollers to squeeze out the moisture.—W. F. F.

Gases [air]; Apparatus for purifying— A. Bart, Cottbus. Ger. Pat. 296,636, June 27, 1914.

THE air or gas is passed through two adjacent vertical purifying chambers, between which are channels which deflect the current from the upper

part of one chamber to the lower part of the other. The chambers may also contain transverse ledges inclined downwards and reaching nearly to the bottom, the object of which is to catch dust and promote uniform circulation of the air, etc.

—C. A. M.

Gases and vapours: Purification of—by the dry method. C. Grosse, Metz. Ger. Pat. 296,837, Sept. 2, 1913.

IN the purification of blast-furnace gas, producer gas, etc., by the dry method, a portion of the filtered gas, which in the course of purification has been cooled to a low temperature, is mixed with the hot crude gas, after being again brought to the same temperature as the latter. By this means the crude gas is dried, and clogging of the filter is prevented. For this purpose, also, a current of the purified gas may be passed through the filter in the reverse direction before being mixed with the crude gas.—C. A. M.

Deplegation: Apparatus for— R. R. Rosenbaum, Chicago, Ill. U.S. Pat. 1,222,801, Apr. 17, 1917. Date of appl. Aug. 22, 1916.

A VERTICAL cylindrical casing, having a vapour inlet at the bottom and outlet at the top, contains a series of deep pans, one above the other, each surrounded by an annular space. A horizontal partition is arranged above each pan, with a central reticulated opening having a wide tube depending into the pan below. Each tube is surrounded by a cooling coil, and pipes are provided for discharging condensed liquid from the pans, and for conveying condensed liquid from the upper pans to the partitions over the lower pans. The vapour passes upwards through the annular space, downwards over the cooling coil, and upwards through the central tube to the next compartment.—W. F. F.

Liquids: Method of treating [solidifying]— F. D. Crane, Montclair, N.J. U.S. Pat. 1,223,153, Apr. 17, 1917. Date of appl. Jan. 8, 1917.

A LIQUID is solidified by dissolving in it a suitable fatty acid, such as stearic acid, and adding an alcoholate, such as a solution of sodium ethoxide in an excess of ethyl alcohol.—W. F. F.

Deflocculating solid materials: Method of— E. G. Acheson, Assignor to Acheson Corporation, New York. U.S. Pat. 1,223,350, Apr. 21, 1917. Date of appl. Jan. 17, 1917.

SOLID material made into a paste with a deflocculating agent is submitted alternately to periods of attrition and relative rest until the desired result is attained.—W. H. C.

Centrifugal separators. T. E. Brown, New York. Eng. Pat. 100,317, Apr. 17, 1916. (Appl. No. 5620 of 1916.) Under Int. Conv., Apr. 16, 1915. SEE U.S. Pat. 1,159,711 of 1915; this J., 1916, 31.

Filter medium for cleaning furnace gases. F. E. Kling, Youngstown, Ohio, U.S.A. Eng. Pat. 105,884, Jan. 19, 1917. (Appl. No. 977 of 1917.)

SEE U.S. Pat. 1,215,385 of 1917; this J., 1917, 377.

Dehydrating or drying apparatus. G. F. Humphrey, Assignor to Alliance Vegetable Co., Ltd., London. U.S. Pat. 1,225,631, May 8, 1917. Date of appl. Sept. 29, 1916.

SEE Eng. Pat. 105,626 of 1916; preceding.

Method and apparatus for evacuating bulbs of electric incandescent lamps and other glass vessels. Eng. Pat. 101,621. See 11b.

Still for the fractional distillation of volatile liquids. Eng. Pat. 105,395. See 111.

Packing rings [from viscose]. Ger. Pat. 296,405. See V.

Oil-fired [melting] furnaces and the like. Eng. Pat. 105,431. See X.

IIA.—FUEL; GAS; MINERAL OILS AND WAXES.

Nitrogen in coal and coke: Chemical condition of— E. Terres, J. Gasbeleucht., 1916, 59, 519—521. Z. angew. Chem., 1917, 30, Ref., 46.

IN carbonisation 10—65% of the nitrogen of the coal remains in the coke, 10—14% is recoverable as ammonia, and the rest is lost as free nitrogen or cyanogen in the gas, a little, however, being found in the tar. By slow distillation it is possible to recover as much as 35% as ammonia, and it seems probable that the nitrogen is split off in the first place as ammonia. The author has attempted to discover what classes of compounds yield ammonia on distillation. Glycocoll, asparagine, egg albumin, animal glue, pyridine, azobenzene, hydrazobenzene, acetonitrile, phenyl isocyanate, and nitrobenzene were all subjected to dry distillation. Ammonia was liberated from the amino and substituted amino compounds only. The conclusion is drawn that the nitrogenous compounds of coal must have the character of proteins. In coke, the nitrogen is probably in the form of a nitride of carbon, as suggested by Rau and Christie. This is confirmed by the experiments of Sachs (this J., 1916, 346), who showed that on gasifying coke with air and steam, 89% of the nitrogen could be recovered as ammonia.—H. J. H.

Sulphur-content of coke: Influence of air and water on— J. R. Campbell, Gornosawodskoje. Djelo, 1916, 23, 13,667. Chem.-Zeit., 1917, 41, Rep., 42.

THE sulphur content of beehive oven coke is not lower than that of by-product oven coke, in spite of the greater access of air in the non-recovery ovens. This is due to the higher yields obtained in by-product ovens. Sulphur present as sulphates in the coal is not driven off at all in carbonisation, and hence it is not possible to produce coke of low sulphur content where the coal ash is basic. Quenching coke with water causes a smell of hydrogen sulphide, but only a small quantity of sulphur is removed thereby. Much more sulphur could be removed by quenching with hydrochloric acid solution.—H. J. H.

Benzol [from coal gas]: Recovery of—by a modified dehydrating plant. E. F. Keable, Eastern Counties Gas Managers' Assoc., May 3, 1917. Gas J., 1917, 138, 288—292.

THE author describes his adaptation of a "Hird" dehydrating plant for debenzolising wash oil. Seven tanks are used. One is sunk below ground to receive the tank-cart delivery of wash oil, which is thence pumped to a main storage tank afterwards passing by gravity to the feed tank of the washer. The latter is a Kirkham, Hulett, and Chandler centrifugal washer, ammonia being removed in the bottom three trays, the remainder being fed with creosote oil at the rate of 50 to 60 galls. per ton of coal. The oil is kept at a temperature above that of the gas and the benzolised oil passes by gravity to another tank, whence it is pumped to the main benzolised oil-storage tank. It then passes through a feed tank to the still; the debenzolised oil is cooled first by incoming benzolised oil, secondly by cold water. The cooled oil passes into the underground tank,

thus completing the circuit. A fractionating column has been fixed to the outlet of the original condenser, one end of the column being sealed in a pot with suitable overflow, the other end being connected to the water-cooled tubular benzol condenser; the waste gases pass through a small line purifier. A supply of live steam has been added to the still, one central supply being fixed in the crown. The steam is superheated by insertion of the feed pipe into the waste gas flue. Before entering the still the oil is raised to 70° C. in the preheater. The steam used in the still is equal to an evaporation of 10 lb. of water per gallon of spirit produced, and the plant has been found capable of dealing with 70 to 80 galls. per hour. With a still temperature of 129° C., steam pressure of 60 lb. per sq. in., and rate of oil flow 70 to 80 galls. per hr., an average of 2 galls. of spirit, testing 68% at 120° C., has been obtained per ton of coal. The oil is saturated to 5%, leaving only 0.2 to 0.8% at 180° C. in the debenzolised oil. Light cresote oil low in naphthalene and of sp. gr. 1.02 is used for absorption. The sulphur compounds in the gas have been reduced 27%, the illuminating power 23%, and the calorific value 5%.—J. E. C.

Benzol recovery plant: An experience in a—
Gas J., 1917, 138, 285.

BENZOLISED oil entering the plant passes through a preheater, absorbing heat from the benzol vapours from the still, and is then heated in a superheater by closed steam coils, the normal temperature reaching 130° C. On one occasion there was a gradual decrease in temperature of the oil leaving the superheater until, even with full steam, it was not possible to obtain a temperature higher than 105° C. Examination of the coil in the superheater showed it to be covered with a layer, about $\frac{1}{8}$ -inch thick, of a dark grey substance, found on analysis to consist almost entirely of sodium sulphate with a little free carbon. The source of this deposit was traced to the practice of putting back into circulation the "bottoms" from a washed solvent naphtha distillation. Evidently a little emulsion containing sodium sulphate found its way into the residue of the still, and on passing into circulation caused a deposit when in contact with the hot surface of the coil. Normal results were again obtained after cleaning the coil and avoiding any further re-circulation of "bottoms."—J. E. C.

Acetone and air: Propagation of flame in mixtures of—. R. V. Wheeler and A. Whitaker.
Chem. Soc. Trans., 1917, 111, 267—272.

THE authors have determined the limits of inflammability and the speed of propagation of flame for mixtures of acetone and air. The limits are tabulated as follows in percentages by volume of acetone:—

Diameter of tube, cm.	Lower limit.			Higher limit.		
	Downward.	Horizontal.	Upward.	Downward.	Horizontal.	Upward.
2.5	2.75	2.40	2.30	6.5	6.7	7.5
5.0	2.40	2.25	2.20	8.3	9.3	9.5
10.0	2.35	2.20	2.15	8.5	9.5	9.7

The speed of flame propagation in a tube 2.5 cm. in diameter was about 55 cm. per sec. with 2.7% acetone, rising to a maximum of about 96 cm. per sec. with 5.5% acetone, and falling to about 31 cm. per sec. with 8.2% acetone. With wider tubes these velocities will probably be greater (e.g. about three times as great for a 60 cm. tube).—W. H. P.

Petroleum spirit: Inflammability of— at low temperatures. J. H. Coste. Analyst, 1917, 42, 168—170.

SAMPLES of motor spirit were cooled by means of liquid air in a thin test-tube 100 mm. long and 25 mm. in diameter, and the tube then transferred to a Dewar tube in which it was supported by means of a card with a hole in the centre. The tube was covered with a card (which was removed at each trial) and the liquid was tested with a small flame at intervals of about 2° C. until it flashed. The temperatures were determined by means of a copper-eureka thermo-couple, with the "hot" junction in ice and water, and the "cold" junction immersed to about 18 mm. in the liquid. The thermo-couple was calibrated by means of the solidification points of monobromobenzene (−31.1° C.), mercury (−38.8° C.), chloroform (−70° C.), toluene (−97° C.), and by means of liquid air. A mirror galvanometer was used and the deflections observed at a distance of 1 m. were taken. The following results were obtained:—Pratt's motor-spirit solidified at −128° C. and flashed at −30° C. (−22° F.) (surface of liquid 18 mm. from the top of the tube). "Standard" spirit flashed at −11° C. (+12.2° F.) (surface of liquid 50 mm. from the top of the tube). "Shell" spirit flashed at −16° C. (+3.2° F.) (surface 50 mm. from the top of the tube). A sample of fairly pure acetone solidified at −96° C. (pure acetone = −95° C.) and flashed at −9.5° C. (+14.9° F.). These results show that ordinary motor spirit is dangerous to handle near a flame at any temperature likely to occur in this country, but that it is not likely to give trouble (as benzene might) in arctic temperatures.—C. A. M.

Benzine and motor oil: Production of— by heating lignite products under pressure. F. Fisher and W. Schneider. Braunkohle, 1916, 15, 291—293, 299—301, 307—310. Z. angew. Chem., 1917, 30, Ref. 66.

THE following yields of the lightest (up to 150° C.) and middle (150—300° C.) qualities of benzine have been obtained by repeatedly heating the products named under pressure:—

	Lightest quality.	Middle quality.
Montan wax	30	29
Paraffin	48	22
Lignite tar	25	29

The products had the following calorific powers:

	Light benzine.	Heavy benzine.	Middle oil.
Montan wax ...	10,268	11,171	10,915
Paraffin	10,780	10,850	10,820
Lignite tar	10,399	10,853	10,636

The flash point of the light and heavy benzine was under 30° C., that of the middle oil from montan wax was 38°, from paraffin 39°, and from lignite tar 41° C. It is possible that similar products may be obtained on a large scale without using high pressures.—A. B. S.

Tars and tar distillates as temporary substitutes for heavy petroleum oils. H. Moore. Petroleum World, 1917, 213.

THE spontaneous ignition test (this J., 1917, 109) may be utilised to ascertain if fuels for Diesel engines require pilot ignition. The high ignition points of coal tar distillates necessitate pilot ignition. Raw coal tars can be burned with pilot ignition, provided the free carbon content is not high.—F. W. A.

Benzene and toluene from petroleum. See page 582.

Experiments with paper tubes. Rudeloff. See V.

PATENTS.

Peat; Apparatus for treating [extracting water from]—. W. L. St. J. Prioleau, London. Eng. Pat. 105,396, Apr. 11 and May 2, 1916. (Appl. Nos. 5309 and 6295 of 1916.)

WET peat, preferably after treatment by freezing, is passed from a hopper through a pair of crushing rolls with surfaces corrugated longitudinally, and falls on to a heated band of absorbent material, such as felt, travelling horizontally, which passes round a steam-heated drum to evaporate the absorbed water. The peat is removed from the band by a scraper and passes through a pair of crushing rolls with coarse transverse corrugations, to another similar absorbent travelling band, from which it passes through a third pair of crushing rollers with smaller transverse corrugations. The absorbent band may be replaced by slightly inclined, perforated, vibrating trays. The peat passes from the third pair of crushing rolls into a briquetting press which removes any remaining moisture, and the briquettes are discharged on to a conveyor for subsequent heat treatment or the like.—W. F. F.

Gas producer plant. C. Whitfield, Kettering, Eng. Pat. 105,419, June 1, 1916. (Appl. No. 7759 of 1916.)

IN a producer-gas plant of the suction or pressure type, the gas leaving the producer at the top passes down through a vertical pipe having a central rod on which unglazed earthenware blocks are threaded so as to leave an annular space. The pipe has a spiral groove on the outside over which cooling water trickles and is evaporated, and the whole is surrounded by an outer pipe having an inlet at the top, and an outlet at the bottom leading to the ash-pit of the producer, so that the air supply to the producer is heated and moistened. After leaving the cooling pipe, the gas passes through a tar extractor of the type described in Eng. Pat. 1118 of 1913 (this J., 1914, 190) to a gas-holder. The inlet pipe of the gas-holder extends centrally nearly to the top and carries a horizontal disc close above it. A concentric sleeve slightly larger than the pipe is suspended from the gas-holder bell, so that when the gas-holder is full, the sleeve comes into contact with the disc and thus closes the inlet.—W. F. F.

Gases; Separation of tar and condensable products from—. E. Haunemann, Graz, Ger. Pat. 296,065, Mar. 9, 1915. Under Int. Conv., Mar. 10, 1914.

THE gas passes through holes in vertical plates and impinges upon baffle-plates behind, to which the tarry particles adhere and down which they drain. This tar separator is fitted with arrangements of screens to cover or uncover at will the openings in the plate, so as to vary the number and area of the holes available for the passage of the gas. A claim is also made for an apparatus in which the gas passes through slits, the width of which can be varied at will. The object to be attained is a variation as desired of the resistance to the passage of the gas and accordingly of the impact on the baffle-plate behind the holes.

—H. J. H.

Liquid fuel for internal combustion engines. J. Hannin, Dublin. Eng. Pat. 105,490, Aug. 3, 1916. (Appl. No. 10,959 of 1916.)

A LIQUID fuel for internal combustion engines consists of petrol 5 galls., paraffin oil 5 galls.,

"pine fluid" 1 oz., nitrobenzene 1 oz., isinglass 1 oz., and tartaric acid 1 oz.—W. F. F.

Volatile liquid fuels; Mixtures of— for internal combustion engines. B. Bonedix, Hamburg. Ger. Pat. 296,193, Jan. 19, 1915.

MIXTURES of petrol or benzol, or benzol and alcohol, with at least 5% of ether are satisfactory fuels for internal-combustion engines.—H. J. H.

Coal; Process for treating— and preparing it for coking purposes. C. H. Smith, Short Hills, N.J., U.S.A. Eng. Pat. 101,539, Aug. 30, 1916. (Appl. No. 12,293 of 1916.) Under Int. Conv., Sept. 18, 1915.

SEE U.S. Pat. 1,177,727 of 1916; this J., 1916, 625.

Burning gases; Process of—. W. A. Bone and J. W. Wilson, Leeds, and C. D. McCourt, Assignors to Radiant Heating, Ltd., London. U.S. Pat. 1,222,922, Apr. 17, 1917. Date of appl., July 11, 1912. Renewed Sept. 8, 1916.

SEE Eng. Pats. 19,490 of 1912 and 5114 of 1913; this J., 1913, 936.

Combustion of mixed gases. Process for producing heat. W. A. Bone and J. W. Wilson, Leeds, and C. D. McCourt, Assignors to Radiant Heating, Ltd., London. U.S. Pats. 1,223,248 and 1,223,249, Apr. 17, 1917. Dates of appl., Oct. 8, 1910, and Nov. 18, 1911. Renewed Mar. 17 and Feb. 3, 1917, respectively.

SEE Eng. Pat. 25,808 of 1909; this J., 1910, 1448.

Heavy [hydrocarbon] oils; Apparatus for treating—. E. Brown, London, Assignor to M. A. H. de Dampierre, Paris. U.S. Pat. 1,225,569, May 8, 1917. Date of appl., Apr. 13, 1915.

SEE Fr. Pat. 478,831 of 1915; this J., 1916, 1102.

Apparatus for straining liquids [e.g., oil fuel for internal combustion engines]. Eng. Pat. 105,630. See I.

Purification of gases and vapours by the dry method. Ger. Pat. 296,837. See I.

Recovery of hydrogen sulphide and hydrogen cyanide from crude gases. Ger. Pat. 296,166. See VII.

Carbonic-acid indicator. U.S. Pat. 1,223,953. See XXIII.

IIb.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

Wood and other vegetable products; Distillation of—. Bull. Imp. Inst., 1916, 14, 566—577.

DESTRUCTIVE distillation trials have been conducted at the Imperial Institute, under conditions approximating to those which would be used in modern works, in connection with the possible initiation of wood distillation industries in Natal, where it is proposed to use wattle wood; in Uganda, where experiments have been made with *Podocarpus milanjianus* with a view to the preparation of a preservative against white ants; in Ceylon, where vera or virai wood (*Hemicycia sepiari*, W.A.) has been tried with a view to the production of acetic acid for coagulation of rubber; and in Egypt, where cotton stalks may be utilised. The results obtained with wattle, olive, pine, and oak are summarised in the table, together with factory results with oak wood.

	Average results of small scale trials at Imperial Institute.				Factory results with oak wood.
	Black wattle.	Olive wood.	Pine wood.	Oak wood.	
Acetic acid	4.7	3.0	2.2	4.4	3.8
Equivalent to acetate of lime	6.2	4.0	2.9	5.8	5.0
Methyl alcohol	1.2	1.6	0.6	1.1	1.1
Tar separated	6.0	7.4	12.9	6.4	4.5
Charcoal	27	29	29	25	26

From these results, taken in conjunction with the results of an examination of the charcoals, it appears that both wattle and olive wood should be at least as profitable to distil as oak. An examination was also made of coconut shell charcoal and vera wood charcoal from Ceylon, and the results are tabulated, in comparison with other fuels, below.

	Calorific value.	Moisture.	Volatile matter.	Carbon.	Ash.	Sulphur.
	Small calories.	%	%	%	%	%
Wattle wood charcoal	7615	20.87	—	77.78	1.35	0.28
Olive wood charcoal	7645	24.58	—	72.90	2.52	0.09
English black charcoal (compressed)	7607	6.80	9.52	82.57	1.11	0.10
English rough charcoal	7413	8.29	7.03	82.56	2.12	0.15
Rhodesian charcoal	7218	4.17	29.97	71.51	3.35	0.07
"Standard" coal (steam coal)	7400	—	—	—	—	—
Welsh coal briquettes	7800	1.0	15.0	80.0	4.0	—
S. Nigeria lignite briquettes	6522	7.14	53.80	53.35	5.71	0.67
German lignite briquettes	5575	15.67	48.28	28.28	7.46	3.29
Coconut shell charcoal	7529	4.7	18.2	76.1	1.0	0.05
Vera wood charcoal	6575	38.2	—	56.6	5.2	0.4

A sample of acetate of lime from Ceylon was a coarse grey powder giving a dark brown solution, and containing moisture, 3.5; calcium acetate, 83.6; sulphates (as CaSO_4), 0.60; carbonates (as CaCO_3), 0.08; ash, 32.2%. No free lime, calcium formate, or sulphites were present.

—E. W. L.

PATENTS.

Charcoal [from sulphite-cellulose waste liqrs] : Process for the production of — A. Knöpfmacher, Vienna. Eng. Pat. 102,608, Oct. 13, 1916. (Appl. No. 14,594 of 1916.) Under Int. Conv., Dec. 4, 1915.

A MIXTURE OF sulphite-cellulose waste liquor 4000 kilos., potassium carbonate 400 kilos., calcium oxide 38 kilos., and ground unburnt lime 60 kilos., is evaporated to dryness, and heated to redness in an iron vessel with the exclusion of air, the evolved gases being drawn off. The resulting material is treated in a Shanks lixiviating apparatus, and the residue extracted in a centrifuge or filter press. The calcium compounds may be extracted by means of acids, e.g., hydrochloric acid, and the remaining charcoal dried and ground. The filtered potassium carbonate solution of about 25° B. (sp. gr. 1.21) is mixed with about 30 kilos. of potassium bicarbonate, evaporated to 50° B. (sp. gr. 1.33), drawn off from the slight residue of potassium sulphate, and added to a fresh quantity of waste liquor for treatment as above. About 100 kilos. of highly active decolorising charcoal is obtained. To obtain charcoal free from ash, a mixture of waste liquor 4000 kilos., calcium oxide 38 kilos., and unburnt lime 100 kilos. is evaporated to dryness and the residue lixiviated with 615 litres of potassium carbonate of density 45° B. (sp. gr. 1.45) derived from the preceding operation. The mixture is filtered, dried, and heated to redness, and then treated as in the first example, with the omission of the acid treatment.—W. F. F.

Incandescent lamps and other glass vessels ; Method of and apparatus for evacuating bulbs of electric — Deutsche Gasglühlicht A.-G. (Auergeres.), Berlin. Eng. Pat. 101,621, July 7, 1916. Under Int. Conv., Sept. 27, 1915. (Appl. No. 9608 of 1916.)

EACH of two removable receivers, one within the other, is provided with a base plate, the space between the two receivers and the space enclosed by the inner receiver having separate connections for exhausting them. The edge of the inner receiver is sealed by a metal of low melting point and low vapour tension, forming a liquid seal on the outer edge of the base plate of the inner receiver, and the latter is heated electrically. One or more plates are arranged within the inner receiver for supporting electrical heating plates, and the openings of the nipples of the bulbs are also supported by the plates during the exhausting and sealing operations; or the bulbs may be held away from the heating plates during exhaustion, and brought into contact with them for sealing off the lamps when the desired vacuum has been established. The free end of each

nipple may be sealed off by a piece of glass, of lower melting point than the glass of the bulb placed within the nipple. The bulbs are supported upon a frame provided with partitions, and may be heated before being placed in the receiver to substantially the same temperature as is obtained later in the receiver.—B. N.

Hydrocarbons and pure carbon ; Production of — from bituminous lignite. P. Schröder. Ger. Pat. 296,539, July 3, 1914.

ACCORDING to Ger. Pat. 295,296 (this J., 1917, 206), raw lignite is converted into a colloid on treating it in a grinding cylinder with hot water containing alkali salts. The colloidal solution is filtered and the filtrate acidulated so as to coagulate the colloids, whilst any inorganic matter remains in solution. It has since been found that if the coagulated product is distilled with superheated steam or other gases at 500° C. and a pressure of 50 atmos., a yield of 18–30% of solid, liquid, and gaseous hydrocarbons and an almost chemically pure carbon are obtained. The raw lignite does not produce so high a yield with superheated steam and no pure carbon is obtained.—A. B. S.

Flame-arc lamp and electrode therefor. G. Egly, Assignor to Gebr. Siemens und Co., Berlin-Treptow, Germany. U.S. Pat. 1,221,039, Apr. 3, 1917. Date of appl., Nov. 26, 1915.

THE negative electrode contains boric acid evenly distributed throughout to prevent the formation of slag, and the positive electrode contains luminous admixtures.—B. N.

Metallic filaments ; Preparation of — J. Pinfisch A.-G., Berlin. Ger. Pat. 296,191, Jan. 20, 1914. Addition to Ger. Pat. 291,994 (see Fr. Pat. 469,212; this J., 1915, 36).

WHEN the metallic wire consists of a single crystal over its whole cross-section (*loc. cit.*) and of

relatively great length, it can be easily drawn through a die, if the speed be not excessive. The internal structure of the wire is thereby left unchanged, the crystal being merely lengthened. It is possible by the process described, to correct for irregularities in metallic filaments by simple wire drawing.—H. J. H.

Destructive distillation of wood and the like. S. E. Seaman, Gauley Mills, W. Va., Assignor to Seaman Waste Wood Chemical Co., Inc., New York. Reissue No. 14,300, May 8, 1917, of U.S. Pat. 1,108,403, Aug. 25, 1914. Date of appl., July 28, 1916.

SEE this J., 1914, 1003.

Methods and means for obtaining high vacua. Eng. Pat. 105,357. See I.

III.—TAR AND TAR PRODUCTS.

Toluene and benzene; Estimation of — in coal tar oils. G. Harker. J. Roy. Soc. N.S.W., 1916, 50, 99—105.

IN estimating toluene and benzene in coal tar oils, it is usual to subject the tar oil to a preliminary distillation to 150° or 170° C., followed by a washing of the distillate with sulphuric acid and caustic soda. The washed product is then distilled under conditions varying considerably. From the volume of the fraction collected between certain temperatures and by reference to tables, the composition may be deduced, but the range of such tables is limited and occasionally pure benzene, toluene, or xylene must be added before distillation (see Colman, this J., 1915, 168; James, this J., 1916, 236). The author has carried out a series of experiments with pure benzene, toluene, and xylene. A Young and Thomas still-head of five sections was used and the rate of distillation was kept at one drop per second. When mixtures of benzene and toluene in the proportion of 3:1 or 4:1 were distilled, the volume distilling over up to 90° C. represented the volume of benzene present. With mixtures of 50 c.c. of benzene and 50 c.c. of toluene, the first 50 c.c. came over slightly above 95° C. Additions of xylene necessitated a still higher temperature. The actual content of benzene and toluene in the samples was obtained by carrying out a blank test after each distillation of the sample. In this blank test, quantities of pure benzene, toluene, and xylene were added to the residue in accordance with the approximate estimation. The mixture was again distilled, whereby any error in the first estimate was corrected. After a preliminary distillation up to 170° C. the distillate was washed with sulphuric acid and caustic soda (cf. Davis, Lunge and Keane's Tech. Methods of Chem. Anal., vol. 2, part 2, p. 767). The washed oil was then distilled and a blank test carried out as described. Paraffins present were estimated by a sulfonation test with anhydrous sulphuric acid (cf. Lunge and Keane's Tech. Methods of Chem. Anal., vol. 2, p. 799; and Allen's Commercial Organic Analysis, 4th ed., vol. 3, p. 241). Details of tests on three samples of coal tar oil of sp. gr. 0.928, 0.98, and 1.012 respectively are given.

—J. E. C.

Benzene and toluene from petroleum. See page 582.

Recovery of benzol [from coal gas] by a modified dehydrating plant. Keable. See IIa.

An experience in a benzol recovery plant. See IIa.

Tars and tar distillates as temporary substitutes for heavy petroleum oils. Moore. See IIa.

PATENTS.

Still for the fractional distillation of volatile liquids [e.g., crude benzol]. Sadler and Co., Ltd., Middlesbrough, and J. Bellerby, North Ormesby, Yorks. Eng. Pat. 105,395, Apr. 11, 1916. (Appl. No. 5306 of 1916.)

CRUDE benzol is passed from a tank through a closed vessel containing a preheating coil, to the top of the main still. The still comprises a casing containing superposed horizontal shelves with overflow pipes at opposite sides alternately, so that the liquid flows downward in a sinuous path. Steam enters at the bottom and passes upward through the shelves by means of short vertical pipes covered by hoods. The steam and distillate are passed through the preheating coil and partly condensed, the liquid (crude toluol) being separated and the vapour passing to a condenser from which it issues as strong benzol. The residue from the still passes to a "stripping still" containing creosote heated above 100° C. by a steam coil. The water and volatile products in the residue are evaporated and passed to a condenser and the stripped creosote remains. The crude benzol is thus separated into four fractions.—W. F. F.

1,5-Dihydroxynaphthalenedicarboxylic acid; Manufacture of —. F. von Ifemmelmayr, Graz, Austria. Ger. Pat. 296,501, Mar. 4, 1915. Addition to Ger. Pat. 296,035.

SOLID bicarbonates are allowed to act on 1,5-dihydroxynaphthalene in presence of an indifferent solvent or medium, e.g., trichlorobenzene or nitrobenzene.—F. W. A.

Manufacture of sodium phenate, sodium salicylate, and salicylic acid. Eng. Pats. 105,611—105,613. See XX.

IV.—COLOURING MATTERS AND DYES.

Dyestuffs; Fastness of —. Standards and processes established by the "Echtheitskommission." Second Report to the Verein deutsch. Chemiker. P. Heermann. Mitt. k. Materialprüf., 1916, 34, 153—156.

CERTAIN standards prescribed in the first report (this J., 1914, 248) have been modified and replaced by the following:—I. *Fastness to light.* (IA.) Fastness of dyed cotton. The sample is exposed together with the dyed standard in a box suspended in the open under glass, one half of the object being covered by paper or cardboard. At the Materialprüfungsamt two exposures are always made, one under glass and one in the open, subject to all atmospheric influences. Dressed goods are faster to light than undressed goods. The type standards are: I. 5% of Chicago Blue 6 B (424) dyed at the boil with two additions of Glauber's salt. II. 0.8% of Methylene Blue B.G. (659) dyed cold to warm with 2% of acetic acid on a 3% tannin and 1.5% antimony salt mordant. III. 1% of Indoin Blue on cotton mordanted as in II. IV. 20% of Kroyen Violet, with 1.5 times its weight of crystallised sodium sulphide, dyed at the boil with the addition of soda-ash and salt. V. 2.5% of Benzo Light Red 8 B.L. dyed as in I. VI. 10% of Hydron Blue G., 20% paste (748) dyed at 60° C. with caustic soda and 5% of hydrosulphite. VII. 8% of Sulphur Black T., extra (720) dyed as in IV. VIII. 25% of Indanthrene Blue G.C. paste, dyed with 6.25% of hydrosulphite and caustic soda. (IB) Fastness of dyed wool. The tests are carried out in the same way as for cotton; in the case of piece goods the exposure should be made both under glass and in the open. The type standards are: I. 3% of Indigotin 1A, powder (877) dyed at the

boil with 10% of Glauber's salt and tartar. II. 1.5% of Ponceau R.R. (82), dyed in the same way. III. 2.75% of Amarant (168). IV. 4.5% of Azo Acid Red B. (64). V. 5% of Acid Violet 4 R.N. (B.A.S.F.), with Glauber's salt and acetic acid, from 40° C. to the boil, finished at the boil with sulphuric acid. VI. 2.5% of Diamine Fast Red F. (343), after-chromed. VII. 4% of Anthraquinone Green G.X.N. (861) dyed as in V. VIII. Indigo (874) dyed to a shade equivalent to 2.4% of Sulphocyanin G.R. extra (257); or 7% of Naphthol Green B. (4) dyed with 10% of Glauber's salt and tartar, beginning at 50° C. and finishing at the boil for one hour. 2. *Fastness to kier-boiling of dyed cotton.* Two tests are made: (A) 5 grms. of the dyed sample is intermingled with an equal weight of bleached cotton and the mixture boiled with 10 times its weight of liquor to which has been added 10% of caustic soda lye of 40° B. (sp. gr. 1.357) calculated on the weight of material, for 6 hours at constant volume. (B) The treatment is repeated as under A with the addition of 1% of "Ludigol" on the weight of the material. Standards: I. The shade is distinctly paler after both treatments and the white cotton somewhat stained. III. The shade is appreciably paler after both treatments but the white cotton shows no more than a trace of stain. In the same class are included cases where the shade becomes paler, when treated as under A and the white cotton is stained, but when treated by the B process the white cotton is not stained. V. The dyed cotton under both treatments remains entirely unchanged and the white cotton shows no more than the slightest trace of a stain. Types: I. Normal Paranitraniline Red dyeing, boiled with soap after development. III. Indigo dyeing to the same depth as 3% Diamine Fast Blue F.F.B.; or 10% Indanthrene Yellow G. paste (849) boiled with soap after dyeing. V. Normal Turkey Red (Old Red) dyeing. *Fastness to decatising of dyed wool.* Three tests are applied: (A) The sample is rolled up with the usual material on a decatising cylinder in six layers uniformly and firmly, or in the case of small samples a layer of decatising cloth is wound on first; three further layers are wound on and the whole tied up. The material is steamed for 10 minutes counting from the time when the steam begins to issue through the cloth; it is then allowed to stand for 5 mins. and unwound. (B) The prepared cylinder is steamed for 5 mins. in a closed vessel under 1 atm. pressure. (C) It is steamed for 10 mins. under 2½ atm. pressure. Standards: I. Under treatment A, a fairly strong change in shade. II. Under treatment A, no change in shade. III. Under treatment B, fairly strong change. IV. No change. V. Under treatment C no change. Types: I. 2% of Thioflavin T. (642) dyed at 50° C. for ½ hour. II. 2% of Sulphocyanin G.R. extra (257) dyed as under 14 V. (*loc. cit.*). III. 2% of Sulphocyanin. IV. 2% of Crocein A.Z. (255) dyed as under 7B V. (*loc. cit.*) V. 9% of Naphthol Black 6 B. (269) with 10% of tartar, beginning at 40° C., finishing at the boil for one hour.—J. F. B.

Benzanthrone and its derivatives; A new synthesis of— A. Schaarschmidt. Ber., 1917, 50, 294–303.

The anhydride of 1-phenyl-2,3-naphthalenedicarboxylic acid on treating with aluminium chloride in presence of an aromatic hydrocarbon, is converted into 3,4-benzofluorenone-1-carboxylic acid, which on distillation yields 3,4-benzofluorenone. The latter on fusing with caustic potash gives a product which on warming with concentrated sulphuric acid yields benzanthrone by the migration of a carbonyl group from the 2 to the 8 position in the naphthalene ring. 1-Phenyl-2,3-naphthalenedicarboxylic acid on

treatment with excess of concentrated sulphuric acid in the cold, or on treatment with phosphorus pentachloride in benzene solution and treatment of the acid chloride thus produced with aluminium chloride in carbon bisulphide solution, is converted into benzanthronecarboxylic acid, which forms deep yellow needles, m. pt. 317° C. When 1-phenyl-2,3-naphthalenedicarboxylic acid or benzanthronecarboxylic acid is heated to boiling with phosphorus pentachloride in benzene solution and the product subsequently treated with aluminium chloride, benzoylbenzanthrone, m. pt. 206° C., is formed. 1-Phenyl-2,3-naphthalenedicarboxylic acid on bromination with bromine and glacial acetic acid yields a mono-bromo derivative, m. pt. 282° C., which can similarly be converted into monobromobenzoylbenzanthrone, m. pt. 212° C. —T. C.

PATENTS.

Dyestuffs soluble in sodium sulphide, alkalis, and water; Process for preparing— Farbwerke vorm. Meister, Lucius, und Brüning. Ger. Pat. 296,169, Oct. 19, 1913. Addition to Ger. Pat. 264,041 (this J., 1913, 1005; see also Ger. Pat. 268,891, this J., 1914, 247).

THE dyestuffs obtained as described in the original patent are treated with sulphuric acid, oleum, or chlorosulphonic acid, of such concentration, for such time, and at such temperatures, as will yield derivatives giving soluble alkali salts. The resulting products, which must be regarded as sulphonic acids, have a strong affinity for fibres in a sodium sulphide bath. They differ from the dyestuffs of the original patent in being soluble, without previous reduction, in water, dilute alkalis, or alkali sulphides.—C. A. M.

Polychloro substitution products of N-dihydro-1,2,2',1'-anthraquinonocazine [Indanthrene]; Process of preparing— Farbwerke vorm. Meister, Lucius, und Brüning. Ger. Pat. 296,841, June 3, 1914.

INDANTHRENE is suspended in an inert organic liquid and treated with chlorine in excess at temperatures not materially exceeding 40° C. The products, and especially the tri- and tetrachloro substitution derivatives, are characterised by their brightness of shade and resistance to the action of chlorine.—C. A. M.

Chlorine derivative of N-dihydro-1,2,2',1'-anthraquinonocazine [Indanthrene]; Process of preparing a— Chem. Fabr. Griesheim-Elektron. Ger. Pat. 296,192, Aug. 10, 1915.

INDANTHRENE is treated with sulphur chloride in an inert medium at temperatures below 100° C. The resulting dichloro-derivative is materially faster to chlorine than Indanthrene Blue G.C.D., and nearly as fast as Indanthrene Blue G.C. The product is in a finely divided state and is suitable for the manufacture of bright-coloured pigments.—C. A. M.

Acid monoazo-dyestuffs for wool; Process of preparing— Farbenfabr. vorm. F. Bayer und Co. Ger. Pat. 296,961, May 5, 1914

DIAZOTISED N-alkylacyl- or N-arylacylphenylenediamines or their derivatives, in which the acyl group is derived from an aromatic acid or its ring-substitution products, are combined with pyrazolone- or methylketosulphonic acids, hydroxynaphthalenesulphonic acids, or acylperiaminohydroxynaphthalenesulphonic acids. The resulting products dye wool from acid baths level yellow to bluish-red and brown shades, fast to milling.—C. A. M.

Monoazo dyestuffs suitable for the manufacture of pigments; Process of preparing—, Badische Anilin und Soda Fabrik, Ger. Pat. 296,391, Aug. 7, 1914.

THE diazo compound of 1-aminoanthraquinone is combined with 1-benzoylamino-7-hydroxynaphthalene, or its derivatives substituted in the benzoyl nucleus, with or without the addition of Turkey-red oil or a similar agent, and in the presence or absence of substrata. Bright-red pigments are thus obtained, which are insoluble in water and in oil, are not affected by alcohol or lime, and are remarkably fast to light.—C. A. M.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

[Paper.] *Proper order of adding furnish (colour and size) to beaters*. A. E. Sunderland, Tech. Assoc. Pulp and Paper Industry, Paper-Making, 1917, 36, 145—149.

IN the sizing of undyed pulp it is usual to add first the rosin size and later the alum; this order is based on the observation that the colloid, on account of its low surface tension, if added first, quickly penetrates the pulp-mass and precipitation by the alum then takes place in and about the fibre cells. In the case of pulps dyed with soluble dyestuffs more complex considerations come into play, because of the reactions between the dyestuffs on the one hand and the fibre, rosin size, and alum on the other. These reactions vary according to the nature of the dyestuff. A series of experiments is described with mixtures consisting of 10 grms. of sulphite pulp in 500 c.c. of water, when treated with 1% of dyestuff, 5% of rosin in the form of size, and 5% of alum, calculated on the weight of the pulp. The ingredients were added to the pulp in six different orders. (1) Colour, size, alum. When the colour is added the pulp absorbs about 75% of the dyestuff; the size forms a precipitate with the colour in the liquor and then begins to strip the colour from the pulp; the alum in most cases reacts with the excess of size, then decomposes the colour-resinate, liberating the colour, which is again absorbed by the pulp. (2) Colour, alum, size. The pulp absorbs 75% of the colour; alum produces no change; the size reacts with the alum. If alum is in excess the colour is unaffected, but if the size is in excess it reacts with the colour in the liquor and then begins to strip the colour from the pulp. (3) Size, alum, colour. The reaction of the size and alum forms a milky precipitate which acts as a resist to the colour; if alum is in excess the colour is slowly absorbed but if the size is in excess the pulp is less deeply dyed. (4) Size, colour, alum. The size reacts with the colour at once and the pulp is only slightly dyed; on the addition of alum the colour resinate is slowly decomposed and the pulp gradually absorbs the colour. (5) Alum, colour, size. Same as (2). (6) Alum, size, colour. Same as (3). The best results are obtained by adding colour first, then alum, and lastly size, as in (2), but too much alum causes a too deeply coloured effluent and the quantity should be considerably less than 5%. This applies to basic dyestuffs. With less alum, less size may be used and any deficiency in the retention of the fine precipitate may be counteracted by the subsequent addition of salt, which induces flocculation. Similar considerations apply to acid and substantive dyestuffs, but more than 5% of alum may be required.—J. F. B.

Paper-yarn sacks for sand; Waterproofing—, L. Cassella and Co., Chem.-Zentr., 1917, 44, Rep., 56.

THE various methods employed for impregnating

paper yarn sacking so as to increase its tensile strength when wet were examined. The best results were obtained by first impregnating the dry paper at 50° C. with a solution containing 80 grms. of glue, 1.5 grms. of tannin, and 1.5 grms. water-glass at 37° B. (sp. gr. 1.345) and then drying it. Strips 30 cm. × 5 cm. gave the following values for the tensile strengths of the warps, the figures in the brackets representing the values for the wefts:—

	Untreated*	Treated.
	kilos.	kilos.
Dry material	34.4 (37.1)	45.7 (44.5)
After 24 hours' soaking in water ..	26.4 (23.7)	34.2 (30.8)
After re-drying	41.2 (37.4)	45.2 (41.1)

The next best results were obtained by first treating the material with cold basic aluminium formate at 6° B. (sp. gr. 1.013) and drying, then at 50° C. with a solution containing 80 grms. of glue per litre, and then repeating the treatment with basic material. The use of mixtures of soap and glue was not satisfactory. Drying between each treatment increased the tensile strength of the product.—A. B. S.

Paper tubes; Experiments with—, M. Rudeloff, Mitt. k. Materialprüf., 1916, 34, 61—77.

TESTS were made with tubes prepared by the process of A. von Valois by rolling paper to the desired diameter and thickness of wall, fastening with a suitable adhesive, and coating. The tubes are intended to serve as pipes for gas and water. The specific resistance to direct hydraulic bursting pressure calculated according to the formula, $\frac{pd}{2W}$, averaged 360 kilos. per sq. cm., where p is the bursting pressure in atmos., d the internal diam., and W the thickness of the wall. The tubes were not appreciably affected by the prolonged action of coal gas, and some which had stood full of water for several weeks showed no perceptible swelling or loss of resistance. These paper tubes are only $\frac{1}{10}$ to $\frac{1}{15}$ the weight of lead pipes and resist 3—4 times the pressure for equal diameters. The joints of the paper pipes consist of tube sections slipped over the two ends to be united, the annular space being packed with a suitable composition. The jointed pipes burst at a considerably lower pressure than the single pipes and in some cases gave way at the joints. Tests for resistance to external pressure showed an average of 27.8 atmos., which is regarded as sufficient resistance to the pressure of the earth, provided the material did not become softened in course of time. Another set of trials was made with "Pertinax" tubes made from paper impregnated with synthetic resin and rolled under tension; the smallest internal diameter obtainable is 5 mm. Tensile tests were made with strips cut from the tubes, both air-dry and after steeping in water; the absorption of water caused a loss of strength of 22—35%, but increased the elongation on breaking; the modulus of elasticity was lowered by steeping. It appeared, however, that the absorption of water took place largely through the unprotected cut edges of the strips and to this extent the tests are not regarded as conclusive. Another make of paper tube was tested for absorption of water when the closed tube was allowed to stand full of water; the absorption was particularly large in the first hour and had not reached its limit after 282 hours; only the inner surface of the tube was softened, the outside not being visibly affected. For use with water, the suitability of paper tubes cannot be regarded as established, but further investigations are necessary before a definite judgment can be pronounced.

The "Pertinax" tubes of small diameter should give good results for oil conduits in view of the well-known resistance of synthetic resins to oil. Bending tests with paper tubes have shown that they cannot be regarded as suitable for constructional purposes. The tensile strength of 10—18 kilos. per sq. cm. with a low specific gravity (1.2) is sufficient, but the compression strength (4.6 kilos. per sq. cm.) is too small and the extremely low modulus of elasticity would produce distortions of the structure even under very moderate stresses.

—J. F. B.

Determination of resin in rosin size. Heuser. See XIII.

Trimethylglucose from cellulose. Denham and Woodhouse. See XVII.

PATENTS.

Wool and other fibrous material; Machines for washing —. W. R. Kay, Cottingham, Yorks. Eng. Pat. 105,463, June 23, 1916. (Appl. No. 8825 of 1916.)

In a washing machine consisting of a bowl and guiding trough for the goods, the guiding trough is constructed with perforated bottom and sides so that the liquor may circulate freely between the inside of the trough containing the goods and the main bowl. The guiding trough may be situated centrally in the outer bowl, or side-troughs or gutters may be used with perforated sides and communicating with the base of the bowl. Agitating or circulating devices are provided in the trough so as to give the liquor a downward and longitudinal thrust, followed by an upward movement. Suitable devices consist of inverted V-shaped agitators mounted on longitudinal bars (see Eng. Pat. 28,192 of 1910; this J., 1911, 1307).

—J. F. B.

Artificial silk; Funnels or thread guides for use in machines for the manufacture of — and apparatus to be used for same. Courtaulds, Ltd., London, and J. Clayton, Coventry. Eng. Pat. 104,225, Mar. 1, 1916. (Appl. No. 3120 of 1916.)

THE funnel or thread guide through which the thread passes from the coagulating bath into the rotating spinning box is provided with a ferrule or sleeve surrounding the part of the funnel which is to be supported in the fitting or bearing of the machine. The ferrule is applied at a predetermined distance from the lower end of the funnel and so that the upper and lower ends of the tubular part of the funnel are in line with the longitudinal axis of the ferrule. The ferrule is adjusted on the funnel by supporting the latter between two conical bearings on a vertical stand which also carries the ferrule at an intermediate point, the centres of the supports and axis of the ferrule being in one line, and when the parts are properly adjusted and secured by a clip, pitch is run into the space between the funnel and ferrule to make a permanent mounting.—J. F. B.

Adhesive coatings; Method of preparing — and applying them to fabrics without the use of solvents. J. Meade, Stoughton, Mass. U.S. Pat. 1,222,967, Apr. 17, 1917. Date of appl., Mar. 16, 1916.

A GUM and a wax are ground together and mixed at a temperature at least as high as that at which the mixture becomes plastic, e.g., 170° F. (77° C.); the mixture is tempered by immersion in a liquid heated to a higher temperature, e.g., 210° F. (99° C.) and is then spread on the fabric at a still higher temperature, e.g., 212°—215° F. (100°—102° C.).—J. F. B.

Cellulose preparations; Process for purifying and improving —. Elektro-Osmose A.-G. (Graf Schwerin Ges.), Berlin. Ger. Pat. 296,053, June 17, 1914.

THE material in a swollen condition is subjected to the action of an electric current between diaphragms; the material may be transported continuously between the electrodes partitioned off by diaphragms. The process is applicable to products derived from viscose, cellulose acetate, formate, or nitrate. The treatment is intended to counteract the adsorption of traces of catalyst which makes these products unstable.—J. F. B.

Paper; New method of sizing —. R. W. Sindall and W. Bacon, London. Eng. Pat. 105,444, May 23, 1916. (Appl. No. 7320 of 1916.)

PAPER is immersed first in a solution of gelatin which may contain soap, starch, gum, or resins, but no alum or aluminium sulphate, and subsequently in a solution of gelatin containing alum or aluminium sulphate. The first solution may safely be heated to a higher temperature than is usually employed in sizing paper and better penetration thus obtained.—J. F. B.

Paper-size and process of making same. J. A. De Cew, Montreal, Canada. U.S. Pat. 1,223,480, Apr. 24, 1917. Date of appl., Feb. 25, 1914.

THE cold size solution contains a non-decomposing ammonium resinate, free ammonium hydrate, and water, without the presence of free rosin; the solution is made from a cold thick size by forcing the latter by means of pressure into a cold aqueous solution.—J. F. B.

Sulphite cellulose; Apparatus for the extraction of hydrocarbons, etc., especially cymol, which arise in the manufacture of —. P. G. Enger, Skotselven, Norway. U.S. Pat. 1,223,158, Apr. 17, 1917. Date of appl., Mar. 9, 1916.

In an apparatus for separating oily and resinous extractives from pulp, several tanks are provided, one of the tanks having an inlet connected with the top outlet of the digester and an outlet near the top of the tank leading to an inlet near the bottom of the second tank. The second tank has an outlet near the bottom, diametrically opposite the inlet, leading to an inlet in a third tank at a slightly higher level than the outlet in the second tank, and a return pipe is provided from the third tank to the digester.—J. F. B.

Packing rings [from viscose]. Chem. Fabr. von Heyden A.-G. Ger. Pat. 296,405, Apr. 14, 1916.

CELLULOSE obtained by the decomposition of viscose is treated with a hygroscopic substance such as calcium chloride, which counteracts its tendency to shrink.—F. W. A.

[Paper;] Paraffin coating machine [for —]. E. H. Vavra, Chicago, U.S.A. Eng. Pat. 105,827, June 14, 1916. (Appl. No. 8386 of 1916.)

Artificial-silk machines; Thread guide for —. Device to be employed in making funnels, or thread-guides, for use in machines for the manufacture of artificial silk. J. Clayton, Coventry, Assignor to Courtaulds, Ltd., London. U.S. Pats. 1,224,070 and 1,224,071, Apr. 24, 1917. Dates of appl., Apr. 18 and Aug. 17, 1916.

SEE Eng. Pat. 104,225 of 1916; preceding.

Fireproofing of fabrics and other articles. T. J. F. Craig, Manchester. U.S. Pat. 1,225,411, May 8, 1917. Date of appl., Feb. 6, 1915.

SEE Eng. Pats. 16,153, 18,310, 19,041, and 23,421 of 1914; this J., 1915, 868.

Cloth for filler-presses. U.S. Pat. 1,222,400. See I.
Production of charcoal [from sulphite-cellulose waste-tyes]. Eng. Pat. 102,608. See III.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Fastness of dyestuffs. Standards and processes established by the "Echtheitskommission." Heermann. See IV.

PATENTS.

Textile fibres: Manufacture [treatment before bleaching] of —. E. T. J. Watremez, Brussels. Eng. Pat. 6195, Apr. 26, 1915. Under Int. Conv., June 16, 1914.

To facilitate subsequent bleaching, vegetable fibres are immersed in a bath containing alkali and a solution obtained by boiling for several hours a solution of zinc or other alkali-soluble metal in concentrated caustic soda or sodium carbonate solution mixed with a soluble oil, e.g., sodium or ammonium sulphuricinate, and then filtering. The bath is raised to the boil for the necessary time, the metallic salts combined with the fibre are removed by means of a mixture of sulphuric and sulphurous acids, and the material is rinsed, or it may be boiled in an alkali bath, and then passed through acid before being rinsed.—F. W. A.

Dyes on the fibre: Production of aniline —. J. F. Moscey and E. M'Cardell, Manchester. Eng. Pat. 105,349, Feb. 9, 1916. (Appl. No. 1898 of 1916.)

BROWN and similar shades on textile fibres or fabrics are obtained by oxidising salts of aniline or its homologues mixed with an aromatic hydroxy-compound containing no nitro-, nitroso-, or amino-groups, e.g., a phenol. *Example.* The fabric is impregnated with a hot solution of a mixture of a 10% aniline solution and a 10% phenol solution, and developed in a bath containing 22 lb. of hydrochloric acid (32 Tw., sp. gr. 1.16) and 14 lb. of sodium bichromate in 200 gallons of water.—F. W. A.

Dyeing. H. C. Miller, London, and H. A. Irlam, Mill Hill. Eng. Pat. 105,353, Apr. 10, 1916. (Appl. No. 3213 of 1916.)

IN dyeing wool, leather, silk, etc., with the dyes obtained by treating gums or gum-resins from plants of the *Xanthorrhoea* genus with sulphuric acid (Eng. Pat. 101,353 of 1916; this J., 1917, 500), more permanent or fast colours of varying shades or tones are obtained by adding a chromium compound, such as a bichromate, or other oxidising agent to the dye-bath, or by pre-treating or after-treating the material to be dyed with such a reagent.—F. W. A.

Dyeing yarns and slubbings: Machines for —. S. S. Partridge, Kidderminster. Eng. Pat. 105,415, May 24, 1916. (Appl. No. 7379 of 1916.)

IN a machine for dyeing yarns and slubbings, a hank-carrying frame in addition to having vertical reciprocating movement, produced by means of mechanism as described in Eng. Pats. 8370 of 1901 and 3114 of 1911 (this J., 1905, 513; 1915, 75) is given a horizontal reciprocating movement so as to carry non-rotating horizontal hank-carrying poles immersed in the vat laterally to and fro. Perfect stirring and circulation of the dyeing liquor through the hanks is thereby effected without providing any additional stirring mechanism in the vat.—F. W. A.

Dyeings on cotton and similar fibres: Production of fast —. Farlow, vorm. Meister, Lucius, and Brüning. Ger. Pat. 296,141, May 31, 1914.

AZO-DYESTUFFS containing one or more molecules of an aminarylpyrazolone or derivatives with a free amino-group in the end position, other than the dyestuffs claimed in Ger. Pat. 289,350 (see U.S. Pat. 1,147,803; this J., 1915, 900), are treated on the fibre with formaldehyde or a substance yielding formaldehyde in warm, acid solution, to improve their fastness to washing.—F. W. A.

Dyeings: Production of —. Farbenfabr. vorm. F. Bayer und Co. Ger. Pat. 296,112, Feb. 10, 1916.

DI- β -NAPHTHYL-4,4'-DIAMINODIPHENYLAMINESULPHONIC acids and their substitution products, containing a hydroxyl group in the naphthalene nucleus, are oxidised on vegetable fibre. The fibre is dyed in neutral or alkaline solution, with or without addition of salts, and the oxidation is carried out in the usual manner by means of chromic acid or its salts, or with copper salts in presence of organic acids, e.g. formic or acetic acid. The shades produced, generally grey on cotton, are very fast to light.—F. W. A.

Calf's-skin in the hair: Dyeing of tanned — and of goods produced therefrom. R. Knote, Furth, Austria. Ger. Pat. 296,394, May 21, 1916.

AFTER degreasing with sodium carbonate solution, the skins are treated with potassium carbonate and caustic potash solution, the surface exposed to air, treated with alum or aluminium sulphate solution, and afterwards with highly concentrated hydrogen peroxide, dried, and then dyed with Indigo Extract or Indigo Carmine by brushing on or by immersion. For white-haired calf's-skin a bottoming of walnut or gallnut extract is used. In order to obtain the desired tone, the dyed skins are treated with salts such as copper sulphate, ferrous sulphate, or potassium bichromate.—F. W. A.

Azo dyestuffs on the fibre: Production of —. Farbenfabr. vorm. F. Bayer und Co. Ger. Pat. 296,559, Oct. 10, 1914.

FABRIC padded with 2,3-hydroxynaphthoyl-aminonaphtholsulphonic acids or their derivatives dissolved in cold, dilute sodium carbonate solution, is treated with unsulphonated diazo-compounds. Clear yellow, red, blue to black dyeings very fast to boiling are obtained.—F. W. A.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Sulphates of sodium: Acid and neutral —. P. Pascal. Comptes rend., 1917, 164, 628–630.

THE author has studied the system sodium sulphate-sulphuric acid-water, at temperatures between -45° and 210° C., defining the conditions of existence in contact with solution of the following solid phases:—Ice, Na_2SO_4 , $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$, $\text{Na}_2\text{SO}_4 \cdot \text{NaHSO}_4$, $\text{NaHSO}_4 \cdot \text{H}_2\text{O}$, NaHSO_4 , $\text{NaHSO}_4 \cdot \text{H}_2\text{SO}_4 \cdot 1.5\text{H}_2\text{O}$, and $\text{NaHSO}_4 \cdot \text{H}_2\text{SO}_4$. The conditions of existence of the hydrate, $\text{Na}_2\text{SO}_4 \cdot 7\text{H}_2\text{O}$, are less clearly defined, while some evidence was obtained of the existence of the compounds, $\text{Na}_2\text{SO}_4 \cdot 2\text{NaHSO}_4$ and $\text{H}_2\text{SO}_4 \cdot 2\text{NaHSO}_4$. From the data afforded by his diagram, the author proceeds to the discussion of the results of cooling nitre-cake, and of crystallising solutions of bisulphate in water. By pouring fused nitre-cake into water and allowing to cool so that crystals of NaHSO_4 , Na_2SO_4 separate, it would be possible to obtain a mother liquor richer in free acid and with a relatively low content of normal sulphate.
—W. H. P.

Potash from Nebraska lakes. R. P. Crawford. Eng. and Min. J., 1917, 103, 777—778.

THE extraction of potash and soda from the more saline of the sand-hill lakes of Nebraska is at present conducted by the Potash Products Co. at Hoffland (now shipping about 1500 tons per month of the crude salts), the Nebraska Potash Works Co. and the American Potash Co. at Antioch, and the Hord Alkali Products Co. and the Palmer Alkali Co. at Lakeside. The brine worked occurs beneath a thin layer of hardpan at the bottom of the lakes, the salinity of the upper water being usually too low for profitable extraction. By means of electrical pumps, provided with filters to exclude sand, the brine is pumped through long pipe-lines to the evaporating plant consisting of vacuum kettles, in which the solution is concentrated to a yellow liquid, and rotary dryers in which the latter is evaporated until crystallisation occurs. The mixed salts thus obtained are marketed in the crude state; they consist of sulphate, carbonate, bicarbonate, and chloride of sodium and carbonate and sulphate of potassium, the Potash Products Co.'s salts containing H_2O 2.14, K_2O 27.35, Na_2O 28.39, CO_2 22.14, SO_3 16.77, and Cl 2.02% according to one analysis.

—W. E. F. P.

Ferrous sulphide; Heat of formation of —. N. Parravano and P. de Cesaris. Gazz. Chim. Ital., 1917, 47, I., 144—149.

PURE iron was obtained by reducing ferric oxide (derived from pure ferric ammonium sulphate) by means of hydrogen at $700^\circ C$. It was mixed with sulphur, which had been purified by three crystallisations from carbon bisulphide, in equimolecular proportions, and the mixture was ignited in a calorimetric bomb by means of an electrically heated platinum wire. The average results of six determinations were 26.2 cal. per grm. of ferrous sulphide formed or 23,070 per grm.-mol.—C. A. M.

Hydrogels of silica; Behaviour of — at low temperatures. B. L. Vanzetti. Gazz. Chim. Ital., 1917, 47, I., 167—189. (See also this J., 1916, 837.)

EXPOSURE to low temperatures has practically no effect upon silicic acid coagulums and hydrogels. The final composition of the coagulums depends not only on the initial composition and age of the mixture, but also upon the degree of moisture in the air during the process of rapid drying. The final molecular ratio $[H_2O]:[SiO_2]$ is frequently less than unity when the hydrogel is dried in the air, especially in the case of coagulums rich in silica. The variations in this ratio are too great to support the view that hydrates of silica are present. The absorption theory of Van Bemmelen and the theory of the granular constitution of the coagulums (this J., 1911, 1056; 1912, 82) appear to give a satisfactory explanation of all the transformations which the colloidal systems of water-silica can undergo.—C. A. M.

Dealings in sulphuric acid. See page 574.

Micro-titration of ammonia. Barnett. See XXIII.

Sodium perchlorate as a general microchemical reagent. Denigès. See XXIII.

PATENTS.

Active oxygen; Compound containing — and the process of making the same. O. Liebknecht, Frankfurt, Germany, Assignor to The Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,222,640, Apr. 17, 1917. Date of appl., May 25, 1916.

A MIXTURE which yields sodium perborate is treated with a soluble zinc compound in presence of sodium carbonate.—B. N.

Hydrogen sulphide and hydrogen cyanide from crude gases; Recovery of —. J. Behrens, Bremen. Ger. Pat. 296,466, Feb. 22, 1916.

THE cooled crude gas is passed over cold charcoal, from which the absorbed hydrogen sulphide and hydrogen cyanide are afterwards liberated by heat, e.g., by means of a current of hot gas or superheated steam. The crude gas may be divided into two portions, of which one is passed over the cold charcoal, whilst the other serves as heating medium to liberate the absorbed gases from the charcoal; the first portion, after one passage over the cold charcoal, is returned to the main stream of crude gas, so that it may be brought into contact with the charcoal a second time. The hydrogen sulphide and hydrogen cyanide liberated from the charcoal are absorbed in water and subsequently recovered separately by fractional evaporation.—F. W. A.

Hydrogen; Apparatus and process for producing —. A. Messerschmitt, Stolberg, Germany.

U.S. Pats. 1,225,262 and 1,225,264, May 8, 1917.

Dates of appl., June 26, 1912, and Jan. 9, 1915.

SEE Fr. Pat. 444,015 of 1912; this J., 1912, 1126.

Hydrogen; Apparatus for producing —. A.

Messerschmitt, Stolberg, Germany. U.S. Pat.

1,225,263, May 8, 1917. Date of appl., June 10, 1913. Renewed Feb. 17, 1917.

SEE Ger. Pat. 268,339 of 1912; this J., 1914, 137.

Electrolytic production of oxygen and hydrogen.

Eng. Pat. 102,974. See XI.

[Electrolytic] gas generator. U.S. Pat. 1,222,809.

See XI.

Apparatus for determination of "noble" gases [argon, etc.] and nitrogen by a gas-analysis method. Ger. Pat. 296,115. See XXIII.

VIII.—GLASS; CERAMICS.

Clay; Refractory properties of —. H. Le Chatelier and F. Bogitch. Comptes rend., 1917, 164, 761—767.

THE authors have heated cubes having sides of 1 cm., under pressure, in a Schloesing's gas-heated furnace. The samples were supported on a block of sintered magnesia with an intervening layer of chromic oxide. The pressure was applied by an iron rod with a 2-in. end-piece made of bauxite burned at $1600^\circ C$. The temperatures were measured by a thermo-couple in contact with the samples. The percentage composition of the clays used was as follows:—

	G.	L.	A.	C.	B.
Alumina	20.0	26.0	26.5	12.6	33.0
Iron oxide	3.4	1.9	3.9	2.4	1.5
Lime	0.8	0.2	2.0	0.0	0.3
Silica, etc. (by diff.)	75.8	71.9	67.6	85.0	65.2

Brick G, of medium quality, burned at $1200^\circ C$, had the following crushing strengths:— 190 kilos. per sq. cm. at $15^\circ C$; 185 kilos. at 600° ; 200 kilos. at 950° , and 180 kilos. at $1080^\circ C$. At temperatures below $1100^\circ C$, the bricks broke suddenly and completely, but at higher ones, they became more plastic and underwent severe deformation before breaking. Thus, at $1300^\circ C$, 65 kilos. per sq. cm. and at $1350^\circ C$, 20 kilos per sq. cm. effected in 20 secs. a deformation of more than 5% of the thickness of the original bricks. The strength of these bricks declined very rapidly at temperatures above $1200^\circ C$. When the tem-

perature of brick G was raised from 1200° to 1398° C. in 11 min., the brick being under a pressure of 10 kilos. per sq. cm., the deformation was 48%, while the brick heated to 1415° C. in 11 min. showed a deformation of 73%, with a pressure of only 1 kilo. per sq. cm. The intervals between the temperatures giving the same amount of deformation at different pressures were less than would be anticipated, and did not exceed 50° when the pressure was increased ten-fold. When brick L was heated under pressure there were intervals of nearly 50° between the temperatures at which the same amount of deformation was produced in bricks burnt at 1200° C. and at 1430° C. respectively.

Small bricks of washed kaolin, burnt at 1200° C., when heated under a pressure of 10 kilos. per sq. cm., showed a deformation of 5.7% at 1400° and 21.7% at 1500° C. Under similar conditions, clay B (which is used for steel crucibles) showed a deformation of 9% at 1460° C.

The quality of bricks may be judged by determining the temperature at which the deformation is 20% under a pressure of 10 kilos. per sq. cm. exercised during one minute.

For the materials tested by the authors this temperature lies between 1350° and 1500° C. The high pressure mentioned was chosen so as to limit the experimental errors, but on prolonged heating, bricks will suffer deformation under much smaller pressures; thus, with a pressure of only 1 kilo. per sq. cm., 20% deformation occurs at 1250°—1350° C. Freshly made bricks are composed of a mixture of kaolinite and quartz; after burning at 1300°—1500° C. for a sufficiently long time, they consist of a mixture of sillimanite, tridymite, and some unconverted material. Thus, brick A from a furnace at Assailly was in a state of equilibrium corresponding to 1000°—1500° C. On heating such a brick to 1600° C. and then cooling it rapidly, part of it may be seen to have been fused. Hence, bricks, like alloys and mixtures of salts, remain solid up to a certain eutectic temperature, at which one constituent fuses completely and the second partially. If the temperature is still further increased, the fusion progresses still further. In the case of silicious compounds, the phenomenon is complicated by the viscosity of the molten material which retards the establishment of an equilibrium; hence the difficulty of determining the reversible fusing and solidifying point of a silica-alumina eutectic mixture. The authors heated a cube of fused silica with 1 cm. sides under a constant pressure of 10 kilos. The mass began to yield at 1300° C. and 10 min. later, at 1400°, the deformation amounted to 40%. They conclude that below 1500° C. vitreous silica is not sufficiently fluid to permit rapid changes towards a state of equilibrium; hence our ignorance of the nature of the fusibility graph of mixtures of tridymite and sillimanite. On the other hand, bricks used in industrial furnaces have been burned at such a temperature and for so long a time that they have reached an equilibrium and are composed of sillimanite and tridymite.

It is suggested that when kaolinite is dehydrated, it is decomposed into amorphous silica and alumina. The silica softens as the temperature rises and combines with the various bases, including alumina. Ordinary glass is quite soft at 800° C. In the fusion of bricks, this gradual fusing of the silica is seen and not the reciprocal solution of the tridymite and sillimanite. On the other hand, any quartzose silica present in a clay does not become amorphous, but is converted into cristobalite or is dissolved in the glassy matrix. This incipient fusion of bricks at the expense of the amorphous silica is followed by crystallisation of the silica in the form of tridymite, and normal fusion can only occur at a still higher temperature. If a brick is heated sufficiently slowly for the various trans-

formations to be completed, it will pass through two zones of fusibility, separated by an interval of recrystallisation. A well-burned brick does not show the first zone.—A. B. S.

PATENTS.

Glass-melting pot. E. A. Gillinder, Philadelphia, Pa. U.S. Pat. 1,223,959, Apr. 21, 1917. Date of appl., Sept. 17, 1915.

A GLASS-MELTING pot, closed at the top, except for a feed-inlet, has a discharge passage in the lower part of its side leading to a well which forms an extension of the pot. The floor of the pot is inclined towards the well.—A. B. S.

Clay: Process and apparatus for refining.—S. A. W. Okell, East Orange, N. J., Assignor to Industrial Chemical Co., New York, N.Y. U.S. Pat. 1,222,979, Apr. 17, 1917. Date of appl., July 6, 1916.

RAW clay is suspended in water to the extent of about 10% and fed continuously into the bottom of a drum wherein it is given a powerful centrifugal motion by means of paddles attached to a vertical shaft. The heavier particles of grit, etc., separate and are removed in suspension from the lower part of the drum. The purified clay is removed through a vertical tube, with a side outlet, attached to the top of the drum.—A. B. S.

Ceramic kiln. A. L. Stevens, Chicago, Ill. U.S. Pat. 1,223,440, Apr. 21, 1915. Date of appl., Sep. 10, 1912.

A REGENERATOR communicates with each unit of a continuous series of bag walls and flues extending the full length of each side of the kiln, and is also provided with an inlet for fresh air. Hot air or gas from the regenerators passes alternately through the flues on opposite sides of the kiln and is discharged through flues on the opposite side, into the regenerator communicating with the latter.—A. B. S.

Spraying ceramic and other articles: Method of affording protection to workmen during the operation of.—Sanitary tile-spraying chamber. H. D. Lillibridge, Zanesville, Ohio, Assignor to American Encaustic Tiling Co., Ltd., New York. U.S. Pats. (A) 1,223,809 and (B) 1,223,810, Apr. 21, 1917. Date of appl., July 28, 1913.

(A) THE spraying is conducted in a closed chamber and any surplus material is intercepted by an absorbent medium such as a curtain or film of flowing liquid towards which the spray is directed. The medium prevents the rebound of the sprayed matter. (B) The apparatus consists of a chamber fitted with a spray, with means for circulating air, with an absorbent curtain of flowing liquid to receive surplus matter, and with means for withdrawing air from near the top of this curtain so that the work may be done without danger of inhaling the sprayed material.—A. B. S.

Muffle kiln for enamels. E. Schröder, Berlin, Ger. Pat. 296,457, Oct. 31, 1915.

IN order to effect a more uniform distribution of the heat, a muffle kiln for enamels is provided with a deep, narrow circumferential flue extending beneath it. The sole of the kiln is built with two or more steps, and part of the kiln wall is constructed of a material (e.g., carborundum) of lower thermal conductivity than fireclay. By this means, the flames play on each support for only a short time and the heat is not so severe as usual. Even if a support is built of poor materials and cracks, it cannot choke the flue. Further advantages are that the flue dust does not attack the walls of the kiln so readily and the muffles last longer.

The sole of the muffle may be built of arch bricks and a better distribution of heat secured.

A. B. S.

Glass; Method of and apparatus for feeding molten — W. J. Mollers-Jackson, London. From Hartford Fairmont Co., Canajoharie, N.Y., U.S.A. Eng. Pat. 105,672, June 19, 1916. (Appl. No. 8649 of 1916.)

Kiln. U.S. Pat. 1,223,732. See 1.

IX.—BUILDING MATERIALS.

Bricks and the like; The properties of — [Proposed standards.] H. Burchartz. Mitt. k. Materialprüf., 1916, 34, 79—152.

In order to arrive at some standard specification for the various types of brick, all the samples tested at the Materialprüfungsamt during the period 1907—1913 according to the standard methods have been grouped, and from the results there has been evolved a series of proposed standard values for each type which should be readily attainable under commercial conditions:—*Volume-weight* in grms. per c.c. (r): for clinker bricks, 1·85; hard-burnt ware, 1·75; building bricks, 1st quality, 1·60. *Specific gravity* (s): clinker, 2·6—2·7; hard-burnt, 2·6—2·7; building bricks, 1st quality, 2·6—2·75. *Specific gravity* decreases very slightly the harder the burning; for instance, average values for the three types were 2·650, 2·660, and 2·680 respectively. It will vary somewhat according to the material, but no brick with a specific gravity below 2·50 is fit for building purposes. *Impermeability* is calculated from the apparent volume-weight and the specific gravity by the formula $1 - \frac{r}{s}$; the proposed standards are

therefore based on the foregoing. *Absorption of water.* The absorptive capacity of bricks varies very largely even for the same sort and it is difficult to lay down any rigid standards; moreover, it has been proved that the capacity for absorption of water bears no direct relationship to the strength. It is only necessary to put forward standards in the case of clinker and hard-burnt bricks which are largely used for conduits and should possess a certain degree of water-tightness. For clinker is suggested an absorption of 5% by weight or 10% by vol., and for hard-burnt, 8% by weight or 16% by vol. *Crushing resistance.* Standards have already been adopted by the German building trade association which, according to the average tests of the Materialprüfungsamt, are by no means too high. These standards prescribe for the crushing resistance, in kilos. per sq. cm., 350 for clinkers, 250 for hard-burnt, 150 for building bricks 1st quality, and not less than 100 for 2nd quality building bricks for use in interiors. The author suggests that the standard for 1st quality building bricks might reasonably be raised to 180. The ratios of crushing strengths when saturated with water and after repeated freezing to the crushing strength of the dry brick are of considerable importance, and it is suggested that the average loss of strength in the saturated condition should not exceed 15% and the loss after freezing should not exceed 25%. Bricks must be free from lime in lump form and finely divided lime should not be present except in harmless quantities. Abrasion tests should be adopted for clinkers which will ensure that they present at least as good resistance to wear as other artificial paving materials.—J. F. B.

Specific heats of various building and insulating materials. M. Kinoshita. Gesundheits-Ing., 1916, 39, 497—503. Z. angew. Chem., 1917, 30, Ref., 65.

THE following results obtained with an ice-

calorimeter show the average specific heats between 0° and t° C. and the volume-weights of the materials:—

	t°.	Kilos. per cb. m.	Kilo-calories :	
			per kilo.	per cb. m.
Expanded, but not impreg- nated, cork	65	163	0·433	70·6
	57	363	0·433	70·6
	44	163	0·432	70·4
	64	163	0·446	72·7
	22	163	0·410	66·8
Greatly expanded cork ..	44	57	0·342	19·5
	47	57	0·325	18·5
Natural cork	20	57	0·335	19·1
	48	152	0·433	65·8
Natural cork	102	162	0·419	67·9
	48	162	0·421	68·2
Cork bonded with pitch ..	22	162	0·405	65·3
	49	190	0·361	68·6
Expanded, impregnated cork	47	206	0·312	64·1
Raw silk	35	564	0·318	179
Straw	36	284	0·211	59·9
	50	284	0·188	53·4
Kapok fibre	36	142	0·320	45·5
Kieselguhr	38	242	0·212	75·8
Marble	34	2682	0·194	518
	21	2682	0·184	494
Sand-lime bricks	16	2122	0·202	429
Fine concrete	16	2133	0·210	448
Rough concrete	16	2264	0·213	469
Bricks	49	1645	0·178	293
	27	1645	0·177	291
Slate	20	2816	0·181	510
Cast asphalt	20	2102	0·224	471
	19	2102	0·223	469
Rammed asphalt	21	1681	0·213	358

A. B. S.

PATENTS.

Mortar; Mixing — E. Becker, Washington, D.C. U.S. Pat. 1,223,239, Apr. 17, 1917. Date of appl., Feb. 24, 1912.

MORTAR consisting of lime or cement, water, and sand is preserved by adding during the mixing, lead acetate in the proportion of more than 0·5% of the lime or cement. Insoluble salts of lead are formed with substances which would otherwise attack the mortar.—W. F. F.

Artificial stone slab, shingle, and plate, and composition for making same. W. Singer, Passaic, N.J., Assignor to Asbestos Slate Roofing Manufacturing Co., Inc. U.S. Pat. 1,223,834, Apr. 24, 1917. Date of appl., Aug. 20, 1915.

A COMPOSITION for making artificial stone slabs, slungles, plates, and the like, consists of hydraulic cement, fine asbestos fibre, chemically active precipitated anhydrous silica, and about twice the weight of the dry mass of water. The surface of the slabs may be hydrated by steam, and the whole mass is strengthened and hardened by the formation of insoluble silicates on exposure to atmospheric moisture and carbon dioxide.—W. F. F.

Shaft-kilns; Preventing the admission of "false air" into — G. Polysius, Dessau, Ger. Pat. 296,155, Mar. 17, 1916.

THE magnesite, lime, cement-mix, or other material to be burned is charged into the kiln through a succession of auto-feeders arranged one above another, the supply to each being shut off before its exit is fully closed. When a rotary hopper is used, it is fitted with trippers which operate the exit slide of a primary supply hopper; it is automatically closed by springs. By these means, material cannot become jammed between the slide and its frame, thus preventing complete closure and admitting "false air."—A. B. S.

Waterproof cement; Production of —. H. Kunze, and "Anneliese" Portland-Cement- u. Wasserkalkwerke A.-G. Ennigerloh. Ger. Pat. 296,537. Apr. 30, 1914.

Hot cement clinker is mixed with a solid material such as paraffin, which melts and, having a low viscosity, fills up the pores. The grinding mills are fed with a mixture of porous and saturated clinker.

— A. B. S.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Cast iron; Metallurgy of —. A. Stadelcr. *Stahl u. Eisen*, 1916, 36, 935—936, 1031—1039. *Z. angew. Chem.*, 1917, 30, Ref., 13.

EXPERIMENTS are reported on the influence of carbon, silicon, manganese, and phosphorus on the properties of cast iron. The quantity and character of the graphite appear principally to determine the mechanical properties. With grey iron containing 1.5% Si, small quantities of manganese, up to 0.3%, increase the formation of graphite, but a further increase to 2.5% has no influence. Cast irons rich in phosphorus, contrary to existing ideas, may be improved by the presence of 1% of manganese. With a rise in the proportion of graphite, the strength of the iron in tension and bending falls off. This occurs also with increase in the percentage of carbon and silicon, both of which favour the formation of coarse graphite. With increase of phosphorus up to 0.3% and of manganese up to 1%, the strength in tension and bending increase. Phosphorus up to 0.3% and also high graphite content favour bending, while manganese and silicon have the opposite effect. The resistance in the impact test, above all properties, shows the greatest sensitiveness to phosphorus. It diminishes rapidly as the phosphorus content rises until this reaches 0.6%, above which the decrease is inconsiderable. This property brings out the superiority of irons low in phosphorus in a special degree. Silicon and manganese have a similar effect. Hardness falls with a rise in graphite content and is increased by a rise in manganese and phosphorus. As graphite is the constituent which has most bearing on the properties of the iron, it should receive most attention in an examination of the microstructure, especially in exceptional cases.—H. J. H.

Malleable cast iron; Influence of time of heating on quality of —. F. Wüst and E. Leuenberger. *Ferrum*, 1916, 13, 161—172. *Z. angew. Chem.*, 1917, 30, Ref., 41.

EXPERIMENTS on the influence of time of heating on the properties of malleable irons melted either in the cupola or in oil-fired furnaces are recorded. These two sorts of iron differ essentially in the sulphur content, which is much lower when the oil furnace has been used; oil fuel, unlike solid fuel, does not increase the sulphur content of the iron. The mechanical properties of the two sorts of iron are given, before and after the heating to render malleable, and the conclusions drawn are:—

(1) Material cast from an oil furnace, owing to low sulphur content, is much superior to that from a cupola in elongation, contraction, and tensile strength. (2) With increase in time of heating, the tensile strength decreases at first slowly and then rapidly, while elongation and contraction increase. (3) With increased time the toughness and resistance to shock are appreciably increased. (4) Hardness falls off with increased time of heating. (5) With heating the specific gravity

decreases but the time is without much influence. Increased silicon content lowers the specific gravity.—H. J. H.

Niegerland spiegeleisen blast furnace; Investigation of —. H. Thaler. *Berg. u. Hüttenm. Rundsch.*, 1916, 12, 61, 69. *Chem.-Zeit.*, 1917, 41, Rep., 16.

THE manganese content of the slag varies from 9 to 10%. The oxygen ratio of silica to lime is 1.7—2.0. If the silica content rises, more manganese goes into the slag. The quantity of slag influences the yield of manganese. The presence of alumina acts beneficially in reducing the content of silica. Manganese losses diminish with increasing manganese content of the iron. A slow passage through the furnace is desirable. For 20% spiegeleisen the manganese loss amounts to 7—8%.—H. J. H.

Steel; Exfoliation and carbon concentration in the case-hardening of —. E. P. Stenger. *Met. and Chem. Eng.*, 1917, 16, 425—433.

THE splitting or exfoliation of carburised zones of case-hardened steel when subjected to alternating shocks was found to be caused by the difference in the volume change of the core and carburised zone which takes place during the hardening, thus producing a stress between the carburised portion and the unaltered core. Discs of ordinary low-carbon steel, nickel-steel, and chrome-steel were prepared of 1½ in. diam. and from ½ in. to ⅝ in. thick, by cutting from a round bar, and case-hardened by placing in a steel container together with carbonaceous material and heating to various temperatures in a wire resistance furnace. In each experiment, the temperature was measured by a thermo-junction and in most cases was maintained constant until equilibrium was attained and the saturation concentration of carbon at the temperature employed was approached. After cementation, segregation of cementite (Fe_3C), or supersaturated zones, could be observed in some of the discs of all the types of steel used, and the phenomenon was not confined to either high or low temperatures or to those discs which were saturated with carbon. Segregation was found to be due to fluctuations of temperature during the heating and takes place to an abnormal degree in industrial cementation when the furnaces used are fired intermittently. The zones of cementite, which rarely exceed a thickness of 0.002 in. will, when subjected to shock, flake from the case-hardened material in the form of thin plates and give a roughened surface, which is a phenomenon distinct from exfoliation, in which the entire case splits off. After removal of the segregations of cementite by grinding a thin layer of metal from the surface of each specimen, drillings were taken from the disc and a determination made of the carbon by direct combustion, and temperature-concentration curves were drawn by plotting the carbon content against temperature. In each case the amount of carbon was less than and the form of the curve different from that given by the equilibrium relation of the iron-carbon system. These results and the observations made of segregation indicate that cementation does not proceed from the initial formation of cementite on the surface in accordance with the equation $3\text{Fe} + \text{C} = \text{Fe}_3\text{C}$, and subsequent diffusion to the core, but that carbon is transmitted by means of gases into the pores of the iron and an equilibrium established between carbon, carbon monoxide, carbon dioxide, and the solution of iron carbide in iron. Small variations in the impurities in the steels were found not to have a marked effect on the saturation point, but high percentages of nickel and chromium

used a considerable lowering of the saturation curves, due probably to the displacement of the transformation point of the γ -iron which is regarded as necessary to cementation. Determinations of the specific gravity of the carburised steels after heating to 850°C . and quenching in water, showed that while with ordinary steels diminution in density, denoting an expansion, produced by cementation, with nickel steel carburised and hardened metal has a greater density than that of the same material which is hardened but not carburised. Tension and not compression is therefore produced in the carburised zones of case-hardened nickel-steel. If the tension leads to rupture the resulting crack will be normal and not parallel to the surface as in the case of exfoliation. It was found by calculation that, in all cases, the stresses depend not only on the volume changes due to differences in the composition of the core and the case, but also on the relative thickness of core and case and on the coefficient of total linear expansion due to hardening. The stresses can be kept below the safe limit by arranging for a given diameter of material a suitable concentration of carbon and thickness of the carburised layer, and by regulating the subsequent heat treatment. The use of stress formulae in terms of the different determining factors showed that very excessive strains are produced by the high carbon carburised zones in both chrome-steels and low carbon steels.

—J. N. P.

Brass scrap of high copper content; Process for recasting.—Z. Ver. D. Ing., 1916, 60, 801. Z. angew. Chem., 1917, 30, Ref., 28.

For casting scrap of red brass, the necessity for adding considerable quantities of copper and zinc can be avoided by the addition of 0.3% of copper-manganese alloy and 1% of zinc, which oxidise the metal. The metal is heated to 1300°C . under a layer of charcoal and poured into a red hot crucible. The copper-manganese alloy is first stirred in, then the zinc previously heated to 200°C ., and the metal is ready to cast.—H. J. H.

Lead mining and smelting at Galtica, Ont. W. E. Newnam. Amer. Inst. Min. Eng. Eng. and Min. J., 1917, 103, 737—738.

At Galtica, S.-E. Ontario, coarse galena occurs with highly crystalline calcite in a fissure vein up to 10 ft. wide. A small concentrating plant was started in 1916, producing 50% of jig product and 50% of table concentrates, averaging lead 9, zinc 2%, and silver 1.14 oz. per ton. The output being too small for a blast-furnace plant and the distance to the nearest lead smelter too great, a smelter producing 15 tons of metal per day was erected. The concentrate is smelted on a coal-fired 8-ft. mechanical hearth with 2—3% of crushed limestone and 3% of coke breeze. The furnace gases pass through four goose-neck condensers, placed in parallel, into a balloon-shaped suspended flue 300 ft. long, at the end of which a "Sirocco" exhaust fan delivers the gas into 99 cotton bags (18 in. by 30 ft.). The dust is pugged with a little burnt lime and re-smelted. The labour cost (2 men per 8 hour-shift) is \$2.20 per ton of lead, the staff numbering 14 men. The lead pigs are melted, skimmed, and poured. The refined metal is 99.95% pure. The dross is returned to the hearth. 12% of the lead goes into the grey slag, which is at present periodically shipped to a distant smelter.—W. R. S.

Aluminium chips: Melting.—H. W. Gillett and G. M. James. Bull. 108, U.S. Bureau of Mines. 88 pages.

Recovery of scrap aluminium, consisting of borings, sheet clippings or punchings, and sweep-

ings, by melting is subject to considerable loss due to oxidation and failure of the metal globules to coalesce when coated with a film of oxide or dirt. Briquetting is expensive, and can only be practiced in large plants; it would but slightly decrease the melting loss and save time and fuel. Fairly high recoveries are obtained by melting in iron pots, at the lowest possible temperature, while stirring constantly to promote coalescence, but the cost of labour is high. The use of volatile fluxes (sal ammoniac, zinc chloride) while melting down gives a low yield, but they are useful towards the end of the fusion. Fusible fluxes (common salt, fluorspar), added in sufficient quantity, are of advantage, by dissolving oxide and dirt rather than preventing oxidation. A preliminary wash with dilute caustic soda, followed by table concentration and drying, would probably give a good yield of clean metal on a commercial scale. Most of the trouble in re-melting could, however, be prevented if the machine shops would keep the borings free from contamination. Some of the many laboratory experiments described gave recoveries as follows:—

	Total metal recovery.
Melting briquetted chips	76
Melting with continuous puddling	71—78
Melting with sal ammoniac	69.5
Adding scrap to "heel" of molten metal	66
Melting with 25% of flux (NaCl 85, CaF ₂ 15%) ..	78—80
Melting after washing with 0.5% caustic soda ...	75—85

—W. R. S.

Aluminium alloy; Acieral, an.—Eng. and Min. J., 1917, 103, 736.

AN American electric furnace plant with a daily capacity of 10 tons of acieral has been in operation for some weeks. The alloy (see Fr. Pat. 473,412 of 1914; this J., 1915, 558) is silver-white, has sp. gr. 2.82, and m. pt. 750°C . Its tensile strength in castings is given as 30,000, in rods and sheets as 28,000—61,000, and heat-treated as 70,000 lb. per sq. in. It resists the action of all acids except hydrochloric acid. It is stated that the alloy may be cast, forged, annealed, drawn, rolled, tempered, electroplated, and soldered and that it is being supplied to the French Government for the manufacture of helmets.—W. R. S.

Molybdenite; Concentrating Canadian.—H. H. Claudet. Canadian Min. Inst., Mar., 1917, Eng. and Min. J., 1917, 103, 786—788.

ALTHOUGH containing a high percentage of pyrites and pyrrhotite, together with some mica, the present Canadian molybdenite ores are sufficiently free from bismuth, nickel, or tungsten minerals to be concentrated readily to a product containing 40—50% MoS_2 which can be smelted in the electric furnace for the direct production of ferromolybdenum. The production of molybdenite in Canada has been developed mainly by the film-flotation method in the Wood machine or its modifications, but oil-flotation by the Elmore vacuum process, as used in Norway, has been also employed to some extent. Water concentration, although formerly used, is not efficient owing to the nature of the ore. In the film-flotation method the ore is "dried" sufficiently to oxidise slightly the iron sulphides without affecting the molybdenite, then crushed to 20—30 mesh size and treated with water. The dry molybdenite floats on the surface while the gangue and oxidised sulphides become wet and sink. The tailings are treated on a Wilfley table to recover the larger fragments of molybdenite which have sunk in the water through being rounded; the concentrates are also re-treated. In the Elmore vacuum process preferential flotation of the molybdenite in wet-crushed, unsized, 10—20 mesh ore is obtained by mixing the thickened pulp with a

very small quantity of coal oil or other light oil and subjecting the mixture to reduced pressure. Under suitable conditions high-grade concentrates and low-grade tailings are the only products obtained by this method which, although possessing marked advantages over the film-flotation process, requires a more bulky plant than the latter. In the film-flotation apparatus of the Canadian Government ore-testing plant at Ottawa, particulars of which are given, 2397.4 tons of Canadian ore containing 43.58 tons of molybdenum sulphide, MoS_2 , was treated, during 1916 and January, 1917, with a percentage recovery of 79.09% in the form of concentrates containing 79.95% MoS_2 . The amounts of concentrates and pure molybdenite produced in Australia, Norway, and Canada during 1916 were about 1590, 538, and 81 tons respectively. The Canadian production of pure molybdenite in 1915 (the first year of any commercial output) was 12.75 tons, and is now approaching 300 tons per annum.—W. E. F. P.

Flotation [of ores]: Percentage of oil in —.
H. A. Megraw. Eng. and Min. J., 1917, 103.
779—781.

IN December 1916 the United States Supreme Court decided in the case of Minerals Separation Ltd. *versus* J. M. Hyde that froth-flotation processes in which the proportion of oil employed is less than 1% of the dry weight of the ore (as in the Minerals Separation Ltd. patents) differ radically in theory and effect from those in which more than 1% of oil is used. Consequently, processes employing the smaller amount of oil are subject to the payment of patent royalties. From an investigation of the records of experimental and practical work at various plants, in which the proportion of oil used has been increased to above 1% since the above decision, it is concluded that although in most cases the extractions approximate to those previously obtained, in many the operating costs are higher than formerly. In general, the data on the use of the larger quantity of oil shows a constantly increasing percentage of extraction, a slowly but constantly improving grade of concentrates, and a very gradual reduction of the total costs. At the present time the amount of ore being treated by froth-flotation processes using more than 1% of oil is about 5000 tons per day.—W. E. F. P.

Heat of formation of ferrous sulphide. Parravano and De Cesaris. See VII.

PATENTS.

Magnetic separators. F. Krupp Akt.-Ges. Grusonwerk, Magdeburg-Buckau, Germany. Eng. Pat. 100,062, Jan. 11, 1916. (Appl. No. 481 of 1916.) Under Int. Conv., Feb. 6, 1915.

THE magnetic fields of the separator are divided into zones of increasing or decreasing magnetic strength, in which all the poles lie on one side of the feeding device. The poles are adjustable and are arranged one above the other, the material during its descent being separated into strongly and feebly magnetic fractions. The distance between two poles can be regulated in the direction in which the material moves, and vertically thereto. Wholly or partially magnetisable rings are mounted co-axially between the magnet system and the material to be treated; the magnet poles are so constructed that the lines of force enter the rings at the sides and the vertical pull on the rings is thus eliminated.—W. R. S.

Magnetic separators. A. Davies, London, and E. Allen and Co., Ltd., Sheffield. Eng. Pat. 105,354, Mar. 7, 1916. (Appl. No. 3376 of 1916.)

IN a separator of the type in which one or more magnetisable rings rotate relatively to a magnetic

field through which the material to be treated is passed, the rings are interrupted at one or more parts of their periphery by sectors of magnetisable material displaced radially relatively to the main magnetic rings, so as periodically to diversify the magnetic field and prevent bridging of the magnetic material between the poles and the attracting rings.—W. R. S.

Alloy containing magnesium; Production of an — serving for the deoxidation of cast iron or steel. Chem. Fabr. Griesheim-Elektron, Frankfort, Germany. Eng. Pat. 100,848, July 10, 1916. (Appl. No. 9714 of 1916.) Under Int. Conv. Apr. 28, 1915.

IN the process claimed in Eng. Pat. 24,007 of 1908 (this J., 1909, 480, 1143) the deoxidiser is prepared by adding magnesium or its alloys with aluminium or nickel to ferrosilicon (Si 50—80% while the latter is in a viscid or pasty condition).—W. R. S.

Zinc; Electrolytic deposition of — on metallic surfaces. P. Marino, London. Eng. Pat. 105,255, Mar. 31, 1916. (Appl. No. 4780 of 1916)

THE electrolyte consists of a concentrated aqueous solution of a zinc salt, to which 8 to 10% of glyceric sulphuric acid (prepared by adding sulphuric acid, sp. gr. 1.12, to one-sixth of its volume of glycerol), 8 to 10% of boric acid, and 5 to 10% of a halogen derivative of lactic acid (prepared by treating zinc chloride with a hot solution of an equimolecular proportion of lactic acid) have been added.—B. N.

Treating [electroplating] articles electrolytically. Apparatus and method of —. C. J. Lan and D. L. Honeyman, London. Eng. Pat. 105,582, Mar. 18, 1916. (Appl. No. 4035 of 1916)

THE articles are fed by electrical means into the vat at regular intervals on an endless conveyor and are maintained in close electrical contact with the cathode bars on the conveyor by magnetic action. When the articles reach the middle of the vat, they are transferred by a revolving drum to the second portion of the conveyor and thence from the vat. The drum is provided with magnetic means for holding the articles for sufficient length of time to turn them over in their passage over the drum.—B. N.

[Melting] furnaces and the like; Oil fired —. I. Hall, Birmingham. Eng. Pat. 105,431, May 5, 1916. (Appl. No. 6452 of 1916.)

IN an oil-fired melting furnace or the like, the combustion chamber is provided with a tangential inlet diverging towards the chamber and carrying adjustable cross-bars at its mouth to atomise the oil fuel. The burner nozzle is fixed concentrically with the inlet and is adjustable towards or away from it, so that the oil impinges on the cross-bars.—W. F. F.

Furnace; Smelting —. J. Kirby, Assignor to O. Kirby, Leechburg, Pa., J. B. Sommerville, Wheeling, W. Va., and S. M. Boyd, Pittsburgh, Pa. U.S. Pat. 1,222,636, Apr. 17, 1917. Date of appl., Dec. 15, 1916.

THE body portion of the furnace is provided with a pair of transverse bridge walls, between which a base plate is placed, thus forming a smelting chamber. Two flue chambers are arranged below and at opposite sides of the smelting chamber and each is provided with a set of longitudinal flues. A transverse partition wall is interposed between these flue chambers, the wall extending from the base plate of the smelting chamber to the bottom of the body portion, and forming a pair of transverse flues leading from the flue

chambers to a stack in the rear of the smelting chamber. The bridge walls, with the outer body portion, form two transverse flues leading to the melting chamber, and the bridge walls are provided with openings connecting these latter transverse flues with the longitudinal flues. A combustion chamber is arranged in front of the melting chamber, with means at the forward end of the partition wall for alternately opening and closing the other of the flue chambers to the combustion chamber, and a similar means provided for alternately closing and opening the stack to the open and closed flue chambers respectively.—B. N.

Furnace for the recovery of easily fusible metals (lead, tin, etc.) from scrap materials of all kinds; Continuous—C. Gauschemann, Frankfurt. Ger. Pat. 295,739, Sept. 10, 1915.

THE apparatus consists of a melting pan provided with a conduit for running off molten material, and built into a shaft, so that the products of combustion from a fire at the bottom of the shaft pass first under the pan and then over it. The material to be smelted is fed into the pan from a door above and the residues can be removed through a door in the side of the shaft just above the pan. This can be done continuously.—H. J. H.

Furnace; Electrically heated shaft—for recovering metals from low-grade ores and slags. Westdeutsche Thomasphosphat-Werke G.m.b.H., Berlin. Ger. Pat. 296,195, Aug. 6, 1915.

THE furnace contains a hearth in which the melting occurs, communicating with shafts at opposite sides through which the ore charge is applied. The electrodes hang vertically and bear of the charge on the hearth itself; air-gate doors for observation of and additions to the charge are provided. Heating is due to electric arcs set up between the electrodes, and with the addition of suitable reducing agents, slags and poor ores which cannot normally be profitably melted are completely freed from metal, e.g., high-grade ferromanganese can be recovered from slags containing 10–20% of manganese.—H. J. H.

Heating furnaces. C. Kugel, Brunswick. Ger. Pat. 296,102, Mar. 12, 1914.

THE temperature distribution in muffles for heating metal sheets and wires is often unsatisfactory, the temperature being excessive at the bottom. This is avoided by applying the heat to the side. The heating gases pass up vertically on both sides to meet over the middle of the roof of the muffle. Passing along horizontally to the end they are led downwards and into a horizontal flue running under the floor of the muffle and thence to the chimney.—H. J. H.

Alloy bearing. H. K. Sandell, Assignor to H. S. Mills, Chicago, Ill. U.S. Pat. 1,223,001, Apr. 17, 1917. Date of appl., June 19, 1916.

BEARING is formed from an alloy of 50% copper, 5% antimony, and 12.5% each of nickel and lead.—B. N.

Metal bodies; Process of producing—C. L. Gebauer, Cleveland, Ohio. U.S. Pat. 1,223,322, Apr. 17, 1917. Date of appl., Apr. 12, 1916.

METAL articles are moulded under great pressure from a mixture of finely disintegrated metallic constituents of varying melting points, and the mixture is subsequently treated at a welding temperature between the melting points of the constituents.—B. N.

Cowper stoves; Increasing the efficiency of—of blast furnaces. Wärme-Verwertungs-Ges. m.b.H., Siemensstadt. Ger. Pat. 295,831, Oct. 29, 1915.

WHERE recuperators are placed after the Cowper stove so as to heat up gas or air for use in furnaces by means of the waste heat from the blast-furnace gases, the resistance of the regenerative apparatus is always small and no considerable back pressure is thrown upon the Cowper stove. By increasing the resistance of the heat-exchange apparatus the back pressure is raised until equal to the strongest chimney draught. Thereby the possibility of the introduction of cold air by suction is excluded and the size of the apparatus can be diminished.—H. J. H.

Metals of different melting points; Separation of—H. Bendheim, Bensheim. Ger. Pat. 296,127, Apr. 25, 1915.

THE material from which the fusible metal is to be removed by melting is charged upon the perforated false bottom of a tray, supported on rails in a furnace chamber. The tray is heated by direct fire from below and is mechanically shaken backwards and forwards on the rails, which are so shaped as to impart to it a vertical motion also. The draining off of the fused metal is thereby facilitated.—H. J. H.

Furnaces [for heating metal billets]. A. Smallwood, London. Eng. Pat. 105,818, May 25, 1916. (Appl. No. 7445 of 1916.)

Hydrometallurgy [of ores]. E. R. Holden, Los Angeles, Cal. Reissue No. 14,298, May 8, 1917. of U.S. Pat. 1,175,867, Mar. 11, 1916. Date of appl., June 10, 1916.

SEE this J., 1916, 546.

Electric [smelting] furnace; Multiple-hearth—A. Helfenstein, Vienna, Assignor to Union Carbide Co. U.S. Pat. 1,223,278, Apr. 17, 1917. Date of appl., June 5, 1914.

SEE Fr. Pat. 473,416 of 1914; this J., 1915, 498.

Smelting-furnace. E. Ruck, Swansea. U.S. Pat. 1,223,738, Apr. 24, 1917. Date of appl., May 6, 1916.

SEE Eng. Pat. 8265 of 1915; this J., 1916, 1066.

Aluminium [foil]; Method for producing bands of—E. R. Lauber and R. V. Neher, Emmishofen, Switzerland. U.S. Pat. 1,225,044, May 8, 1917. Date of appl., Feb. 12, 1915.

SEE Eng. Pat. 20,455 of 1911, and Addition, dated Dec. 27, 1911, to Fr. Pat. 431,400 of 1911; this J., 1912, 192, 647.

[Electrical] commutator brush. Metal composition. U.S. Pats. 1,222,999 and 1,223,092. See XI.

XI.—ELECTRO-CHEMISTRY.

Electrolytes; Concentration of—in the vicinity of electrodes. S. Procopiu, Comptes rend., 1917, 164, 725–727.

IT is generally admitted that round an electrode there is a double (Helmholtz-Lippmann) layer of the electrolyte and that the remainder of the solution has a constant and definite concentration. Evidence is now submitted that there is another layer between the double layer and the remaining mass of the liquid, and the thickness of this layer is discussed.—W. P. S.

PATENTS.

Oxygen and hydrogen; Electrolytic production of —, G. F. Jaubert, Paris. Eng. Pat. 102,974, Dec. 28, 1916. Under Int. Conv., Dec. 29, 1915. (Appl. No. 18,553 of 1916.)

THE electrodes are covered by bells brought near to each other to diminish the resistance, and the active surface of each electrode projecting below the lower level of the bell is inversely proportional to the volume of gas liberated at each electrode, whilst the volume of each bell is directly proportional to the volume of gas liberated. The bells are provided with cocks, or outlet collectors for the gases, and with insulated sleeves for the cables connected to the electrodes.—B. N.

[Electrolytic] gas-generator. L. P. Sábille, Providence, R.I. U.S. Pat. 1,222,809, Apr. 17, 1917. Date of appl., June 16, 1916.

OXYGEN and hydrogen are generated electrolytically and collected in separate reservoirs. The pressure in each reservoir operates a valve which controls the flow of gas to the other reservoir. A device actuated by a float is provided for automatically shutting off the supply of gas to one reservoir when the pressure in the other exceeds that in the first by more than a predetermined amount.—W. F. F.

Electrolysing apparatus. R. J. J. Mueller, Assignor to Universal Oxygen Co., Sheboygan, Wis. U.S. Pat. 1,221,206, Apr. 3, 1917. Date of appl., Aug. 16, 1915.

A METAL tank is provided at the top with a flange projecting outwards, and with longitudinal partitions forming with the sides of the tank the electrodes of one polarity. An arched metal cover for the tank is provided with a corresponding flange, and the outer margin of a metal diaphragm support is fitted between the two flanges, but separated from them by insulating packing gaskets drawn tightly together by insulated bolts. The diaphragm support, thus separating the gas spaces above and below it, is formed integrally with depending gas conduits, through which pass metal plate electrodes, depending from the cover, alternating with the sides and partitions of the tank. Tubular diaphragms, surrounding the electrodes depending from the cover, are clamped in grooves in the lower ends of the gas conduits by rods and co-operating yokes; the diaphragms consist of material pervious to liquid, but when wetted are impervious to gas.—B. N.

Electric arcs; Process and apparatus for effecting chemical reactions by means of —, A. V. Lipinski, Zürich, Switzerland. Eng. Pat. 105,135, Apr. 28, 1916. (Appl. No. 6121 of 1916.)

ELECTRIC arcs are produced within a casing between practically equidistant electrodes, which are arranged in one or several parallel planes, and are connected to the various phases of a polyphase current, the arcs being spread magnetically into a disc-like or conical form; the electrodes may be annular and concentric or in the form of parallel bars. The gases are preheated within the outer casing, and are then forced through several openings against one or both sides of the flame. Cold reaction gases, or chilling substances in the form of powder, are blown through openings against one or both sides of the flame, so as to form a chilling zone on the outside of the reaction zone away from the flame, the chilling gases partly carrying the reaction gases forward, and partly exerting a suction effect upon them, whilst there is also a sharp fall in temperature between the two zones.—B. N.

Chemical gas-reactions by the aid of a diffuse electric discharge; Process for carrying out —, H. Andriessens, Munich. Ger. Pat. 296,395, Sept. 21, 1913.

THE reacting gases are led into an alternating current are struck between two parallel electrodes. Midway between the electrodes, with its axis at right angles to the plane of the electrodes is a magnetic field produced by an alternating current synchronous with that of the arc current.—B. V. S.

Galvanic cell. M. L. Kaplan, Brooklyn, N.Y., Assignor to Beacon Miniature Electric Co., Inc., New York. U.S. Pats. (A) 1,221,061 and (B) 1,221,062, Apr. 3, 1917. Dates of appl., (A) June 1 and (B) Nov. 20, 1914.

(A) HYDRATED manganese peroxide for use in Leclanché cells is produced by oxidising a mixture of two equivalents of manganous hydroxide and one equivalent of a manganous salt, with a hot solution containing two equivalents of potassium permanganate. (B) A depolarising agent for dry batteries of the Leclanché type is composed of a mixture of 10 parts of finely-divided graphite and 15 parts of an ignited, anhydrous, artificial higher oxide of manganese. The latter is free from water-soluble substances capable of causing local action, and has less combined oxygen than is shown by the formula, MnO_2 .—B. N.

Battery-depolarisers; Method of making —, M. E. Holmes, Lakewood, Assignor to National Carbon Co., Cleveland, Ohio. U.S. Pat. 1,221,991, Apr. 10, 1917. Date of appl., Aug. 25, 1913.

MANGANESE peroxide is deposited on powdered graphite from a solution of potassium permanganate and a manganese salt; steam is admitted before and during the precipitation, and the product is dehydrated by calcination.—J. H. L.

[Electrical] commutator-brush. Metal composition. H. K. Sandell, Assignor to H. S. Mills, Chicago, Ill. U.S. Pats. (A) 1,222,999 and (B) 1,223,002, Apr. 17, 1917. Dates of appl., (A) Mar. 20, (B) Sept. 12, 1916.

(A) A COMMUTATOR brush is cast from an alloy of about 50% copper, about 33% antimony, and about 17% of nickel and lead, with more than 5% of nickel. (B) A cast metal contact point, for making and breaking electrical circuits, is formed from a composition comprising substantially pure nickel containing upwards of 3% of uncombined graphitic carbon.—B. N.

Electrode [for electric furnaces] and coating therefor. J. C. King, Montreal, Canada. U.S. Pat. 1,223,986, Apr. 24, 1917. Date of appl., July 31, 1916.

THE coating comprises a mixture of 25 to 75% of graphite, and 75 to 25% of fireclay by weight, the mixture having approximately the same expansion and contraction as the material of the electrode.—B. N.

Electrolysis; Process for treating organic compounds by —, A. Piguet, Assignor to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,225,052, May 8, 1917. Date of appl., Dec. 31, 1915.

SEE Eng. Pat. 15,750 of 1915; this J., 1916, 384.

Process for purifying and improving cellulose preparations. Ger. Pat. 296,053. See V.

XII.—FATS; OILS; WAXES.

Fish-liver oils; Natural occurrence of high percentages of hydrocarbons in certain —, A. C. Chapman. Analyst, 1917, 42, 161—168.

THE presence of high proportions of hydrocarbons in shark-liver oils (this J., 1917, 392) involves a revision of the accepted constants for those oils. For example, the sp. gr. of Arctic and Japa-

shark oils at 15°/15° C. is given in text books as ranging from 0.9105 to 0.9285, whilst that of shark liver oils composed largely of the hydrocarbon ranged from 0.86 to 0.88, and it is probable that genuine oils may show intermediate values. Iodine values recorded for shark oils range from 98.9 to 162, whereas the hydrocarbon-containing oils show iodine values of about 360. Ordinary shark-liver oil, again, yields 20 to 25% of a bromine compound insoluble in ether, as compared with upwards of 76% obtainable from hydrocarbon-containing oils. In view of these facts shark-oil will in future have to be bought and sold on the results of analysis. Shark oil containing spinacene may be distinguished from fish-liver oils adulterated with added hydrocarbons by the high iodine value of the unsaponifiable matter and the high yield of bromides insoluble in ether. Since spinacene does not give the ordinary colour reactions of liver oils, shark-liver oil which contains it gives these colour reactions much more faintly than ordinary liver oils. Spinacene gave an efflux velocity of 78 sec. for 50 c.c. in Redwood's viscometer at 21° C., as compared with an average of 370 sec. for rape oil. As this hydrocarbon oxidises very readily, the use of oil containing it might be dangerous for such purposes as the oiling of wool (see Fairley and Burrell, this J., 1917, 113).—C. A. M.

Whale oil; Chemical composition of hardened —. B. Svendsen. Tidskrift Kem. Farm. og Terapi. 1916, [20], 285—292. Z. angew. Chem., 1917, 30, Ref., 95.

A SAMPLE of hardened whale oil had acid value 1.5, saponification value 195.7, iodine value 59.8, refractometer reading at 40° C., 50; it yielded no insoluble bromide. The fatty acids consisted of 10.8% of myristic acid, 17.9% of palmitic acid, 10.6% of Bull's C_{16} -acid (this J., 1906, 1158), 10.8% of stearic acid, 27.7% of oleic acid, 3.4% of arachidic acid, 8% of a solid acid, $C_{22}H_{40}O_2$, 2.5% of behenic acid, and 8.8% of a solid acid, $C_{22}H_{40}O_2$.

Eruic, brassidic, and isoerucic acids; Isomerism of —. V. L. Mascarelli. Gazz. Chim. Ital., 1917, 47, I., 160—167. (See this J., 1916, 262.)

RESULTS obtained by the cryoscopic and eutectic methods confirm the conclusions previously drawn with regard to the relationship of these acids. Between erucic and brassidic acids there is a relationship of true isomerism comparable with that existing between oleic and elaidic acids. The results also agree with those previously obtained which indicate that erucic acid has a *cis*- and isoerucic acid a *trans*- configuration. The relationship between brassidic and isoerucic acids does not appear to be one of true isomerism, but is more probably a case of polymorphism. —C. A. M.

PATENTS

Catalytically-useful substances [for hydrogenating oils]; Method of packing —. N. Sulzberger. New York. U.S. Pat. 1,223,123, Apr. 17, 1917. Date of appl., Sept. 5, 1916.

A PRECIPITATED catalyst obtained by treating a soluble nickel compound with sodium silicate, is preserved and rendered suitable for shipment by mixing it with hardened or hydrogenated cottonseed oil which is solid at ordinary temperatures. The solid mass may be cut into pieces containing known amounts of catalytic material. The catalytic product is suitable for hydrogenating further quantities of cottonseed oil.—W. F. F.

Detergents; Process of preparing —. A. Imhausen, Witten. Ger. Pat. 296,922, Dec. 11, 1915.

A DETERGENT is made from a mixture of soap,

petroleum spirit (benzine), and a compound which yields oxygen (sodium perborate), with the addition of alkali carbonate and an equivalent quantity of an acid, or of ammonium chloride, to protect the benzine vapours from oxidation and avoid the risk of explosion when the preparation is mixed with hot water.—C. A. M.

Catalytic device [for hydrogenating fats or oils]. J. Dewar, London, and A. Liebmann, Weybridge, Assignors to The Procter and Gamble Co., Cincinnati, Ohio. U.S. Pat. 1,222,608, Apr. 17, 1917. Date of appl., June 16, 1915.

SEE Eng. Pat. 15,668 of 1914; this J., 1915, 1102.

Catalysing agent for the reduction of fats and unsaturated fatty acids; Process of making a —. C. Paal, Erlangen, Germany, Assignor to The Hydrogenation Co., Cincinnati, Ohio. U.S. Pat. 1,222,660, Apr. 17, 1917. Date of appl., Mar. 18, 1911.

SEE Fr. Pat. 425,729 of 1910; this J., 1911, 1022.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Oil varnishes; Determination of volatile "thinners" in —. A. de Waele and F. Smith. Analyst, 1917, 42, 170—173.

VOLATILE solvents in oil varnishes may be rapidly and accurately determined by the following method:—From 3 to 4 grms. of the varnish is boiled with 60 to 70 c.c. of water in a carbon-dioxide flask over a free flame until no odour of the solvent is perceptible in the escaping steam (about 5 min.). To facilitate the removal of the solvent it is advisable to have a piece of weighed broken glass in the flask, which is kept in constant rotary motion during the boiling. After removal of the bulk of the water by decantation, a few c.c. of strong alcohol or methylated spirit is added, and the flask is immersed up to the neck in boiling water. This treatment is repeated with acetone until the residue appears quite clear, which indicates the removal of all water. The acetone vapour is then expelled by blowing, and the flask is cooled and weighed. The results thus obtained are usually about 1.5% lower than those given by McIlhenny's method (this J., 1895, 78), but it is pointed out that in the latter method an average allowance of 2 c.c. per 100 grms. of varnish is made irrespective of the nature of the distillate, and that it is probable that the allowance for the solubility of petroleum spirit in water should not be so high as this.—C. A. M.

Resin in rosin size; Determination of —. E. Heuser. Papier-Zeit., 1916, 41, 1503—1504. Z. angew. Chem., 1917, 30, Ref., 40.

A VOLUMETRIC method may be used instead of the more tedious gravimetric method:—25 c.c. of the size solution is treated in a separating funnel with dilute sulphuric acid and extracted with ether. The ethereal solution is washed with water until neutral, evaporated slightly, and made up with alcohol to 100 c.c. An aliquot portion of this solution is titrated with $N/10$ sodium hydroxide; the values calculated from the result coincide within 0.5% with those obtained gravimetrically. With sizes made from rosin of unknown origin, an average acid value of about 12 should be used in the calculation.—J. F. B.

PATENTS.

Paint or enamel material; Process of making —. L. Ornstein, Brooklyn, N.Y. U.S. Pat. 1,222,980, Apr. 17, 1917. Date of appl., May 1, 1916.

A MIXTURE of a phenol or cresol solution an

alkali, formaldehyde, and hydrochloric acid is allowed to settle in order to produce an oil-like precipitate. A second oil-like precipitate is produced by heating a mixture of a phenol solution, an alkali, and formaldehyde to the boiling point and adding a further quantity of formaldehyde. These two precipitates are then combined, with or without the addition of an acid salt.—A. B. S.

Titanic oxide pigment; Composite — and method of producing the same. L. E. Barton, Niagara Falls, N.Y., Assignor to The Titanium Alloy Manufacturing Co., New York. Reissue No. 14,289, Apr. 24, 1917, of U.S. Pat. 1,155,462, Oct. 5, 1915. Date of appl. Aug. 3, 1916.

SEE this J., 1915, 1104. The product, which may contain a small proportion of iron oxide, is a soft fine powder, of white colour faintly tinged with cream, and sp. gr. 2.95–3.10.

Titanic oxide pigments; Manufacture of composite —. H. Wade, London. From The Titanium Alloy Manufacturing Co., New York. Eng. Pat. 105,616, May 10, 1916. (Appl. No. 6701 of 1916.)

SEE U.S. Pat. 1,155,462 of 1915, and Reissue thereof; this J., 1915, 1104, and preceding.

Titanic oxide pigments; Manufacture of composite —. H. Wade, London. From The Titanium Alloy Manufacturing Co., New York. Eng. Pat. 105,515, May 9, 1916. (Appl. No. 6659 of 1916.)

SEE U.S. Pat. 1,205,141 of 1916; this J., 1917, 91.

Resilient composition for printers' rollers. C. E. Soane, Assignor to Usher-Walker, Ltd., London. U.S. Pat. 1,223,745, Apr. 21, 1917. Date of appl. Feb. 2, 1916.

SEE Eng. Pat. 2167 of 1915; this J., 1916, 368.

Process of preparing monoazo dyestuffs suitable for the manufacture of pigments. Ger. Pat. 296,931. See IV.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Plantation rubber; Investigations of the quality of — conducted under the Ceylon rubber research scheme. Bull. Imp. Inst., 1916, 14, 495–566.

THE investigations deal with the effect upon the mechanical properties of the vulcanised rubber of (1) different methods of coagulation; (2) the addition of substances to the latex to retard coagulation; (3) the form of the rubber; (4) the method of drying; (5) "over-working" freshly coagulated rubber in the washing machine; (6) various methods of smoking; (7) drying sheet rubber under tension; (8) rolling up wet and dry sheet rubber, with and without tension; (9) conversion of wet and dry crêpe into block; (10) separating the rubber from the latex in successive portions. The latex was obtained from two sets of trees, 7 and 16–20 years old respectively, on the Gikiyanakande estate Kalutara. Full details of the methods of preparing and of testing samples are given; control specimens were prepared in each section of the work. Under (1), spontaneous coagulation, and coagulation by acid and by heat were studied; under (2) the effect of ammonia, sodium sulphite, and formaldehyde; under (3) pressed and machine sheet, thin and thick crêpe and block; under (4) drying at different temperatures in the air, and in a vacuum dryer; under (6) were included the Wickham and Byrne processes. From the results obtained the following conclusions were drawn:—Spontaneous coagulation usually yields good, quick-curing rubber, but the method is scarcely

suitable for practical use. Vulcanised tree scrap has a low tensile strength. Acetic acid is a quite satisfactory coagulant, and is less likely to affect the rubber adversely than *e.g.*, sulphuric acid. Unsmoked sheet vulcanises fairly rapidly (rubber 90, sulphur 10%, 70 minutes at 50 lb. pressure (117.6 C.) in a mould) and gives good tensile results (2300–2400 lb. per sq. in.). Crêpe vulcanises much more slowly (105–130 minutes) than the corresponding sheet, and has very often inferior mechanical properties. Over-working of freshly coagulated rubber, in preparing crêpe, has little effect on mechanical properties of the vulcanised product or upon rate of cure (compared with lightly-worked crêpe). Thick crêpe built up from thin differs little from the latter in cure or strength, but when made direct from the coagulum cures quicker than the corresponding thin crêpe. Different methods of drying have very little effect. Smoking of sheet rubber lengthens the time of cure and sometimes affects mechanical properties adversely. Addition of alkaline cresote before coagulation does not affect the properties of dry sheet rubber. The Wickham and Byrne processes do not give superior mechanical properties in the vulcanised product. Pressing dry rubber into block, or rolling with or without tension has very little effect. Products obtained by fractional coagulation do not differ appreciably. Rubber allowed to remain wet after coagulation of creosoted latex, cures quickly and has good mechanical properties. Such rubber loses some protein on washing. Rate of cure appears to be related to the moist condition of the rubber and sometimes varies inversely with the amount of protein present, but a sample obtained by evaporation of latex *in vacuo*—containing therefore much protein—also cured very quickly. It would appear that a quick-curing rubber with good mechanical properties could be obtained by pressing wet creosoted sheet into blocks of suitable size. Bulking the product obtained over long periods seems at present to be the only method of ensuring approximate uniformity in rate of cure.—E. W. L.

Rubber; Sugar as coagulant for —. O. de Vries. Central Rubber Station, Buitenzorg. India-Rubber J., 1917, 53, 653.

AS a result of a number of comparative experiments on the coagulation of latex by acetic acid and by sugar, it was found that the differences between the rubbers produced were very slight. Tensile strength, "slope," and viscosity were nearly always the same, while in the rate of cure a small difference was generally observed, sometimes favouring acetic acid and sometimes sugar. In three series of experiments, the uniformity from day to day with sugar-coagulation equalled that with the acetic acid process. Preliminary observations indicate that sugar-coagulated rubber possesses good keeping qualities.

Raw rubber; Tackiness in —. K. Gorter. Gummi-Zeit., 1916, 30, 351. Chem.-Zeit., 1917, 41, Rep., 36.

SAMPLES of raw rubber contained in sealed tubes were unaffected by exposure to light when the tubes were filled with hydrogen or carbon dioxide, but became tacky when oxygen was present. Oxidation was slow during the first 6 days, then increased in speed, reaching a maximum in 30 days. Enzyme action is excluded, since samples sterilised by heat behaved in the same way. Aldehydes were present in the tacky rubber.—E. W. L.

PATENT.

Cloth for filler-presses. U.S. Pat. 1,222,100. See I.

XV.—LEATHER; BONE; HORN; GLUE.

Green walnut shells; Tannin content of —. J. Paessler. *Ledertechn. Runds.*, 1916, 8, 189. *Z. angew. Chem.*, 1917, 30, Ref., 48.

GREEN walnut shells contain 22.2% of a tannin which, though sensitive, is apparently usable. In addition the relation between this and the non-tans is satisfactory. The collection of these walnut shells for leather manufacture is recommended.—H. J. H.

Humic acid and tannins. W. Moeller. *Collegium*, 1916, 330–333, 356–359. *Z. angew. Chem.*, 1916, 29, Ref., 520.

EXTRACTS made from decomposing oakwood give the Procter-Hirst reaction for sulphite-cellulose with an intensity varying with the degree of decomposition, and evidently contain compounds similar to those present in sulphite-cellulose. Extracts of other decomposed vegetable materials also give the reaction, which apparently depends on the presence of the humic acid always formed by the decomposition of wood, etc. Hide tanned with humic acid showed the characteristic defects of a sulphite-cellulose tannage.—F. C. T.

Humic acid and tannic acid. W. Moeller. *Collegium*, 1916, 385–393. *Z. angew. Chem.*, 1917, 30, Ref., 48. (See preceding abstract.)

THE whole of the tannin can be precipitated from solutions by humic acid with the addition of hydrochloric acid. As the quantity of humic acid necessary varies with the kind of tannin, the author holds that the "humic acid value" should be useful in analytical work. With tannin solutions containing sulphite-cellulose, a separation is possible by the use of humic acid.—H. J. H.

Tanning substances; Fischer's synthesis of depsides and —. J. A. Wilkinson. *South Afr. J. Sci.*, 13, No. 4. *Chem. News*, 1917, 115, 208–209, 217–218.

THIS paper summarises Fischer's work on the synthesis of depsides and the constitution of gallo-tannic acid. (See this J., 1913, 500; 1912, 503 and 1043.)—F. C. T.

PATENTS.

Leather; [Tanning] process for manufacturing —. F. W. Weber. *Perth Amboy, N.J.*, Assignor to the Roessler and Hasslach Chemical Co., New York. U.S. Pat. 1,221,929. Apr. 10, 1917. Date of appl., Sept. 11, 1915.

THE hides are prepared in any suitable manner and then soaked in a solution of a zinc salt and a tanning liquor, the latter consisting of a solution of chromium sulphate, having as a maximum two mols. of base to three of acid or as a minimum four of base to five of acid. The hides are then treated with a solution of a "diphosphate," and sufficient peroxide to neutralise the diphosphate, rinsed, and treated with fat, to act on the oxygen retained in the pores.—B. N.

Tanning hides and skins; Process for —. L. Schupp. *Neckargemünd.* Ger. Pat. 296,071. June 10, 1914.

THE hides and tan liquor are contained in a revolving drum in which a vacuum is maintained. The bulk of liquor diminishes by evaporation, but the reduced pressure makes it possible to draw fresh liquor into the drum through a channel in the axle without interruption of the process. The evaporation has a cooling effect and prevents the heating up of the charge. The tanning process is accelerated and has a beneficial effect on the leather produced.—H. J. H.

Stabilising of bile and other tryptic enzymes [e.g., artificial bates]; Process of —. O. Riehensahn, Wohlauf, Germany. Ger. Pat. 296,361. May 26, 1916.

BILE or other like enzyme preparation is treated with aluminium silicate, when it may be preserved for months free from smell.—F. W. A.

Electro-tanning; Method and apparatus for —. L. A. Groth. London. U.S. Pat. 1,222,861. Apr. 17, 1917. Date of appl., Oct. 5, 1914.

SEE Eng. Pat. 19,239 of 1912; this J., 1913, 952.

Dyeing of tanned cat's-skin in the hair, and of goods produced therefrom. Ger. Pat. 296,394. See VI.

XVI.—SOILS; FERTILISERS.

Soil; Biological changes in — during storage. F. E. Allison. *Soil Sci.*, 1917, 3, 37–62.

TO ascertain how long a fresh soil sample would be kept without alteration of its biological properties, four different soils (Penn shaly loam, Penn gravelly loam, Sassafras sandy loam, and Alloway clay) were investigated. The samples were taken in winter, when the ground was lightly frozen, and it was found that the bacterial numbers underwent a marked initial decline in the first two hours, and then began to rise. After the first day there was another decrease, followed by a steady increase between the fourth and seventeenth days. Hence, in winter, change of temperature is the factor determining the bacterial numbers in a soil on removal from the field to the laboratory. Ammonification of the nitrogen in peptone and in dried blood tended to vary directly with the numbers of bacteria whether in solution culture or in the soil itself. The effect of storage on azoifying and nitrifying organisms was very small. Similar experiments made on air-dried soil samples showed, generally, a marked decrease in bacterial numbers and activities during the drying. The decrease was particularly great for the clay and sandy loam soils, but was absent entirely from the shaly loam. The decrease in the ammonification of peptone was great for all soils, but with dried blood ammonification was as rapid in air-dried as in moist samples. The experiments were repeated on samples of shaly loam and sandy loam taken in mid-summer, and similar results were obtained, except that the biological changes were much less abrupt, the decrease in bacterial numbers and of ammonifying power continuing slowly for at least two months. During the winter months, plates should be poured for the bacterial counts and ammonification tests should be started immediately the soil is brought into the warm laboratory. In summer, it is advisable to start the counts without much delay, but the ammonification experiments need not be begun for about 10 days.—E. G. T.

Soil bacteria; Effect of some acids and alkalis on — in the soil solution. O. M. Gruzit. *Soil Sci.*, 1917, 3, 289–295.

SOIL solutions were extracted from a sandy and a rich sandy loam soil and after treatment to render them acid, alkaline, or neutral, were placed in pure sterile sand, bacterial counts being made at intervals on sodium asparaginate agar. With N/1200 hydrochloric or sulphuric acid about 99% of the bacteria were destroyed; with N 2164 acid the number remained constant; and with N/2840 acid the growth was inhibited to the extent of 13%, as compared with the growth in presence of N/112 alkali, almost exactly corresponding to the toxic action of this strength of acid to Indian corn (maize) seedlings. Alkali solutions became toxic at a concentration of N/1000; on standing they gradually became neutral and

then acid. Neutral media supported bacterial life only feebly and for a short time, and as they became acid the bacterial numbers diminished rapidly.—E. H. T.

Soil: Organic matter of the ——. III. Production of humus from manures. R. A. Gortner. *Soil Sci.*, 1917, 3, 1—8. (See this J., 1917, 226, 227.)

POWDERED silk waste, powdered wool, flour, and alfalfa (lucerne) meal, were added to moist subsoil from the farm of the Minnesota Agric. Exp. Station, the mixtures moistened with infusion of soil bacteria, and left for one year in bottles in a greenhouse, the moisture content being kept constant. Determinations of the organic carbon, nitrogen, and humus showed that the incubation had resulted in a loss of carbon, varying from 18.4 to 55%, a loss of nitrogen (50–26.5%) which was not proportional to the loss of carbon, and a loss of ammonia-soluble humus, the amount of which appeared to be directly proportional to the loss of nitrogen. When the humus extractions were made without previous leaching with 1% hydrochloric acid, there was no appreciable change in three cases, and in the fourth there was a loss of 60%. Hence the belief in the specific humification of organic material added to a soil appears to be without foundation. (See also Fraps and Hammer, *Texas Agric. Exp. Stat., Bull. No. 129*, 1910.) —E. H. T.

Soil: Organic matter of the ——. IV. Some data on humus-phosphoric acid. R. A. Gortner and W. M. Shaw. *Soil Sci.*, 1917, 3, 99—111. (See preceding abstract.)

DETERMINATIONS of the phosphoric acid contents of the ash derived from the humus which had been extracted with 1% ammonia solution (as NH_4OH) without preliminary leaching, and of that extracted by leaching with 1% hydrochloric acid, showed that in three of the eight soil types more phosphorus was dissolved by the former process than by the latter, and only in one case did the acid extract more phosphoric acid than the alkali. No relation could be traced between the amounts of phosphoric acid extracted directly by ammonia and that extracted by the same solvent after leaching with hydrochloric acid, nor between the humus-phosphoric acid contents and the known fertility of the soils. Although no analytical method of differentiating organic phosphoric acid and that adsorbed by soil colloids has been devised, yet it is probable that the phosphoric acid in humus is mostly of inorganic nature. The fact that the ash content of ammonia extracts of the same soil varied between 6.7 and 32.6% shows that much adsorbed mineral matter must have been present. Similarly, determinations of humus potash are vitiated by the presence of adsorbed potassium compounds, and probably potash occurs in soils only in inorganic combination.—E. H. T.

Lime-requirement methods; Relation between indications of several — and the soil's content of bases. C. J. Schollenberger. *Soil Sci.*, 1917, 3, 279—288.

THE utility of many methods of determining the lime-requirement of soils is restricted because the indications afforded by them do not agree sufficiently accurately with the requirements of field-practice. Nevertheless the data supplied by such determinations, when properly interpreted, throw light upon the changes taking place in the basic materials of a soil. Experimenting upon a Miami clay loam and upon a Clyde clay soil, both acid-extracted and washed, the vacuum method (heating the soil with finely-divided calcium carbonate under diminished pressure and determining the liberated carbon dioxide) was found to be the most nearly quantitative, as well as the most

generally applicable. The results obtained by the Hutchinson-MacLennan method (this J., 1914, 932) gave consistent results for the two soils, and although they ran parallel to those from the vacuum method, they were consistently lower; the tests with unextracted soils resulted similarly. Outdoor pot experiments on a variety of soils containing growing soya beans, wheat, and clover, showed that the addition of quantities of precipitated calcium carbonate, indicated as necessary by the vacuum method, rarely led to results which were not satisfactory. A few experimental data indicated the existence of a relation between the percentage of the total lime-requirement satisfied and the reaction to litmus, carbonates being absent.—E. H. T.

Nitrous nitrogen in irrigated soils. J. E. Greaves, R. Stewart, and C. T. Hirst. *Soil Sci.*, 1917, 3, 119—151.

THE results of over eight hundred determinations of nitrous nitrogen in a calcareous soil during four seasons, showed that the amount was very small, but evenly distributed throughout the soil. The total quantity varied from a mere trace to 17 lb. per acre, and variations in the amount of irrigation water and in the application of manure had no appreciable influence. There was no observable relationship between the nitrous and nitric nitrogen contents, the ratio varying from 1:3.03 to 1:80. A slight seasonal variation was discovered; with alfalfa (lucerne) and oat crops the nitrous nitrogen was highest in the spring and fell towards autumn, with potatoes and maize it was lowest in the spring and highest in the autumn. The maximum amount in fallow soil was found in mid-summer, and in alfalfa soil during the spring, whilst soil under oats contained the least during mid-summer. —E. H. T.

Nitrogenous fertilisers; Ammonifiability versus nitrifiability as a test for the relative availability of —. C. B. Lipman and P. S. Burgess. *Soil Sci.*, 1917, 3, 63—75. (See also this J., 1917, 229.)

AMMONIFICATION and nitrification tests were performed on dried blood, high-grade tankage, steamed bone-meal, cottonseed meal, and fish guano, in presence of 22 different soils, mostly of the arid type. The ammonification experiments were carried out with 50 grms. of soil and 1 gm. of fertiliser contained in tumblers, the whole being incubated for 7 days at 28°–30° C., and the ammonia determined by the magnesia-distillation method. The nitrification data were obtained, after incubating 100 grms. of soil and 1 gm. of fertiliser for four weeks, by the phenoldisulphonic acid colorimetric method. The results obtained were very discordant, in fact the order of availability was often exactly reversed according to the method employed. Since nitric nitrogen is regarded as the most important form of the element for plant nutrition, the nitrification tests are recommended as the safest criterion of availability of nitrogenous fertilisers, at least for arid soils.—E. H. T.

Phosphorus; Effect of — on alfalfa (lucerne) and alfalfa bacteria. H. W. Truesdell. *Soil Sci.*, 1917, 3, 77—98.

THAT alfalfa and some other legumes respond readily to phosphorus treatment is a well-established fact, and the considerations that bacteria such as *Azotobacter chroococcum* contain a relatively higher percentage of the element than many of the higher plants, that phosphorus acts as a stimulant to various groups of bacteria, and that its application results in the increased development of the root-nodules of many leguminous plants, leave no doubt that its fertilising action on alfalfa is a consequence of bacterial action. The effect of the addition of the diphosphates of potassium, sodium,

and calcium to sterilised soils inoculated with a pure culture of the alfalfa organism, *B. radicola*, was greatly to increase the number of organisms, the increase varying with the nature and the solubility of the salt. Alfalfa seed was grown in the greenhouse in pots, and the soil treated with calcium phosphate (CaHPO_4) with and without the addition of urea, the conditions being aseptic throughout except for the addition of alfalfa bacteria at the time of planting. An early increase in the growth was observed, and this was ascribed to direct plant nutrition, to stimulation of the plant cells, and to the quickening of bacterial processes in the soil. After the seedling state was passed, the nodule formation, the dry weight of the roots, and the total nitrogen content were all increased; and when the plants were cut for the third time, it was discovered that the phosphorus treatment was responsible for a part of the nitrogen increase; hence the treatment had stimulated the bacterial activity and caused a greater fixation of nitrogen.—E. H. T.

Seeds; Some effects of salt-treated soils on absorption by—W. F. Gericke. Soil Sci., 1913, 3, 271—278.

LABORATORY experiments were undertaken to find out if the addition of certain toxic salts to a light sandy soil had any effect upon the absorption of water by seeds planted in it, the absorption being measured by weighing. Applications of copper sulphate at the rate of 125—500 parts of anhydrous salt per million of soil produced an increased absorption with bean and barley seeds, but the results obtained with maize were indefinite; with 150 parts per million the rate of absorption was retarded in all three cases. Similar experiments with sodium carbonate showed that the smaller applications favoured absorption, and with sodium chloride, small or large applications decreased the absorption of water by all the seeds used.—E. H. T.

PATENTS.

Calcium cyanamide; Process for granulating—G. W. Sinclair, Petersham, Surrey, and Nitrogen Products and Carbide Co., Ltd., London. Eng. Pat. 105,578, Mar. 16, 1916. (Appl. No. 3924 of 1916.)

CALCIUM cyanamide in powder form is treated with 10—20% of water, the heat of reaction being maintained above 60° C. but below 100° C. A second quantity of 12% of water is then added, the temperature being kept between 20° C. and 45° C., and the mass is compressed under rollers into granular form. A diluting material, such as fine calcium cyanamide dust from a previous operation, may be added between the two additions of water. To prevent, as far as possible, separation of dust, the drying of the material may be conducted in an atmosphere of aqueous vapour, such as that given off from the material itself.—J. H. J.

Manurial value of gas liquor; Process for increasing the—A. Schubert, Pasing, Germany. Eng. Pat. 105,729, Dec. 11, 1916. (Appl. No. 17,818 of 1916.)

SEE Ger. Pat. 292,145 of 1914; this J., 1917, 299.

XVII.—SUGARS; STARCHES; GUMS.

Trimethylglucose from cellulose. W. S. Denham and H. Woodhouse. Chem. Soc. Trans., 1917, 111, 244—249.

THE authors present arguments to show that it is not likely that the crystalline trimethylglucose obtained by them from cellulose (this J., 1914, 1084) is a derivative of γ -glucose (see this J., 1914, 770 and 1915, 627), and that it probably has a

butylene oxide structure. Condensation of the trimethylglucose with hydrogen cyanide, followed by hydrolysis, yields an acid which behaves on titration as if partly lactonised, but containing only two methoxy groups. Of the possible formulae the one which best represents this behaviour of the trimethylglucose is



—W. H. P.

PATENTS.

Sugar liquor; Processes of refining—J. A. McCaskell, Salt Lake City, Utah. U.S. Pats. (A) 1,221,553 and (B) 1,221,554, Apr. 3, 1917. Date of appl., Aug. 17, 1915. Renewed Feb. 5, 1917.

(A). For the filtration and decolorisation of sugar-liquors or other liquids containing suspended matters, a filtering material of greater specific gravity than the suspended matter is mixed with the liquid, and the whole filtered so as to form a cake, which may afterwards be disintegrated in presence of a liquid and freed from lighter impurities by subsidence, or which may be re-vivified *in situ* and used repeatedly before being broken up. (B) Sugar liquors are mixed with bone charcoal and filtered, and the cake, washed free from sugar, is broken up, freed from lighter foreign matters, and used again for further quantities of liquors. The filtered liquors are decolorised by mixing with another charge of charcoal and filtering; the cake is washed *in situ*, revived, and used in the treatment of further quantities of filtered liquors.—J. H. L.

Starch; Process of obtaining—H. C. Holden, Pittsburgh, Pa., Assignor to Washburn Crosby Co., Minneapolis, Minn. U.S. Pat. 1,221,990, Apr. 10, 1917. Date of appl., July 3, 1916.

IMPURITIES such as gluten and fibrous materials are removed from starch liquor by entanglement in a voluminous froth produced by injection of air, and carried over into a separate receptacle.—J. H. L.

Starch; Apparatus for freeing lump— from adhering dust or powder. A. W. H. Lenders, Cedar Rapids, Iowa. U.S. Pat. 1,223,406, Apr. 24, 1917. Date of appl., June 6, 1914.

LUMP starch is fed into a hopper from which it falls through a short tube with perforated sides, across which currents of air are directed from a central pipe. A suction hood surrounds the perforated pipe for the purpose of carrying away the dust removed from the starch.—J. H. J.

Starch; Process of making—and products thereof. C. C. Moore, Washington, D.C., Assignor to F. C. Stevens, Attica, N.Y. U.S. Pat. 1,221,951, May 8, 1917. Date of appl., Dec. 16, 1911.

SEE Eng. Pat. 530 of 1914; this J., 1914, 1217. Before being dried, the comminuted starch-containing material may be impregnated with an enzyme poison.

Sugar cane and similar mills. J. W. Hyatt, Newark, N.J., U.S.A. Eng. Pat. 105,833, July 6, 1916. (Appl. No. 9558 of 1916.)

Sugar; Apparatus for washing—E. Roberts and A. H. Gibson, Lehi, Assignors to Sugar Centrifugal Discharger Co., Salt Lake City, Utah. U.S. Pat. 1,224,095, Apr. 24, 1917. Date of appl., May 20, 1913.

SEE Fr. Pat. 460,231 of 1913; this J., 1914, 36.

XVIII.—FERMENTATION INDUSTRIES.

Barley: Behaviour of the mineral substances of — during germination. W. Windisch and W. Dietrich. *Jahresb. Versuchs- und Lehranst. für Brau.* Woch. Brau., 1916, **33**, 353—354.

THE authors studied the distribution of lime, magnesia, and phosphoric and sulphuric acids in the barley corn during malting. The proportions of these constituents which can be extracted by water at 0° C. increase in the course of germination but diminish again during the kilning process. Lime, magnesia, and phosphoric acid pass into the growing rootlet in such quantities as to maintain there practically the same concentration as in the rest of the corn. Sulphur passes into the rootlet in relatively larger amounts, so that the sulphur-content of the endosperm falls below that of the growing parts, and this in spite of the fact that throughout germination only about 9% of the total sulphur of the corn is present as soluble sulphate. The authors conclude that the remainder of the sulphur is present as a constituent of proteins and that the mechanism of the transference of sulphur to the rootlet consists in transformation of protein sulphur into soluble sulphate in the endosperm, diffusion of the soluble sulphate into the embryo, and reconversion there into protein sulphur.—J. H. L.

Yeast: Observations on —. T. Bokorny. *Pflüger's Archiv*, 1916, **164**, 203—273. *Woch. Brau.*, 1916, **33**, 231—232. (See also this J., 1916, 612, 900.)

YEAST weakened by several hours' treatment with 0.1% formaldehyde solution, phenol, mercuric chloride solution, or chloroform water, was found to ferment sucrose or maltose solutions more rapidly than dextrose solutions of the same concentration. It is suggested that when sucrose or maltose is hydrolysed by yeast enzymes, the hexoses formed are in the nascent state more reactive than in their ordinary condition. Yeast decomposes amygdalin (although hydrocyanic acid is strongly toxic), but not salicin, arbutin, or coniferin. It assimilates nitrogen more readily from peptone than from asparagine, aspartic acid, leucine, tyrosine, glycine, urea, ammonia, or somatose (flesh albumose), the last-named being unassimilable. Storage of pressed yeast at -15° C. for 24 hours, was found to have no effect on its reproductive and fermentative powers, and drying at the ordinary temperature destroyed only the maltase amongst the yeast enzymes. Three weeks' storage of yeast in 50% sugar solution destroyed the zymase but not the invertase. The growth of yeast was found to be inhibited in presence of solutions containing 0.01% of hydrofluoric acid or copper sulphate, 0.1% of caffeine, formaldehyde, or hydrochloric acid, 0.5% of phosphoric acid, or 5% of ethyl alcohol.—J. H. L.

Cider yeasts. E. Kayser. *Comptes rend.*, 1917, **164**, 739—741.

OWING to the great demand for alcohol, attempts have been made to produce it from a mixture of beetroot and apple juice, but the product was found to contain large quantities of esters and volatile acids. It is shown that this is due to the presence of cider yeasts the activity of which preponderates over that of other yeasts, particularly in cases where sulphuric acid has been employed in obtaining the beetroot juice by diffusion. Ordinary yeasts will scarcely tolerate an acidity of 0.09% of sulphuric acid, whilst cider yeasts are still active in a solution containing 0.2% of sulphuric acid. In fermenting such mixtures, acidity should be kept as low as possible and the temperature maintained below 10° C., so as to minimise the formation of esters and volatile acids by the cider yeasts.—W. P. S.

Alcohol: Determination of —. A. Ponyo. *Communications, U.S. Master Brewers' Assoc.*, 1917. *Western Brewer*, 1917, **48**, 84—85.

IN the determination of alcohol in hopped beverages the results are liable to be slightly high (e.g., by 0.02—0.01%), owing to traces of hop constituents carried over during distillation which reduce slightly the specific gravity of the distillates. Theyenet (*Western Brewer*, 1917, **48**, 61) has stated that these hop constituents are acid in character and that the error mentioned may be entirely avoided if the liquid to be distilled is first rendered slightly alkaline. The author, however, failed to detect any indication of acidity in distillates from hopped liquids, and found that the error in question was not obviated by addition of calcium carbonate before distillation, as recommended, in the methods of the U.S. Association of Official Agricultural Chemists, for beverages of excessive acidity. The error is usually very small, but might be greater in cases where part of the hops is added only shortly before the conclusion of wort-boiling.—J. H. L.

Brewers' grains: Composition of —, and the dust from them. H. F. E. Hulton and J. L. Baker. *J. Inst. Brew.*, 1917, **23**, 254—255.

THE dust produced during the drying of mash-tun grains was analysed and found to be considerably richer in protein, and of greater feeding value, weight for weight, than the grains as a whole. The dust should therefore be as uniformly blended with the grains as possible, to raise their feeding value. It constitutes a dangerous source of wort infection, so should not be allowed to blow about in the vicinity of a brewery.—J. H. L.

Regular and irregular antiseptics. Richet and others. See XIXb.

PATENTS.

Musts, wines, brandies, alcohols, syrups, honey substitutes, and jellies: Process for preparing —. E. Disdier, Malaga, Spain. *Eng. Pat.* 105,282, June 9, 1916. (*Appl. No.* 8202 of 1916.)

THE residue obtained in pressing grapes, consisting of pulp and skins with about 50—60% of must, is freed from stalks, dried, and then freed from stones or seeds. The product, which may be kept indefinitely without spoiling, is used in conjunction with sugar solutions, for the preparation of musts, syrups, fermented beverages, etc.—J. H. L.

Beverage: Process for making a non-alcoholic —. A. L. Straus, Baltimore, Md. *U.S. Pat.* 1,223,121, Apr. 17, 1917. *Date of appl.*, Feb. 23, 1917.

FERMENTED malt liquor is boiled to remove alcohol, and hot water is added equal to that evaporated. During the boiling, salt, hops, gum arabic, and sugar are added, with more hops at the close. After boiling is completed, the temperature is rapidly reduced to 4° C. and 0.5—1 oz. of "liquid quassia" added per barrel of liquor, together with finings and a chill-proof preparation. The beverage is stored for 2—5 days, and during this period four tablets of potassium metasilphite are added to each barrel. After storage, the beverage is filtered and carbonated.—J. H. J.

Apparatus for dephlegmation. *U.S. Pat.* 1,222,801. See I.

XIXa.—FOODS.

Bread making with various flours. Balland. *Comptes rend.*, 1917, **164**, 712—714.

BAKING experiments showed that quite satisfactory bread can be made from wheat flour mixed with from 10 to 15% of its weight of barley, rye, maize,

rice, or tapioca flours, but the best results are obtained with a mixture of wheat and barley flours. Slightly roasted earthenut meal, after the excess of oil has been expressed, may be added to wheat flour to the extent of 10%, but the resulting loaf has a dark colour.—W. P. S.

Condensed milk. H. de Rothschild and C. Porcher. *Ann. Falsif.*, 1917, 10, 111—129.

EXAMINATION of samples of many brands of condensed milk which have appeared recently on the French market showed that the weight of the contents of the tins in some cases varied by as much as 50 grms.; differences were found in the composition of the milks, the chief variations being as follows:—Unsweetened whole milk, total solids, 23.6 to 32.7%. Sweetened whole milk, total (milk) solids, 32.7 to 43.1%, sugar, 25.4 to 43.42%. Sweetened skimmed milk, total (milk) solids, 25.1 to 32.6%, sugar, 32.9 to 49.8%. As regards the composition of the original milk, it was found that, in one case, the milk could only have contained 2.7% of fat, although the condensed milk was sold as being made from whole milk. It is suggested that all receptacles containing condensed milk should bear a statement as to the weight of their contents or, better, the volume of normal milk which the condensed milk will yield when suitably diluted; the degree of concentration and the quantity of added substances should also be indicated on the label. Antiseptics or preservatives should not be present.—W. P. S.

Eggs; Deterioration of—Lindet and Husson. *Ann. Falsif.*, 1917, 10, 106—111.

THE quantity of ammonia in eggs increases on keeping; in the case of fresh eggs, the white contains 0.006% and the yolk 0.016% of ammonia. After six weeks, the white contains 0.015 to 0.022% and the yolk 0.030%. Many different kinds of bacteria are found in eggs, together with some moulds; the latter have but a feeble peptonising action, the greater changes being effected by the bacteria. Hard-boiled eggs become "bad" much more rapidly when kept than do raw eggs under the same conditions.—W. P. S.

Corn [maize] as a source of protein and ash for growing animals. A. G. Hogan. *J. Biol. Chem.*, 1917, 29, 485—493.

CALCIUM is the principal mineral substance which is lacking in the ash of maize, but there appears to be no deficiency in phosphate constituents. The proteins of maize are deficient in tryptophane and, to a less extent, in lysine.—W. P. S.

Vitamines; Chemical nature of—III. *Structure of the curative modifications of the hydroxypyridines.* R. R. Williams. *J. Biol. Chem.*, 1917, 29, 495—520. (See this J., 1916, 912, 1081, 1130.)

THE two crystalline forms of α -hydroxypyridine are isomeric and can be converted into one another, the stability of each form being determined by temperature, solvent, etc. Only the form crystallising in needles is curative for polyneuritis; the corresponding crystal form of γ -hydroxypyridine and the anhydrous forms of methylpyridone, trigonelline, and betaine have similar curative properties, but the three last-named substances do not appear to have any protective action. It is concluded that the curative form of α -hydroxypyridine is a *pseudo*-betaine and that more or less conformity in structure or energy conditions to the type of a betaine is an essential characteristic of antineuritic vitamins. There is a theoretical possibility of the existence of such a structure in most of the simpler nitrogenous constituents of animal tissues, and especially in the nucleic bases. Nicotinic

acid may exist in a betaine form and the curative properties of Funk's vitamine may have been due in part to this isomeric form of nicotinic acid or to a polymeride or simple derivative of it.—W. P. S.

Flavouring extracts; Canadian standards of quality for—.

AN Order-in-Council, dated 31st March, 1917, specifies the new standards of quality which have been established for flavouring extracts, in substitution of those established by Order-in-Council of the 17th October, 1912. The new standards are as follows:—

1. A flavouring extract intended for the purpose of flavouring food, is a solution of correct strength, as hereinafter defined, of sapid and odorous principles derived from an aromatic plant or parts of a plant, with or without its natural colouring matters; and conforms in name to the plant used in its preparation.

2. The usual solvents employed in the preparation of flavouring extracts are ethyl alcohol, water, and glycerin. In the event of any other solvents than ethyl alcohol, water, and glycerin being used, such solvents shall be harmless to health, and their names shall be plainly stated on the label.

3. Solutions of natural or synthetic preparations such as vanillin, coumarin, benzaldehyde, methyl salicylate or other sapid and odorous compounds, more or less resembling substances found in plants, or absolutely identical with these, if harmless to health, may be sold for flavouring purposes, if properly labelled so as to make it quite clear that they are not extracts as above defined; and preferably by the use of the word "Artificial" or "Imitation." The word "Artificial," or "Imitation," or other equivalent word, shall appear on the label in type as large and conspicuous as that used in any other word on the label.

4. If an extract be fortified or strengthened by having such natural or synthetic preparations as are referred to in the immediately preceding section added to it, the fact of such addition shall be clearly stated on the label, or the word "compound" or "mixture" shall be used to describe it. The word "compound" or "mixture" shall appear on the label in type as large and conspicuous as that used in any other word on the label.

5. Lemon extract is the flavouring extract prepared from the lemon peel, or from oil of lemon, and contains, along with more or less of the terpenes of lemon oil, not less than 0.2% of citral derived from oil of lemon.

6. Terpene lemon extract is the flavouring extract prepared as above described, and contains not less than 5% of oil of lemon, and not less than 0.2% of citral, derived from oil of lemon.

7. Vanilla extract is the flavouring extract prepared from vanilla bean with or without sugar or glycerin, and contains in 100 c.c. the soluble matters from not less than 5 grams of the vanilla bean (the dried, cured fruit of *Vanilla planifolia*).

8. Vanilla extract shall contain no colouring matter other than that supplied by the vanilla bean itself.

9. Artificial and compound extracts of vanilla may contain added colour of harmless character, provided that declaration of such added colour be made by the use of the word "coloured" on the label, in type as large and conspicuous as that used in any other word on the label.

Composition of brewers' grains, and the dust from them. Hulton and Baker. *See* XVIII.

Determination of theobromine. Debourdeaux. *See* XX.

PATENTS.

Food products: Art of estimating solid content of liquid — J. J. Mojonniier, Oak Park, Ill., Assignor to Mojonniier Bros. Co., Portland, Me. U.S. Pat. 1,221,357, Apr. 3, 1917. Date of appl., Nov. 23, 1914. Renewed Jan. 31, 1917.

THE method consists in boiling a weighed quantity of the liquid for a few minutes at 180° C. and then evaporating it to dryness at 100° C. The residue is placed in a vacuum cooling and drying chamber, and finally is weighed.—J. H. J.

Wheat and other grains: Process of cleaning — A. C. Von Hagen, Kansas City, Mo. U.S. Pat. 1,221,636, Apr. 3, 1917. Date of appl., Mar. 3, 1916.

THE wheat or other grain is treated with powdered lime, and afterwards a small quantity of water, insufficient to dissolve the lime, is added. The wheat is then treated to remove the alkali and the material adhering to it.—J. H. J.

Bread: Manufacture of — H. A. Kohman, T. M. Godfrey, and L. H. Ashe, Pittsburgh, Pa., Assignors to Ward Baking Co., New York. U.S. Pat. 1,222,301, Apr. 10, 1917. Date of appl., Aug. 16, 1916.

A CASEIN material, such as cheese, to serve as a yeast food, is incorporated with the flour, yeast, and other ingredients of the dough.—J. H. J.

Cereals and cereal products: Method of treating — E. E. Werner, Indianapolis, Ind. U.S. Pat. 1,222,830, Apr. 17, 1917. Date of appl., May 13, 1913.

THE cereals are steeped before grinding in a liquid containing ammonium persulphate or a mixture of ammonium persulphate and phosphoric acid.—J. H. J.

Sea mammals: Method of making the meat of — fit for food. G. A. Holzapfel, Leipzig, Germany. U.S. Pat. 1,223,790, Apr. 24, 1917. Date of appl., Jan. 31, 1916. Renewed Mar. 15, 1917.

THE flesh of sea mammals is treated alternately with cold and hot water, and is then placed in a pickle of common salt, sugar, and a pungent alcoholic liquor, a savoury vegetable sometimes being added. The meat is subsequently pressed to remove excess of the pickle and extractive matters of offensive taste.—J. H. J.

Dried milk: Preparation of — Hamburger und Co., Vienna, Ger. Pat. 295,801, Oct. 5, 1913.

THE milk is passed through a narrow channel between parallel plates into a revolving drum heated externally. The channel is kept cold at the junction with the drum to prevent conduction of heat to the milk and consequent separation of solid constituents prior to its entry into the drum. By careful drying, a product is obtained with satisfactory solubility and keeping qualities.—H. J. H.

Process for preparing musts, wines, brandies, alcohols, syrups, honey substitutes, and jellies. Eng. Pat. 105,282. See XVIII.

XIXB.—WATER PURIFICATION; SANITATION.

Antiseptics: Regular and irregular — C. Richet, H. Cardot, and P. Le Rolland. Comptes rend., 1917, 164, 669–673.

THE amount of acidity produced in a culture medium by the growth of one of the lactic acid bacilli is very regular, provided all precautions are taken to have identical conditions in all the tests. If the arithmetical mean of the variations from

the mean of each test in a series be divided by the mean acidity of the whole series, a number is obtained which may be called the relative mean variation of the series. In the presence, however, of small quantities of antiseptics there are considerable differences in the numbers obtained. Thus, in a normal medium the relative mean variation is 0.089, in the same with thallium nitrate added 0.195, with mercuric chloride 0.162, with sodium fluoride 0.066, with magnesium chloride 0.063. The relative mean variation was always greater when the acidity of the culture was low, and it decreased with increasing acidity until the numbers were practically identical with all the antiseptics. The amount of antiseptic necessary to bring about a diminution of growth of 50% was difficult to determine accurately, but the differences between individual antiseptics was very marked. Sodium fluoride, magnesium chloride, and phenol gave fairly regular results; whereas mercuric chloride and sodium arsenate gave very irregular results.—J. H. J.

Antiseptics: Effect of glycerin on — H. P. Goodrich. Brit. Med. J., 1907, 617. Pharm. J., 1917, 98, 453.

RECENT experiments show that glycerin impairs the antiseptic power of thymol, phenol, boric acid, and mercuric chloride in aqueous solution. Many antiseptics, inorganic as well as organic, are much more soluble in glycerin than in water. For example, the approximate solubilities per cent. at ordinary temperatures of the following substances in water and glycerin respectively are: Thymol, 0.06, 0.526; phenol, 7.7, 350.0; mercuric chloride, 5.26, 61.5; boric acid, 4.0, 25.0. In a mixture of equal volumes of water and glycerin about five times as much thymol will dissolve as in plain water, but the resulting solution has no better antiseptic power than the aqueous solution containing only a fraction of the amount of thymol. The same applies to boric acid; a saturated solution in water will kill all the organisms on a thin film of *Staphylococcus pyogenes aureus* in just over an hour, whereas a saturated solution in water and glycerin containing more than four times as much boric acid requires about six hours. It has long been assumed that solutions in glycerin were more antiseptic than the weaker aqueous solution, but it is a fact that even water compares well in disinfecting power with 50% glycerin. Pure glycerin easily kills protozoa, but it is by virtue of its osmotic action. Dilute solutions are not even preservative. A 3.3% solution of phenol in water destroyed all the individuals in a standard culture of *S. pyogenes aureus* contained on a thin film on a cover-glass in less than a quarter of a minute; the same strength solution in water and glycerin required more than a minute. The comparative figures for mercuric chloride (0.005% solution) are $\frac{1}{4}$ and $\frac{1}{2}$ minute; for boric acid (saturated aqueous solution, i.e., 4%), 65 minutes; half saturated solution, 12 $\frac{1}{2}$ minutes; 2 per cent. solution in water and glycerin, more than 480 minutes; thymol (saturated solution), $\frac{1}{4}$ minute; half-saturated solution (0.03%), 12 $\frac{1}{2}$ minutes; same strength in glycerin and water, more than 300 minutes.

Drinking water: Disinfection of — H. D. Dakin and E. K. Dunham. Brit. Med. J., 1917, 682.

THE authors state that *p*-sulphodichloramino-benzoic acid is the most suitable substance, both chemically and bacteriologically, for disinfecting drinking water. The compound, $\text{Cl}_2\text{N}.\text{SO}_2.\text{C}_6\text{H}_4.\text{COOH}$, for which the name "halazone" is suggested, is obtained from *p*-toluenesulphonic amide, prepared by the action of ammonia on the acid chloride. The amide is oxidised to *p*-toluene-

sulphaminobenzoic acid, which on suitable treatment with chlorine is converted into the dichloro-anilino compound. The disinfectant compound may be made into tablets weighing about 0.1 gm., containing 4% of the substance, together with 4% of sodium carbonate, the remainder being sodium chloride. One tablet is usually sufficient to sterilise one litre of water, though more may be required where the contamination is excessive.

Experiments with paper tubes. Rudeloff. See V.

PATENTS.

Adding chemical reagent to water or other liquid; Apparatus for —. W. Paterson, London. Eng. Pat. 105,086, Mar. 22, 1916. (Appl. No. 4281 of 1916.)

A SHORT, somewhat tapering pipe is inserted in a vertical position in an enlarged portion of a pressure main. In the pipe is mounted a shaft carrying a weighted disc, and the lower portion of the shaft ends in a tapered extremity which passes through a slot in the bottom of the main, and acts as a by-pass. The weighted disc rises and falls proportionally with the rate of flow in the main, and by the same action the amount of water passing through the by-pass is similarly regulated. The water which is by-passed travels by a pipe into a closed reagent tank and passes on with a proportionate amount of the reagent into the main beyond the enlarged portion.—J. H. J.

Liquids; Electrochemical treatment of —. C. P. Landreth, Philadelphia, Pa. U.S. Pat. 1,222,637, Apr. 17, 1917. Date of appl., Aug. 6, 1915.

AN electric current is passed through the liquid or water containing in solution materials producing temporary hardness, and a soluble hydroxide or carbonate is introduced in excess of the amount required to react with the dissolved material, so that free alkali is present in the resulting effluent.—B. N.

Sewage; Tanks for the purification of —. T. Caink, Worcester. Eng. Pat. 105,654, May 20, 1916. (Appl. No. 7206 of 1916.)

THE apparatus is designed to be used in the purification of sewage by the activated sludge process and consists of a tank divided into several bays in series and covered with an air-tight roof. It is filled to the roof with sewage. Air is admitted along the bottom of one side of each bay, and imparts to the sewage a vertical circulatory motion, which is aided by suitable guiding baffles arranged so as to prevent deposition of solids on the floor of the bay. In another form, the tank is divided into a number of parallel bays and air is supplied along the side of the first bay only, parallel to the direction of the flow of sewage. The dividing walls between the bays have openings at the top and bottom to permit of the passage of air to and fro at right angles to the flow of the sewage. This imparts a spiral motion to the sewage in the tank.—J. H. J.

Sewage; Process for disposal of — by micro-organisms. O. F. Starr, Utica, N.Y., Assignor to E. A. Robinson, Mount Vernon, N.Y. U.S. Pat. 1,223,001, Apr. 17, 1917. Date of appl., Apr. 10, 1914. Renewed Feb. 12, 1917.

A POOL of sewage, having a non-disturbing inflow and outflow, is secluded from light, air, and agitation, until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid constituents of the flowing sewage. The pool is disposed in such a manner as to provide a restricted surface area materially smaller than the cross-sectional area at the bottom of the pool, thus concentrating the action of the micro-organisms in the upper portion of the

pool, whilst at the same time gases accumulate under the surface of the pool, producing a pressure greater than the atmospheric pressure.—B. N.

Sewage; Tank for the treatment of —. H. Y. Scarborough, Minneapolis, Minn. U.S. Pat. 1,223,127, Apr. 24, 1917. Date of appl., Aug. 2, 1915. Renewed Sept. 27, 1916.

SEWAGE from a closet bowl enters the first chamber of a tank where the solids are disintegrated by bacterial action, and overflows into a second chamber from which it passes under a baffle-wall into a sterilising chamber. Before the sewage passes under the baffle, it is confined temporarily while a sterilising agent is added to it. The sterilising chamber has a siphon discharge, and the rise and fall of the liquid controls the addition of the sterilising agent.—J. H. J.

Air; Process and apparatus for purifying and re-oxygenating —. J. F. Place, Glen Ridge, N.J., U.S.A. Eng. Pat. 105,105, Mar. 29, 1916. (Appl. No. 4632 of 1916.)

THE apparatus consists of a cylindrical vessel open at top and bottom and packed with a series of wire baskets holding caustic potash or slaked lime. An electric motor and fan, for drawing air upwards through the cylinder, are placed in the opening at the top. Just below the fan is the mouth of a pipe conveying a supply of oxygen from a cylinder of the compressed gas and from a vessel containing liquid oxygen which passes through an evaporating coil before entering the supply pipe, or from one of these sources. The air from the inhabited space to be treated is drawn through the treatment vessel where its carbon dioxide and moisture are removed, and as it leaves at the top it has its volume of oxygen made up again.—J. H. J.

Insecticides or plant washes. G. J. Lemmens, Wateringbury, and P. J. Fryer, Tonbridge, Kent. Eng. Pat. 105,478, July 13, 1916. (Appl. No. 9863 of 1916.)

ARSENICAL compounds are made into a thick cream by the addition of water and a substance such as glue, starch, gluten, soaps, resin soaps, gum arabic, or nitrogenous materials. The presence of these substances causes the arsenical compound to be held in suspension when the mixture is diluted for use.—W. P. S.

Insecticides, sheep dips, animal washes, and the like. G. J. Lemmens, Wateringbury, and P. J. Fryer, Tonbridge, Kent. Eng. Pat. 105,525, Dec. 4, 1916. (Appl. No. 17,381 of 1916.)

THE seeds, leaves, and other portions of the plants known as tephrosia, particularly *Tephrosia vogelii*, are extracted with benzene, the extract is evaporated, and the residue is diluted with water (1.5 to 12 oz. per 100 galls.) to form an insecticide or sheep dip. Other ingredients may be added.—W. P. S.

Purifying liquids; Process for —. Elektro-Osmose A.-G. (Graf Schwerin Ges.), Frankfurt, Germany. Eng. Pat. 100,638, May 12, 1916. (Appl. No. 6828 of 1916.) Under Int. Conv., June 10, 1915.

SEE Ger. Pat. 291,754 of 1915; this J., 1917, 402.

Sterilising water and other potable liquids; Method and apparatus for —. W. J. Mellersh-Jackson, London. From C. F. Burgess Laboratories, Madison, Wis., U.S.A. Eng. Pat. 105,611, May 4, 1916. (Appl. No. 6108 of 1916.)

SEE U.S. Pat. 1,200,165 of 1916; this J., 1916, 1233.

Absorbent for carbon dioxide in breathing apparatus for use in mine-rescue work or like purposes. E. J. Bevan, London, U.S. Pat. 1,223,241, Apr. 17, 1917. Date of appl. Nov. 17, 1915.

SEE Eng. Pat. 22,719 of 1914; this J., 1915, 148.

Method of affording protection to workmen during the operation of spraying ceramic and other articles. Sanitary life-spraying chamber. U.S. Pats. 1,223,809 and 1,223,810. See VIII.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Theobromine; Determination of—, L. Débourdeaux, J. Pharm. Chim., 1917, 15, 306–311.

MAUPY'S method (this J., 1897, 611) is founded on sound and accurate principles, but owing to the fact that the theobromine precipitated by ether is contaminated by 6–12% of impurities, it cannot be recommended, as it stands, for the accurate determination of theobromine in cacao. The author has adopted this method in conjunction with a process of purification. 100 grms. of cacao is triturated with 10 c.c. of water and the moist material is introduced into a flask of 1 litre capacity with 60 grms. of solid phenol and 310 grms. of chloroform. The mixture is boiled under a reflux condenser for two hours, cooled, poured on a filter, and the residue sucked dry and washed with chloroform. The residue is then put back into the flask with 300 grms. of chloroform and 50 grms. of the above chloroform-phenol mixture and again boiled for an hour. The filtration is repeated and the residue boiled a third time with 300 grms. of pure chloroform. After standing, preferably for twelve hours, the united chloroform extract is filtered into a large conical flask and the filter washed with chloroform. The chloroform is distilled off, preferably on an electric hot-plate, and 900 grms. of ether is added to the residual phenol solution, the mixture being allowed to stand all night. The theobromine is precipitated, while the caffeine, fat, and most of the colouring matter remain in solution. The ether is decanted off, the precipitate collected on a filter, the flask and filter are washed with ether, the theobromine and filter are put back in the flask with 20 grms. of sulphuric acid and 180 of water; the liquid is boiled and filtered hot into another flask containing 250 c.c. of ammonia solution of sp. gr. 0.924. The first flask and the filter are washed with a boiling solution of 7.5 grms. of sulphuric acid and 112.5 of water and then with 150 c.c. of boiling water containing 30 drops of sulphuric acid. The ammoniacal solution is treated with 3 grms. of silver nitrate, and evaporated on the water bath until all the ammonia has been driven off. It is made up again to about 500 c.c., allowed to stand for a night, and the precipitate of the silver compound of theobromine is collected on a filter, washed with 250 c.c. of water, placed in a conical flask with 50 c.c. of water, and allowed to stand several hours in an atmosphere of hydrogen sulphide; 600 grms. of amyl alcohol is then added and the mixture slowly distilled with a Vigreux tube until about 200 c.c. of aqueous amyl alcohol has come over and the boiling point is 127–128° C. The solution remaining in the flask is filtered hot into a beaker standing in a water-bath and the flask and filter are washed twice with 100 grms. of boiling amyl alcohol. The filtrate is kept in a cool place for 12–36 hours until the theobromine has crystallised out; the alkaloid is collected on a tared filter and the filtrate is weighed in order to make a correction on the assumption that 1000 grms. of amyl alcohol at 15° C. dissolves 0.2 gm. of theobromine. The theobromine is washed with

ether, dried at 100° C., and weighed. The method is very accurate and gives results in close accordance with factory yields.—J. P. B.

Phenolic bases; Researches on—, J. von Braun and E. Danziger, Ber., 1917, 50, 286–289.

β -ACETAMINO- β -METHYLHYDRINDENE on nitrating with concentrated nitric acid is converted into *p*-nitro- β -acetamino- β -methylhydrindene, m. pt. 144° C. This on reduction with tin and hydrochloric acid is converted into the corresponding amino-compound, m. pt. 153–154° C., which on treatment with sodium nitrite in hot mineral acid solution is converted into *p*-hydroxy- β -acetamino- β -methylhydrindene, m. pt. 112° C. On hydrolysis with 20% hydrochloric acid at 120° C., the acetyl group is removed and *p*-hydroxy-amino- β -methyl- β -hydrindene, m. pt. 154° C., is obtained. *p*-Hydroxy-amino- β -methyl- β -hydrindene is not more active physiologically than amino- β -methyl- β -hydrindene and hence affords an exception to the rule that the introduction of a *para*-phenolic group results in increased physiological activity.—T. C.

Allylbetaine and allylhomocholine; Preparation and physiological properties of—, J. von Braun and E. Müller, Ber., 1917, 50, 290–293.

THE methyl ester of dimethylaminoacetic acid, obtained by the dry distillation of betaine, reacts with allyl iodide in ethereal solution forming a quaternary iodide, m. pt. 83° C., and the latter, on treatment with colloidal silver, yields allylbetaine, m. pt. 66° C., which forms a crystalline platinum salt, m. pt. 174–175° C., and a crystalline gold salt, m. pt. 116° C. γ -Hydroxypropyldimethylamine combines rapidly with allyl iodide in ethereal solution yielding the quaternary iodide, m. pt. 57–58° C. The corresponding chloride, allylhomocholine, forms a thick oil giving an oily gold salt and a crystalline platinum salt, m. pt. 182° C. As in the case of *N*-allylmorcodeine and codeine, allylbetaine and allylhomocholine have the opposite physiological effect to betaine and homocholine respectively. *N*-Allylpyrrolidine, *N*-allylthalline, 1-allyltheobromine, allylstrychnine, and diallyl sulphate do not show this reversal of physiological action.—T. C.

Acetylsalicylic acid; Some salts of—, M. Bouvet, Bull. Sci. Pharm., 1917, 24, 86. Pharm. J., 1917, 98, 419.

Sodium acetylsalicylate, or "hydropyrine," may be obtained by a modification of Richter's process (Ger. Pat. 218,467; this J., 1910, 452). A solution or suspension of acetylsalicylic acid in methyl alcohol, containing a little water, is treated with the theoretical equivalent of sodium carbonate. An excess of ether is then added, which precipitates the sodium salt. This is collected, drained, and dried at 40° C. The white salt thus obtained melts at 218° C. with decomposition. It is very hygroscopic and unstable, and rapidly hydrolysed on contact with water into sodium salicylate and acetic acid. *Lithium acetylsalicylate*, known as "hydropyrine L.," "grifa," or "apryone," has been recommended as a substitute for the more unstable sodium salt. It is, however, hygroscopic, and is difficult to prepare, generally containing not less than 5 per cent. of impurities. It forms prisms containing 0.5 mol. of water. It is hydrolysed on contact with water, but somewhat less rapidly than the sodium salt. *Calcium acetylsalicylate* is a much more stable salt than the two described above. It is not hygroscopic; is very soluble, giving clear 1:20 solutions with water, and these solutions are only slightly acid. It is the best salt for pharmaceutical use for the preparation of cachets or tablets. For this purpose it has been introduced into

commerce under the names "soluble aspirine," "kalmopyrine," and "solupyrine." It is best prepared by Mathé's process: Pure lime is slaked with water, suspended in alcohol, and treated with the theoretical amount of acetylsalicylic acid in gradually increasing concentration in alcoholic solution. The pinkish mass obtained is pressed, washed with ether, and dried at 40° to 50°C. Thus obtained it contains 2 mols. of water, of crystallisation, is readily soluble in water, less soluble in alcohol, and insoluble in ether. It may also be obtained in needles, containing 3 mols. of water. It has a slightly chalky taste. According to Gerngross (Fr. Pat. 464,081; this J., 1914, 439), the use of organic solvents for the preparation of this and similar salts of acetylsalicylic acid is unnecessary; better results are obtained with aqueous solutions. *Magnesium acetylsalicylate* is easily obtained by agitating together calcined magnesias, 4 grms.; acetylsalicylic acid, 36 grms.; and water, 189 grms.; then adding methyl alcohol, and precipitating the salt with ether. *Magnesium acetylsalicylate* is soluble in water and in methyl alcohol, less soluble in ethyl alcohol. It crystallises from aqueous solutions in hexagonal tables containing 3 or 4 mols. of water. Among the other little known acetylsalicylates the following are mentioned:—*Potassium*, forming tables, m.p.t. 65°C.; *zinc*, rhombic tables sparingly soluble in water and in alcohol; *copper*, prisms, insoluble in water and in alcohol; *silver*, needles, insoluble in water; and *mercury*, crystallising from aqueous solutions with 1 mol. of water, m.p.t. 136°C. with decomposition; from chloroform it crystallises in anhydrous prisms, m.p.t. 142°C. with decomposition. It is claimed for the calcium salt that it does not cause pharyngeal or gastric pain like the free acid, and that it occasions less renal irritation, while it has all the therapeutic properties of acetylsalicylic acid.

Ethylene; Action of bromine water on —. J. Read and M. M. Williams. Chem. Soc. Trans., 1917, 111, 210—244.

The action of bromine water on ethylene at 0°C. yields ethylenebromohydrin as well as ethylene dibromide. In one experiment where ethylene was passed into 500 c.c. of water, to which successive quantities of 7.2 grms. of bromine were added amounting to 200 grms. in all, the yields were 88 grms. of dibromide and 85 grms. of bromohydrin. The yield of bromohydrin is diminished by rise in temperature, and by an increase in the concentration of the bromine water. Attempts to increase it by adding calcium carbonate or sodium bicarbonate to the water were not successful, owing to the greater amount of decomposition of hypobromous acid into hydrobromic acid and water. Ethylene bromohydrin appears to form a crystalline addition compound with calcium chloride, but the ease with which it is decomposed by moist air makes a determination of its composition very difficult.—W. H. P.

Sozoiodol-mercury compounds. E. Rupp and A. Herrmann. Arch. Pharm., 1917, 254, 488—500. Z. angew. Chem., 1917, 30, Ref., 69.

The solubility of sozoiodol-mercury in sodium chloride solution is due to formation of mercuric chloride; the existence of the acid salt or simple sulphonate is considered to be improbable. In the interaction of sozoiodol-sodium with mercuric acetate or nitrate, the precipitate formed is at first dark red and then orange-coloured; the red intermediate product has been isolated. In the first stage of the reaction, combination takes place at the free hydroxyl group, whilst afterwards the sodium combined with the sulphy-group is displaced by mercury. It is considered to be

highly probable that sozoiodol-mercury has a binuclear structure, but for practical purposes the mononuclear formula may be retained. The chromophor in sozoiodol-mercury is the O.OH group. Sozoiodol when heated with hydrochloric acid in a sealed tube yields 2,4,6-tri-iodophenol, phenol, and iodine. By the action of chlorine water-dimercuphenol-*p*-sulphonic acid is converted into 2,6-dichloroquinone, whilst iodine solution converts it into sozoiodol.

Mercurised derivatives of p-phenolsulphonic acid. E. Rupp and A. Herrmann. Arch. Pharm., 1917, 254, 500—509. Z. angew. Chem., 1917, 30, Ref., 69.

HYDRARGYROL is described as mercuric *p*-phenol-sulphonate, but a product prepared according to the process described originally had properties different from those of hydrargyrol, hence the latter must have another constitution; possibly it is a derivative of phenol-*o*-sulphonic acid. The chief product formed by mercurising phenol-*p*-sulphonic acid is dimercuroxyphenol-*p*-sulphonic acid, whether 1 or 2 mols. of mercuric oxide is used. When 1 mol. is used, a small quantity of a colourless, crystalline monomeric phenol-*p*-sulphonate is formed. With 3 mols. of mercuric oxide, the mercuric salt of the dimercuro-derivative is formed.

Camphor oil from the Federated Malay States and Mauritius. Bull. Imp. Inst., 1916, 14, 577—585.

FURTHER samples of camphor oil from the Federated Malay States and Mauritius (see this J., 1913, 505; 1916, 274) have been examined at the Imperial Institute. The former are found to differ in the same way as previous samples from ordinary commercial camphor oil in that the camphor has not been separated from them, and that they contain no safrole. Their commercial value, is, however, about the same, the absence of safrole being compensated by the camphor present. The Mauritius samples, which were obtained from leaf, twig, root, and wood respectively, were abnormal in character and did not resemble commercial camphor oil; no solid camphor was obtained from them, and subsequent distillation trials in Mauritius showed that the trees, which are genuine *Cinnamomum camphora*, Nees, do not yield solid camphor on distillation.

—E. W. L.

Cnidium officinale; Essential oil of —. Sakei. Mitt. Med. Ges., Tokyo, 1916, 6, 358. Perf. Ess. Oil Rec., 1917, 8, 174.

Cnidium officinale is an umbelliferous plant the root of which is used medicinally in China and Korea. The active principle is an essential oil of which the specimen of drug examined yielded 0.82%. It is a yellow laevo-rotatory liquid, having a bitter taste; its sp. gr. is 1.030 to 1.040. It contains an unsaturated acid, $C_{12}H_{19}O_3$; an alcohol, $C_{16}H_{25}O_3$; and another constituent possibly a lactone, $C_{12}H_{18}O_2$.

Bay oil; Montserrat —. H. A. Tempany. Perf. and Ess. Oil Rec., 1917, 8, 160.

SAMPLES of bay oil from Montserrat distilled in 1916 had sp. gr. varying from 0.926 to 0.910 at 30°—31° C. (corresponding to 0.938 to 0.952 at 15° C.), and phenol content varying between 46% and 54%. The author sees no correlation between phenol content and date of distillation, nor between phenol content and yield of oil.

Terpenes; Autoxidation of — in the light. II. E. Sernagiotto. Gazz. Chim. Ital., 1917, 47, I., 150—153.

PULEGONE was exposed for 1 month to the light in flasks containing oxygen and some water, and

the liquid portion then distilled in a current of steam. The distillate contained acetone, formic acid, and traces of higher fatty acids. The liquid residue in the flask when made alkaline with sodium carbonate and extracted with ether yielded the crystalline lactone of a ketonic acid, $C_{10}H_{14}O_5$, which melted at $183.5^\circ C.$ and formed an oxime melting at $116^\circ C.$ When oxidised with chromic acid, it yielded a crystalline acid, β -methylglutaric acid (m. pt. $86.7^\circ C.$), together with some acetone. The alkaline residue from the ether extraction was a viscous brown oil, from which was separated an acid melting at $84^\circ C.$ and having the composition of β -methyladipic acid, $C_7H_{12}O_4$, and an acid, $C_{10}H_{18}O_5$, of unknown constitution.—C. A. M.

Carrone; Products of the isomerisation of — in the light. E. Sernagiotto. Gazz. Chim. Ital., 1917, 47, I., 153—159.

The solid isomeride of carvone (carvone-camphor) which Ciamician and Silber (this J., 1908, 711) obtained by exposing a dilute alcoholic solution of carvone to the light for several months, melts at $100^\circ C.$ and boils at $206.5^\circ C.$ When oxidised with alkaline potassium permanganate solution it yields a dibasic acid, $C_{10}H_{14}O_4$, soluble in petroleum spirit and melting at $171^\circ C.$, and a monobasic ketonic acid (m. pt. $196^\circ C.$), $C_9H_{12}O_3$, which is insoluble in petroleum spirit. On treating carvone-camphor in alcoholic solution for some days with sulphuric acid, and distilling the mixture in a current of steam a liquid isomeric derivative, isocarvone-camphor, $C_{10}H_{14}O$, is obtained. This distils at 222° — $221^\circ C.$, and forms an oxime melting at $167^\circ C.$ and a semicarbazone melting at $209^\circ C.$ By reducing carvone-camphor by means of sodium in alcoholic solution, it yields the corresponding alcohol, carvone-borneol, $C_{10}H_{16}O$, which melts at $135^\circ C.$ and yields a semicarbazone melting at $239^\circ C.$ —C. A. M.

Chemical nature of vitamins. Structure of the curative modifications of the hydroxypyridines. Williams. See XIXA.

Sodium perchlorate as a general microchemical reagent. Demigès. See XXIII.

PATENTS.

Acetic anhydride; Manufacture of —. H. Dreyfus, Basle, Switzerland. Eng. Pat. 100,350, May 8, 1916. (Appl. No. 6583 of 1916.) Under Int. Conv., April 19, 1915.

IN the manufacture of acetic anhydride by treating sodium acetate with sulphur chlorides, the evolution of sulphur dioxide and the formation of chlorinated by-products may be avoided by: (a) using the reagents in the proportion of 6 atoms of chlorine to 8 acetyl groups; (b) employing a diluent such as acetic anhydride; (c) maintaining a temperature below 10° — $15^\circ C.$, and preferably below $0^\circ C.$, until all the sulphur chloride has been added. Sulphur may be removed from the product by heating it with compounds of metals which form sulphides in the presence of acetic acid, e.g., oxides or acetates of lead or copper, or it may be oxidised to sulphuric acid by permanganates, nitric acid, or nitrates. *Example:*—A mixture of 720 kilos. of dry pulverised sodium acetate and 600 kilos. of acetic anhydride is cooled below $0^\circ C.$, and 306 kilos. of sulphur dichloride is gradually introduced, the temperature being maintained at about $0^\circ C.$, and the mixture being continually stirred. When all the sulphur dichloride has been added, stirring is continued for some time, and the acetic anhydride is then

distilled off, preferably *in vacuo*. The product is heated with a small quantity of copper oxide until free from sulphur.—F. Sp.

Nucleic acid or nucleates; Manufacture of —. W. B. Bottomley, London. Eng. Pat. 105,166, June 21, 1916. (Appl. No. 8914 of 1916.)

AN alkaline extract of peat, such as is obtained in the preparation of humic acid, contains also nucleic acid, which is, however, too soluble to be precipitated with the humic acid on acidification. After separation of the humic acid, or without this separation if the mixture of acids is required, the nucleic acid may be separated by concentrating the liquid to about one-twentieth of its volume and then acidifying with hydrochloric acid and sodium acetate. If the peat is extracted with a solution of an alkali bicarbonate the humic acid is not extracted. Heating the mixed peat and alkali solution to about $100^\circ C.$ by passing in live steam at 60 lb. pressure increases the yield of nucleic acid.—B. V. S.

Sodium phenate [pheno.cide]; Manufacture of —. W. Everitt and Co., Ltd., and W. Everitt, Southall, Middlesex. Eng. Pat. 105,611, Apr. 19, 1916. (Appl. No. 5739 of 1916.)

IN the manufacture of sodium phenoxide by heating together equivalent quantities of phenol and caustic soda, with about 5% of sodium sulphite, to 250° — $280^\circ C.$, the reaction is carried out in a grinding ball-mill (see Eng. Pat. 105,614, page 584), preferably provided with one hollow trunnion to allow of the escape of steam or the introduction of a thermometer, and when the evolution of steam has ceased, the product is cooled *in vacuo*, to prevent absorption of water.—F. Sp.

Sodium salicylate; Manufacture of crude —. W. Everitt and Co., Ltd., and W. Everitt, Southall, Middlesex. Eng. Pat. 105,612, Apr. 19, 1916. (Appl. No. 5740 of 1916.)

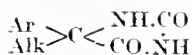
IN the manufacture of crude sodium salicylate from sodium phenoxide and carbon dioxide, a charge of sodium phenoxide is placed in a rotating autoclave, and carbon dioxide is introduced, preferably through a hollow trunnion, avoiding undue heating. When absorption has nearly ceased, the pressure of the carbon dioxide is increased to 100 lb. per sq. in. or more, for some hours. The gas supply is then interrupted, and the autoclave is heated to 120° — $140^\circ C.$ until conversion is complete.—F. Sp.

Salicylic acid; Manufacture of —. W. Everitt and Co., Ltd., W. Everitt, and C. G. Jackson, Southall, Middlesex. Eng. Pat. 105,613, Apr. 19, 1916. (Appl. No. 5741 of 1916.)

PURE white salicylic acid is produced by passing a faintly acid hot solution of crude sodium salicylate through masses of intermingled zinc and decolorising charcoal. *Example:*—Crude sodium salicylate is dissolved in nine times its weight of water and the solution is made faintly acid with sulphuric acid. It is first pumped through a column over granulated zinc, and then heated to 80° — $100^\circ C.$ and passed through a tower containing the mixed charcoal and zinc, e.g., 95% of charcoal and 5% of zinc. The tower may consist of flanged sections bolted together, containing masses of zinc and charcoal separated by partitions of moleskin fabric. The liquor passing from the tower yields pure white salicylic acid on acidification.—F. Sp.

Arylalkylhydantoins: *Manufacture of* ——. O. Inray, London. From Farbw. vorm. Meister, Lucius, u. Brünig, Höchst, Germany. Eng. Pat. 105,719, Oct. 25, 1916. (Appl. No. 15,203 of 1916.)

ARYLALKYLHYDANTOINS of the general formula,



are produced in the same way as other hydantoins or cyclic ureides, starting from arylalkylamino-acetic acids, or causing the latter to be produced during the process. They are therapeutically valuable on account of their hypnotic action. Eight methods of preparation are described. *Examples*:—(1) 20 parts of α -phenyl- α -aminobutyric ester is neutralised with dilute hydrochloric acid, and a concentrated solution of 8 parts of potassium cyanate is added. After standing for a short time, the solution is boiled. Phenylethylhydantoin separates, and is recrystallised from dilute alcohol. It melts at 198° C., is readily soluble in acetone, alcohol, and glacial acetic acid, but insoluble in water and benzene. It forms soluble alkali and alkaline-earth salts. (2) A solution of 2.3 grms. of sodium in 30 grms. of ethyl alcohol is added to 15.6 grms. of phenylcyanacetamide dissolved in 250 c.c. of alcohol. 11 grms. of ethyl bromide is added, and the mixture is boiled for 2—3 hours. On evaporating the alcohol and adding water, phenylethylcyanacetamide (m.pt. 120° C.) is precipitated. 19 grms. of phenylethylcyanacetamide is introduced with constant stirring into a hypobromite solution made from 16 grms. of bromine, 38 grms. of 35% caustic soda lye, and 400 c.c. of water. When the amide has dissolved, the mixture is heated to 40° C., and then cooled. 10 c.c. of a 38% solution of sodium bisulphite is added, and the phenylethylhydantoin is precipitated by acidifying with hydrochloric acid. Phenylmethylhydantoin melts at 193° C., piperonylmethylhydantoin at 192°—193° C., and *p*-chlorophenylethylhydantoin at 212° C. —F. Sp.

Cephaeline amyl ethers and salts thereof: *Preparation of* ——. J. W. Meader, Indianapolis, U.S.A. Eng. Pat. 105,722, July 18, 1916. (Appl. No. 16,037 of 1916.) Addition to Eng. Pat. 103,881, Feb. 21, 1916 (this J., 1917, 402).

CEPHELINE amyl ethers other than the iso-amyl ethers which form the subject of the principal patent, are produced by treating cephaeline with an alkali metal and an amyl halide. The process is the same as described in the principal patent, and the product has similar properties.—F. Sp.

Kelones: *Manufacture of* ——. G. Schicht Act.-Ges., and A. Grün, Aussig, Ger. Pat. 296,677, May 5, 1915. Under Int. Conv., May 27, 1914. Addition to Ger. Pat. 295,657 (this J., 1917, 569).

MONOCARBOXYLIC acids of b. pt. above 300° C. are heated in the liquid state in iron vessels without the addition of catalysts. *Example*: By heating technically pure stearic acid of m. pt. 68° C. for three hours to 295° C., a quantitative yield of technically pure stearone free from acid and of m. pt. 84.6° C. is obtained. It is not necessary to provide for the continuous removal of the carbon dioxide and water, as might be expected; it is preferable to carry out the operation in an autoclave.—F. W. A.

Lipoid-like nitrogen-containing compound from blood: *Preparation of a* ——. Soc. Chem. Ind. in Basle, Switzerland. Ger. Pat. 296,678, Mar. 16, 1916. Addition to Ger. Pat. 295,840 (see Eng. Pat. 11,215 of 1915; this J., 1916, 72).

INSTEAD of extracting the blood with strong

alcohol, as in the chief patent, benzene or toluene or similar solvent, in which the extract is more soluble, is used. The greater part of the solvent is distilled off from the resulting solution and the residue mixed with water and again extracted with chloroform, carbon tetrachloride, benzene, or toluene.—B. V. S.

Calcium acetylsalicylate: *Manufacture of* ——. A. Busch, Brunswick, and R. Lauch, Assignors to J. A. Wülfing, Berlin, Germany. U.S. Pat. 1,225,407, May 8, 1917. Date of appl. June 9, 1915.

SEE Eng. Pat. 100,343 of 1916; this J., 1916, 914

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

PATENTS.

Colour photography and kinematography. C. F. Jones, San Francisco, Cal., U.S.A. Eng. Pat. 105,350, Apr. 7, 1916. (Appl. No. 5130 of 1916.)

Two negatives are taken, No. 1 through a red screen and No. 2 through a green screen. A positive from No. 1 is made on paper or a transparent support and toned blue. This is then re-sensitised with a solution of bichromate containing a yellow dye, dried, exposed under a positive from No. 2 on a transparent support, and developed, etc., as usual. The super-position of the yellow dye on the blue-toned print gives the desired green print. This is finally stained with a solution of a red dye, the absorption of which varies inversely with the hardening due to the exposure behind positive No. 2.—B. V. S.

Selenium toning bath for photographic silver prints. Chem. Fabr. auf Actien, vorm. E. Schering, Ger. Pat. 296,009, Jan. 24, 1914. Addition to Ger. Pat. 280,679.

By the addition of more sodium sulphite, up to 30 grms. per litre, to the toning bath mentioned in the chief patent (sodium thiosulphate 100 grms., sodium selenosulphate 1.5 grms., sodium sulphite 13 grms., water 1 litre), a combined fixing and toning bath is obtained producing no yellowing of the whites.—B. V. S.

Paper for photographic uses: *Coating material for* ——. G. W. Leighton and C. S. Babcock, Chicago, Ill. U.S. Pat. 1,225,146, May 8, 1917. Date of appl. May 10, 1909.

SEE Fr. Pat. 418,906 of 1910; this J., 1911, 1109.

XXII.—EXPLOSIVES; MATCHES.

Propagation of flame in mixtures of acetone and air. Wheeler and Whitaker. See II A.

PATENTS.

Explosive material: *Compressors for bundled* ——. Sabulite (Great Britain), Ltd., and W. H. McCandlish, London, and A. B. Robson, Ware, Herts. Eng. Pat. 105,794, Apr. 26, 1916. (Appl. No. 5980 of 1916.)

Means applicable for use in drying materials in vacuo. Eng. Pat. 105,617. See I.

XXIII.—ANALYSIS.

Ammonia: *Micro-titration of* ——. G. D. Barnett, J. Biol. Chem., 1917, 29, 459—162.

TEN c.c. of the solution to be tested is placed in a

test-tube (22 by 380 mm.), 10 c.c. of saturated potassium carbonate solution, free from ammonia, is added, and, after the test-tube has been connected with a larger one (30 by 110 mm.) containing a measured volume (less than 0.5 c.c.) of *N* 100 hydrochloric acid and 15 c.c. of distilled water, a current of air is drawn through the apparatus for 20 mins. at the rate of 5 litres per min. The excess of acid in the absorption test-tube is then titrated with *N* 200 alkali solution added from a 1 c.c. micro-burette; methyl-red is used as the indicator. The tube connecting the two test-tubes may contain a plug of cotton-wool to prevent any alkaline spray from passing over into the second test-tube. —W. P. S.

Mercury salts; Detection of traces of — for toxicological purposes. K. C. Browning. Chem. Soc. Trans., 1917, 114, 236–240.

THE method recommended consists of electrolysis of the solution to be examined, with subsequent spectroscopic examination of the cathode. Of the various metals available for the cathode, gold foil is most sensitive, silver gauze being next best. These metals as obtained "pure" from Kahlbaum always give a strong mercury spectrum unless previously purified by heating to about 900 °C. for some time. No advantage was observed in using electrodes larger than 1.5 cm. by 0.65 cm. Conditions of electrolysis depend on the amount of solution available. If only about 10 c.c. can be obtained, 10 to 15 minutes at 0.2 ampère, without stirring, is sufficient. With larger quantities (200 c.c.) 2 ampères may be used, with rapid stirring, but care must be taken to avoid loss of mercury by heating of the solution, which takes place if electrolysis is prolonged. The cathode is washed with water and placed in one limb of a Dupré tube. This limb is heated to 200–250 °C. in an oil bath. The tube is exhausted by a Gaede oil pump, washed out with hydrogen, and again exhausted. The discharge is passed from a moderately strong coil (15 cm. spark) and the spectrum examined by a direct vision spectroscope. With only 10 c.c. of solution, one part of mercuric chloride in one hundred million parts of solution can be detected in this way. Solutions of this concentration lose mercury on evaporation and cannot be satisfactorily concentrated. If kept in glass or quartz vessels they lose mercury by adsorption on the walls of the vessel, from which it can be recovered by washing a few times with concentrated nitric acid. —W. H. P.

Sodium perchlorate as a general microchemical reagent. G. Denigès. Bull. Trav. Soc. Pharm. Bordeaux, 1917, 5. J. Pharm. Chim., 1917, 15, 322–323.

SODIUM perchlorate has been recommended as a microchemical reagent for cocaine; it is now found that the same salt gives sparingly soluble compounds with many other substances, most of which can be identified by their characteristic crystalline forms. Many of the alkaloids, notably those of the strychnine and morphine series, can be identified microchemically by their perchlorates; also certain metals, such as potassium, rubidium, and caesium, give sparingly soluble perchlorates, whereas lithium, ammonium, and thallium do not. Precipitates are obtained with soluble salts of tropacocaine, berberine, narceine, cotarnine, and papaverine (non-crystalline at first). A concentration of 5–10% is advisable in these cases. Salts of morphine give a precipitate at 1% concentration. Brucine and especially strychnine solutions give crystalline precipitates at very low concentrations (0.2–0.1%) when the sides of the vessel are rubbed with a

glass rod. Veratrine and narcotine in dilute acetic acid solution give non-crystalline precipitates having the appearance of fat-globules. —J. F. B.

Estimation of toluene and benzene in coal-tar oils. Harker. See III.

Fastness of dyestuffs. Standards and processes established by the "Echtheitskommission." Heermann. See IV.

Determination of volatile "thinners" in oil varnishes. De Waele and Smith. See XIII.

Determination of resin in rosin size. Heuser. See XIII.

Humic acid and tannic acid. Moeller. See XV.

Relation between the indications of several lime-requirement methods and the soil's content of bases. Schollenberger. See XVI.

Ammonifiability versus nitrifiability as a test for the relative availability of nitrogenous fertilisers Lipman and Burgess. See XVI.

Determination of alcohol. Fonyo. See XVIII.

Determination of theobromine. Débourdeaux. See XX.

PATENTS.

Carbonic-acid indicator. A. Frisak, Woodbury, N.J. U.S. Pat. 1,223,953, Apr. 24, 1917. Date of appl., Jan. 6, 1917.

A VESSEL containing caustic soda is closed at the top by a stopper, through which an inlet tube for the gases extends and terminates in a horizontal curved portion just below the stopper. The outlet tube extends into the vessel nearly to the surface of the caustic soda solution and both tubes are provided with stopcocks. One limb of an inverted U-tube communicates with the vessel and the other end dips into a vessel of mercury provided with a vented stopper. A scale is provided adjacent to the latter limb of the U-tube, which enables the diminution in pressure in the vessel due to absorption of carbon dioxide to be determined. —W. F. F.

"Noble" gases [argon, etc.] and nitrogen; Apparatus for determination of — by a gas-analysis method. R. Brandt, Ludwigshafen. Ger. Pat. 296,115, May 16, 1915.

A MIXTURE of argon, etc., with nitrogen, hydrogen, carbon oxides, methane, and such gases is treated, in a tube connected with a manometer and a two-way tap, with metallic calcium in the form of large crystals, or with alloys of calcium with magnesium and aluminium, and with calcium nitride. The former absorbs all nitrogen and the latter absorbs hydrogen, methane, etc., at temperatures between 200° and 650° C. —B. V. S.

Testing materials by impact: Apparatus for —. W. and T. Avery, Ltd., A. W. Brown, and E. A. Allent, Birmingham. Eng. Pat. 105,669, June 16, 1916. (Appl. No. 8487 of 1916.)

Art of estimating solid content of liquid food products. U.S. Pat. 1,221,357. See XIXa.

INCOME AND EXPENDITURE ACCOUNT FOR YEAR ENDING 31st DECEMBER, 1916.

Corresponding figures for 1913.		£ s. d.		£ s. d.		£ s. d.		INCOME.	
EXPENDITURE.		£ s. d.		£ s. d.		£ s. d.		By Entrance Fees	
To Journal—Editorial and Sundry expenses—		£ s. d. <td colspan="2">£ s. d.<td colspan="2">£ s. d.<td colspan="2">Life Composition Fees</td></td></td>		£ s. d. <td colspan="2">£ s. d.<td colspan="2">Life Composition Fees</td></td>		£ s. d. <td colspan="2">Life Composition Fees</td>		Life Composition Fees	
Editor's Salary		550 0 0		550 0 0		550 0 0		Annual Subscriptions	
Do. Expenses		40 0 0		40 0 0		40 0 0		Journal Advertisements	
Do. Assistant		180 0 0		180 0 0		180 0 0		" Sales	
Abstractors		530 6 4		530 6 4		530 6 4		Collective Index—Subscriptions ..	
Sub-Editor's Salary		50 0 0		50 0 0		50 0 0		Decennial Index—Sales	
Foreign Journals		16 4 6		16 4 6		16 4 6		Dividends and Interest on Investments—	
Sundry Journals		26 12 8		26 12 8		26 12 8		£ s. d.	
French and U.S.A. Patent Specifications		7 3 0		7 3 0		7 3 0		4476 9 2 Metropolitan 3%	
Insurance of Stock		1 12 10		1 12 10		1 12 10		Consolidated	
Index and Indexing Journals		£1401 19 4		£1401 19 4		£1401 19 4		1000 0 0 New Zealand 3%	
Publishing expenses—		224 17 3		224 17 3		224 17 3		1277 4 8 New South Wales (1945)	
General		812 9 9		812 9 9		812 9 9		600 0 0 Gas Light and Coke 3% (1935)	
Postage on Copies		3037 7 0		3037 7 0		3037 7 0		1084 13 4 North British 3% Co 3% Debentures	
Sectional expenses—		£439 6 4		£439 6 4		£439 6 4		1686 0 0 Midland Rly. 2½%	
Boston		20 0 0		20 0 0		20 0 0		1509 0 0 Great Eastern Rly. 4% Irredeemable	
Birmingham and Midland		45 0 0		45 0 0		45 0 0		673 0 0 South Eastern Rly. 4½% Preference	
Canada		102 8 3		102 8 3		102 8 3		1000 0 0 Metropolitan Water Board 3% "B"	
Liverpool		80 0 0		80 0 0		80 0 0		200 0 0 Nottingham Debentures	
London		79 12 3		79 12 3		79 12 3		1250 0 0 Great Western Rly. Station 3%	
Manchester		58 19 10		58 19 10		58 19 10		800 0 0 Great Northern Rly. 5% Guaranteed	
Newcastle-on-Tyne		103 4 10		103 4 10		103 4 10		450 0 0 Nottingham and Grantham Canal 4½% Consolidated	
New York		26 11 2		26 11 2		26 11 2		724 8 0 India 3½%	
Nottingham		66 12 6		66 12 6		66 12 6		834 9 2 India 3%	
Scotland		15 19 8		15 19 8		15 19 8		1400 0 0 Dominion of Canada —Canadian Pacific Rly. 3½% Land	
Sydney		21 15 9		21 15 9		21 15 9		700 0 0 Canada 4% (1940)—Grant Bonds 1938	
Yorkshire		515 0 0		515 0 0		515 0 0		703 8 5 Western Australian Government 4%	
Research Grant (Cellulose)		620 3 9		620 3 9		620 3 9		700 0 0 War Stock 3½%	
Annual Meeting expenses		66 13 4		66 13 4		66 13 4		1700 0 0 War Stock 4½% (Bearing)	
Superannuation (Late Editor & Sec.)		163 3 0		163 3 0		163 3 0		820 13 10 War Stock (Consols)	
Working expenses—		594 8 11		594 8 11		594 8 11		Interest on Deposit	
Secretary's Salary		430 0 0		430 0 0		430 0 0		£ s. d.	
Clerks in Secretary's Office		140 0 0		140 0 0		140 0 0		221 11 0	
Honorary Treasurer		77 10 0		77 10 0		77 10 0		58 16 9	
Assistant and for Clerical		213 15 9		213 15 9		213 15 9		4692 6 9	
Rent, Lighting, and Cleaning		205 15 1		205 15 1		205 15 1		532 5 6	
Stationery, Binding & Library		93 19 1		93 19 1		93 19 1		884 17 10	
Postages, Bank Charges, Telephone and Sundry expenses		1160 19 11		1160 19 11		1160 19 11		2 1 0	
Excess of Income over Expenditure		6465 6 4		6465 6 4		6465 6 4		2 10 0	
Total		£7856 13 1		£7856 13 1		£7856 13 1		£ s. d.	
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Total		£7856 13 1		£7856 13 1		£7856 13 1			

	£	s.	d.	£	s.	d.
To Sundry Creditors	£	s.	d.	£	s.	d.
" Subscriptions received in advance	1025	19	1	1758	18	2
" Annual Reports on applied Chemistry—	136	13	0			
" Amount received in advance	133	6	8	47	10	0
" Overdraft—London City and Mid-	214	0	3	—		
land Bank						
" Accumulated Fund—						
Balance 31st December, 1915 .. 22,236	14	2		103	5	4
Add—Excess of Income over	891	6	9			
Expenditure, 1916			23,128			
			0 11			
Valuation:						
31st December, 1916.	£	s.	d.	£	s.	d.
2999 4 6 at 67						
630 0 0 " 63				4163	2	1
894 1 3 " 70				870	0	0
804 5 6 " 98				1122	3	1
312 0 0 " 57				1031	15	4
629 2 2 " 58				507	0	0
338 11 2 " 46				900	5	6
465 12 0 " 44				1157	4	0
1063 16 10 " 701						
501 7 7 " 741				1629	14	5
600 0 0 " 60				747	0	7
118 0 0 " 59				922	10	0
1212 10 0 " 97				106	0	0
488 0 0 " 61				1762	10	0
333 0 0 " 74				606	0	0
481 14 4 " 664				495	0	0
470 16 2 " 571				700	0	0
1036 0 0 " 74				700	0	0
581 0 0 " 83				1372	4	0
562 14 9 " 80				676	8	1
595 0 0 " 85				698	3	0
1066 0 0 " 98				661	0	2
				1690	18	2
	£16,821	16	3	22,698	18	5
				£24,698	11	11

Depreciation = 25.9% on cost.

To the Members of the Society of Chemical Industry.

We have audited the above Balance Sheet, dated 31st December, 1916, and have verified the investments and the Bank overdraft. In our opinion the Balance Sheet shows correctly the position of the Society at 31st December, 1916.

28, Regent's Hall Street, London, E.C.1

(Signed) FRANK B. CO.

Official Notices.

ANNUAL GENERAL MEETING, 1917.

In accordance with the provisions of By-law 64, notice is hereby given that the Annual General Meeting will be held in The University Buildings, Edmund Street, Birmingham, at 10.30 a.m. on Wednesday, July 18th, 1917. A programme of the proceedings was inserted in the June 15th issue.

In accordance with the provisions of By-law 24, those members whose names are printed in *italics* in the List of Council in the April 30th issue of the Journal will retire from their respective offices at the forthcoming Annual Meeting.

Prof. Henry Louis has been nominated to the office of President under By-law 20; Dr. Charles Carpenter has been nominated Vice-President under By-law 20; Mr. John Gray, Mr. A. R. Ling, Prof. R. F. Ruttan, and Mr. J. T. Wood have been nominated Vice-Presidents under By-law 24.

Mr. A. G. Bloxam, Mr. W. J. Rees, Mr. Edwin Thompson, and Prof. James Walker have been nominated to fill the four vacancies among Ordinary Members of Council, under By-law 25. No ballot will be required.

J. P. LONGSTAFF,
Secretary.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY.

The first volume of these reports is now ready. As the issue is strictly limited, those who desire to obtain copies are advised to apply for them without delay. The price is 3s. to members and 5/6 to non-members, including postage.

DYES DEPARTMENT OF THE BOARD OF TRADE.

In order to promote the further development of the dye-making industry in the United Kingdom, the President of the Board of Trade has decided to establish a special temporary Department of the Board of Trade to deal with matters relating to the encouragement, organisation, and, so far as necessary, the regulation of that industry. The Department will be under the direction of Sir Evan Jones, Bart., M.I.C.E., who will have the official title of Commissioner for Dyes. The Commissioner will act in close consultation with the various dye-making and dye-using interests concerned. Any communications on the subject should be addressed to:—Commissioner for Dyes, Board of Trade, 7, Whitehall Gardens, London, S.W.1.

CHEMICAL TRADE CONFERENCES.

The Director of the War Trade Department has agreed to arrange for regular conferences to be held at stated intervals at the Department's offices to discuss matters of interest to the chemical trade in much the same way as questions connected with the wool trade have been discussed at conferences for some time past. Lord Emmott has suggested that the best procedure is for the Chamber of Commerce interested to submit to the Department at the beginning of each month a summary of the subjects which are important enough to bring up at a conference, specifying the particular chemical, drug, or dye which they desire to discuss. If the list of subjects is of sufficient magnitude and importance to make a conference of undoubted

interest to all parties, the conference would be convened; if not, the matter would be dealt with by direct correspondence with the Chambers concerned.

FRANCE: PROHIBITED EXPORTS.

A French Presidential Decree, dated the 29th May, prohibits the exportation and re-exportation from France, as from 1st June, of acetic anhydride, animal black, insulating materials other than rubber (the exportation of rubber was already prohibited), metallic formates, oxalates, sulphites and hyposulphites, ores of strontium and of lithium, preparations derived from sabadilla seeds, quillaia bark (*Quillaia saponaria*), soda lime, sulphate of baryta (barytine) and of magnesia, uranium, zirconium and zircon, quillaia bark may however be exported and re-exported from France, without special authorisation, when consigned to the United Kingdom, the British Dominions, Colonies, and Protectorates, and certain other countries.

SULPHATE OF AMMONIA PRICES.

The Food Production Department of the Board of Agriculture draws attention to the advantages to be obtained from ordering sulphate of ammonia at once. Prices have been arranged with the manufacturers for the season ending 31st May, 1918, in such a way as to give an advantage of £1 per ton to those who purchase before the end of September.

(1) The terms and conditions which will be applicable to the sale of sulphate of ammonia, 24½% basis, in makers single bags, net cash delivered to consumer's station in any part of the United Kingdom, in quantities of not less than two tons, are:—

For orders placed with makers for delivery during the following periods:—

(a) 1st June, 1917—30th September, 1917, £15 7s. 6d. per ton. For this first period orders for 60 tons and upwards are to be placed by the 20th June for delivery in Great Britain, and by the 10th July for delivery in Ireland. Delivery in Great Britain must be in four equal monthly quantities, and in Ireland in three equal monthly quantities. Smaller quantities must be ordered before the 15th September.

(b) 1st October, 1917—31st December, 1917, £15 15s. per ton. For this period orders for 60 tons and upwards must be placed by the 10th September for delivery in three equal monthly quantities either for Great Britain or Ireland. Smaller quantities must be ordered by the 10th of each month for delivery during that month.

(c) 1st January, 1918—31st May, 1918, £16 7s. 6d. per ton. For this period all orders, large and small, must be given by the 10th of each month for delivery during that month.

The foregoing prices are subject to a discount for cash of 10s. per ton to manure mixers, agricultural merchants and dealers and co-operative societies.

(2) Quantities of less than 2 tons will be supplied at the above rates, provided they form part of a bulked order of not less than 2 tons, so as to facilitate railway transport and avoid the wasteful use of trucks.

(3) Where the purchaser takes delivery at the maker's works for conveyance otherwise than by rail the price will be 10s. per ton less. For sulphate of ammonia of a higher or lower quality a difference of 3s. 3d. per ton is to be allowed in respect of each quarter per cent. above or below 24½%.

Fractional differences of less than a quarter per cent. will not be taken into account. Where makers require purchasers to provide their own bags the actual cost of bags at the time of delivery shall be allowed.

(1) The net cash retail prices of sulphate of ammonia to consumers, in quantities under two tons, for delivery in Great Britain by dealers or store or by makers or works, shall not exceed the following:—

	Quantities of 28 lb. and less than 1 cwt.	1 cwt. and less than 2 cwt.	2 cwt. and less than 1 ton.	1 ton and less than 2 tons.
	per cwt.	per cwt.	per cwt.	per ton.
1st June, 1917, to 31st Dec., 1917	20s.	18s.	17s.	£16 10s.
1st Jan., 1918, to 31st May, 1918	21s.	19s.	18s.	£17 5s.

No additional charge to be made for excess over 24½% basis in respect of these small quantities.

Dealers and farmers, if unable to obtain supplies from local works, should apply to the Sulphate of Ammonia Distribution Committee, Food Production Department, 72, Victoria Street, London, S.W.1.

Glasgow Section.

Meeting held at Glasgow on Tuesday, 27th February, 1917.

MR. JAMES MACLEOD IN THE CHAIR.

LOW TEMPERATURE CARBONISING AND SOME PRODUCTS.

BY ROBERT MACLAURIN.

My early oil work experience at Stanrigg convinced me that non-coking coals could be successfully carbonised without any external heating, and if a method could be devised of preventing the condensing oils from trickling down into the hot producer zones, coking coals, I considered might also be dealt with. This hoped was largely based on Percy's statement that coals when slowly heated lost their power of coking. After many elaborate schemes had been drawn out, the present simple method gradually evolved (see Collar C, Fig. 1). The scheme was put before Bailie W. B. Smith, convener of the Smokeless Fuel Committee of the Glasgow Corporation, and Mr. Lackie, head of the Electricity Department. After consideration by the Gas and Electricity Committees it was agreed to undertake an experiment jointly. I must here record my indebtedness to Bailie Smith, to the members of both committees, to the Corporation of Glasgow, and to the heads of the Electricity Department, and the Staff at Port Dundas, for their help and courtesy.

The plant as erected with the compartments A and B (Fig. 1) was intended to be used for two purposes. One of these was for the production of smokeless fuel and illuminating gas, and the other for the production of power-gas—both with oil and ammonia as by-products.

Power gas.

For the production of power gas, air and steam were blown into compartment A, by passage E, indicated by dotted lines, and the gas passed up through the fuel, carbonising it and distilling off the oils. The heavier oils condensed, and ran

down to the collar where they were trapped and overflowed along the pipe, G, to the seal tank, S. Here the heavier oils were left, and the gases ascended through the first scrubber, where they met a very fine spray of water, containing about 1% of free sulphuric acid; from this they entered the second scrubber, in which they were intended to be treated with a shower of heavy oil, to abstract the lighter oils, though this was never put into use. From this scrubber they were drawn by a Sirocco fan, and passed to burners, where they were burnt under a water-tube boiler. The quantity and quality of power gas made depended entirely upon the fuel used and the quantity of steam passed. Addition of fresh fuel was not traceable by any change of quality in the gas. This was anticipated, for the fresh fuel is supplied on to the top of fuel, the temperature of which is probably not above 100° C. A fairly uniform power gas is therefore easily maintained, and as there is no destruction of the oils, the gas is perfectly free from stringy masses of tar. The length of producer enables the carbon in the fuel to be burned practically completely. With the coals tried, clinkering difficulties hardly appeared, although the steam used was occasionally very low. When working steadily we aimed at a saturation at 70° C.

The following is a typical analysis of the power gas made: CO₂ 12.9%, O₂ 0.9, C₂H₄ 0.2, CO 5.6, CH₄ 10.0, H₂ 8.9, N₂ 61.5%. Calculated heating value = 134 B.T.H.U. per cub. ft.

Smokeless fuel.

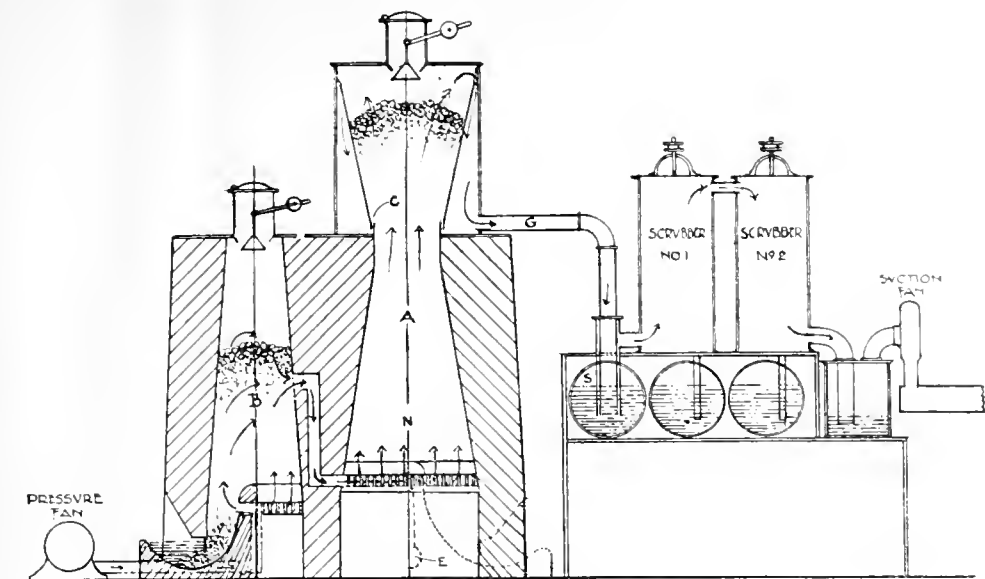
The manufacture of smokeless fuel, contrary to expectation, worked smoothly. The fuel came down regularly and was thoroughly carbonised. No matter the size of the coal used, it was always uniformly coked from outside to centre.

Working for smokeless fuel I anticipated getting from 10 to 12 cwt. per ton of coal, about 10,000 cubic feet of gas of about 550 B.T.H.U., from 15 to 25 gallons of oil, and a yield of ammonia at least equal to gas-works practice. The estimate for the coke was made on the assumption that about 2 cwt. of the coal would require to be burned to ash to carbonise one ton of coal. To prevent this ash being mixed with the smokeless fuel, the furnace was made with two compartments. The coal was to be carbonised in compartment A, and the hot power gas was to be made in compartment B, Fig. 1.

In the first trials cannel coals were used and gave no trouble, but the quantity of ash in the fuel was too high for domestic use. A coking coal was next tried, and was used at first just as delivered, i.e., large and small mixed. The downward progress of the fuel was carefully watched—by its effect on the pressure gauges—and before any serious trouble arose we recognised that the quantity of fine coal was too great, and thereafter the fine was riddled out. Later we found that riddling was only necessary when a large quantity of dross was present. Good screened coal presented no trouble. Only twice in the course of a year's experimenting after this had we any occasion to poke down the fuel—and in both cases the necessity arose from starting with a half empty producer, and filling up the empty internal hopper too rapidly.

The first coke, from Cadder coking coal, unriddled, showed evidence of the fine dust binding the coal into large masses; this we only once experienced. When excessive dross was riddled out, the coke retained in the main the shape and size of the coal going in. It is, however, very much harder than the original coal, and some of it is very hard indeed.

Dr. Marie Stopes has examined under the microscope samples of the coke obtained at different levels of the furnace, and has been able



Maclaurin producer.
FIG. 1.

to trace the organic structure of the original coal, down into the regions where a medium temperature must have existed, then follows a very sharp change in which the original structure disappears. Unfortunately the temperature for each sample examined was not known, but I hope to be able to determine this exactly at a later date. Evidently, the coal under the slow heating to which it is subjected does not intumesce, and by the time it reaches the hotter regions, where a definite structural change takes place, it has lost the power of doing so.

Three coals have been coked in the producer so far; these are Tannochside cannel, Cadder coking coal, and Greenhill coking coal. The analysis of the coals and the dried coke is shown in the accompanying table and for comparison there is shown alongside an analysis of gas work coke obtained at the high temperature of

	Water. %	Volatile matter. %	Carbon. %	Ash. %
Cannel coal	10.70	30.72	46.51	12.17
Residue from same	—	—	—	18
Cadder coking coal	10.40	32.97	50.44	16.19
Dried smokeless fuel from same	—	4.77	86.71	8.52
Greenhill coal	12.69	33.09	50.63	3.85
Dried smokeless fuel from same	—	3.9	—	—
Coke from horizontal re- torts	—	4.30	86.40	9.30

a horizontal retort. I would specially draw attention to the small quantity of volatile matter left in this coke. In one test it is actually less than in the gas works coke. I had always assumed that a low-temperature coke contained a considerable percentage of volatile matter, but in the present instances this is far from being the case. The low percentage of volatile matter might lead one to expect that the coke was as difficult to kindle as the ordinary gas works coke, but trial shows it to be quite easily kindled, certainly quite as readily as coal. Mr. Peter Fyfe, Secretary of the Coal Smoke Abatement Society, had a sample tested against ordinary coal and found that the coke fire kindled more quickly, and attained full redness in 45 minutes, while the coal fire took 1½ hrs. to attain to an equal redness.

The coal fire had to be re-charged in two hours, while the coke fire did not require to be replenished before 4 hours had elapsed. The temperature in the room with the coke fire was higher by two degrees than the temperature of the room with the coal fire.

Heat necessary for carbonising.

To ascertain how much hot gas would be required to carbonise satisfactorily one ton of coal, 13 tons of coal was treated, yielding an average of 13,725 cub. ft. of gas per ton; all the coke coming out during the run, which was of 22 hours' duration, seemed satisfactorily carbonised. Assuming 5000 cub. ft. of rich gas (700 to 800 B.Th.U.) to be given off from each ton of coal in compartment A, this meant a make of about 9000 cub. ft. of producer gas in compartment B, and as this gas, presumably, had a value of about 130 B.Th.U., the calorific value of the mixed gas should have been 351 B.Th.U. The average value found by calorimeter was 180 B.Th.U., and by gas analysis on one sample 206 B.Th.U. The small quantity of hot gas necessary to carbonise the fuel was very gratifying, but the low calorific value was both disappointing and inexplicable. According to published figures, by the late Prof. Lewes, with distillation at 400° C. one ton of coal would yield the products shown in column 1. Column 2 shows what were obtained at Port Dundas. Column 3 shows gas works results with high temperature carbonisation.

	Carbonising at 400° C.	Port Dundas method.	Gas works practice.
	Cub. ft.	Cub. ft.	Cub. ft.
C ₂ H ₂ , etc.	315	53	317
CH ₄ , etc.	3090	1420	3755
H ₂	1060	1685	4627
CO+CO ₂	620	2973	1200
N ₂	50	6294	100

In this trial therefore we obtained one-sixth of the olefines obtained by low temperature and high temperature distillation, and less than half the volume of methane. Unfortunately at this stage accurate measurements of the oil were impossible, owing to the difficulty of separating oil from water, but the percentage of light oil was ascertainable.

The following were the figures, supplied me through the kindness of the Gas Department, for the portion of the oil condensing in the first scrubber: Sp. gr. of water-free oil, 1.037. Distilling at 170° C. 0.34%, sp. gr. 0.968; 170° to 270° C. = 21.26%, sp. gr. 0.970; 270° to 425° C. 15.11%, 0.995; residue (solid), 62.30%, sp. gr. 1.085; loss, 0.69%.

The crude naphtha from low temperature tars is given by Lewis T. Wright as equal to 9% on the tar, or 9 lb. per ton of coal. With a high temperature it falls to 3.45% or about 3½ lb. per ton. In the Port Dundas results it falls to about ½ lb. per ton of coal.

In a second test run the gas was no better. The quantity of oil obtained, however, amounted to about 16 gallons per ton of dry coal. This time the distillate up to 170° C. gave 2.6% of naphtha of sp. gr. 0.965.

A third test was made in March of last year, using water gas, made by decomposing steam in compartment B, for effecting the carbonisation of the fuel. Naturally, this gave a better gas, owing to the comparative freedom from nitrogen, but the percentage of olefines varied from 0.2 to 1.1% and the methane from 7% to 13%, and the gas was therefore in this respect little better than formerly.

To ascertain whether light oils, if produced, could pass the scrubbers, gasoline of sp. gr. 0.650 was added both before and after the first scrubber at the rate of ½ gall. per 1000 cub. ft. The improvement in the gas at the gasometer was not apparent, and analysis showed the olefines and the methane to be practically unchanged. In the first test the olefines amounted to 0.2%, in the second to 1.1%—practically the same as the preceding two tests when no gasoline was used. The completeness with which the scrubbers were removing the gasoline might have misled, but fortunately the next test saved an erroneous impression. The scrubbers are centrifugal brush scrubbers, designed for cheapness. Each scrubber is 10 ft. × 4 ft. In order to keep conditions as uniform as possible, during the additions of the gasoline, the fuel was not disturbed in either A or B compartment, but as soon as the tests were over, ash was removed in compartment B, and an immediate improvement in the composition of

temperature method; though I firmly believe that illuminating gas will yet be made in a plant such as I have described. This, however, will be done by a semi-high temperature method.

At the completion of the third trial, in an endeavour to account for the absence of the light hydrocarbons, the oils were examined more thoroughly. The oil was so hopelessly mixed up with the ammonia liquor that it seemed impossible to get it into a marketable state. Even a sample which to all appearance was water-free, showed about 20% of water on distillation.

In the examination of these oils the Corporation allowed me to have the assistance of Mr. Harris, head of the Chemical Department, when required. Mr. Harris appointed Mr. Cockburn to assist in the investigation, and I have here to thank both gentlemen for their assistance and suggestions. The Gas Department also carried through analyses and distillations for me, and to them I am also indebted. The fickle character of the oil under distillation appears to be wholly responsible for the fact that a distillation carried out by the Chemical Department had no resemblance to a distillation of the same oil by the Gas Department. For instance, when Mr. Cockburn distilled a certain portion of the oil in a glass retort he got a series of fractions of steadily increasing viscosity. When the Gas Department distilled a larger quantity in a copper still, perfectly liquid oils came over to the end.

Oil.

The oils obtained from cannel coals were distinctly lighter than water, brownish green in colour, buttery in consistency. The setting point was about 30° C., they were apparently paraffinoid in character, and resembled the crude oil obtained from shale rather than that from coal tars. The oils from coking coals were decidedly heavier than water, darker in colour, about the consistency of butter; having a setting point about 20° C. and in general less paraffinoid in character than the oils from cannel. Both oils retain a considerable percentage of water with great tenacity. Typical distillation tests of some of the crude oils obtained are given below with water deducted.

Oil from cannel. Sp. gr. about 0.950.		Oil from coking coal distilled from copper retort.		Coking coal. Oil distilled from iron retort. Sp. gr. 1.048.	
	%		Sp. gr.		%
Oil of 0.819 sp. gr.	13.0	Oil to 170° C.	0.965	Oil to 170° C.	6.95
Oil of 0.850 sp. gr.	13.0	170° to 270° C.	0.968	170° to 230° C.	13.06
Oil of 0.910 sp. gr.	32.75	270° to 425° C.	0.992	230° upwards	46.64
Paraffin scale, m. pt. 119° F.	7.25	Residue	1.108	Residue	34.25
(without freezing)					
Hard pitch	6.75				
Loss on washing, etc.	27.25				
	100.00		100		100.00

the gas followed. The olefines rose to 1.4%, the methane to 15.7%, and the calorific value to 377 B.Th.U. This improvement in the gas followed the bringing down of new fuel in B compartment, and the rise in the olefines was undoubtedly due to the hydrocarbons driven off from this fuel being partly decomposed, as they passed up through the hot fuel in compartment A, into ethylene and other light hydrocarbons. The scrubber allowed these light gaseous hydrocarbons to pass, while it prevented the passage of the heavier hydrocarbons of the gasoline.

These results, together with later results and numerous unrecorded results, convinced me that it was hopeless to look for rich gas by a true low

The high percentage of water made these oils troublesome to distil. The large percentage of pitch from the coking coals at the low prices prevailing, the want of knowledge of the nature and use of the distillates, made distillation unpromising. The prospect of using the oil direct for creosoting seemed more hopeful. On testing for phenolic substances, by extracting with caustic soda, 40 to 50% of the oil passed into apparent solution. With the high prices prevailing for carbolic and cresylic acids, it seemed unreasonable to offer this oil even at 3d. per gallon, the price of creosote oil, and I extracted a portion of the oil with caustic soda, separated the supposed phenols with sulphuric acid, and sent a sample of this

to the makers of Iysol, but they reported that it was useless to them.

Low temperature carbonisation has been repeatedly credited with a heavy yield of cresylic acid, and I considered that in this material there was probably a group of phenols of high boiling point. Phenol itself was not present in any quantity, since only very occasionally could its presence be traced by its action on the skin. The boiling point might have been a true indication as to whether the crude oils contained much cresol, but I found that decomposition apparently set in at about 200° C., so I assumed that we had to deal with phenolic bodies in combination with organic bases.

Crude oil and resinous portion.

Distillation appearing unsatisfactory, direct uses were sought for the crude oil. The fact that it dried on wood, leaving a glossy surface, when well rubbed in, suggested its use as a furniture polish or as a protective covering for wood. Wood rubbed with crude oil will afterwards take both paint and varnish. This, I am told, is not the case with coal tar oils, unless specially prepared.

The separated cresylic portion (see diagram), when heated at slightly over 200° C. for a short time, gives off phenolic vapours. Fully two-thirds will not come over at this temperature, but remains behind as a resinous pitch.

At this stage it was found that when the oil was agitated with paraffin in a separator, the mixed liquids divided into three layers, the top being a semi-liquid oil, the middle one water, and the lowest layer a heavy black resinous tar. If weak acid is added to the top oil, and it is again agitated, a second separation takes place, almost exactly similar to the first, only the bottom layer is redder in colour. This I have termed red resin. If the top oil of this second treatment be now treated with caustic soda, a portion passes into solution, and this can be separated with acid. For want of a better name I have termed it the cresylic portion. The neutral oil that remains after washing with water, I term Port Dundas lubricating oil. The diagram, Fig. 2, will help to visualise the separation, and the approximate quantities.

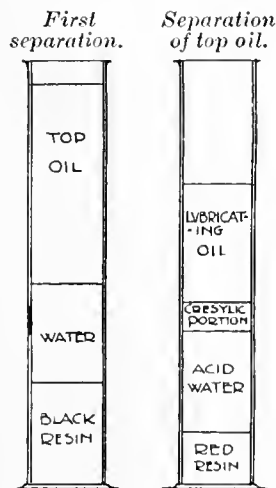


FIG. 2.

The resins, when thinned with turpentine, give satisfactory yellow varnish stains; with methylated spirit brown stains, and with benzol, black varnishes.

Distillation of the separated portions of the oil seemed to promise to give useful information, so we had the resin distilled. The result of dis-

tillation in a glass retort obtained by Mr. Harris's Department, is given below:—

C. D. Resin.

	%	
Water	3.3	
Oil to 150° C.	0.9	Dark brown fluid.
150°—185° C.	1.1	Yellow fluid.
185°—195° C.	1.3	
195°—215° C.	18.2	Golden brown } More viscid than above
215°—240° C.	2.6	Golden brown } Viscid.
240°—270° C.	3.5	Brown. } Very viscid.
270°—300° C.	7.5	Brown. } Thick jelly.
300°—320° C.	7.1	Dark brown. } Solid jelly.
320°—350° C.	7.1	Dark brown. } Solid jelly.
350°—355° C.	8.8	Almost black solid jelly.
	61.4	
Residue	38.6	
	100.0	

The temperature remained fairly constant at 200° C., and decomposition apparently set in at 355° C. The residue was a blackish, very friable pitch. Guaiacol and creosol were found to be absent, as was also abietic acid.

With the object of getting larger quantities of each fraction for refractionation, Mr. Macdonald, at Tradeston Gas Works, distilled a larger quantity in a copper still. The results of this are noted below.

C. D. Resin.

	%	Sp. gr.
Water	5.9	—
Oil up to 170° C. ..	3.35	0.907
170°—200° C.	1.55	0.962
200°—215° C.	4.65	0.974
215°—240° C.	5.80	0.980
240°—270° C.	6.00	0.982
270°—300° C.	8.30	0.986
300°—325° C.	3.60	0.991
325°—350° C.	0.20	
350°—370° C.	0.50	
	39.85	
Pitch	60.15	Sp. gr. 1.14; very hard and brittle.
	100.00	

All products were quite fluid, but dark in colour, and had an odour like that of solvent naphtha.

The difference in these results made it appear that distillation would be useless unless under reduced pressure or in a current of steam.

Lubricating oil.

A distillation of the lubricating portion of the oil, made by Mr. Cockburn, is given below. Up to 170° C. water=3.4%; oil=2.6%; 170° to 200° C.=1.0%; 200° to 270° C.=16.2%; 270° to 360° C.=34.0%; 360° to 370° C.=9.2%; 370° to 375° C.=4.4%; 275° to 310° C.=5.6%. The small percentage distilling over below 170° C. and the smell indicated the absence of benzene, toluene, etc., and of all the lighter paraffins, olefines, and naphthenes. The respective members of the three groups boiling about 200° C. are dodecane, $C_{12}H_{26}$; dodecene, $C_{12}H_{24}$; and dodecanaphthene, $C_{12}H_{18}$. Towards the end of the distillation crystals formed in the distillate, particularly between 290° and 360° C. These were apparently higher paraffins, but might be olefines or naphthenes. The drop in temperature, at 375° C. is particularly noteworthy. Mr. Cockburn remarks that "at this point (*i.e.*, 375° C.) the character of the distillate changed—a reddish oil coming over. The temperature fell steadily till it registered only 310° C. All the time, however, the reddish oil continued coming over, and a strong smell of ammonia was noticed (and detected by litmus). This reddish distillate measured 5.6%. Granular crystals separated on cooling—mostly naphthalene (judging by the picrate test). Decomposition of nitrogen compounds explains the presence of the ammonia."

This oil impressed me from the beginning as having remarkable lubricating qualities, and

although Lunge states that oils from blast-furnace tars made only inferior lubricants. I had the Port Dundas oil tested by the kindness of Dr. Gray in the Thurston friction machine. The first tests were very encouraging, and later tests have confirmed the remarkable lubricating power of these oils. I selected the best oils given by Hurst, for durability, and compared them with the Port Dundas oil, run under similar conditions. The results are shown on the following diagrams.

Fig. 3 gives the results with castor oil, sperm oil, and a heavy Port Dundas lubricating oil. With the castor oil the friction was so great that

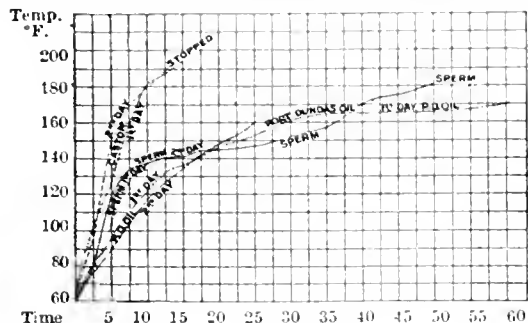


FIG. 3.

the test was not proceeded with. The Port Dundas oil ran for 60 minutes the first day, and 25 minutes the second day. The pure sperm ran for 15 minutes the first day, and 50 minutes the second day. It is remarkable that the Port Dundas oil has always run at a lower temperature the second day, while most of the other oils tried have been slightly higher.

Fig. 4 shows a Scotch mineral oil of sp. gr. 0.890 run against a light Port Dundas oil for friction and durability only. This oil was the distillate between 290° and 340° C. of the lubricating portion of the oil. On filtering out the crystals, which were large, flat, waxy crystals, like paraffin, the durability of this oil decreased. The crystals smeared on the bearing improved the results again.

All the tests were run at 48 lb. pressure to the square inch on the bearing, and at 2000 r.p.m. Neither of these two oils indicated any tendency to gum.

The remarkable feature in the Port Dundas oil is the high durability shown, combined with the fact that its viscosity is very low; also the complete absence of any tendency to gum in a coal tar oil, which had not been distilled, and from which resinous substances had only been extracted by treatment with soda.

Dye products.

About this time it was found that water which had been standing over the resin, became strongly coloured red on addition of caustic soda. It was therefore of interest to examine the effect of alkalis on the resin; 3½ gallons was agitated with dilute sodium carbonate solution, the red liquor poured off, and the process repeated until 8 gallons of strong red liquor had been obtained. This occupied a week. The liquor after this became browner and muddier, and the extraction was stopped. Evidently if water extracted this colouring matter from the oil, the ammonia liquor which had been so thoroughly mixed with the oil should contain the same material. On adding caustic soda to the slightly acid ammoniacal liquor from the tanks, a bright blue colour was produced at once; a little more soda turned this red. The purple ammoniacal liquor was found to dye wool neutral grey shades. The red liquor does not dye unmordanted wool, but the colour is fixed

satisfactorily on a chrome mordant. When the purple colour was oxidised with bleaching powder, a dull yellow was obtained, which also dyed unmordanted wool.

The Port Dundas ammoniacal liquor is apparently free from both ferrocyanides and thiocyanates. The purple grey colouring matter can be obtained in a solid form by evaporation of the neutral liquor. The quantity present is quite considerable, and without any purification whatsoever, the ammoniacal liquor produces pleasing purple grey shades, which are at least faster to light than those obtained with the ordinary aniline dyes.

With the object of separating basic substances from the resin remaining after the soda treatment, it was treated repeatedly with dilute sulphuric acid, air being blown through the solution meanwhile. The solutions were coloured yellow, and on cooling deposited a golden-yellow resin very soluble in caustic soda and in alcohol, but insoluble in dilute acids. At the end of the third day's treatment the quantity of resin remaining amounted to about 4% of the oil originally used. It was still black, and on further treatment dissolved in the same manner as before.

The dilute yellow solutions thus obtained were found to dye wool, at the boil, without mordant, in shades fairly fast to washing. When the solutions were evaporated a dirty, unpossessing powder was obtained. This had very little dyeing power. When the resin itself was treated with nitric acid of a certain concentration a decided action ensued, and a yellow liquid was obtained, together with a light, spongy char. The yellow liquid was neutralised with lime, filtered, and evaporated to dryness. Attempts to purify this further resulted in the colour steadily disappearing. A rough calculation indicated that one ton of coal would have yielded sufficient resin to give by sulphuric acid treatment sufficient colour to dye 800 lb. of wool, but the yellow liquor obtained from the nitric acid solution would only dye a minute fraction of this. For some time I could not account for the disappearance of the yellow dye, until I found that the "char" from the nitric acid treatment, on addition of caustic soda solution, immediately gave rise to a solution so strongly coloured as to indicate that this char is practically solid yellow dye. On heating, this char softens like a resin. I am unable to give any enlighten-

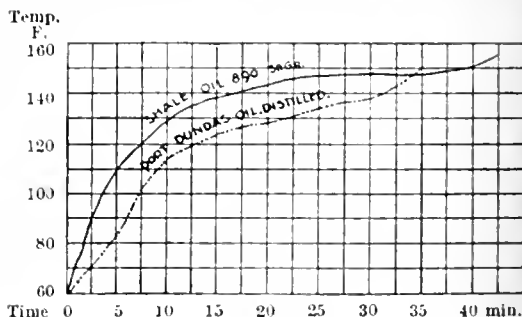


FIG. 4.

ment as to the chemical nature of this product. It does not appear to contain nitrogen. By treating with sodium nitrite, chocolate and neutral browns are obtained, and these seem fairly fast to washing and to light.

All the shades produced by these products are much faster than picric acid and Methyl Violet dyeings; the least fast faded to about the same extent as Patent Blue, which is one of the faster of the triphenylmethane dyes. The dark grey blues on chrome mordanted wool, and some of the neutral browns have only been slightly affected.

The weak acid solution from a cannel coal,

contains a pale primrose colouring matter. The "cresylic portion" from a cannel contains no cresylic acid, but gives a red brown precipitate which by treatment with weak nitric acid gives two portions, a resinous scale and an iron-red precipitate. Both portions give with caustic soda raw sienna colouring matters, of considerable purity. These soda-soluble substances would suggest a phenolic or naphtholic origin, but the black resin, after boiling with caustic soda until the soda takes up no further colour and then treating with weak nitric acid, gives an almost similar colouring matter, in great quantity. I calculate now that one ton of coal will yield sufficient colour to dye 1500 lb. of wool.

I must mention, however, that the action of soda on the tars has been most erratic. A percentage equal to the black resins is extracted from the crude oil by caustic soda, while the black resin, precipitated by acid, is only very partially soluble in soda. The portion of this resin distilling over between 170° and 240° C. when treated with weak nitric acid also gives a yellow resinous colouring matter in large quantity.

I have already remarked that the crude oil dries quickly in air, and much more rapidly by the addition of a drier, such as manganese dioxide, in this respect behaving somewhat like a boiled oil. After agitating the oil in a closed separator with caustic soda, I have frequently noticed the inrush of air, on removing the stopper.

Before leaving the subject of dyes I must express my indebtedness to Mr. Steven and Dr. Gray for their help in the matter.

Ammonia.

The titration of the ammonia liquor does not require the addition of an indicator. In practice the change from a yellow colour to a purple colour indicated the time for the addition of more acid. The liquor was generally kept slightly acid (about 0.5% free sulphuric acid). If the rate at which the coal was being gasified was known, the time taken to neutralise a carboy of acid of known strength gave a measure of the free ammonia being produced, and this could be told directly by the appearance of the purple colour. My anticipation of 45 lb. per ton was based largely on the results obtained by Beilby in 1883, who found that when coal was exposed for several hours to a gas containing hydrogen at a moderate red heat, from 60 to 70% of the nitrogen of the fuel was obtained as ammonia. To keep down the temperature, both Beilby and Mond adopted the expedient of increasing the quantity of steam. Now steam is costly, and it has to be condensed out, and this involves large plant; I therefore decided to obtain the time of contact with the fuel, at an ammonia-yielding temperature, by ensuring that the fuel would not reach the combustion zone until it had been exposed for many hours to the hot gases at temperatures varying from 450° to 750° C. This only necessitated providing a large storage chamber surrounded by thick non-conducting walls. In Fig. 1 the zone, N, is the ammonia-producing zone, and as the coal takes approximately 20 hours to be heated from 15° C. to 1000° C. it will take about one hour for every 50° increase, and therefore an increase of 300° will occupy about 6 hours. By the time it reaches 750° C. I consider it has been sufficiently stripped of its nitrogen to make any further loss negligible.

The ammonia results are, unfortunately, for a variety of reasons, perhaps the least accurate; this side of the problem has not yet received the amount of attention which its importance merits.

My first experiments were with a cannel coal from Ayrshire. This gave approximately 40 lb. of sulphate of ammonia per ton. The next coal tested was also a cannel, this time from Lanark-

shire, and this, by determining the time to neutralise a carboy of acid, showed 63 lb. to the ton. The next tests were on Cadder coking coal, while running for smokeless fuel. As the oil and liquor could not be separated, no actual estimate was taken, but tests of the ammonia in the gas gave very low results. The coke in this case had very often a highly-glazed surface skin and probably did not allow of free access of the combustion gases to its centre.

The results with Greenhill coal, working for power gas, were better, one result showing 36 lb., and the one following 19 lb. as measured by the acid neutralised. In steady running these yields are likely to be exceeded, as on beginning the experimental test showing 36 lb., the fuel in the producer, at the start, had been much more completely denuded of its nitrogen than the fuel remaining in the producer at the end of the test. The cooling and scrubbing plant consisted of the two scrubbers already referred to, and as acid only passed through the first scrubber any ammonia passing to the second scrubber was entirely omitted. The amount of ammonia escaping would not be very great, our experience being that so long as the rate of gas passage did not exceed 50,000 cub. ft. per hour, little ammonia was carried forward.

Regarding the commercial side of the process, it is impossible to speak definitely until the market value of the oil products has been ascertained, but 2d. per gallon for the crude oil should make it worth considering in most situations.

The capital cost before the war of a plant capable of handling 20 tons of coal per day amounted to about £1000, exclusive of coal crushers, elevators, and driving engine.

The yields of all the products have been equal to my anticipations for the coals concerned, except illuminating gas, which has been a complete disappointment, though the enhanced value of the oils may be found to more than counterbalance this.

Approximate yields for the kinds of coal handled are given below.

Working for smokeless fuel. Gas, 10,000 cub. ft. per ton. 330 B.Th.U. Oil, 16 galls. (7%). Liquor, 12%. Smokeless fuel (5% volatile), 65%.

Coking coal. Gas, 141,000 cub. ft. per ton. 112 B.Th.U. Oil, 16 galls.; sulphate of ammonia, 45 lb. Energy loss, 6,250,000 B.Th.U. per ton.

Cannel coal. Gas, 80,000 cub. ft., 114 B.Th.U. Oil, 32 galls. Sulphate of ammonia, 36 lb. Energy loss, 4,750,000 B.Th.U. per ton.

The energy losses will probably be reduced as experience grows. The low capital cost of the plant is largely due to the gases leaving the producer comparatively cool, hence reducing the condensing power to a minimum.

The small amount of steam necessary makes a great saving in working costs and condensing plant.

The most interesting results from the chemical side are:—

- (1) The small quantity of hot gas required to carbonise a ton of coal.
- (2) The small percentage of light olefines present in the gas.
- (3) The relative absence of light portions—benzene homologues, carbolic and cresylic acids—in the crude oil.
- (4) The presence of resinous substances in the oil.
- (5) The lubricating quality of the non-resinous oil.
- (6) The drying properties of the crude oil.
- (7) The presence of dyes in the ammonia liquor and the oil.

Further investigation of these various products is likely to prove fruitful commercially, and highly interesting.

In conclusion, the author desires to express his thanks to those who have assisted him, especially to the Corporation of Glasgow, and to Mr. Hardie, upon whom a great deal of the work has devolved.

London Section.

Meeting held at Burlington House, on Monday, June 4th, 1917.

MR. A. R. LING IN THE CHAIR.

THE RATE OF REVERSION OF MIXTURES OF SUPERPHOSPHATE WITH BASIC SLAG AND ROCK PHOSPHATES.

BY G. SCOTT ROBERTSON, M.Sc.

During the past winter considerable difficulty has been experienced by British farmers in obtaining superphosphate. Up to the present the shortage in the supply of this important fertiliser has been due chiefly to the unlimited demand made by the Ministry of Munitions for sulphuric acid. It was highly desirable, therefore, to ascertain the best method of eking out the limited supply of superphosphate. With this object in view, and at the suggestion of the Board of Agriculture, the experiments recorded in this paper were undertaken. Just as the investigation was completed the Board was informed that the available supply of sulphuric acid was in excess of the supply of rock phosphate. Although, therefore, the investigation loses its immediate importance, yet certain of the results are capable of practical application. Furthermore, it is possible that the British farmer may experience similar difficulties during the coming winter.

If suitable mixtures of superphosphate with insoluble phosphates can be obtained, the superphosphate will be distributed over a much larger area, and the aggregate return will be much greater, than if the superphosphate were applied to a limited area at the usual rate of 2-6 cwt. per acre.

Basic slag of low and high citric solubility, and rock phosphates are the two chief sources of insoluble phosphate, and of each the available supply is far beyond our present requirements.

It is, therefore, a matter of importance to determine the extent of the changes which take place when the above-mentioned insoluble phosphates are mixed with superphosphate.

Basic slag and superphosphate mixture.

This mixture consisted of $\frac{1}{2}$ cwt. 26% water-soluble superphosphate and $\frac{1}{2}$ cwt. 26% citric-soluble basic slag (Albert's). The slag and superphosphate were thoroughly mixed together, passed through a riddle, sampled, and the water-soluble and citric-soluble phosphate determined at once. During mixing the mixture became exceedingly hot, and by the time it was ready for putting into the bag it was as hot as the hand could comfortably bear. The bag was removed from the mixing shed and stored in the laboratory. There was a marked tendency on the part of the mixture to form small but rather hard lumps.

The analysis of the slag and superphosphate used is given in Table I. By calculating from these analyses, the mixture at the moment of mixing had the following composition:—

Water-soluble phosphate ($\text{Ca}_3\text{P}_2\text{O}_8$)	12.99
Citric-soluble " "	26.38
Total phosphate ($\text{Ca}_3\text{P}_2\text{O}_8$)	28.18
Citric solubility of the phosphate	93.6

The mixture was sampled several times in the course of four months. On each occasion it was spread on the laboratory floor and turned over

at least three times before the sample was withdrawn. The sample was quickly and gently ground by means of a mortar and pestle and the water-soluble and citric-soluble phosphate determined immediately. The results are given in Table II.

Reversion of the water-soluble phosphate to the water-insoluble form takes place at a very rapid rate. About 80% of the water-soluble phosphate in the mixture reverts to the water-insoluble form

TABLE I.

	Gafsa rock phosphate. Basic slag.	Super-phosphate
	%	%
Water-soluble phosphoric acid (P_2O_5)	—	11.90
Water-soluble phosphate ($\text{Ca}_3\text{P}_2\text{O}_8$)	—	25.98
Citric-soluble phosphoric acid (P_2O_5)	9.78	12.53
Citric-soluble phosphate ($\text{Ca}_3\text{P}_2\text{O}_8$)	21.35	27.35
Citric soluble lime	17.44	14.28
Total lime, CaO	42.50	29.20
*Carbon dioxide (CO_2)	5.34	—
Free caustic lime (CaO) by sugar solution	—	1.60
Silica (sand)	8.21	15.90
Total phosphoric acid	25.10	13.28
Total phosphate ($\text{Ca}_3\text{P}_2\text{O}_8$)	54.79	28.99
• Equivalent as calcium carbonate	12.14	0.21
Lime as uncombined calcium carbonate	0.72	—
Citric solubility of the phosphate	39.0	91.3

within 24 hours; 60% of the water-soluble phosphate reverts before portions can be withdrawn for analysis, that is to say within half an hour. It seems clear also that reversion practically ceases before the mixture is four days old.

The basic slag used in the mixture contained 47.75% of calcium oxide (lime), 23.89% of available lime,* including 1.69% of free or caustic lime, and 0.12% of lime (CaO) as calcium carbonate. The amount of available lime present in the mixture is more than five times the amount required to revert the whole of the water-soluble phosphoric acid to the water-insoluble form. It is clear, therefore, that the extent of the reversion of the water-soluble phosphate in any such mixture is directly proportional to the amount of caustic lime and calcium carbonate which the mixture contains.

The amount of caustic lime and calcium carbonate in basic slag is much less than is generally assumed, but in the slags which the writer has examined it is seldom much less than 2% of lime (CaO).

The percentage of citric-soluble phosphate in the mixture is very close to the calculated amount. Just after mixing there seems to be a slight decrease in citric solubility, followed by a gradual recovery on keeping, but the differences are so small as to be negligible and are certainly without any practical significance.

On the whole it cannot be said that a superphosphate and basic slag mixture has anything particular in its favour. If the basis of the mixture is one half 26% superphosphate and one half basic slag, it is clear that if the slag contains 2% of caustic lime practically all the water-soluble phosphate in the mixture will revert in a few hours. The mechanical condition is not improved by

* The term "available lime" means the excess of citric-soluble lime over that required to combine with the citric-soluble phosphoric acid to form tricalcium phosphate, $\text{Ca}_3\text{P}_2\text{O}_8$. In basic slag the greater part of the so-called "available lime" is, together with silica, combined with the calcium phosphate, and only a small amount, often not more than 2%, is in the form of caustic lime or calcium carbonate.

phosphate, but it should be borne in mind when comparing these results that the residual value of the Tunisian rock phosphate will be felt to a far greater extent on the succeeding crops than the superphosphate.

The experiments conducted by Professor Gilchrist at Cockle Park also demonstrate in a striking manner the efficiency of a mixture of superphosphate and rock phosphate for a three years' ley.*

In the Journal of the Irish Department of Agriculture, referred to above, the opinion is expressed that on no account should the 2 to 1 mixture be purchased without a guarantee that the mineral phosphate contained therein is of "North African origin," and the results which follow lead to the assumption that Tunisian phosphate is the most suitable for mixing with superphosphate.

This opinion is certainly open to criticism. The comparative absence of uncombined calcium carbonate, and the availability of the phosphoric acid, in the rock phosphate are far more important points in deciding the suitability for mixing with superphosphate than the question of origin. North African phosphates are not always free from excessive amounts of uncombined calcium carbonate; indeed Tunisian phosphate is very liable to contain large quantities of uncombined calcium carbonate—varying in the author's experience from 2 to 12% of calcium oxide. The larger the amount of uncombined calcium carbonate present, the greater will be the reversion of water-soluble phosphate to the insoluble form when mixed with superphosphate.

Gafsa rock phosphate (a North African phosphate) is probably the most suitable for mixing purposes, as it very rarely contains more than 0.75% of calcium oxide in the form of free carbonate. This phosphate has the additional but doubtful advantage of being more soluble in 2% citric acid than any of the other rock phosphates. Egyptian phosphate is probably the next best for mixing purposes, and then come Florida pebble phosphate, and Makatea Island phosphate, followed by Tunisian and Algerian phosphates.

If Gafsa phosphate containing at least 26% of phosphoric acid is used for mixing with superphosphate, the reversion of water-soluble phosphate will be small. But if low grade varieties of rock phosphates, containing 25% and under of phosphoric acid, are used, the reversion of the water-soluble phosphate to the water-insoluble form in the superphosphate mixture will be considerable.

Superphosphate and rock phosphate produce a very nice mixture, particularly if the superphosphate is in a friable condition.

Mixtures of rock phosphate and superphosphate might be rendered even more efficient if the rock phosphate was ground a great deal finer than it is. As a rule rock phosphate for the making of superphosphate is not ground quite so finely as basic slag. From 70 to 80% only passes a sieve with 10,000 holes to the square inch, whereas basic slag has a corresponding fineness of from 80 to 90%. It is perfectly feasible to have the rock phosphates ground so that upwards of 80% will pass a sieve with 40,000 holes to the square inch, and there is every reason to suppose that by so doing the efficiency of the mixture with superphosphate would be greatly improved.

The author wishes to acknowledge his indebtedness to Mr. J. G. Stewart, M.A., of the Board of Agriculture and Fisheries, and to Mr. R. M. Wilson, B.Sc., Principal of the East Anglian Institute of Agriculture, at whose suggestion this investigation was undertaken.

* Guide to Cockle Park, 1915, pp. 39—41.

Manchester Section.

Meeting held at the Grand Hotel on Friday, May 4th, 1917.

MR. J. H. HOSEASON IN THE CHAIR.

THE EXAMINATION OF ACETIC ANHYDRIDE.

BY L. G. RADCLIFFE, M.Sc. TECH., AND
S. MEDOFSKI, B.Sc. TECH.

Acetic anhydride is, unfortunately, of rather variable composition owing to the lack of care given to its purification. Its technical value depends very largely on the percentage of real anhydride which it contains or, in other words, on its freedom from acetic acid. The examination of acetic anhydride must include the detection of impurities resulting from the process used in its manufacture. In the Feb. 28th, 1916, issue of this Journal (pages 210—213) will be found an excellent review, by J. T. Hewitt and C. H. Lumsden, of the methods used for preparing acetic anhydride, in which is also included an account of methods for the detection of such impurities as phosphorus, chlorine, and sulphur.

Commercial acetic anhydride usually contains from 70 to 90% of real anhydride, and the percentage of anhydride can readily be increased to 97% or more by careful fractional distillation with a suitable still-head (*vide* Orton and Jones, Chem. Soc. Trans., 1912, 101, 1721; this J., 1912, 898). In one experiment the amount was increased from 85% to 91% anhydride by one fractional distillation.

The authors have made a comparative study of the published methods for determining the percentage of actual anhydride in commercial acetic anhydride, and the methods and results are given below. Much of the acetic anhydride now available is yellow in colour and this coloration is difficult to remove by simple distillation, but if the acetic anhydride is distilled off from a little phosphorus pentoxide the resulting product is colourless. This treatment has no effect in raising the percentage of anhydride, indeed, it appears to decompose the substance slightly as the pentoxide blackens and the residue after distillation is viscid and almost black; the percentage of anhydride after three treatments with phosphorus pentoxide and distillation is actually less than in the original sample. This points to a decomposition being effected by the phosphorus pentoxide. It was thought that the acetic acid might be removed from the acetic anhydride by shaking the latter quickly with a saturated solution of salt, then separating, drying over anhydrous sodium sulphate, filtering, and distilling, but again the percentage of anhydride was diminished from 85% to 73%.

Incidentally it was noticed that some of the sodium sulphate had dissolved in the mixture of acetic anhydride and acetic acid. The three distillations over phosphorus pentoxide reduced the percentage of anhydride from 85 to 77%.

The percentage of acetic anhydride in mixtures of anhydride with acetic acid cannot be determined by direct methods. The procedure generally adopted is:—

(A) *Treadwell's method* ("Analytical Chemistry," 1911, Vol. 2), in which a known quantity of the anhydride is treated with barium hydroxide solution and the excess of this titrated as described later. Another method, similar in principle, is to hydrolyse the anhydride with water and determine the amount of acetic acid formed.

(B) *Method of Menschutkin and Vasilieff* (J. Russ. Phys. Chem. Soc., 1889, 21, 190), in which

the anhydride is mixed with aniline, with which it forms acetanilide and acetic acid, the acidity being determined after the reaction. This method has been modified and described in the "Analysis of Crude Glycerine, International Standard Methods, 1911." The details of the methods as used by us are as follows:—

(A) *Direct titration.* Into a weighed stoppered bottle containing from 10 to 20 c.c. of water is run in about 2 grms. of the sample of acetic anhydride and the stopper replaced and the bottle again weighed. The mixture is allowed to stand, with occasional shaking, for several hours or it may be heated gently in a flask fitted with a reflux condenser, on a water-bath, until the acetic anhydride has been completely hydrolysed; this requires about twenty minutes. The acid is then titrated with *N*/1 caustic soda, using phenolphthalein as usual. If *p* is the weight of sample taken, and *q* the weight of acetic acid found from the number of c.c. of *N*/1 caustic soda used, then the weight of acetic anhydride present is $5.6641(q-p)$.

(B) *Barium hydroxide method of Treadwell.* About 1 gm. of the sample is weighed into a flask and mixed with a known volume, *i.e.*, an excess, of barium hydroxide solution, usually *N*/5 or *N*/10. The flask is attached to a small reflux condenser fitted with a soda-lime tube and the mixture heated on a water-bath until the anhydride is completely hydrolysed. The excess of barium hydroxide is then titrated with *N*/10 hydrochloric acid, using phenolphthalein as indicator. The equations for calculating the percentage of anhydride are the same as in the previous method (A).

Analysis of Crude Glycerine, 1911," and has been abstracted entirely therefrom.

Into a weighed stoppered vessel, containing 10–20 c.c. of water, is run about 2 c.c. of the anhydride, the stopper replaced and the vessel weighed and allowed to stand, with occasional shaking, for several hours till all anhydride is hydrolysed; the mixture is then diluted to about 200 c.c. with water, and titrated with *N*/1 caustic soda, in presence of phenolphthalein. This gives the total acidity due to free acetic acid and the acetic acid formed from the anhydride. Into a stoppered weighing bottle containing a known weight of recently distilled aniline (from 10–20 c.c.) is measured about 2 c.c. of the sample, the stopper is replaced, the contents mixed, allowed to cool, and the bottle weighed. The contents of the weighing bottle are washed into about 200 c.c. of cold water and the acidity titrated as before. This yields the acidity due to the original, preformed, acetic acid plus one-half the acid due to anhydride (the other half having formed acetanilide); the second result is subtracted from the first (both calculated for 100 grms.) and the result doubled, obtaining the c.c. of *N*/1 caustic soda per 100 grms. sample (1 c.c. of caustic soda = 0.0510 gm. anhydride).

(E) If the method of Menschutkin and Vasilieff be modified so as to use 20 c.c. of aniline instead of 2 or 3 c.c., then the heat generated by the reaction is absorbed by the excess of aniline and the secondary reaction does not take place. As will be seen in the table, the results obtained when using this modification agree with those given by the other methods.

Description of sample.	Sp. gr. 15.5°.	Refractive index 15.5°.	B.pt. °C.	Method A.	Method B.	Method C.	Method D.	Method E.
I.—Commercial sample, yellow	1.0783	1.3802	133–146	84.92	85.61	98.42 98.76	85.30	84.80
II.—Same after distillation over P ₂ O ₅ , colourless	—	—	—	84.90	—	—	85.20	85.40
III.—Original sample (I.) fractionated with 4 pear-bulb column.								
(a) Fraction b.pt. 133°–137°, vol. 15 c.c.	—	—	—	73.64	73.89	—	74.12	73.67
(b) Fraction b.pt. 137°–140°, vol. 150 c.c.	1.0798	1.3820	—	90.56	90.83	—	89.72	90.76
(c) Fraction b.pt. 140°–146°	—	—	—	89.62	—	—	89.13	88.76
IV.—"Pure" acetic anhydride, colourless ..	1.0824	1.3851	135–138	92.48	94.35	109.23 108.73 109.56	92.72	93.1

(c) *Method of Menschutkin and Vasilieff.* Into a stoppered weighing bottle containing a known weight of aniline (2 to 3 c.c.) is run in about 2 grms. of the sample, the stopper replaced, and the contents shaken. Much heat is generated, and the mixture is allowed to cool and is weighed after which it is washed into a flask with alcohol and titrated with *N*/1 caustic soda, using phenolphthalein as indicator.

Treadwell has criticised this method, asserting that a secondary reaction takes place due to the great heat of the reaction between the acetic anhydride and the aniline, this causing the acetic acid produced to acetylate some of the aniline. He found that the percentages of anhydride obtained by this method were invariably from 14 to 16% too high. In several trials by this method, a sample of acetic anhydride, which according to the barium hydroxide method contained 94.3% of acetic anhydride, gave results indicating 109.23, 108.73, and 109.51% of acetic anhydride. Analyses of a sample of acetic anhydride which had been found to contain 85% of anhydride by the barium hydroxide method and also by the method described in detail below, were found to give figures from 98.42 to 98.76% of anhydride.

(D) The following method was given by the British Expert Committee's "Report on the

There is no doubt that, of the methods described, the direct titration is the shortest but the British Expert Committee's method is the safest in that it affords three ways of arriving at the percentage of acetic anhydride, *i.e.*, using the formula given in (A), the formula in (C), and the method given in (D).

In connection with the study of the behaviour of various strengths of acetic anhydride for acetylations, and also of the sulphur chloride method for its preparation, it became necessary to examine the anhydrous sodium acetate used. It has been stated that crystallised sodium acetate corresponds to the formula, $\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$, and that on exposure to air the salt effloresces and loses the whole of the water of crystallisation. According to the experiments recorded below the latter statement is incorrect. Ordinary crystallised sodium acetate was treated in a platinum crucible with strong sulphuric acid and heated until the weight of the sodium sulphate residue remained constant; from this the percentage of sodium in the salt was calculated.

Calculated for $\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$ —16.9% of Na.
Found, 16.85% Na.

Two weighed samples of this sodium acetate, one in crystals and the other in fine powder, were exposed on watch glasses for one week, to the air

of the laboratory, and weighed every day. No loss in weight occurred in either case, indeed a slight gain was noticed. These experiments dispose of the idea that crystallised sodium acetate loses its water of crystallisation on exposure to ordinary air. In a further experiment the weighed quantities of the sodium acetate were placed on watch glasses in an ordinary calcium chloride desiccator and weighed repeatedly during a period of 12 days; at the end of this time the weight remained constant and the loss corresponded exactly to the change of $\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$ into the anhydrous CH_3COONa . Theoretical loss 39.7%, found 39.7%. The loss averaged about 1% per day, and was singularly regular.

A sample of the same crystallised sodium acetate lost, on careful fusion, 39.4%. A further trial was made heating the crystallised acetate in a steam oven, at 97° to 100° C., when the loss, in 12 hours, amounted to 39.8%.

From these experiments it is clear that crystallised sodium acetate can be completely dehydrated either by heating in a steam oven or by simply confining in a desiccator for a prolonged period.

Anhydrous sodium acetate is very hygroscopic and should be preserved in a desiccator. A sample of carefully fused and powdered sodium acetate exposed to the air at the ordinary temperature in the laboratory absorbed 65.5% of moisture in 32 days. Fused sodium acetate should absorb 65.8% of moisture if it regenerates the crystallised salt, $\text{CH}_3\text{COONa} \cdot 3\text{H}_2\text{O}$.

We desire to thank Mr. M. Barash for his assistance in some of the later experiments.

DISCUSSION.

Dr. J. J. Bloch asked whether acetic anhydride had been distilled over dry sodium acetate and if the yield of anhydride had been increased.

Mr. RADCLIFFE said the experiment had been tried but there was no appreciable increase in the strength of the anhydride.

Professor A. LAPWORTH mentioned that Kipping, some 20 years ago, had found that fatty acids yielded the corresponding ketones with phosphorus pentoxide, so that the formation of acetone would be expected in that case; dehydration of acetone with acetic anhydride would be very natural and consequently there would be a fall in the percentage of anhydride. There was a danger in generalising about losses of moisture from hydrated salts; he assumed that the experiments with sodium acetate had been made in Manchester; possibly if they had been carried out in Japan or other places where calcium chloride solutions are said to dry up in the open air, the sodium acetate might have lost its moisture.

Mr. RADCLIFFE agreed with Professor Lapworth with respect to the first point. He appreciated Professor Lapworth's remarks with regard to the loss of moisture; though under the conditions mentioned no loss took place, it was quite possible that dehydration might take place under suitable atmospheric conditions. A process was described by Hewitt, in which acetic anhydride was made in fairly large quantities by the action of sulphur chloride on anhydrous sodium acetate. In adopting this process it was essential that the sodium acetate should be thoroughly dry.

paid last year by the author to the United States. Industrial research is classified according to whether it is undertaken by manufacturing corporations, associations of manufacturers, universities and colleges, national institutions, commercial laboratories, or scientific societies. Typical examples are given of research laboratories connected with each of the above classes, and descriptions and illustrations of these laboratories are included.

The author points out that as yet little has been done to prevent overlapping of research and that there is at present no comprehensive scheme of research applying to industry in the United States as a whole. Reference is made to the appointment of the National Research Council, with the object of co-ordinating the scientific research work of the country. A movement has also been started by the Land Grant College Engineering Association, which has resulted in the promotion of a Bill having for its object the establishment in each State of a "Mechanic Arts Experiment Station" for conducting researches in connection with the production of "substances utilised in the application of mechanic arts to industrial pursuits." The Federal Government is asked to contribute £3000 per annum to each State for this purpose, and it is proposed that these experiment stations should co-operate with the existing Agricultural Experiment Stations.

The American Association for the Advancement of Science has appointed a committee, comprising some of the most prominent men connected with industrial research, with the object of securing more effective adaptation of research facilities in the various universities and experiment stations to industrial and national needs.

The U.S. Department of Agriculture and Bureau of Mines represent very complete organisations for dealing with their particular fields of research, and embody features which may serve as a basis for a national research scheme in other industries; particularly is this the case in regard to the means that have been developed for collecting and distributing data.

Discussing the organisation of British industrial research, the author urges that the higher forms of research should be carried out on national lines and should be organised in such a way as to link up the scientific resources of the Empire. An Imperial research organisation might not only result in the development of means for cheapening the production of raw materials, but might also assist in finding suitable outlets for the use of new materials discovered in the Overseas Dominions.

The following alternative schemes of research are suggested as possible in Great Britain: (a) Research laboratories in individual works. (b) Research laboratories for a group of works in the same industry. (c) The centralisation of research in the universities or colleges. (d) An Imperial centralised laboratory for the whole of industry. This centralised laboratory would result from the grouping together of the single laboratories dealing with the research requirements of each industry (b), and would be controlled by a board largely represented by manufacturers. It would possess many advantages; thus costs would be lower by adopting this form of co-operation, but the greatest advantages would accrue from the corporate life of such an institution and the interchange of views between the heads of the various sections. It is suggested that university staffs might take up research work from time to time in this laboratory, and so keep in close touch with modern progress. It is believed that the establishment of such a central institution would induce firms to instal their own laboratories, in co-operation with the central laboratory, for dealing with manufacturing troubles and problems connected with their own products.

Industrial Notes.

INDUSTRIAL RESEARCH IN THE UNITED STATES.

The Advisory Council for Scientific and Industrial Research has published, under the above title, the first of a series of papers bearing on industrial research. The present paper, by A. P. M. Fleming, has been prepared as a result of a visit

The author concludes by urging the necessity for better education and training of men for all grades of industrial employment, and also for bringing before the public the value of industrial research, with its possibilities and benefits, and so developing public opinion on desirable lines

DEVELOPMENT OF INDIAN FOREST PRODUCTS.

Lecturing before the Royal Society of Arts on April 19th, Mr. R. S. Pearson, F.L.S., Forest Economist at the Forest Research Institute, Dehra Dun, India, said that in 1906 the Government of India, at the instance of Sir Saint-Hill Eardley-Wilmot, the then Inspector-General of Forests, embarked on a scheme to encourage more intensive management in the forests and to further the development of forest industries. The scheme contemplated the erection of a Forest Research Institute, consisting of five branches, namely, Silviculture, Botany, Forest Economy, Chemistry, and Zoology. Later, the services of pulp and tan experts were made available. This Institute has lately been completed, and supplies a long-felt want.

Manufacture of matches.

The first enquiry of any magnitude undertaken was in connection with the match industry. Mr. R. S. Troup, the then Forest Economist, sent specimens of many species of timber to Europe to be tested, and, after inspecting various areas, selected factory sites near the source of supply of suitable timbers. He also collected information as to the supply of chemicals, studied the state of the markets, etc. Before this investigation was carried out a few match-factories existed in India, though they were at that time only in an experimental stage. Since then several new and much larger factories have come into existence, and the industry may now be considered to be established in that country. The solution to manufacturing matches of the first quality in India lies in the use of the Himalayan silver fir and spruce. The difficulty in the way of such a proposition is extraction, as these species occur at high altitudes in the Himalayas, while many of the trees are of great size. To overcome this, it is probable that mechanical means of extraction, such as wire ropeways or light tramways, will have to be adopted, combined with the erection of portable splint-making machines in or in the vicinity of the forests, whence the splints will be exported to central places in the plains, and there made up into matches.

Manufacture of paper pulp.

The manufacture of paper in India is not a new industry, it having been started by the erection of a mill near Bombay in 1862. At the present time there exist at least four large paper mills, which not only manufacture paper, but also part of their pulp requirements. Their gross out-turn was about 25,000 tons per annum in pre-war times, the output having somewhat increased since 1914. The imports of paper into India in 1914-15 amounted to 51,390 tons, valued at £709,372.

The most universally known raw material used for the manufacture of paper pulp in India is a grass known as "sabai" or "bhabar" (*Ischemum angustifolium*). Other raw materials used are waste jute, ropes, old gunny bags, and a limited amount of old paper and rags. The remainder of the pulp utilised for the manufacture of paper by the Indian mills consists of imported mechanical and sulphite spruce pulp, the imports of which in 1912-13 amounted to 13,250 tons.

Researches on bamboos by R. W. Sindall and W. Raitt, and on certain elephant grasses by Raitt

and R. S. Hole, carried out at the Forest Research Institute, have definitely established the value of these products as raw materials for paper manufacture. In the case of the bamboo, the investigation has resulted in leases being taken up in India and Burma for the manufacture of paper pulp; the war has, however, prevented much progress being made in the erection of factories. The investigation of the elephant grasses established the fact that certain of them, especially *Saccharum spontaneum*, *S. Narenga*, and *Phragmites Karka*, occurred in abundance and could be extracted cheaply, whilst the pulp prepared from the stems, especially of the former species, was of fair quality.

There is no doubt that both bamboos and certain elephant grasses may in the future play a prominent part in the paper-pulp industry of the world, as they present no great difficulties in extraction, while from their mode of growth and quick reproduction they have an enormous advantage over wood, which takes many years to come to maturity.

Antiseptic treatment of timbers.

In 1909 a series of experiments was carried out to ascertain the most suitable methods of treating various timbers for use as railway sleepers. The antiseptics used were coal-tar creosote and petroleum products, salts, and combinations of salts and oils. Generally speaking, the oils have given better results than the salts, which is as might be expected, as the salts are apt to be leached out of the timber by excessive moisture. Again, the lower boiling-point oils have not answered so well as those containing heavier fractions, as, for instance, green oil.

Later a more extensive series of tests was started, five species of timber being treated with four different antiseptics. In all, nearly 8000 sleepers have been treated, the timbers used being *Pinus longifolia* and *exelsis*, *Dipterocarpus tuberculatus* and *alatus*, and *Terminalia tomentosa*. The results to date are satisfactory, though the sleepers have not yet had time to demonstrate the true value of the treatment; still it may be noted that while *Pinus longifolia* lasts two and a half years at most in an untreated state, it has only been found necessary to remove two or three "Powellised" sleepers after five years, and those for mechanical and not physical defects. The other species are more durable than the above pine and last for four to five years in an untreated state, while *Terminalia tomentosa* may last up to eight or ten years in exceptional cases. All the above sleepers were treated in open tank with long immersion periods. Sleepers were also sent to England for treatment, both by the "full-cell" and "Rüping" processes, and afterwards returned to India and laid.

As an outcome of this movement to treat sleeper woods in India, three open-tank treating plants have been erected by the United Provinces Government, in which *Pinus longifolia* sleepers are treated in creosote and petroleum oil mixed in equal quantities. The State railways are also considering the erection of a pressure plant on the North-Western Railway. Other schemes for treating *Dipterocarp* sleepers from the Andamans and Assam are also under consideration and may be expected to mature after the war.

All creosote has to be imported and costs about 1s. 4d. per gallon at a treating centre in India, so that every effort has to be made to reduce the cost of the antiseptic. A good grade of creosote has recently been produced in India, but at a relatively high price, which, however, can no doubt be reduced. As soon as a good grade of coal-tar creosote is obtainable in India at a reasonable figure, it is anticipated that the antiseptic treatment of timber will advance by leaps and bounds, while a new industry will come into existence by the manufacture of creosote.

Rosin and turpentine industry.

An industry which was started many years ago on a modest scale was that of the production of turpentine and rosin from "drip," obtained from *Pinus longifolia*. In the last six years great developments have taken place in that industry: the United Provinces Government has erected a steam distillation plant at Bhowali, near Naini Tal, which is capable of handling about 3000 tons of crude rosin annually, while the Punjab Government has purchased an up-to-date French plant, of about 1000 tons capacity, which has been erected near Lahore. Improved methods of tapping have also been evolved. The result has been a heavy drop in American imports, and the commencement of a modest export trade. The industry is capable of still further development in the *Pinus longifolia* areas, and can probably be extended to Assam and Burma in connection with the "drip" obtained from *Pinus Khasya*.

Tannin extracts.

It is thought that there is a good opening for the preparation of tannin extracts from mangrove barks. Mangrove forests are found extending over large areas on the Aracan, Bassein, Tavoi, and Mergui coasts of Burma. The Government have recently appointed a tan expert from England, who is bringing out an up-to-date plant with which to experiment.

Boswellia serrata oleo-resin.

One of the most common trees in the dry zone forests of India is *Boswellia serrata*. It yields a valuable oleo-resin, and a simple means has been found by which it is possible to split it up into its component parts. Quite recently samples of the resin have been submitted for valuation to the Imperial Institute, which classed it as equal to "G" grade colophony, while one Calcutta firm has pronounced it excellent for varnish work, and another suitable for the preparation of shellac. Samples of turpentine have been pronounced to be of very good quality and closely resembling American turpentine oil, except as regards the smell.

Other industries.

Amongst other industries which it is hoped may be developed in the near future in India, are the introduction of more up-to-date methods of extracting "cutch" and "kuth" from *Acacia catechu*; the introduction of steam distillation instead of the present direct fire process for the extraction of "rosha" or "palmarosa" oil from *Cymbopogon Martini*, a grass found in Central India, the Central Provinces, and the Deccan; the more extensive cultivation of lac and improved methods of preparation; and the extraction of "kosum" oil for soap-making and the preparation of glycerin from the seeds of *Schleichera trijuga*.

Interim reports were received and approved on the necessity for an anthropological survey of the British people, on the best methods for carrying on the International Catalogue of Scientific Literature, and on an enquiry into the desirability or otherwise of the adoption of the metric system throughout the British Isles.

The Sub-Committee on National Instruction in Technical Optics reported that a scheme approved by the Board of Education had now come into operation. Under the aegis of the Imperial College of Science and Technology, an Advisory and Administrative Committee had been formed to organise instruction, and Mr. F. J. Cheshire, a member of the Sub-Committee of the Board, has been appointed Director of Studies in Technical Optics. Although the President of the Board of Education did not see his way to adopt the suggestions of the Sub-Committee, the Board heard with satisfaction that a promising effort has been made to solve a question of considerable national importance.

A Sub-Committee, having considered special cases of magnetic disturbances revealed by a magnetic survey of the British Isles and their possible connection with the occurrence of iron ores, recommended a detailed investigation of two test areas, in order of ascertain how far, under the conditions of the British iron ores, the magnetic survey was likely to prove of economic value. Arrangements for carrying out the investigation are in progress.

An Agricultural Sub-Committee, with the Earl of Portsmouth as Chairman, reported that it is at present devoting itself mainly to engineering questions. It is engaged in collecting information with regard to the transport of raw materials to farms and agricultural products from them, to the power required for this purpose, and for seasonal operations on the land, with a view to comparing the relative advantages and costs of steam or internal combustion engines and electrically operated machines. It is dealing also with the possibility of co-operation in repairs and skilled labour, and is considering the various types of tractor most suitable to large and chiefly arable farms and to moderate sized mixed farms, having regard to the different local circumstances and requirements.

A Sub-Committee was nominated to report on what is at present being done to ascertain the amount and distribution of water power in the British Empire.

PRESERVATION OF GLASS RECEPTACLES.

In view of the great scarcity of glass bottles, jars, etc., the Board of Trade draws attention to the desirability of not destroying any glass receptacles when emptied of their contents, but of returning them to the trade through bottle dealers or otherwise for use again. Arrangements have been made by the Confectionery and Preserved Food Manufacturers' Federation for the purchase for cash by meat-preserving firms of glasses issued by them, provided that they are in a usable condition. It is suggested that second-hand bottle dealers, having collected a quantity of such glasses, whether from private houses or shops, to the weight of not less than one ton, should communicate with the Secretary to the Federation, 9, Queen Street Place, London, E.C.4., with a view to their purchase through the Federation's collecting agency. Glasses so collected will be thoroughly cleansed before being used again, but in view of the importance of avoiding any danger to public health users should, wherever possible, wash any glasses in their possession before returning them.

CONJOINT BOARD OF SCIENTIFIC SOCIETIES.

The fourth meeting of the Conjoint Board of Scientific Societies was held at the Royal Society on June 13th. Sir Joseph J. Thomson, O.M., Pres.R.S., in the chair, to receive the report of the Executive Committee on the work of the previous six months.

The Report indicates that a number of important questions of scientific and industrial importance have occupied the attention of the Board. Various bodies are at present interested in the formation of a census of the mineral resources of the Empire. It was agreed to enter into communication with these bodies and to make suggestions with a view to the publication of information in a form useful to the general community.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each, to the Comptroller of the Patent Office, Southampton Buildings Chancery Lane, London, W.C.

United States.—1s. each, to the Secretary of the Society.

French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56, Rue Ferou 8, Paris (3e); Patent from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

Embrittling action of sodium hydroxide on mild steel, and its possible relation to seam failures of boiler plates. Merica. See X.

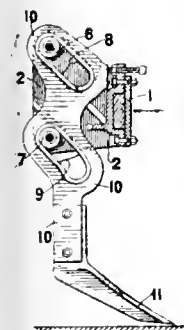
PATENTS.

Nitration and sulphonation: Apparatus for—. J. W. Leitch, Huddersfield, and F. R. Lank-shear, Manchester. Eng. Pat. 105,775, Mar. 22, 1916. (Appl. No. 4264 of 1916.)

To cool the liquids undergoing nitration or sulphonation more effectively, the cooling pipes or coils are provided with gills.—W. H. C.

Mixing machines. E. Rhodes, Leeds, and F. E. Bristowe, London. Eng. Pat. 105,870, Nov. 4, 1916. (Appl. No. 15,763 of 1916.)

THE mixing blades, 11, are supported from the radiating arm, 1, by the extension piece, 10, having slots, 8, 9, which fit over the pins, 6, 7, in the bracket, 2. If the blade, 11, comes into contact with an obstruction, the extension piece, 10, slides upwards and backwards on the pins, lifts the blade over the obstacle, and drops it back again into position.—W. H. C.



Liquid fuel furnaces. F. W. Cotterill, Ltd., and G. R. West, Darlaston, Staffs., and J. Spencer, Walsall. Eng. Pat. 106,077, May 22, 1916. (Appl. No. 4262 of 1917.)

IS a liquid fuel furnace, which is particularly suitable for heating iron and steel bars in the manufacture of nuts and bolts, or for making drop stampings or forgings, the horizontal burner nozzle opens into a preliminary combustion chamber in front of the main heating chamber. Oil fuel and a hot air blast are supplied to the burner nozzle. The top of the heating chamber is closed by a removable slab having a central opening through which the waste gases escape. A preheating device for the air blast is placed just above the central opening, and a blast of secondary air is supplied by an additional pipe connecting it to a nozzle opposite the burner nozzle, so as to ensure complete combustion and mixing of the gases in the heating chamber.—W. F. F.

Tunnel muffle furnaces for burning ceramic ware and heating metals, chemicals, and other materials. H. T. Padelt, Leipzig-Schleussig. Ger. Pat. 295,987, Nov. 24, 1914.

THE heating flues built in, or adjacent to, the walls of the furnace decrease in cross-section from the lowest flue upwards, and each flue can be separately heated. The air for combustion is reheated in a series of flues similarly constructed n, or adjacent to, the walls of the cooling zone of the furnace, and these flues open into a common main flue, whence the air is conducted to different parts of the combustion zone.—C. A. M.

Drying sand and the like: Apparatus for—. A. A. Bratton, McVextown, Pa., Assignor to Pennsylvania Glass Sand Co., Lewistown, Pa. U.S. Pat. 1,224,132, May 1, 1917. Date of appl., July 16, 1913.

A VERTICAL drying chamber is provided with a number of superposed horizontal pipe coils over which sand passes. The pipes of the coils are of progressively smaller diameter, and the coils are closer, from the top downwards, the lowest coil forming a screen for the dried sand. Steam is passed through each coil separately, and the pipes of vertically adjacent coils extend in opposite directions from inlet to outlet. Moist air is withdrawn from the drying chamber and the dried sand is collected in a compartment below the lowest pipe coil.—W. F. F.

Separation of impurities from liquids by centrifugal force. J. Hamill, Honolulu, Hawaii. U.S. Pat. 1,224,164, May 1, 1917. Date of appl., Mar. 13, 1911.

A VERTICAL cylindrical rotary bowl, having an inverted conical bottom with a central opening, is provided with an annular conical partition similar to the bottom of the bowl and midway between top and bottom. Liquid is fed into the bowl near the bottom and passes out at the top, the overflow rim at the top being slightly nearer the axis than the rim of the central partition. The contents of the bowl are discharged downwards when it is brought to rest.—W. F. F.

Grinding in tube-mills. O. Schultz, Brooklyn, N.Y., Assignor to F. L. Smidth and Co., New York. U.S. Pat. 1,225,061, May 8, 1917. Date of appl., Feb. 12, 1911.

THE inlet chamber of a rotary tube-mill is of small diameter relatively to the co-axial outlet chamber, from which it is separated by a transverse perforated partition. The speed of rotation is such that the flint pebbles in the inlet chamber have a cascading action and the metallic grinding bodies in the outlet chamber take a continuous whirling path owing to the greater peripheral speed.

—W. H. C.

Distillation process. H. L. Doherty, New York. U.S. Pat. 1,225,226, May 8, 1917. Date of appl., July 16, 1912.

A GASEOUS medium is circulated in a closed circuit in contact with the liquid to be distilled, which moves in the opposite direction. The gas is heated at an intermediate point in its zone of contact with the liquid, to a temperature above the desired point of distillation. The vapour is taken up by the gas, which is then brought into contact with the initially cool liquid, so that vapour is condensed and the liquid preheated. The cooled gas is brought in counter-current into contact with the heated residual liquid to reheat the medium and cool the liquid.—W. F. F.

Liquids containing solids: Process for changing the consistency of—. I. S. Merrell, Assignor to Merrell-Soule Co., Syracuse, N.Y. U.S. Pat. 1,225,348, May 8, 1917. Date of appl., Oct. 19, 1916.

THE substance to be concentrated is caused to pass through a heated, vertical, centrifugal chamber whereby the solid portion travels upward and the liquid portion is given off as vapour to the interior

of the chamber, from which it is withdrawn. Means are provided for wiping the inner surface of the chamber.—W. H. C.

Condensing gas under high pressure: Apparatus for —. G. L. and J. J. Cabot, Boston, Mass. U.S. Pat. 1,225,574, May 8, 1917. Date of appl., Oct. 26, 1914.

A CLOSED, heat-insulated chamber is provided with horizontal partitions forming a zigzag passage, and a pipe coil follows the course of the passage, the lower end being connected to a flat, horizontal, closed vessel in the bottom of the

plated to prevent attack by pyridine) was used. Glass rods were placed in the basket carrying the charge prior to filling; on removing them the charge was loosened. Common salt or potassium sulphate was mixed with the coal to prevent caking during extraction. Though unaffected by the pyridine, they could be extracted with water from the residue at the end. The extract was concentrated by distillation *in vacuo*, and added to an excess of dilute hydrochloric acid which produced a brown precipitate. This was washed with water and dried *in vacuo*. The residue insoluble in pyridine was treated with water and hydrochloric acid and dried.

Sample.	Ash.	Volatile matter.	Fixed carbon.	Pyridine extract.	Volatile matter in coal substance.*	Volatile matter in coal residue.*	Difference.
Béthune, Mine 11	1.95	34.40	63.65	19.90	35.09	31.48	-3.61
Frankenholtz, Seam X	2.40	39.85	57.75	19.3	40.83	35.80	-5.03
" " XI	1.85	43.07	55.08	18.6	43.88	39.04	-4.84
" " XII	2.51	40.36	57.10	17.6	41.41	38.08	-3.33
Lens, Mine 3	4.17	34.47	61.06	24.9	35.97	32.24	-3.73
" " 7	3.46	13.48	83.06	Trace.	13.96	14.32	+0.36
" " 8	2.20	21.27	76.53	0.44	21.76	22.75	+0.99
Belgian anthracite	3.43	8.70	87.87	nil.	—	—	—
Boghead	13.92	17.47	38.64	5.36	55.21	54.38	-0.83
Spanish lignite	6.19	43.66	59.24	21.55	46.49	40.68	-5.81

*Calculated on ash-free substance.

chamber. The gas to be condensed enters the top of the pipe coil, and escapes from the closed vessel at the bottom by an expansion valve operated manually from outside the closed chamber. The cooled gas then passes over the pipe coil in the zigzag passage to an outlet at the top. Condensed liquid collects in the vessel at the bottom.—W. F. F.

Separating unfilterable material from a mixture of filterable and unfilterable matter: Apparatus for —. C. W. Merrill, Berkeley, Cal. U.S. Pat. 1,226,402, May 15, 1917. Date of appl., June 7, 1910. Renewed Feb. 16, 1917.

SEE Eng. Pats. 2802, 3102, and 7601 of 1911, this J., 1912, 136.

Filter-presses; Process for treating semi-solid material in the containers of — and removing the same therefrom. C. W. Merrill, Berkeley, Cal. U.S. Pat. 1,226,404, May 15, 1917. Date of appl., June 7, 1910.

SEE Fr. Pat. 431,106 of 1911; this J., 1912, 16.

Chilling molten material and obtaining the solid in a subdivided state. J. W. Leitch, Huddersfield, U.S. Pat. 1,226,542, May 15, 1917. Date of appl., Jan. 10, 1916.

SEE Eng. Pat. 15,063 of 1915; this J., 1916, 294.

Purification of gases. Eng. Pat. 105,826. See VII.

Tunnel kiln. U.S. Pat. 1,225,318. See VIII.

II A.—FUEL; GAS; MINERAL OILS AND WAXES.

Coal; Solvents of —. A. Wahl, Bull. Soc. Chim., 1917, 24, 76—88.

THE author records extraction experiments with pyridine and quinoline on a series of coals, and results of examination of the residue and extract. The coal was powdered to pass a sieve of 900 meshes to the sq. cm., dried *in vacuo*, and extracted with boiling pyridine in a Soxhlet apparatus. Generally a large apparatus of copper (silver-

Generally speaking, the pyridine extract is large when the volatile matter is high, but there is no close parallelism. The volatile matter in the residue, compared with the original coal, is also reduced, excepting in those cases where the extraction is slight. The small increase in such cases is probably accidental and due to retention of pyridine. The residue has either reduced coking properties or else none at all, but extract and residue mixed will still coke. The pyridine extracts are brown powders, insoluble in water, acids, and alkali, but partially soluble in organic solvents giving fluorescent solutions. The extract is soluble in fuming nitric acid, and if the extract be first suspended in glacial acetic acid, oxidation is minimised. The product, on precipitation with water, resembles the original substance but is more combustible. The pyridine extract and also coals low in volatile matter, even anthracite, behave similarly. The coal from Lens (mine 8) was also extracted with quinoline. The extract at 120° C. was more than 4 times greater than with pyridine at about the same temperature. At the boiling point of quinoline (238° C.), 5.56% of the coal was extracted. At this temperature decomposition seemed to occur in addition to simple solution, for the residue had lost all coking properties and these could not be restored by mixing the extract with the residue. Ultimate analyses of the pyridine extract and the original coal were almost identical. The hydrogen and nitrogen contents of the extract were higher in the former case, due perhaps to retention of solvent. The methods of metallographic analysis were applied to some of the samples. A polished specimen of coal from Lens (mine 8) which gives a small pyridine extract, showed no change of structure after etching with pyridine. A sample from mine 3 showed dark areas which became more marked after etching. A sample of coal from Frankenholtz (seam X), which showed a perfectly polished surface before attack, disclosed granular bands after pyridine extraction.—H. J. H.

"Double gas" process. H. Strache. Z. Ver. Gas- u. Wasserfachm., 1916, 54, 301—309. Z. angew. Chem., 1917, 30, 106.

In the author's form of producer, the coal is first

carbonised and the coke produced is more or less completely gasified, yielding a mixed gas of calorific value about 3500 calories per cb. m. (395 B.Th.U. per cb. ft.). Even lignite can be treated, giving a gas of calorific value 3200–3400 cal. per cb. m. (360–280 B.Th.U. per cb. ft.). In character this double gas lies between water-gas and ordinary coal gas. It is cheaper than water-gas and requires about the same outlay on plant. Its calorific value exceeds that of water-gas although both have the same flame temperature. Its advantages as an auxiliary to town gas manufacture are similar to those of water-gas and are summarised as follows:—1. The plant is always ready for action. 2. Smallness of floor-space and capital outlay required. 3. Cheapening of running costs because of continuity of operation. 4. Possibility of controlling coke prices. 5. Mechanical operation. The "double gas" can be led directly into the crude gas main if the exhauster is powerful enough; but even alone it can be used satisfactorily in incandescence burners with proper regulation of air supply. It is also suitable for industrial purposes.—H. J. H.

Toluene extraction [from coal gas]. H. C. Applebee, Manchester and District Jun. Gas Assoc. Gas J., 1917, 138, 338–340.

THE "C" process, in which the gas is washed by coal tar or carburetted water-gas tar, has not been entirely satisfactory and in the majority of cases oil-scrubbing processes have been substituted. These processes vary in the form of washer or scrubber and in the nature of the wash oil used. Centrifugal washers are being used, it is claimed, with more success than any other form. At the Bradford Road works of the Manchester Corporation, tower scrubbers packed with wood laths are used with decided success. Results of tests showed that coal tar creosote was more suitable as a washing medium than petroleum (gas oil), the latter also presenting difficulties in the recovery of the extracted products. Wash oil should not contain any large amount of naphthalene, the sp. gr. should be over 1.00, and the specific heat should not be too high. Tests as to the effect of the treatment on the illuminating power of the gas suggest that there is a point of maximum reduction, this point in the experiments being reached at about 924 gallons of wash oil per 10,000 cub. ft. By calculation from analyses the reduction in heating value was estimated at about 6 to 8%. Tests with petrol showed that in replacing the benzol extracted a more volatile spirit gave better results but was not quite as successful as benzol is reputed to be. Many conditions affect the amount of products recovered from gas, viz., amount of wash-oil used, quality of wash-oil, temperature of oil and gas, circulation of oil, mechanical efficiency of the scrubbers (packing, number in use, etc.). At Bradford Road the amount of wash-oil used has varied from 70 to 105 galls. per ton of coal, the lower rate always being accompanied by a diminution in crude benzol recovered. It is advisable to change the oil when its sp. gr. rises to 1.06 to 1.065, or when the distillation shows less than 50% at 300° C. Temperatures at the scrubbers should be kept down to 25° C. and a suitable degree of saturation of wash-oil is 3%. The author's tests showed an efficiency of 75 to 78% when using three scrubbers and 74 galls. of wash-oil per ton, the figure rising to 88% on using six scrubbers and 108 galls. of wash-oil per ton. Carburetted water-gas has recently been scrubbed, giving a yield of 2.5 to 2.8 galls. per 11,000 cub. ft. The Simon-Carrès recovery plant consists of a still proper, heat interchanger, dephlegmator, superheater, and two tubular condensers. Rich oil passing through the first condenser helps to cool the benzol vapours and

is itself heated to 50° C.; in the dephlegmator its temperature reaches 65° C., in the heat exchanger 80° C., and in the superheater 120° C. In the still proper it is brought into contact with open steam, and passes thence through the heat interchanger to the oil coolers. The benzol vapours pass through the dephlegmator and the first condenser, and condensation is completed in the last water-cooled condenser. The crude benzol is worked up in a Dempster still of 5000 galls., giving 60% of once-run benzol and 15% of once-run toluol, the residues being run off and cooled to separate naphthalene. The once-run benzol and toluol are washed separately with sulphuric acid (sp. gr. 1.84), in a washer of a capacity of 2500 galls. Acid is added in two portions of 5 and 46 galls. respectively. After agitation, settling, and washing with water the benzol is washed with caustic soda (20 Tw., sp. gr. 1.1) and finally with water. The loss in washing is estimated at 7%. The washed product is re-fractionated in a still of the Dempster type, intermediate products being put back for re-working, and residues being run to the naphthalene trays.—J. E. C.

Aromatic hydrocarbons from the thermal decomposition of natural gas condensate. J. E. Zanetti and G. Egloff. J. Ind. Eng. Chem., 1917, 9, 471–478.

THE fraction of a natural gas condensate (from West Virginia), composed mainly of butanes, propane, and ethane, was subjected to thermal decomposition at about 900° C. in an electrically heated tube furnace, and the product passed through a Cottrell (electrical) separator to effect complete precipitation of the tar "fog" formed. The 1.5 kilos. of tar thus obtained (sp. gr. 1.109) was separated into fractions boiling up to 170°, 170°–230°, 230°–270°, 270°–330°, 330° to above 360° C., and residue (the proportions found being 9.7, 18.7, 11.1, 15.1, not stated, and 39.1% by weight, respectively) and from these benzene, toluene, naphthalene, acenaphthene, anthracene, phenanthrene, pyrene, and chrysene were isolated.—W. E. F. P.

Sulphur in petroleum: Detection and determination of —. C. K. Francis and C. W. Crawford. J. Ind. Eng. Chem., 1917, 9, 479–481.

FROM an investigation of oils from the Mid-Continent (U.S.A.) Field, especially of those from the Bartlesville sand in the Cushing pool, it is concluded that the "methylene blue" test provides an extremely delicate reaction for the detection of any form of sulphur in petroleum and may also be used for determining the presence of hydrogen sulphide. The oil is heated with excess of sodium, the residue extracted with water, and the solution neutralised with hydrochloric acid, of which a 10% excess (by volume) is then added. A small crystal of *p*-aminodimethylaniline sulphate is then dissolved in the liquid and several drops of dilute ferric chloride solution added, when the presence of sulphur is indicated by the development of a blue coloration which becomes more intense on standing or changes to violet if cyanides are also present. For the determination of sulphur in petroleum, satisfactory results for crude oil were obtained by heating with sodium peroxide in a Parr bomb, and also by a modified Dammer combustion method in which the oil was burnt in a stream of oxygen, the products passed through a strong solution of hydrogen peroxide, and the acidity of the latter determined by titration with standard alkali after decomposition of the excess of peroxide by boiling. No hydrogen sulphide or carbon bisulphide was found in the Bartlesville oil, most of the sulphur being probably in the form of alkyl sulphides.—W. E. F. P.

Ignition point of oxy-hydrogen gas. Mitscherlich.
See VII.

PATENTS.

Washing coal, coke breeze, and other minerals; Apparatus for —. W. Taylor, Ossett, Yorks. Eng. Pat. 105,835, July 10, 1916. (Appl. No. 9668 of 1916.)

COAL, coke, breeze, or other mineral is impelled by a stream of water along an inclined trough fitted with baffles or detachable partitions. The inclination of the trough may be varied by adjusting a vertically movable sling, and means are provided for imparting a rotary or semi-rotary movement to the trough, whereby the heavier impurities retained by the baffles may be discharged.—J. E. C.

Coal; Non-abrusion process and apparatus for washing and sorting —. H. Adams, Assignor to the Adams Mining Machinery Corporation, New London, Conn. U.S. Pat. 1,221,350, May 1, 1917. Date of appl. May 11, 1916.

COAL, or other mineral, or ore or the like is allowed to drop freely through the apparatus. Individual jets of water under pressure are directed from one side against the falling material. The various elements are deflected according to their respective gravities and fall into separate troughs at the bottom of the apparatus.—J. E. C.

Coke breeze and similar materials; Apparatus for washing —. W. H. Orbell, Wakefield, Eng. Pat. 105,817, May 25, 1916. (Appl. No. 7410 of 1916.)

COKE breeze or other similar material is agitated in a funnel-shaped tank by a steel screw spinner. The discharge valves for scale are operated alternately by a crank with opposite throws, and sufficient water is retained in the tank to make the process continuous.—J. E. C.

Coal; Process and apparatus for treating [briquetting] —. C. H. Smith, Short Hills, N.J. U.S. Pat. 1,221,121, May 1, 1917. Date of appl. May 5, 1916.

COAL is heated to expel a substantial portion of the volatile matter and to convert it into a plastic mass which is kept agitated. Whilst in this state the coal is removed from the heating zone, freed from "entrained" gases, and compressed into a briquette.—J. E. C.

Coal; Method of treating [briquetting] —. C. E. Hite, Burlington, N.J., Assignor to Universal Briquetting Co. U.S. Pat. 1,224,641, May 1, 1917. Date of appl. June 21, 1909. Renewed Oct. 6, 1916.

PULVERISED coal is dried, mixed with crude petroleum oil, and subjected to a temperature of approximately 400° F. (about 200° C.). Water is then added to stiffen the oily portion of the mixture, which is moulded into blocks or briquettes and subjected to a temperature of 500 to 600° F. (about 260 to 320° C.).—J. E. C.

Furnace with vertical retorts and producers beneath the retorts. Bunzlauer Werke Lengersdorf und Co., Bunzlau, Ger. Pat. 297,252, Jan. 20, 1916. Addition to Ger. Pat. 293,061 (this J., 1916, 958).

ABOVE the burners and below the regenerator chambers is built a horizontal flue which receives and leads away the products of combustion from all the groups of burners. The accessibility of the different parts of the setting is improved and control is easier than when a separate flue is provided for each group of burners.—H. J. H.

Gas producers. W. H. Bricknell, Te Kuiti, and A. Burt, Auckland, N.Z. Eng. Pat. 100,730, Apr. 13, 1916. (Appl. No. 5150 of 1916.) Under Int. Conv., June 22, 1915.

THE efficiency of producer gas manufacture can be increased by utilising the heat radiated from the walls. The producer is enclosed in an iron shell and the air, or air-steam supply, enters the annular space thus formed, and in rising upwards becomes preheated by radiation from the producer wall. At the top it enters pipes built into the wall and is conveyed downwards into a blast chamber, the inner wall of which is perforated, so that the warmed blast can be uniformly distributed into the charge. These perforations slope downwards to avoid the entry of coal, etc., into the blast chamber.—H. J. H.

Gas generators. W. P. Tinsley and J. G. Nash, Fort Worth, Tex., U.S.A. Eng. Pat. 105,788, Apr. 25, 1916. (Appl. No. 5902 of 1916.)

A GAS generator tank, not affected by acids used in manufacturing gas, and capable of resisting internal pressure, is constructed of reinforced concrete and comprises a base fitted with an outlet pipe, walls, and a cap. The tank is filled with gas-making material and means are provided for feeding hydrocarbon oils and acids.—J. E. C.

Hydrogen retorts; Treatment and utilisation of gases supplied to the furnaces of —. J. M. Ballingall, and R. and J. Dempster, Ltd., Manchester, Eng. Pat. 106,067, Jan. 6, 1917. (Appl. No. 290 of 1917.)

SPENT water-gas from a hydrogen-retort plant is preheated in a regenerator and passed through the reaction zone of a gas producer. The dissociated gas is burnt together with producer gas in the region of the retorts with a deficiency of air so as to form a reducing atmosphere at that point. On leaving this region any unburnt gases are consumed by a further addition of air and give up a portion of their heat to the incoming spent water-gas in a continuous counter-current regenerator.—J. E. C.

Producer gas; Manufacture of — [from powdered coal]. J. E. Bell, New York, U.S. Pat. 1,223,242, Apr. 17, 1917. Date of appl. July 17, 1915.

THE producer consists of two narrow chambers built side by side, communicating at the bottom with each other and with separate regenerators at the top. Powdered coal is allowed to fall down one chamber in a current of hot air from the appropriate regenerator. Partial combustion occurs and the producer gas formed passes up the second chamber, clinker being deposited at the bottom, and from the top into the second regenerator which becomes heated while the gas is at the same time cooled. At regular intervals the current is reversed and the second chamber becomes the gasifier, and its regenerator heated by the producer gas now warms the air supply.—H. J. H.

Gas producer. E. Nimphius, Evanston, Ill., Assignor to J. H. Whitaker, Chicago, Ill. U.S. Pat. 1,225,018, May 8, 1917. Date of appl. Apr. 23, 1915.

A GAS producer comprises a stationary combustion chamber, a rotary conical grate, and a stationary ash platform beneath the grate. Air is introduced through passages in the grate at an inclination opposite to the direction of rotation, and a revolving scraper blade co-operates with the ash platform.—J. E. C.

Carbonic oxide; Method of producing —. G. H. Benjamin, New York, U.S. Pat. 1,225,390, May 8, 1917. Date of appl. June 7, 1911.

COAL is decomposed in a producer by the high temperature effects of mixed furnace gases and air,

and an electric current is transmitted through a portion of the coal in the producer, whereby the liberated carbon dioxide and that present in the furnace gases is decomposed, and combines with carbon to form carbon monoxide.—J. E. C.

Distillation gases from coal: Purification of—
E. Ciselet and C. Deguide, Brussels, Ger. Pat. 297,101, July 6, 1915.

THE gas is washed with an ammonia liquor containing lime in suspension. The ammonia combines with the acidic constituents of the gas, which are then fixed by the lime, as calcium salts, the ammonia being regenerated. The ammonia is therefore not consumed, but acts merely as a carrier. After filtering, and boiling to expel ammonia, the liquor may be treated with an iron salt to fix cyanides and with carbon dioxide to expel hydrogen sulphide.—H. J. H.

Gaseous fuel for internal combustion engines: Production of—
A. W. Southey, London, Eng. Pat. 105,606, Apr. 18, 1916. (Appl. No. 5668 of 1916.)

INTERNAL combustion engines may be fed with liquid fuel, *e.g.*, paraffin, vaporised by a flame burning freely in air at a wick dipping into the reservoir of oil. The flame, drawn by suction from the engine, impinges on a vertical tube communicating with the oil reservoir and kept full by the suction of the engine. The oil in this tube is vaporised. The vapours, mixed with flame gases and air, are drawn into a wide tube standing over the oil-feed tube and thence to the engine. The supply of fuel and air is regulated automatically by the suction of the engine, and as the oil is merely vaporised, without cracking or combustion, the calorific power of the original oil is fully utilised. In an alternative device the flame impinges on the surface of the oil maintained at constant level and excluded from contact with air. The oil is vaporised and carried to the engine as before.—H. J. H.

Crude oil: Treatment of—
Apparatus for treatment of natural oils and residues of same. W. S. Barnickel, St. Louis, Mo., U.S. Pats. (A) 1,223,659 and (B) 1,223,660, Apr. 24, 1917. Dates of appl., Nov. 19, 1914, and Mar. 6, 1916.

(A) CRUDE mineral oil in the form of an emulsion of petroleum, brine, and other organic matter is clarified by intimately admixing a small quantity of a soluble water-softening agent capable of precipitating the alkaline earths present in the emulsion. The precipitate carries down insoluble salts of calcium, etc., and organic matter, and the brine and petroleum then separate into two layers. As precipitants, soluble carbonates, sulphates, hydroxides, fats or other soap-making materials are proposed. (B) An apparatus suitable for the process consists of a vat furnished with a vertical central pipe having numerous fine jets. The precipitant is forced through these jets into the contents of the vat. The aqueous liquor and precipitate settle out at the bottom of the vat and may be drawn off and returned by means of a pump to the jets.—H. J. H.

Mineral oils: Process of transforming—
[into terpenes and aromatic hydrocarbons]. A. S. Ramage, Assignor to Bostaph Engineering Co., Detroit, Mich., U.S. Pat. 1,224,787, May 1, 1917. Date of appl., Apr. 27, 1916.

PARAFFINS and olefines are transformed into terpenes and aromatic hydrocarbons by subjecting them in the state of vapour to restricted oxidation by iron oxide at a temperature of 580° to 750° C.—J. E. C.

Combustible fluids: Process of securing—
from carbonaceous solids. J. H. Reid, Newark, N.J., Assignor to Patents Process Co., U.S. Pat. 1,224,788, May 1, 1917. Date of appl., Aug. 26, 1915.

COMBUSTIBLE fluids are obtained from carbonaceous solids, *e.g.*, shale, by mixing them with charcoal and passing electricity through the mixture until the desired product is evolved.—J. E. C.

Liquid fuel composition and process of making same. A. W. Swanberg, Minneapolis, Minn., Assignor to F. C. Fisk, Williamsville, N.Y., U.S. Pat. 1,225,405, May 8, 1917. Date of appl., June 23, 1916.

LIQUID fuel for internal combustion engines and the like is prepared by dissolving anthracene in carbon bisulphide in the presence of moisture and mixing the solution with kerosene. The proportions of anthracene and carbon bisulphide in the resulting mixture are specified as about 2 oz. and 6 oz. per gallon respectively.—J. E. C.

Petroleum products: Process and apparatus for transforming heavy—
into lighter products. F. B. Deakin, London, From P. Roth and M. E. Venturino, Buenos Aires, Argentine, Eng. Pat. 106,042, Sept. 20, 1916. (Appl. No. 13,363 of 1916.)

SEE U.S. Pats. 1,208,214 and 1,208,378 of 1916; this J., 1917, 126.

Mineral oils and residues: Treatment of—
for the production of lower-boiling hydrocarbons. C. White, London, U.S. Pat. 1,226,041, May 15, 1917. Date of appl., May 13, 1914.

SEE Eng. Pat. 5434 of 1914; this J., 1915, 651.

Liquid fuel furnaces. Eng. Pat. 106,077. See I.

Manufacture of sulphuric acid. [Removal of hydrogen sulphide from coal gas.] Ger. Pat. 295,709. See VII.

Process of chlorinating [hydrocarbons] and products thereof. U.S. Pat. 1,224,485. See XX.

[Paraffin] *war tapers for matches or other purposes.* Eng. Pat. 106,071. See XXII.

II B.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

Chemical composition of the higher fractions of maplewood creosote. Pieper and others. See III.

PATENTS.

Electric glow lamps: Carbon filament—
C. O. Bastian, London, Eng. Pat. 105,929, Jan. 26, 1916. (Appl. No. 1271 of 1916.)

A CARBON filament electric glow lamp comprises an air-tight globe, containing an atmosphere of inert gas and a carbon filament in the form of a spiral of very small diameter, manufactured by winding a thread of cellulose in a single continuous layer on a mandril of small diameter, removing the mandril, and carbonising the spiral.—J. E. C.

Electric glow lamps. C. O. Bastian, London, Eng. Pat. 106,036, Jan. 26, 1916. (Appl. No. 11,968 of 1916.)

IN the manufacture of incandescence electric lamps, etc., the globe is filled with an inert gas and the lamp freed from oxygen by the prolonged and combined effect of chemical action and externally applied heat. A de-oxidising liquid, such as fused sodium nitrite at about 280° C., may be used to combine with the oxygen.—J. E. C.

III.—TAR AND TAR PRODUCTS.

Frag carbon in coal tar : Determination of —, P. Falcicola. *Annali Chim. Appl.*, 1917, 7, 152—157.

The following modification of Ceruti's method (this J., 1911, 111) is proposed:—About 5 grms. of the coal tar is added little by little to 125—150 c.c. of olive oil, which has previously been heated to 110—160° C., and the mixture is brought to about 180—190° C., and then cooled to about 150° C. and filtered through a counterpoised filter. The residue of carbon in the basin is again heated with 50 to 75 c.c. of the oil at 180—190° C., and the oil extract cooled to 150° C. and passed through the same filter. The residue is then transferred to the filter by means of carbon tetrachloride or other, washed until free from oil with the same solvent, dried, and weighed. The amounts of carbon thus determined in various types of coal-tar agreed very closely with those determined by Lange's method. Naphthalene is soluble in its own weight of olive oil at 65° C., whilst the solubility of anthracene is 5% at 100° C., and 26% at 180° C. Castor, linseed, sesame, and vaseline oils have a very similar solvent action upon naphthalene and anthracene.—C. E. M.

Maplewood creosote : Chemical composition of the higher fractions of —, E. J. Pieper, S. F. Acree, and C. J. Humphrey. *J. Ind. Eng. Chem.*, 1917, 9, 162—165.

A COMMERCIAL sample of maplewood creosote yielded 75% of wood creosote and 25% of pitch. About 14% of the creosote distilled at 93° to 195° C., 31% at 195° to 230° C., and 55% at 230° to 280° C. On extracting the different fractions distilling above 195° C. with alkali they yielded from 70 to 85% of phenols, some of which were separated as sodium salts. The phenols consisted chiefly of pyrogallol-dimethyl-ether, and a small quantity of propyl-pyrogallol-dimethyl-ether, and were therefore identical with those found in beechwood creosote, although present in different proportions.—C. A. M.

Aniline from ammonia and benzene at high temperatures and in presence of contact substances : Formation of —, J. P. Wibaut. *Ber.*, 1917, 50, 511—516.

MEYER and TANZEN (this J., 1913, 1060) have stated that aniline is formed by the action of ammonia on benzene at 550° C. The author, however, finds that ammonia is without action on benzene in a porcelain tube until a temperature of 700° C. is attained, when a trace of aniline is produced. In presence of freshly reduced iron, copper, or nickel, somewhat larger amounts of aniline were formed.—F. W. A.

Diphenyl derivatives : Some new —, W. Borsche and B. G. B. Scholten. *Ber.*, 1917, 50, 596—611.

As a starting point for researches on *o*-hydroxydiphenyl derivatives, phenylbenzoquinone-3-oxime was employed, obtained by the action of diazobenzene chloride on an alkaline solution of quinone-oxime. With nitric acid it gave a dinitrohydroxydiphenyl, which is shown to be a 3,5-dinitro derivative with both nitro groups in the same nucleus. This was proved by Ullmann and Nadai's reaction, by warming with *p*-toluene sulphochloride and dimethylaniline; there were obtained about equal proportions of an ester of *p*-toluenesulphonic acid and 3,5-dinitro-2-chlorodiphenyl. These observations have been utilised in experiments with the commercially obtainable *o,o*-dihydroxydiphenyl, which when treated in glacial acetic acid solution with nitrous acid readily gives diquinone-3,3'-dioxime, from which may be obtained the diamino-dihydroxy derivative and

thence diquinone. Nevertheless the two latter may be more conveniently prepared by the reduction of 5,5'-dibenzeneazo-2,2'-dihydroxydiphenyl by hydrosulphite and dilute alkali. 3,5,3',5'-Tetranitro-2,2'-dihydroxydiphenyl was also treated with *p*-toluenesulphochloride and dimethylaniline but did not yield the expected toluenesulphonic ester and tetranitro-2,2'-dichlorodiphenyl derivative; instead there was exclusively obtained 3,5,3',5'-tetranitrodiphenylene oxide. When 2,2'-dimethoxydiphenyl is nitrated in presence of much sulphuric acid it yields 3,5,3',5'-tetranitro-2,2'-dimethoxydiphenyl, and this when heated with alcoholic ammonia at 150° C. passes easily into 1,3,6,8-tetranitrocarbazole. Failure to obtain the tetranitro-*o,o*-dichlorodiphenyl led the authors to make parallel researches with the *m,m'* and *p,p'* isomerides. In the case of the *p,p'* derivative the application of Ullmann's reaction to tetranitro-4,4'-dihydroxydiphenyl, obtained from benzidine, gave only a di-*p*-toluenesulphonic ester, while the nitration of *p,p'*-dichlorodiphenyl yielded only a dinitro compound with the nitro groups in the *meta* position to the chlorine. On the other hand, *m,m'*-dichlorodiphenyl easily gave 2,4,2',4'-tetranitro-5,5'-dichlorodiphenyl because both the chlorine and the phenyl influence the entry of the nitro groups in the same sense.—J. F. B.

Toluene extraction [from coal gas]. Applebee. See II A.

Aromatic hydrocarbons from thermal decomposition of natural gas condensate. Zanetti and Egloff. See II A.

PATENTS.

Toluol : Manufacture of —, W. H. Gartley, Assignor to The United Gas Improvement Co., Philadelphia, Pa. U.S. Pat. 1,225,237, May 8, 1917. Date of appl. Mar. 30, 1916.

COAL tar naphtha is distilled under a pressure of about 35 lb. per sq. in. and is thereby converted into a lighter portion from which toluol may be recovered, and a heavier portion which is redistilled under atmospheric pressure, the recovered naphtha being again submitted to the pressure distillation process.—W. H. C.

Nitro aromatic compound and process of making same. J. R. Mardick. New York. U.S. Pat. 1,225,317, May 8, 1917. Date of appl. June 6, 1916.

IMPURE tar is nitrated by relatively weak acid at a temperature between 10° and 60° C. The strength of the acid is then increased and the temperature allowed to rise to between 70° C. and 90° C. The mass is allowed to stand until separation takes place, the lower watery liquid is drawn off, and the upper practically solid layer treated with strong nitric and fuming sulphuric acids between 95 and 105° C.—W. H. C.

Ketones of the thiophene series : Preparation of —, W. Steinkopf. Berlin-Halensee. Ger. Pat. 297,203, Nov. 7, 1911.

KETONES can be prepared by treating thiophene with acid chlorides (aliphatic and aromatic) in the presence of phosphorus pentoxide. Combination takes place, with the elimination of hydrochloric acid, on simply heating the substances together under a reflux condenser, and satisfactory yields are obtained.—H. J. H.

Benzoyl derivatives of 3-hydroxy- or α,β -di- and poly-hydroxyanthraquinones : Preparation of —, R. Wedekind und Co., Uerdingen. Ger. Pat. 297,261, Mar. 9, 1915.

THE process applies particularly to 2-hydroxyanthraquinone, 2,6- and 1,2-dihydroxyanthraquinone, and 1,2,6- and 1,2,7-trihydroxyanthraquinone,

which are treated with benzoic acid with or without the addition of sulphuric acid. The weight of benzoic acid taken is ten to fifteen times that of the hydroxyanthraquinone, and although the sulphuric acid accelerates the reaction it is not essential. The reaction is completed by heating the mixture at atmospheric pressure. The process obviates the employment of benzoyl chloride.—H. J. H.

Apparatus for nitration and sulphonation. Eng. Pat. 105,775. See I.

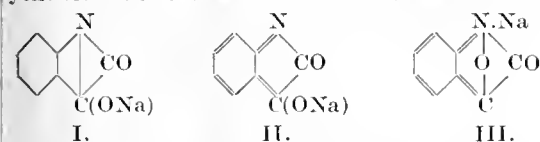
Process of transforming mineral oils [into aromatic hydrocarbons]. U.S. Pat. 1,224,787. See IIa.

Process of nitrating toluols containing paraffins. U.S. Pat. 1,225,324. See XXII.

IV.—COLOURING MATTERS AND DYES.

Isatin salts: Constitution of the blue——. M. Claass. Ber., 1917, 50, 511—515.

THE view of Heller (Ber., 1916, 49, 2757) that the blue or bluish-violet alkali salts of isatin and its derivatives are not O-salts but N-salts is considered incorrect, as N-salts are decomposed by water, whereas the blue isatin salts are produced in aqueous solution in which they are relatively stable. On the same grounds Heller has stated that the formulae recently advanced for the sodium salt of sulphurylindoxyl- α -indole-indigo and for indigo (Claass, this J., 1916, 1150) are incorrect, the tinctorial power of the latter being considered to be entirely due to the stilbene linkage, C=C; the formulae proposed by Heller for the sodium salt of isatin as a N-salt does not include a chromophore or a double linkage. Heller suggests that all N- and C-salts are blue, and that all O-salts are red; it is considered that the chemical behaviour of these compounds is more decisive than their colours. Heller (*loc. cit.*) has found the third isomer of isatin, isatol, to be a weak phenol which yields a relatively stable sodium salt (I). In aqueous solution the blue N-sodium salt of isatin is converted into the yellowish-red O-salt. The blue salts of isatin



soluble in water without alteration in colour are considered to be derived from the β -form with the quinonoid nucleus (II). The deep blue-black colour of the N-sodium salt of isatin is probably due to a betaine-like grouping of the carbonyl oxygen with quinquivalent nitrogen (III).—F. W. A.

Azine dyestuffs: Notes on——. F. Kehrmar. Ber., 1917, 50, 554—563.

DETAILS are given of the preparation of phenyl-apsafranine and its reactions with aniline. The product obtained by the action of aniline on the 2-amino-derivative of Flavinduline (phenyl-phenanthrenazonium) has been synthesised from phenanthraquinone and 4,6-dianilino-1,3-phenylenediamine, and the dyestuff from benzil and 4,6-dianilino-1,3-phenylenediamine has been prepared. The introduction of aryl groups into indamines of the type of Toluyene Blue only increases their fastness to washing and not to acids or to light.—F. W. A.

Bixin. A. Heiduschka and A. Panzer. Ber., 1917, 50, 546—551.

THE varying formulae for bixin suggested by Van Hasselt (this J., 1914, 677) and Herzig (this J., 1915, 866) and others are attributed to the use of different extracting and recrystallising agents. Bixin from glacial acetic acid and ethyl acetate has a methoxyl content of 8.03%, corresponding to the formula, $C_{25}H_{30}O_4$, given by Pregl (see Herzig, *loc. cit.*) from the results of micro-analysis.—F. W. A.

PATENTS.

Anthracene vat dyestuffs: Manufacture of——. R. Wedekind and Co., Uerdingen. Ger. Pat. 297,080, Sept. 16, 1913. Addition to Ger. Pat. 296,207 (see Eng. Pat. 19,435 of 1913; this J., 1914, 415).

ANTHRAQUINONE itself or a reduction product, e.g., anthranol, in place of its sulphonic acids or their salts, as claimed in the main patent, is heated with thiosulphates. The products are insoluble in water, alkali, and sodium sulphide, and dye cotton from an alkaline vat olive to olive-brown shades similar to, but faster to chlorine than, the products of the main patent.—F. W. A.

Azo dyestuffs: Manufacture of insoluble——. Badische Anilin und Soda Fabrik. Ger. Pat. 297,185, Nov. 20, 1914. Addition to Ger. Pat. 295,025 (this J., 1917, 78).

ARYLIDES of acetoacetic acid are used in place of ethyl acetoacetate claimed in the main patent. Coupling may be effected in alkaline solution, and in presence of Turkey-red oil or similar substance, or substrata generally used in pigment manufacture may be added.—F. W. A.

Monoazo dyestuffs: Manufacture of—— suitable for the production of pigments. Badische Anilin und Soda Fabrik. Ger. Pat. 297,414, Sept. 4, 1914. Addition to Ger. Pat. 296,991 (this J., 1917, 592).

IN place of 1-benzoylamino-7-hydroxynaphthalene or its derivatives substituted in the benzoyl nucleus claimed in the main patent, their N-alkyl derivatives are used. The latter are obtained by the action of benzoyl chloride or its substituted derivatives, in presence or absence of reagents to neutralise the acid produced, on the 1-alkylamino-7-hydroxynaphthalenes, obtained by alkaline fusion of the corresponding sulphonic acids.—F. W. A.

Process of obtaining sodium sulphate and sulphur from sodium thiosulphate [e.g., residues from the manufacture of sulphur dyes]. Ger. Pat. 295,859. See VII.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Sulphite-cellulose: Recovery of the free sulphur dioxide from the blow-off gases and liquors in the digestion of——. A. D. J. Kuhn. Wochenbl. Papierfabr., 1916, 2139, 2179, 2233, and 2270. Chem.-Zeit., 1917, 41, Rep., 118.

IN modern sulphite pulp mills, working with fine pyrites in mechanical roasters, the latter only give satisfactory results when operated near the limit of their capacity, and there is little margin for variations in output. The liquor reservoirs must be large enough to cover two days' consumption, in order that the operations may not be suspended in the event of troubles in the liquor preparing department. Arrangements must also be provided for the complete utilisation of the sulphur dioxide from the gases and liquor blown off during the digestion for enriching the fresh liquor. The

liquor blown off along with the gas will contain organic matters as soon as the attack on the wood has commenced, and the gas must be separated from this liquor before it is admitted to the absorption plant. Three different types of arrangement for dealing with the blow-off gases are described:—(1) Those in which the blow-off gases and liquor are taken off together, cooled, and conducted to the absorption plant which is full of liquor. (2) Those in which the blow-off liquors are discharged from the digesters separately from the gases. (3) Those in which the separation of the gas and liquor is effected in a special vessel outside the digester. One of the last-mentioned type has a special gas separator by which the gas is conducted to an absorption tower packed with Raschig rings or blocks of wood; the clear liquor which is separated at first, is cooled and passed to a tower filled with limestone for conversion into fresh liquor, and the impure liquor which comes over later is run to the waste-liquor tank. The hot water which results from the cooling of the blow-off gases is pumped to an upper tank and utilised for washing the pulp in the digester. To illustrate the effect of the introduction of such a plant on the composition of the fresh digestion liquor, a case is quoted in which the sulphur dioxide content of the fresh liquor was raised from 3.43 to 5.58%, while the lime was reduced from 1.07 to 0.99%.—J. F. B.

Oil of turpentine recovered in the digestion of sulphate wood pulp. Halse and Dedichen. *See* XIII.

PATENTS.

Yarn and other materials: Conditioning apparatus for —. T. Andrew, Manchester. Eng. Pat. 165,789, Apr. 25, 1916. (Appl. No. 5927 of 1916.)

THE conditioning chamber has suction and delivery parts connected with the suction and delivery of a fan or its equivalent, one part, at the fan-delivery side, receiving air in the form of several currents delivered in parallel, whilst the other part, connected with the fan suction pipe, receives the air after its passage through the material, this air being withdrawn from the chamber, also in the form of several currents; means are provided for supplying independently regulated amounts of moisture to the various parallel currents of air and for introducing a separate supply of air at the entrance end of the chamber. The material to be treated is passed through the chamber on trucks or trolleys and the parallel currents of air are passed through it both upwards and downwards; elevators are provided at the entrance and exit ends for the material. The trucks or trolleys for carrying the yarn form divisions between the upper and lower portions of the chamber to ensure that the air passes through the receptacles, and after their discharge they are returned to the inlet by a runway beneath the chamber.—J. F. B.

Fibrous and other bodies: Apparatus for conditioning and dehydrating —. G. H. Benjamin, New York. U.S. Pat. 1,225,211, May 8, 1917. Date of appl., Aug. 1, 1911.

THE apparatus comprises an air filter, an air-feed main, a waste-air main, a series of drying cells interposed between the air feed and the waste air mains, with air passages connecting them with both mains, means in the air passages from the feed main for changing the direction of movement of the air currents through the cells, and supplemental air-heating devices, in proximity to each of the cells, controlling the temperature of the air currents passing through the cells. A weighing apparatus is provided for each cell and means

structurally independent of the weighing apparatus, but operated by it, for indicating the change in weight of the material contained in the cell.

—J. F. B.

Cotton and cotton goods and other combustible substances: Treatment of — to render them permanently less inflammable. W. H. Perkin, Oxford, and S. Bradbury, Ashton-upon-Mersey. U.S. Pats. 1,221,204 and 1,221,205, May 1, 1917. Date of appl., July 31, 1911.

SEE Eng. Pats. 17,811-5, 20,971-2, and 21,088 of 1913; this J., 1911, 1015.

Sizing solution and method of making the same. U.S. Pat. 1,221,125. *See* VI.

Apparatus for making bisulphide liquor. U.S. Pat. 1,221,578. *See* VII.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Capillary phenomena and their importance in technical processes [dyeing, etc., and ore concentration]. S. A. Shorter. *J. Soc. Dyers and Col.*, 1917, 33, 107—111.

THE tendency to include under the term "capillarity" the whole of the phenomena presented by colloids is incorrect; the physical surface possesses a thickness of 10—50 $\mu\mu$, and the particles of a solution of albumin, for example, are much smaller than this and hence do not possess a physical surface to which can be applied the method of treating molecular forces in bulk, which forms the basis of the theory of capillarity.

Technical applications of surface tension phenomena are: (1) in calico-printing the treatment of fabric with a water-soluble oil to reduce the dye solution-fibre tension to practically zero and assist the wetting of the fabric; (2) the removal of grease after addition of soap to the water to bring about wetting by lowering the water-air and water-grease tensions; (3) the Elmore process for separating metallic sulphides from silicious matter, and other preferential wetting processes, such as the selective removal of diamonds from aqueous suspension by means of grease, the "flotation process" of separating minerals by bubbles of gas in presence of oil, etc. An explanation is advanced of the efficacy of foam in producing thorough wetting by a small amount of liquid, e.g., in foam dyeing.—F. W. A.

PATENTS.

Sizing solution, and method of making the same. M. N. Aisen, Chicago, Ill. U.S. Pat. 1,221,125, May 1, 1917. Date of appl., Apr. 28, 1914.

A NEUTRAL alcoholic solution containing glue is hydrolysed by an acid.—J. B. C. K.

Thickening agent for printing colours and sizing. M. and P. A. Zaesle, Pilsen, Bohemia, Ger. Pat. 295,670, Apr. 9, 1911. Under Int. Conv., July 1, 1913.

ROOTS, such as manioc and arrowroot, rich in starch, gums, and fats, are ground and winnowed in such a way that the cellulose is separated, practically completely, from the starch, which retains the fat and gums. The resulting product is then treated with acids or oxidising agents to obtain a gelatinous adhesive mass suitable for thickening printing colours, or as an adhesive paste which does not lose its stickiness when kept.—C. A. M.

Weighting, firing, mordanting, dyeing, and bleaching silk, artificial silk, cotton, wool, and other textile materials. R. Clavel, Assignee of Soc. de Teinture et d'Apprêt, ci-dev. A. Clavel et F. Lindenmeyer, Basle, Switzerland, Eng. Pat. 103,638, Oct. 21, 1916. (Appl. No. 15,118 of 1916.) Under Int. Conv., Jan. 25, 1916.

SEE Fr. Pat. 480,761 of 1916; this J., 1917, 133.

Fireproofing and bleaching of fabrics and the like. T. J. I. Craig, Assignor to Whipp Bros. and Tod, Ltd., Manchester. U.S. Pat. 1,224,145, May 1, 1917. Date of appl., June 4, 1915.

SEE Eng. Pats. 22,617 of 1914 and 1448 of 1915; this J., 1915, 1205.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Nitrogen oxides from ammonia; Use of — in the lead chamber [sulphuric acid] process. H. Petersen. Metall u. Erz, 1916, 197, 204. Chem.-Zeit., 1917, 41, Rep., 70.

THE direct use of the nitrogen oxides obtained by the Frank-Caro process of oxidising ammonia, is not recommended owing to practical difficulties, loss of unoxidised ammonia, etc. A condensing plant, consisting of nine Pützer towers for oxidation and preliminary condensation, followed by three towers for the main condensation, is the most economical of any yet devised, the all-in working cost for a yield of 1200 kilos. of nitric acid (36° B., sp. gr. 1.332) per 24 hours being M. 0.60 per 100 kilos.—E. H. T.

Nitric acid vapour; Absorption spectrum of —. K. Schaefer and S. Deichsel. Z. anorg. Chem., 1916, 98, 70—76. J. Chem. Soc., 1917, 112, ii, 186.

ON account of the rapid decomposition of nitric acid vapour by light, it was necessary to maintain a stream of the vapour through the absorption tube during the photographing of the spectrum. The absorption tube was electrically heated at 130° C., the constant boiling acid being used. There is no absorption band, the curve being very similar to that given by liquid 98.7% acid. The NO₃ group in the vapour is therefore in a similar state to that in the alkyl nitrates and in the concentrated acid.

Nitric and sulphuric acids; Optical investigation of mixtures of —. K. Schaefer and H. Niggemann. Z. anorg. Chem., 1916, 98, 77—85. J. Chem. Soc., 1917, 112, ii, 186.

THE absorption limit of 0.2-N nitric acid is displaced towards the ultra-violet even by 20% sulphuric acid, the absorption curve being flattened at the same time, and this effect increases with increasing concentration of sulphuric acid. The sulphuric acid is considered to act as a dehydrating agent, displacing the equilibrium between the two modifications of the NO₃ group.

Lead sulphate; Solubility of — in highly concentrated and fuming sulphuric acid. H. Ditz and F. Kanhäuser. Z. anorg. Chem., 1916, 98, 128—140. J. Chem. Soc., 1917, 112, ii, 208—209.

THE solubility of lead sulphate in highly concentrated sulphuric acid, as in the manufacture of the acid by the contact process, is greater than appears in the literature. The solubility increases with the concentration of the sulphuric acid, slowly up to 97%, then rapidly up to 100%, a discontinuity observed between 98.6% and 98.9% being possibly due to experimental error. From the maximum solubility at 100%, the curve falls to about 5% of free sulphur trioxide, where there is a minimum.

after which it again rises rapidly to 15% of trioxide, and then less rapidly to 22%. The known curve of electrical conductivity of sulphuric acid is very similar to the curve just described. The degree of attack of highly concentrated sulphuric acid on metallic lead also corresponds in general with the same curve.

Basic calcium salt [nitrate]; Synthesis of a — on the ground of a change of properties of milk of lime. N. Busvold. Z. anorg. Chem., 1916, 98, 202. J. Chem. Soc., 1917, 112, ii, 207.

THE power of milk of lime to resist settling is increased by the addition of calcium nitrate, a maximum value for the permanence being found at the composition 2CaO.Ca(NO₃)₂. By slaking quicklime with a concentrated solution of calcium nitrate, white needles of the salt 2Ca(OH)₂.Ca(NO₃)₂.2H₂O, are obtained, which become turbid on the addition of water.

Potassium salts; Utilisation of the mother liquors of sea salt works as a source of —. II. Composition of the mother liquors. III. The bromine and potassium salts industry at Salin de Giroud. E. Manzella. Annali Chim. Appl., 1917, 7, 123—132; 133—141. (See also this J., 1917, 453.)

THE discordant analyses of the mother liquors from salt works are attributable to the different concentrations of the liquids. Analyses by Lacroix of the mother liquors from the salt pans at Salin de Giroud gave the following results:—MgCl₂, 260; NaCl, 34; KCl, 11; MgSO₄, 82; and NaBr, 4 grms. per litre. The composition is thus very similar to that of the mother liquors obtained in the extraction of carnallite and potassium chloride in the Stassfurt works (viz. MgCl₂, 270; NaCl, 38; KCl, 45; and MgSO₄, 36). A sample of the mother liquors from the Trapani sea salt works had sp. gr. 1.278 at 15° C. (=31.4 B.), and contained:—NaBr, 3.07; NaCl, 111.91; KCl, 29.72; MgCl₂, 116.17; MgSO₄, 162.24; and CaSO₄, 1.28 grms. per litre. According to the average results of the analyses of different chemists, mother liquors of 30 B. (sp. gr. 1.262) contain 13.40 grms. of potassium per litre (=25.55 grms. of potassium chloride). The approximate quantities of bromine and potassium chloride which might be obtained annually from the Italian sea-salt works are estimated at 10,775 quintals and 136,386 quintals respectively. If this source of bromine were fully utilised the amount produced by the 32 Italian salt works would be four times as much as that imported into Italy in 1913—1914.

The mother liquors concentrated by the spontaneous evaporation of sea water to 31 B. (sp. gr. 1.271) form the raw material for the extraction of potassium chloride and bromine in the salt works of Salin-de-Giroud, S. France. The mother liquors are concentrated to 34 B. (sp. gr. 1.308) in a series of tanks and separated from the deposit of "mixed salt" (sodium chloride and magnesium sulphate). Formerly this was used for the manufacture of sodium sulphate, but this salt is now obtained more economically as a by-product in other industries. The mother liquors are next conveyed to four large communicating brick-work reservoirs, with outlets for the discharge of the deposits of magnesium sulphate, and are allowed to remain there during the winter. When the temperature falls to 12° C. magnesium sulphate is deposited, whilst to prevent the liquid cooling below that point, when "carnallite" would also be deposited, the surface is covered with a layer of soft water from the Rhone. The following spring the layer of mother liquor, which will then have a density of 32 to 33 B. (sp. gr. 1.285—1.296), is ready for the extraction of the bromine. This is effected by pumping the mother liquors into vessels each of which has a capacity of 20

ch. m., and from these they descend in a regulated stream into stone rectifying columns. At the base of these they meet a current of chlorine derived from connected cylinders of liquid chlorine, and also encounter a jet of steam at a pressure of about 2 atmos. The liberated bromine passes through the successive compartments of the column to the top, and thence is conducted through an inclined U-tube into a condensing coil. The condensed bromine and water are separated by gravity, and the bromine water is returned to the column, whilst the crude bromine is transferred to another vessel where it is heated with steam. The chlorine and part of the vaporised bromine are condensed in another vessel. The greater part of the condensed bromine is collected in bottles, whilst the mixture of uncondensed bromine and chlorine remains in the column. Three separate apparatus are used, each of which is capable of dealing with 50 to 60 cb.m. of mother liquors in 21 hours and yields about 160 kilos. of bromine. About 41 tons of bromine containing only about 1% of chlorine is thus obtained from 15,000 cb.m. of mother liquors. After removal of the bromine the mother liquors, which have a density of about 30 B. (sp. gr. 1.262) at 65 to 70 °C., escape from the bottom of the column and are pumped into Porion evaporators where they are concentrated to 35–36 B. (sp. gr. 1.320–1.332) at a temperature not exceeding 80 to 82 °C. On leaving these tanks they have the following mean composition:—NaCl, 51.80; MgCl₂, 31.68; MgSO₄, 76.50; and KCl, 51.24 grms. per litre. They are now mixed with an equal volume of the solution of magnesium chloride obtained as a secondary product in the further operation of precipitating the double chloride of potassium and magnesium (artificial carnallite), and the hot mixture is pumped into a tank where it deposits while still hot a large amount of "mixed salt," which is now a waste product. The clear supernatant liquid is transferred to crystallisation vessels in which it is cooled to about 20 °C. by means of cooling coils, and the resulting deposit of carnallite is drawn off by means of buckets and drained in cylindrical vessels with false bottoms. The final mother liquor is concentrated to about 40 B. (sp. gr. 1.384) and is used partly for mixing with the liquors coming from the Porion evaporators, and partly in the manufacture of crystalline magnesium chloride. The carnallite is washed with a limited quantity of water, e.g., 900 litres of soft water and 600 litres of washings of 28 B. (sp. gr. 1.211) from a previous operation to 2700 kilos. of the salt, in cylindrical vessels provided with mechanical agitators. After 4 hours the potassium chloride is allowed to settle, and the mother liquor, which is still rich in potassium chloride, is concentrated in a Porion evaporator for further treatment. The crude potassium chloride is washed in 3-ton lots, for about an hour, with 1 cb.m. of cold soft water, in a cylinder provided with an agitator, and is then transferred to a vessel with a false bottom, where it is drained, and is finally dried in a battery of hydro-extractors. The resulting product contains 72 to 75% of potassium chloride, but may be obtained in purer form by repeating the washing. About 600 tons of 72% potassium chloride is thus obtained annually by the treatment of 15,000 cb.m. of mother liquors of 33 B. (sp. gr. 1.296) in the marine salt works of Salin-de-Giroud.—C. A. M.

Potash from silicate rocks: Extraction of—. 11. W. H. Ross, J. Ind. Eng. Chem., 1917, 9, 167–172. (See this J., 1912, 1077.)

By digesting 1 part of felspar and 1.7 parts of lime with water under a steam pressure of 10 to 15 atmos., about 90% of the potash present is dis-

solved, whilst the residue is suitable for the manufacture of Portland cement clinker. By increasing the pressure to 90 atmos. the felspar is almost completely decomposed, but if the proportion of lime is reduced much below that given above, only partial decomposition of the felspar takes place, even at the increased pressure. The addition of a soluble calcium salt equivalent to the alkalis in the felspar increases the amount of potash recoverable when only a limited proportion of lime is used. Since the dust escaping from cement-works kilns contains free lime, it may be found possible to separate the soluble and insoluble potassium salts by digesting the material with water alone under pressure, leaving a residue suitable for cement manufacture (see this J., 1917, 458). In the absence of lime, felspar is not decomposed when digested with water, even at pressures up to 1450 atmos. Estimating the average amount of potash in felspar at 10%, and that 90% thereof is readily recoverable by the above process, a ton of felspar would yield 214 lb. of caustic potash, worth \$10.70. In the case of the potash recoverable by volatilisation from the cement dust when felspar is substituted for clay in the manufacture of cement, it is estimated that the value of the potash recovered as potassium salts would be \$6.75. Assuming the cost of burning 1 ton of lime to be about \$1.00, the expense involved in the addition of the proper proportion of lime to felspar would be about \$1.70 per ton of felspar, so that the difference in the value of the potash recoverable by the two methods would be \$2.25. The potash in felspar is always accompanied by a certain amount of soda. This would depreciate the commercial value of the caustic potash recovered, but would not affect its value for the manufacture of concentrated fertilisers (see also this J., 1912, 531; 1917, 397).—C. A. M.

Calcium carbonate: Rôle of inorganic agencies in the deposition of—. J. Johnston and E. D. Williamson, J. Geology, 1916, 24, 719–750. J. Chem. Soc., 1917, 112, ii, 213. (See also this J., 1916, 688, 735.)

THE authors discuss the effects producible by variation of certain factors which affect directly the solubility of calcium carbonate, and thus induce its precipitation from aqueous solution. The factors concerned are the partial pressure of the carbon dioxide in the atmosphere, the temperature and the concentration of the solution in respect of calcium. At a given temperature, the equilibrium between calcite and its saturated solutions is determined by the coefficient of solubility of carbon dioxide, the ionic solubility product, $[Ca^{++}][CO_3^{--}]$, the ionisation-coefficients of carbonic acid, and the coefficient of hydrolysis of calcium carbonate. The free and the total carbonic acid, that is to say, $[H_2CO_3] + [CO_2^*] + [HCO_3^-]$, determine the degree of alkalinity or acidity of the solution as measured by $[OH^-]$, and no change can be made in any one of the quantities without affecting each of the others. At 16 °C., the solubility of calcite increases from 44 to 75 parts per million, when the partial pressure of the carbon dioxide increases from 0.0001 to 0.0005. Under atmospheric conditions for which the mean value of the partial pressure may be taken as 0.00032, the solubility decreases from 81 parts per million at 0° to 52 parts at 30° C. A change in the partial pressure from 0.00032 to 0.00030, or an increase of temperature of 2° C., would result ultimately in the precipitation of about 2 grms. of calcite from every cubic metre of a solution saturated with it. Comparison of the calculated solubilities with the available analytical data indicates that the warmer surface layers of the sea are substantially saturated with respect to calcite, and precipitation is consequently

to be anticipated if there is a reduction in the partial pressure of the atmospheric carbon dioxide or a rise in temperature of the surface layers in question. Although aragonite is occasionally formed in nature, it is considered that pure aragonite cannot persist in contact with sea-water for any length of time. If, however, the aragonite takes up other substances in the form of a solid solution, and its solubility is thereby reduced below that of calcite, it is possible that such impure aragonite may be stable in contact with sea-water. The accurate determination of temperature, salinity, and free and combined carbonic acid in sea-water in a systematic way would have an important bearing on many outstanding biological and geological problems.

Carbonates of calcium, strontium, barium, and magnesium: Temperatures of formation and decomposition of the — under a pressure of one atmosphere. J. A. Hedvall. Z. anorg. Chem., 1916, **98**, 47—56. J. Chem. Soc., 1917, **112**, ii., 208.

DISSOCIATION temperatures may be determined more rapidly by taking heating and cooling curves than by measurements of pressure. Calcium carbonate gives a well-marked arrest on heating, but the contraction on formation of lime makes the mass so little reactive that the cooling curve is continuous. On increasing the surface of the lime by grinding, however, the absorption of carbon dioxide is hastened, and a corresponding arrest is found on the cooling curve. The dissociation temperature of calcium carbonate is thus found to be 913° — 923° C., this being independent of the size of grain. The dissociation of strontium carbonate begins at 1141° C., but only becomes rapid at 1255° C. Barium carbonate only begins to dissociate at 1361° C., its melting point. Magnesium carbonate dissociates at 516° C.

Carbon dioxide and titanium dioxide and silica respectively: Equilibria between — in alkali, lime-alkali, and alkali-aluminate fusions. P. Niggli. Z. anorg. Chem., 1916, **98**, 241—326. J. Chem. Soc., 1917, **112**, ii., 211—212. (Compare this J., 1913, 1107.)

For the investigation of the system $K_2O-TiO_2-CO_2$, pure titanium dioxide was added to potassium carbonate in a platinum crucible in a continuous stream of carbon dioxide. After equilibrium had been reached, the crucible was quenched and allowed to cool in a desiccator in an atmosphere free from carbon dioxide. Under similar conditions, less carbon dioxide was expelled by titanium dioxide than by silica. The solid phase formed is $K_2Ti_2O_5$, the reaction beginning in the solid state, but only becoming rapid at about 860° C. Carbon dioxide is absorbed on cooling, so that equilibrium may be reached from both directions. Treatment with hydrochloric acid leaves only titanium dioxide, in the form of transparent pseudomorphs after the titanate. In the molten mass other titanates, probably K_2TiO_3 , are formed. In the system $Na_2O-TiO_2-CO_2$, the solid titanate readily separates from the fusion, and there is also loss of sodium carbonate by volatilisation. Carbon dioxide is also frequently evolved during solidification. The principal solid phase is $4Na_2O \cdot 5TiO_2 = Na_8Ti_5O_{11}$, but a titanate, $Na_2Ti_2O_7$, is also formed, as well as Na_2TiO_3 at high temperatures. $Na_8Ti_5O_{11}$ crystallises in forms resembling angite; its refractive index is more than 1.74. The silicates and titanates obtainable from fusions are comparable with hydrated salts, silica and titanium dioxide playing a part similar to water of crystallisation. In the system $Na_2CO_3-CaCO_3$, the double salt, $Na_2CO_3 \cdot CaCO_3$, forms large crystals, m.p. 813° C. Mixtures containing more than 50 mols. % of calcium carbonate deposit calcite as the second solid phase.

The eutectic point between the double salt and the solid solution rich in sodium carbonate is at 786° C. and 40 mols. % $CaCO_3$, the solid solution curve passing through a maximum at about 870° C. The eutectic point in the system $K_2CO_3-CaCO_3$ is at 755° C. and 40 mols. % $CaCO_3$, the solid solution curve being without a maximum. The compound $K_2CO_3 \cdot CaCO_3$ melts at 812° C., and closely resembles the sodium compound. In the system $K_2O-CaO-TiO_2-CO_2$, fusions containing an excess of calcium carbonate convert the whole of the added titanium dioxide into perovskite $CaTiO_3$. Any excess of titanium above this proportion forms $K_2Ti_2O_5$. The corresponding sodium system is quite similar. The product when silica is added to potassium and calcium carbonates is the orthosilicate, Ca_2SiO_4 , and when wollastonite, $CaSiO_3$, is added to the carbonate fusion it is converted into the orthosilicate, Ca_2SiO_4 , and $CaCO_3$ may occur together as solid phases from the same fusion at about 850° C. under atmospheric pressure in carbon dioxide. When alumina is present, silica first acts on the carbonate as if alumina were absent, but the silicate then reacts with alumina, so that an alkali aluminosilicate crystallises, and the liberated alkali then recombines with carbon dioxide. With potassium carbonate, potash-nepheline, $K_2O \cdot Al_2O_3 \cdot 2SiO_2$, is the product from all fusions. Orthoclase is decomposed by alkali carbonate, forming potash-nepheline, the silica thus liberated forming alkali silicate. A ternary diagram for the system $K_2O-Al_2O_3-SiO_2$ is given.

Silica: Reactivity of — with the oxides of calcium, barium, and magnesium in the solid state. J. A. Hedvall. Z. anorg. Chem., 1916, **98**, 57—69. J. Chem. Soc., 1917, **112**, ii., 205.

THE reactions between these oxides have been investigated by means of heating and cooling curves. Lime and precipitated silica react at 1011° C., but the reaction comes to a standstill owing to the formation of a layer of metasilicate. A more vigorous reaction begins shortly above 1400° C., owing to the eutectic temperature of the lime-silica system being reached. The reactivity of other varieties of silica diminishes in the order: silica glass, cristobalite, quartz. Calcium carbonate is acted on to a small extent by precipitated silica at or below 900° C., possibly owing to the presence of a larger proportion of small particles, but the lime formed at the dissociation temperature is not specially reactive. Precipitated silica reacts with barium oxide at 900° C., whilst no arrest has been observed on the heating curve of a mixture of silica and magnesia.

Sodium tetraborate: Water content of crystalline —. J. Hoffmann. Chem. Ind., 1916, **39**, 411—412. J. Chem. Soc., 1917, **112**, ii., 206.

ESTIMATION of the loss of water of crystallisation of sodium tetraborate at different temperatures has shown that the first five molecules begin to be lost below 100° C., whilst six molecules are lost at 100° C.; the seventh and eighth molecules escape at 130° C., the ninth at 150° C., whilst the tenth is evolved at 160° C. and above. At the ordinary temperature crystalline borax has the formula $Na_2B_4O_7 \cdot 10H_2O$; at 100° C., $Na_2B_4O_7 \cdot 5H_2O$; at 130° C., $Na_2B_4O_7 \cdot 3H_2O$; at 150° C., $Na_2B_4O_7 \cdot 2H_2O$; at 180° C., $Na_2B_4O_7 \cdot H_2O$. The penultimate molecule of water of crystallisation is retained more firmly than the others, and prolonged heating is necessary to remove it. Borax of the composition, $Na_2B_4O_7 \cdot H_2O$, exists in traces far above this temperature, but below 318° C. the bulk of the water is driven off. When it is desired to obtain practically anhydrous borax in the non-glassy form, the crystalline material is heated at 318° C. (m.p. of potassium nitrate). Absolutely anhydrous borax is difficult to obtain in the non-glassy

state, since the dehydrated powder absorbs water more readily than the glassy material. The latter during five months only absorbs 0.1% of water, whilst this amount is absorbed by the former in twenty-four hours. After sixteen months the powdered form had absorbed 10, the glassy 0.6, molecules of water.

Barium sulphate: Effect of adsorption on the physical character of precipitated —. H. B. Weiser. *J. Phys. Chem.*, 1917, **21**, 311—333.

IN accordance with the general principle that a solid salt shows a distinct preferential adsorption for its own ions, the barium ion is always present in barium sulphate precipitates, even when produced in solutions containing an excess of soluble sulphate. An important effect is exerted by adsorption on the state of division of the precipitate; barium sulphate is precipitated in the most finely divided state when in presence of those substances for which it shows the greatest specific adsorption. By mixing $N/10$ barium chloride with a small excess of $N/10$ sodium sulphate in solution containing one part of water to five of glycerol, a fairly stable colloidal suspension of barium sulphate resulted, which owed its stability to preferential adsorption of the sulphate ion. By examining the direction of migration in an electric field, the colloid was seen to be negatively charged. Positive colloidal solutions of barium sulphate stabilised by preferential adsorption of the barium ion have been previously prepared. It was found that barium sulphate is obtained much more finely divided when precipitated from a solution with barium chloride in excess than with sulphuric acid in excess. Precipitates produced with potassium sulphate are also more finely divided than with sulphuric acid. This is due to the fact that barium sulphate adsorbs its own ions strongly and hydrogen ions are more strongly adsorbed than most cations. With excess of sulphuric acid, the strong adsorption of the sulphate ion is checked by the presence of the hydrogen ion, whereas with potassium sulphate the adsorbed sulphate ion is not so completely neutralised. By substituting magnesium for potassium sulphate, the precipitate obtained appeared somewhat less finely divided, as would be expected from the fact that divalent ions are adsorbed more strongly than univalent ones. The effect of the presence of hydrochloric acid on the crystal size was studied both in the presence of barium and of sulphate ions in excess. In all cases the barium sulphate was more coarsely crystalline when precipitated in the presence of an appreciable amount of hydrochloric acid. With barium chloride in excess and in presence of hydrochloric acid, the strong adsorption of both hydrogen and barium ions and the relatively weak adsorption of chlorine would be expected to cause a finer crystalline structure, but here the adsorption effects are overcome by the larger influence exerted by the solvent action of the acid, on account of which large crystals are always obtained in presence of an excess of hydrochloric acid. With the same concentration of hydrochloric acid, the precipitate is more crystalline in the presence of sulphate ions in excess than with barium ions in excess, as the tendencies for adsorption of sulphate and hydrogen ions are mutually opposed.—J. N. P.

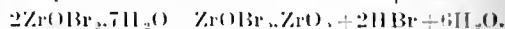
Uranium oxide (UO_2): Preparation of black —. C. L. Parsons. *J. Ind. Eng. Chem.*, 1917, **9**, 166—167.

URANYL chloride when heated with a reducing agent in a fused salt bath yields uranium oxide, and the reaction may be utilised in practice by

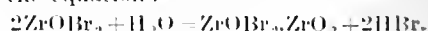
fusing sodium uranate with carbon in a salt bath. Based upon this principle, a purer uranium oxide than has hitherto been prepared industrially is now being made in ton lots in the National Radium Institute, U.S.A., by the following method:—A mixture of 35 parts of salt, 20 parts of sodium uranate, and 1 part of ground charcoal is heated in a cast steel pot of pure low carbon steel, 19 in. deep, by 16 in. wide, with wall $\frac{1}{4}$ in. thick. The pot is heated by means of an oil burner in a crucible furnace, and its contents are not stirred during the reaction, but as the charge subsides a fresh quantity of the mixture is added from time to time. Reaction takes place at a red heat and is allowed to continue until no more carbon monoxide escapes from the mass. The resulting oxide is then dipped from the bottom of the pot, by means of an iron ladle, and transferred together with the salt melt to an iron trough. About 1 charge per day can be worked in each furnace, and the steel pot will take from 35 to 40 charges before being destroyed by the heat. After cooling, the salt mass is broken up and treated with boiling water, and the uranium oxide is washed by decantation. As a rule it contains some iron and aluminium, but, if necessary, these can be extracted by washing the oxide with 5% hydrochloric acid. In commercial practice, however, no attempt is made to separate the whole of the iron, as its presence is not objectionable in the manufacture of ferro-uranium, and a product with a degree of purity equivalent to 97% U_3O_8 is usually obtained. Sodium uranate made from carnotite always contains a certain amount of vanadium. In the process described, the sodium vanadate dissolves with the salt and the vanadium may be separated by precipitation with iron sulphate. The value of the recovered vanadium will pay for about half of the whole process. The average cost of producing the black oxide of uranium is slightly less than 11 cents per lb., but it could be reduced by running the furnace continuously. —C. A. M.

Zirconyl bromides. E. Chauvenet. *Comptes rend.*, 1917, **164**, 816—818.

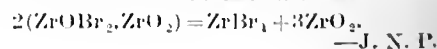
ON evaporating on a water bath a solution of zirconium hydroxide, $Zr(OH)_4$, in hydrobromic acid, needle-shaped crystals separate, which, on drying in a current of air at 15° C. until of constant weight, correspond to the formula, $ZrOBr_2 \cdot 8H_2O$. This compound is readily soluble in water, and if entirely free from hydrobromic acid is non-hygroscopic, but in presence of retained acid it absorbs water, whilst in dry air, or *in vacuo*, water is given up with the formation of $2ZrOBr_2 \cdot 7H_2O$, which is the lowest hydrate of zirconyl bromide. The anhydrous bromide does not appear capable of existence. On heating the above hydrate to over 60—70° C., decomposition takes place in accordance with the equation:—



The oxybromide is also precipitated from a $N/100$ solution of zirconyl bromide on standing for several months. By following the variation of electrical conductivity, hydrolysis of the bromide was found to take place in accordance with the equation:—



A hydrate of the complex oxybromide of the formula, $ZrOBr_2 \cdot ZrO_2 \cdot 12H_2O$, was isolated by adding ether to an alcoholic solution of zirconyl bromide. The oxybromide, on heating to redness or in a current of dry hydrogen bromide, decomposes into zirconium bromide and oxide:—



—J. N. P.

Osmium dioxide. O. Ruff and H. Rathsburg. Ber., 1917, 50, 484—497.

WHEN osmium dioxide is obtained by reduction of osmium tetroxide or potassium osmate, or by hydrolysis of ammonium hexachloro-osmate, it is always pyrophoric, in the sense that it decomposes very readily in air, with considerable evolution of heat or even with detonation. The decomposition appears to be due to the presence of compounds containing carbon and hydrogen or nitrogen and hydrogen. A stable preparation may be obtained by the hydrolysis of potassium hexachloro-osmate. This product contains a little alkali, but is free from reducing substances. Pure osmium dioxide can only be obtained in the crystalline form by heating the finely divided pure metal in osmium tetroxide vapour. The precipitated dioxide is colloidal and has the composition, $\text{OsO}_2 \cdot 2\text{H}_2\text{O}$. It readily forms sols in water which is slightly acid or alkaline, or free from neutral electrolytes. On heating in an indifferent gas (carbon dioxide or nitrogen) half of the water is lost below 120°C . and the remainder below 200°C . The anhydrous dioxide thus prepared has sp. gr. 7.71. On further heating to 400°C . the change of density proceeds along with a progressive change of colour. The original dihydrate is bluish black and the final product distinctly brown. At about 460°C . decomposition into osmium tetroxide and metallic osmium begins to be evident, but this change can be delayed to about 650°C . by heating in an atmosphere containing osmium tetroxide. Under these circumstances the dioxide is finally converted into copper coloured octohedral and hexahedral crystals of sp. gr. 7.91.—W. H. P.

Carbon suboxide: Preparation of — from malonic acid and phosphorus pentoxide. A. Stock and H. Stoltzenberg. Ber., 1917, 50, 498—502. (See also this J., 1906, 500; 1907, 169; 1908, 182, 1133.)

THE authors have improved the method of preparing carbon suboxide (C_3O_2) by taking precautions to avoid excessive polymerisation of the suboxide in presence of phosphorus pentoxide, and opportunity for the suboxide to react with acetic acid which is produced along with carbon dioxide by decomposition of the malonic acid. From 20 grms. of malonic acid they obtained 968 c.c. of suboxide containing only 0.7 c.c. of carbon dioxide. The melting point of the suboxide is -111.3°C . and its vapour pressure at 0°C . 59 cm. Polymerisation to the red solid is an autocatalytic reaction, depending on the nature of the surface of the containing vessel, independent of the action of light, accelerated by phosphorus pentoxide, and retarded by diminution of pressure or dilution with carbon dioxide. The suboxide dissolves readily in carbon bisulphide and in xylene, and reacts quantitatively with water giving malonic acid.—W. H. P.

Oxy-hydrogen gas: Ignition point of —. A. Mitscherlich. Z. anorg. Chem., 1916, 93, 145—166. J. Chem. Soc., 1917, 112, ii., 199.

DRY oxy-hydrogen gas, prepared electrolytically, was passed through a tube heated by means of a large, gas-heated copper tube, the temperature being measured by quartz-mercury thermometers reading up to 650°C . When highly diluted with inert gas, no noise of explosion was perceptible, but the ignition point could be fixed by the appearance of a flash in a darkened room, even when the action was insufficient to cause any perceptible movement of the mercury in the manometer. The ignition temperature was higher, the lower the velocity of the gas in passing through the tube, when the velocity was low. At higher velocities, the temperature was independent of the

velocity. The formation of water took place below the ignition point, to an extent which varied with the condition and previous treatment of the glass tube. In silica tubes there was a still greater formation of water below the ignition temperature, whilst very little was formed in tubes of glazed, and especially unglazed, porcelain which had been previously heated for a long time at 700°C .

Fluorine; Preparation of — from hydrogen fluoride or other fluorides by chemical means. O. Ruff, W. Plato, and G. Winterfeld. Z. anorg. Chem., 1916, 98, 27—37. J. Chem. Soc., 1917, 112, ii., 201—202.

BRÄUNER (Chem. Soc. Trans., 1891, 65, 393) claims to have prepared fluorine by heating the double salt, $3\text{KF} \cdot \text{HF} \cdot \text{PbF}_4$ (compare following abstract). This result has not been confirmed, the products of decomposition by heat being lead difluoride and platinum tetrafluoride when a platinum vessel is used. Liquid or gaseous silicon tetrafluoride is practically without action on the double salt, a small quantity of gas acting on potassium iodide-starch paper being obtained at 250°C . but without altering the composition of the salt. A larger quantity is obtained by the use of antimony pentafluoride. Sulphur and iodine form sulphur fluoride and iodine pentafluoride respectively. Triammonium hydrogen plumbodifluoride, $3\text{NH}_4\text{F} \cdot \text{HF} \cdot \text{PbF}_4$, was prepared by dissolving lead tetra-acetate in concentrated hydrofluoric acid and adding ammonium hydrogen fluoride, filtering, and evaporating. The salt may be heated at 190°C . under atmospheric pressure or even under 10 mm. pressure without change, but in a good vacuum decomposition takes place at 100°C . nitrogen being evolved.

Fluorine: Preparation of — from tripotassium hydrogen plumbodifluoride by chemical means. B. Brauner. Z. anorg. Chem., 1916, 98, 38—46. J. Chem. Soc., 1917, 112, ii., 202. (Compare preceding abstract.)

THE differences between the results obtained by the author in 1894 and those of Ruff are not explained. The earlier lead preparation contained manganese, which may have acted as a catalyst, or the gas evolved by heating may not have been fluorine. It is, however, shown that silicon does not inflame spontaneously in dry hydrogen fluoride.

Sulphate of ammonia prices. See page 619.

Embrittling action of sodium hydroxide on mild steel, and its possible relation to steam failures of boiler plates. Merica. See X.

New fulminates and azides. Wölder and Martin. See XXII.

Yellow mercuric oxide as standard in alkalimetry. Ince. See XXIII.

PATENTS.

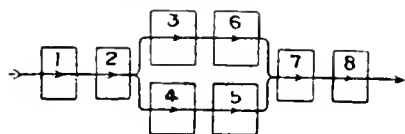
Acids or other liquids: Concentration or recovery of —. L. J. R. Bouhon. London, Eng. Pat. 105,935, Feb. 21, 1916. (Appl. No. 2579 of 1916.)

THE apparatus comprises an evaporating chamber containing a series of plates inclined to the horizontal and having a corrugated or dimpled surface, over which the acid or other liquid is caused to flow evenly. Connected with this evaporating chamber is a furnace for heating air which is supplied under pressure, and is forced through a series of heating tubes before passing on to the evaporating chamber. A condensing chamber completes the apparatus, and here the

moisture carried away by the heated air is cooled and condensed. The air supply can be regulated as required.—J. B. C. K.

Sulphuric acid; Manufacture of — in tower systems. F. Curtius and Co., Duisburg, Ger. Pat. 295,708, July 17, 1911.

THE arrangement of towers is shown in the diagram. Two methods of working are described:—(a) Tower 8 is sprinkled with acid from the Glover tower, and the product,



together with the acid from the other towers, is conveyed to tower 1 where it is denitrated. Some of the denitrated acid is removed and the rest is brought back to 8. Acid flows between 2 and 7, 3 and 6, 4 and 5, in both directions. (b) Tower 8 receives the Glover acid, and the product is conveyed to 7, 2, 1 in succession, the acid from the other towers also passing to 1, where the whole is denitrated. Towers 3 and 6, and 4 and 5, work in a closed circuit.—E. H. T.

Sulphuric acid; Manufacture of —. [Removal of hydrogen sulphide from coal gas.] B. Krizko, Lupény, Hungary. Ger. Pat. 295,709, Mar. 31, 1915.

HYDROGEN sulphide, or a gas containing it, is passed into copper sulphate solution, and the precipitated copper sulphide is mixed with an excess of copper oxide and heated in air, whereby it is reconverted into sulphate. The latter is extracted with water, and the residual oxide used again. The method is especially suitable for eliminating hydrogen sulphide from the gases obtained in the destructive distillation of coal.

—E. H. T.

Sulphuric acid; Manufacture of —. B. Dirks, Hemelingen, Ger. Pat. 295,906, Dec. 12, 1915.

AMMONIUM sulphate, prepared by the action of ammonia and carbon dioxide gases on gypsum or anhydrite, is decomposed with phosphoric acid, the resulting sulphuric acid being free from arsenic and selenium. The residual ammonium phosphate is decomposed by heat and the ammonia and phosphoric acid recovered.—E. H. T.

Sulphur dioxide; Furnace for making —. J. Pintsch A.-G., Berlin. Ger. Pat. 295,747, Jan. 7, 1915.

A VESSEL, shaped like a filter-funnel is fitted into a cylindrical oven divided laterally into two parts, the cone of the funnel being in the upper, and the stem in the lower compartment. The sulphur is melted in the conical part, which is surrounded by a hot oil-jacket, and falls on to the hearth of the lower compartment where it is burnt, the gases which enter the upper part serving to keep the sulphur melted. There is an exit pipe in each compartment, and by regulating the draught the sulphur can be maintained at the requisite temperature.—E. H. T.

Gases (ammonia); Purification of —. W. T. Gidden, Smethwick. Eng. Pat. 105,826, June 12, 1916. (Appl. No. 8301 of 1916.)

AN impure but substantially homogeneous gas, e.g., ammonia, is bubbled through a quantity of the same gas which has been liquefied. The liquefied gas collects the impurities and may be

allowed to evaporate so as to assist the purifying action by the cold produced, or it may be prevented from evaporating by the application of cold or pressure.—W. H. C.

Metallic sulphides; [Electrolytic] production of —. C. O. Griffith, Wormit, Fife. Eng. Pat. 105,830, June 28, 1916. (Appl. No. 9087 of 1916.)

ZINC, antimony, or other metallic sulphide is prepared by electrolysing a solution of ammonium or other suitable chloride, using an anode and cathode of the same metal (zinc, antimony, etc.), the cathode being coated entirely or in part with sulphur.—B. N.

Aluminium carbide; Art of producing —. M. Barnett and L. Burgess, New York. U.S. Pat. 1,222,593, Apr. 17, 1917. Date of appl., Jan. 26, 1917.

A MIXTURE of about 2 parts of alumina with 1 part of carbon, the latter being in excess of the quantity necessary for the reduction of the alumina, is packed around a core of carbon or graphite through which is passed an electric current sufficient to raise the temperature to about 2000° C., but not to that of the electric arc.—B. V. S.

Aluminium salts from silica's; Method of obtaining —. R. H. McKee, Orono, Me. U.S. Pat. 1,222,960, Apr. 17, 1917. Date of appl., Mar. 13, 1916.

SILICATES such as sericite are roasted with lime or limestone and a chloride, and the resulting mass extracted with water to remove the soluble potassium salts. The residual silicate is decomposed by an acid reagent.—B. V. S.

Oxygen compounds of nitrogen; Production of — from ammonia. N. Busvold, Rjukan, Norway. U.S. Pat. 1,222,928, Apr. 17, 1917. Date of appl., Dec. 16, 1915.

A GASEOUS mixture containing oxygen and ammonia is passed over a suitable catalyst in such a way that the pressure of the issuing mixture is lower than that of the atmosphere; the drop of pressure in the catalyst is not more than 50 mm. of mercury.—B. V. S.

Oxides of uranium; Process for preparing —. Process for the purifying of uranium compounds. C. L. Parsons, Durham, N.H. U.S. Pats. (A) 1,221,013 and (B) 1,221,014, Apr. 24, 1917. Date of appl., May 19, 1915. (Dedicated to the public.)

(A) A MIXTURE of a uranium compound, such as a uranate, a flux, and a reducing agent, such as carbon, is fused and the resulting mass washed with an alkali solution, water, and an acid. (B) Alkali uranates may be purified by fusion with a flux, such as a chloride, incapable of forming a soluble compound with the uranium, and washing the residue. Vanadium and similar impurities are removed (see also page 644).—B. V. S.

Bisulphite liquor; Apparatus for making —. G. A. Stebbins, Watertown, N.Y. U.S. Pat. 1,221,578, May 1, 1917. Date of appl., Aug. 31, 1915.

THE apparatus comprises absorption and agitating compartments, an overflow receptacle provided with a constant level device in communication with the lower portion of the agitating compartment, and a cooling coil discharging into the upper portion of the absorption compartment. Gas is supplied to the lower end of the absorption compartment and is withdrawn from the upper end and delivered to the lower part of the agitating compartment. A basic solution is supplied to the upper part of the agitating compartment. Means are provided for elevating monosulphite liquor from the constant-level receptacle to the cooling

coil, and agitating means within the agitating compartment, and between the gas inlet and the inlet for the basic solution.—J. B. C. K.

Chromates; Manufacturing metallic——. K. Toabe, Winchester, Mass. U.S. Pat. 1,225,374, May 8, 1917. Date of appl., Oct. 6, 1916.

A METAL, such as lead, is subjected at a selected temperature, 60° to 140° C., to the action of a solution containing water, chromic acid, and an acid, such as nitric acid, which has a solvent action on the metal.—B. N.

Percarbonate; Manufacturing alkali-metal——. A. Schaidhauf, Frankfort, Germany, Assignor to Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,225,722, May 8, 1917. Date of appl., Jan. 16, 1917.

SODIUM percarbonate is produced by mixing hydrogen peroxide with sodium carbonate, previously roasted to destroy detrimental catalysts. The mixing operation is done in the presence of a magnesium alkali silicate, and gum arabic is added to the product of the reaction.—B. N.

Electrolysis [of alkali chlorides]; Device for—— with a mercury cathode. Farbenfabr. vorm. F. Bayer und Co. Ger. Pat. 295,800, Apr. 12, 1914.

To prevent alkali amalgam rising to the surface of the brine, and the accompanying increase of resistance, two diaphragms are placed between the anode and the mercury, the upper one supporting the mercury.—E. H. T.

Sodium thiosulphate [e.g., residues from manufacture of sulphur dyes]; Process of obtaining sodium sulphate and sulphur from——. Act.-Ges. f. Anilinfabr. Ger. Pat. 295,859, Apr. 25, 1914.

THE thiosulphate is decomposed by treatment with warm sulphuric acid, or with the equivalent amount of an acid salt of a di- or poly-basic acid, in particular with a bisulphate. The reaction proceeds quantitatively, and can be used for working up the residues from the manufacture of sulphur dyes.—E. H. T.

Zinc oxide containing lead, lead sulphate, carbonate, etc.; Partial or complete removal of lead from——. S. E. Goldschmidt und Sohn, Breslau. Ger. Pat. 295,921, Feb. 20, 1914.

THE oxide, freed from carbonate by ignition, is treated with zinc sulphate, the lead sulphate is extracted with a solution of sodium or potassium acetate, and the solution treated with barium sulphide. In this way both lead and sulphuric acid are completely removed, and the alkali acetate solution may be used again.—E. H. T.

Tungsten carbide; Production of pieces of—— of any desired size or shape. Voigtländer und Lohmann, Metallfabrikations-Ges. m.b. H., Essen. Ger. Pat. 295,726, May 17, 1914. Addition to Ger. Pat. 289,066 (this J., 1916, 423).

In order to prevent the carbide becoming crystalline, a small amount of molybdenic oxide or carbide, or metallic molybdenum, is added before the second heating takes place.—E. H. T.

Sulphuric acid; Manufacture of——. W. H. Waggaman, Washington, D.C., U.S.A. Eng. Pat. 101,408, Aug. 14, 1916. (Appl. No. 11,482 of 1916.) Under Int. Conv., Sept. 4, 1915.

SEE U.S. Pat. 1,185,029 of 1916; this J., 1916, 736.

Concentrating acids; Method and apparatus for——. T. C. Oliver, Charlotte, N.C., U.S.A. Eng. Pat. 105,993, May 11, 1916. (Appl. No. 6743 of 1916.)

SEE U.S. Pat. 1,195,075 of 1916; this J., 1916, 1015.

Ammonia; Catalytic production of——. C. Bosch and A. Mittasch, Assignors to Badische Anilin und Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,225,755, May 15, 1917. Date of appl., Nov. 18, 1911.

SEE Fr. Pat. 436,472 of 1911; this J., 1912, 432.

Titanic products; Manufacture of——. H. Wade, London. From The Titanium Alloy Manufacturing Co., New York. Eng. Pat. 105,853, Aug. 14, 1916. (Appl. No. 11,492 of 1916.)

SEE U.S. Pats. 1,196,030 and 1,196,031 of 1916; this J., 1916, 1016.

Treatment and utilisation of gases supplied to the furnaces of hydrogen retorts. Eng. Pat. 106,067. See HA.

Method of producing carbonic oxide. U.S. Pat. 1,225,396. See HA.

Process of making white hydraulic cement and potash salts. U.S. Pat. 1,221,454. See IX.

Treatment of lead sulphide ores [to produce basic lead sulphate]. U.S. Pat. 1,225,296. See X.

Apparatus for effecting endothermic gas reactions by an electric arc. Eng. Pat. 105,953. See XI.

VIII.—GLASS; CERAMICS.

Glasses for protecting the eyes from injurious radiations. W. W. Coblentz and W. B. Emerson. U.S. Bureau of Standards, Techn. Paper No. 93. J. Franklin Inst., 1917, 183, 629.

BLACK, amber, green, greenish-yellow, and red glasses efficiently protect the eyes from ultra-violet light. White glass affords some protection from the extreme ultra-violet rays from mercury-quartz lamps and from electric arcs between iron, copper, or carbon. For shielding the eyes from infra-red rays, deep black, yellowish-green, gold-plated, sage-green, and bluish-green glasses are efficient, the two last being preferable for furnace work. Of the infra-red rays emitted by a furnace at 1100° C., about 90% are obstructed by gold-plated glasses, 95% by sage- or blue-green glasses, 80% by very deep black glasses, and 60% by greenish-yellow glasses. For working with oxy-acetylene or in electric welding, it is important to wear the darkest glasses available.—A. B. S.

Refractory materials; Deterioration of—— in the iron and steel industries. H. B. Croushaw. Trans. Faraday Soc., 1917, 12, 153—165.

THE chief cause of the deterioration of bricks in open-hearth furnaces is the combination of basic flue-dust and volatilised oxides with the material of the bricks. The intensity of the bombardment by dust particles is greatest in the centre of the roof and least in the middle of the furnace. The slag formed by the action of the dust on the bricks forming the roof seems unable to penetrate them, so that permeability and porosity are not so serious as is often supposed. It has a better opportunity of penetrating the bricks forming the lower part of the walls. The "cutting action" of flames, the rapid movements due to sudden changes in temperature, and particles of slag shot up from the molten charge also assist in the destruction of the bricks. The deterioration of regenerator bricks is mainly of a chemical nature, due to the fluxing action of the basic dust derived from the charges and slag, and carried over from the body of the furnace.

The deterioration of the bricks used in lining blast furnaces and cupolas varies with their position. Near the top of the furnace the chief

cause is the abrasion due to fresh charges of ore and fuel, but within the shaft the brickwork is largely replaced by a black porous "scar" of graphite. At the hearth, chemical action between the contents of the furnace and the bricks is the chief cause of the destruction of the latter. Bricks free from iron oxide, and the exercise of care to prevent the formation of this oxide, are recommended. Deterioration by dust may be partially prevented by keeping the amount of dust produced (especially when charging) as low as possible, by suppressing the dust before it reaches the regenerators, and possibly by using neutral or basic bricks made of bauxite, serpentine, steatite, limestone, dolomite, and magnesian limestone, though the application of these materials opens up a wide field of research. To resist destruction in blast-furnaces and cupolas, the composition and texture of the bricks must be adjusted, and bricks used which are free from iron oxide. Abrasion is only important in blast-furnaces and cupolas, and in these it is increased by the formation of a friable scar and by careless charging. Differential movements tend to general disintegration and open up cracks and joints into which corrosive slags and vapours may penetrate. Other factors concerned are workmanship, regulation of temperature, adjustment of the-rods, variation in shape and size of fire-bricks, and the use of damaged bricks.

—A. B. S.

Refractory materials used in the iron and steel industries: Standardisation of—H. B. Cross-shaw. Trans. Faraday Soc., 1917, 12, 166—169.

STANDARD specifications for any particular industry must state to what furnaces and portions of furnaces the tests apply, and before limits can be set the chemical and physical conditions prevailing in each part of every furnace typical of the industry must have received full investigation. The following suggestions are merely tentative:—*Mineral composition* should be determined by means of analysis and microscopical examination of thin sections. *Texture* should be described in terms of precise form, size, and manner of aggregation of the particles. *Uniformity of shape and size* should be kept within specified limits. *Position marks* should be used to prevent errors in laying the bricks. The *soffening point* should be determined under strictly specified conditions. *Permeability* should be determined by partially immersing a cube of the material in molten slag and then comparing its porosity with that of an untreated sample; the nature of the penetration should be studied in micro-sections. *Resistance to sudden changes in temperature* should be tested by raising the sample to a definite temperature, cooling rapidly under stated conditions, and then determining the crushing strength. *Dilatation* is measured by measuring a sample when cold and then at a prescribed high temperature. (No method has yet been devised for this.) *Permanent expansion and contraction* should be measured as in the Institution of Gas Engineers' specification (this J., 1912, 612). *Hardness* is determined by an abrasion test. *Crushing strength* tests are useful in conjunction with other tests.—A. B. S.

Reactivity of silica with the oxides of calcium, barium, and strontium in the solid state, Hedvall. See VII.

PATENTS.

[Glass] *insulator*. F. M. Locke, Victor, N.Y. U.S. Pat. 1,225,147, May 8, 1917. Date of appl., Sept. 1, 1914.

A HEAT-RESISTING glass of low coefficient of expansion (not more than 0.000005) is formed by fusing

together relatively large amounts of silicic material with a boron compound, cryolite, and a small amount of an alkali.—B. N.

Glass furnace: Regenerative—C. Menzel, Lommatzsch. Ger. Pat. 295,933, June 15, 1916. Addition to Ger. Pat. 289,827 (this J., 1916, 424).

THE roof of the furnace chamber is provided with projecting ribs, whereby the heating gases passing from the inlets on one side to the outlets on the other acquire a rotary motion, which promotes their action upon the glass mass.—C. A. M.

Saggars. W. L. Aynsley and G. Reynolds, Longton, Staffs. Eng. Pat. 105,995, May 12, 1916. (Appl. No. 6796 of 1916.)

IN a cylindrical saggur for firing earthenware in a Dressler tunnel kiln, the sides and bottom are perforated to admit the hot gases to the earthenware, and the upper edge may also be indented. The base may be perforated to receive the lowest thimble-supporting members for the ware. In a rectangular saggur the sides, ends, and base are perforated, and the sides may be lower than the ends so that the saggars may be placed one above the other, leaving longitudinal slots. The upper edges of the side walls may be grooved longitudinally to receive the thimble supports. The base of the saggur is provided with a longitudinal knife-edge support.—W. F. F.

Brick-kiln and method of operating the same. C. E. Vredenburg, Mechanicsville, N.Y., and T. Lacey, Quincy, Mass. U.S. Pat. 1,224,243, May 1, 1917. Date of appl., Feb. 19, 1915.

A FORCED draught of air is supplied to the zone of fuel between the heads of the kiln and passes downward through the fuel. An independent forced draught is supplied laterally to the fuel beneath the head or heads, and the two draughts of air are prevented from mixing.—W. F. F.

Kiln for and method of treating ceramic and similar material. J. T. Underwood and I. M. Justice, Dayton, Ohio, Assignors to Underwood Engineering Co., Detroit, Mich. U.S. Pat. 1,224,978, May 8, 1917. Date of appl., Apr. 17, 1916.

GAS and air are forced into the top of a kiln and are there burned. The outlet flue in the sole is restricted, so that the pressure inside the kiln is greater than that outside and incoming draughts of cold air are prevented. (See Reissue of U.S. Pat. 1,105,724; this J., 1917, 310.)—A. B. S.

Tunnel kiln. C. Dressler, Marlow, England. U.S. Pat. 1,225,318, May 8, 1917. Date of appl., May 21, 1916.

A MODIFICATION of Eng. Pats. 18,114 and 28,617 of 1910 (this J., 1911, 1251) in which a series of sleeves, each with gas- and air-burners, is provided for heating the combustion chambers at several points, in addition to the burner at one end of each chamber.—A. B. S.

Earthenware and the like: Cranks or frames for supporting—during firing. W. L. Aynsley and G. Reynolds, Longton, Staffs. Eng. Pat. 106,145, May 17, 1916. (Appl. No. 7021 of 1916.)

Apparatus for drying sand and the like. U.S. Pat. 1,224,132. See 1.

Tunnel muffle furnaces for burning ceramic ware and heating metals, chemicals, and other materials. Ger. Pat. 295,987. See 1.

IX.—BUILDING MATERIALS.

Cement drain tiles [pipes] and concrete in alkali soils; Durability of —. R. J. Wig, G. M. Williams, A. N. Fimm, S. H. McCrory, E. C. Bebb, and L. R. Ferguson. U.S. Bureau of Standards, Tech. Paper No. 95. J. Franklin Inst., 1917, 183, 625—628.

THE use of concrete has proved unsatisfactory in some of the arid regions of the United States in which the soil contains free alkalis. It is concluded that in such situations only a dense concrete, made with not less than 1 part of Portland cement to 3 parts of aggregate and with a minimum amount of water to give a "quaking" consistency, should be used. Porous concrete is liable to disintegration resulting from the expansion of crystalline salts absorbed by the concrete from the soil. Apparently, the greater the quantity of sulphate and magnesium present and the greater the total concentration of salts, the greater will be the disintegration. The cores should not be removed until several hours have elapsed after casting. Machine-made pipes are more resistant than hand-made ones. Steam curing is not better than sprinkling with water. Sand-cement is not so good as Portland cement. A tar-coating and cement grouting do not prevent the absorption of alkalis from the soil. The addition of ferrous sulphate confers no advantage.—A. B. S.

Extraction of polish from silicate rocks. Ross. See VII.

Reactivity of silica with the oxides of calcium, barium and magnesium in the solid state. Hedvall. See VII.

Deterioration of refractory materials in the iron and steel industries. Cronshaw. See X.

Standardisation of refractory materials used in the iron and steel industries. Cronshaw. See X.

Treatment and utilisation of lead blast-furnace slags. Von Schlippenbach. See X.

PATENTS.

White hydraulic cement and polish salts; Process of making —. C. Ellis, Montclair, N.J., Assignor to Ellis-Foster Co. U.S. Pat. 1,224,454, May 1, 1917. Date of appl., June 29, 1911.

A MIXTURE of a silicate mineral containing potassium with a calcareous substance is heated to a temperature below the volatilising point of the potassium compounds, and the heated mixture is quenched in calcium chloride solution. The product in a subdivided condition is rapidly heated to a clinkering temperature, thus forming a cement clinker, and volatilising the potassium salt, which is separated from the gases.—W. F. F.

Cement mortar [and concrete]; Process of mixing —. M. T. Hochstrasser, Gainesville, Fla. U.S. Pat. 1,225,129, May 8, 1917. Date of appl., July 25, 1916.

FINELY ground cement is sifted into an excess of water to form a colloidal mass. The excess of water is drained off, and the residue is then mixed with the coarser ingredients of the concrete or mortar.—A. B. S.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Ferromanganese in the iron and steel industry. R. J. Anderson. J. Franklin Inst., 1917, 183, 579—592.

IN a statistical review of the industries concerned,

particulars are given of the chief sources of manganese ore and the production of ferro-alloys. The uses of manganese in the metallurgy of iron and steel are described and reference is made to the more limited employment of other deoxidants (aluminium, ferrosilicon, ferrotitanium, etc.) in metallurgy, and also to the use of molten ferro-manganese in the manufacture of special steels. Practically no organised effort to find a substitute for manganese in the iron and steel industry has been made hitherto, and to this end the co-operation of manufacturers and research chemists is now urged.—W. E. F. P.

Steel; Torsional hysteresis of mild —. J. J. Guest and F. C. Lea. Proc. Roy. Soc., 1917, A.93, 313—332.

THE angular strain produced in bars of steel when subjected to a varying torsional force was measured by the displacement of a beam of light reflected from two mirrors attached at a definite distance apart along the bar. For any given value of the torque, the slope of the stress-strain curve, and thus the modulus of rigidity, was found to depend upon the way the stress is changing; at any given stress, including zero stress, it is not a constant quantity but depends on the previous history of the material. Hysteresis loops given by the stress-strain curves on cyclical variation of the load were found to exist at stresses considerably below the accepted elastic limits for mild steel; they increase with the range of loading. By allowing bars which had been overstrained to rest for several days, the width of the hysteresis loop was reduced, and heating to 100° C. had also a marked effect in extending the range in which the hysteresis loop is narrow. This is in accordance with the observation that the elastic limit in compression of cold-drawn steel tubes is raised by tempering at temperatures from 300° to 550° C. Steel in which a condition of overstrain has been produced, e.g., by cutting machinery, may be normalised gradually by a considerable period of rest or rapidly by slight heat treatment. Since fatigue effects depend on the gradual increase of the width of the hysteresis loop with repetition, it would appear that tempering at comparatively low temperatures removes initial stresses and thus considerably increases the resistance of the steel to repetition stress.—J. N. P.

Steel; Embrittling action of sodium hydroxide on mild —, and its possible relation to seam failures of boiler plates. P. D. Merica. Met. and Chem. Eng., 1917, 16, 496—503.

FAILURES at the seams of boiler plates have been traced to the action by alkali on the steel and the effect has been found to be analogous to the brittleness produced during the "pickling" of steel in dilute acids, or when the metal is exposed as cathode during electrolysis. In all these cases, nascent hydrogen is generated on the surface of the metal and diminishes the toughness of the steel. While at ordinary temperatures iron is passive or non-reactive to hydroxide solutions at concentrations between $N/10$ and $2N$, if the concentration of the hydroxide is increased, the passivity disappears and a reaction of the form: $\text{Fe} + x\text{OH} = \text{FeO}_x + x\text{H}$, becomes possible. With $2N$ sodium hydroxide, iron assumes a potential of about 0.2 volt, and with $16N$ sodium hydroxide this increases to about 1.2 volt, at which the formation of hydrogen becomes possible. At higher temperatures, the reaction is more rapid, hydrogen being generated by the action of $N/1$ sodium hydroxide on steel at 150°—200° C. Measurements were made of the tensile strength, and resistance to impact and alternating stress, on samples of steel after exposure in closed

iron vessels to a solution of 13·6N sodium hydroxide, for intervals varying from 5 to 30 days, at temperatures of 100°, 180°, and 280° C. The steel used was in the form of annealed wire of $\frac{1}{4}$ in. diam. and contained C 0·18, P 0·024, S 0·015, and Mn 0·42%. The degree of chemical action was indicated by the pressure of hydrogen generated. The results of the tensile tests showed no effect of the sodium hydroxide on the yield point or on the ultimate strength, and the lowering of elongation was generally within the limits of experimental error. A marked embrittling effect of the sodium hydroxide was shown by the results of the repeated bending test, the number of alternations of stress withstood after treatment at 180° and 280° C. being on an average about 20% lower than the value for untreated metal. The influence of time of treatment showed that the brittleness increased up to about one week, and then decreased, the steel recovering its original mechanical properties either partially or wholly. This effect may be due to the hydrogen liberated during the first period of the action of the alkali, before the oxide is formed by corrosion, being given up in the nascent state and absorbed by the iron, while later the hydrogen formed by the anodic solution of the iron is evolved at the cathode, which is now the electro-negative oxide and can come in contact with the iron itself only by secondary diffusion or after it has assumed the molecular state. After the embrittling action of the alkali has ceased, the metal gradually returns to its original condition through continued exposure to heat, which enables the hydrogen to diffuse out of the material, as in the case of iron which has been "pickled" in acid and which loses the acquired brittleness by subsequently heating for a short time to 100° C. It was found that at a higher temperature the alkali reacts more quickly and to a greater degree than at lower temperatures. With more concentrated alkali, the action was increased; with N/10 alkali at 200° C. no effect on the tensile properties was observed, though there was noticeable corrosion. Samples exposed while under tension in a steel frame showed slightly less tendency to become brittle by the action of alkali. Apart from the view that the action of alkali on the physical properties of steel is due to absorption of nascent hydrogen, the action has been attributed to a penetration of the alkali into the metal, causing an eating away of the amorphous intercrystalline material, which is the first to be attacked. It has also been suggested that sodium hydroxide causes a crystallisation or coalescence of the smaller crystals into larger ones. According to either of these theories, which do not account for the gradual recovery of the original mechanical properties, the brittleness would be similar to that produced by burning or overheating, whereas no increase in grain size was observed as a result of treatment with alkali. Measurements of potential showed that after treatment with concentrated alkali at 100° C. and above, the E.M.F. of samples of steel in contact with dilute sodium hydroxide, was considerably higher than that of the original metal, and by turning off from 0·015 to 0·30 in. from the surface of the metal before measuring, it was found that the effect extends into the specimen for a considerable distance, and that this increase of potential is also produced by immersion for a few minutes in dilute acids or by cathodic polarisation. The embrittling effect of alkali can be prevented, as would be expected from the theory of hydrogen occlusion, by adding an oxidising agent such as sodium bichromate to the solution. Potential measurements showed this action to be one of depolarisation, and the E.M.F. between iron and concentrated solutions of sodium hydroxide was considerably lowered by the

addition of bichromate. The corrosion of samples of steel by alkali was also found to be considerably diminished and of a different character in presence of bichromate. With sodium hydroxide alone, the surface became rough and covered with a porous, loose deposit of black Fe_2O_3 , while with the addition of sodium bichromate, the surface was smooth and covered with a thin, firmly adherent coating of brown Fe_2O_3 . The corrosion of boilers which occurs at the seams and tube caps has been particularly observed in cases where the feed water contains appreciable amounts of sodium carbonate. By dissociation of the carbonate and escape of the carbon dioxide, sodium hydroxide is left and becomes concentrated in the seams by enclosure and leakage outwards. Moreover as the passivity of iron in alkali at low concentrations is diminished by the presence of chlorides, corrosion may take place at low hydroxyl concentrations. Sodium carbonate is also frequently present as a constituent of boiler compounds. Samples of boiler scale or incrustation which ooze through at the seams have been found to contain from 1 to 5% of sodium hydroxide. The remedy against the corrosion in question would appear to consist in the elimination from boiler water of alkali, which can be precipitated by adding ferrous or magnesium sulphate. Sodium chromate, which inhibits the action of the alkali, might also be advantageously added to alkaline water.—J. N. P.

Iron and boron. N. Tschischewsky and A. Herdt. *Rev. Soc. russe Mét.*, 1915, 1, 533—546. *Rev. Mét.*, 1917, 14, Extr., 24—26.

IRON-BORON alloys containing up to 11·54% B were prepared from pure Swedish iron and ferroboron, and their cooling curves determined. For micrographic examination the specimens were cooled slowly and etched with a solution of sodium picrate. The eutectic alloys presented the appearance of pearlite ("boron-pearlite") to a greater degree than the corresponding carbon steels. At 0·08% B continuous masses of ferrite were exhibited, surrounded by thin lines of pearlite; the latter gradually widened and extended as the boron content increased, until the eutectic composition and the maximum of pearlite were reached at 3·1% B. At 3·5% B the formation of prismatic boride crystals ("boron-cementite") commenced; these increased with the boron content and finally agglomerated into masses separated by veins of eutectic. Polished sections of alloys containing more than 8% B were prepared only with difficulty, owing to general brittleness and lack of cohesion. The 8·85% alloy consisted of a mass of long prismatic crystals of the composition Fe_2B . The results of the chemical, thermal, and micrographic analyses are shown in a diagram.—W. E. F. P.

Iron-boron-nickel alloys [boron-nickel steels]. N. P. Tschischewsky and S. Mikhailovsky. *Rev. Soc. russe Mét.*, 1915, 1, 547—559. *Rev. Mét.*, 1917, 14, Extr., 16—21.

THE effect of boron upon iron is similar to that of carbon as regards progressive hardening, but more intense; the hardness is accompanied by great brittleness. In seeking to produce ternary alloys which, while retaining the hardness of the iron-boron series, would also possess sufficient tenacity for commercial requirements, nickel was employed as the alloying metal. From pure Swedish iron (C 0·1%), ferroboron (B 19·56, C 0·17%), and pure nickel, ten series of alloys were prepared containing (1) C 0·05—2·27%, B and Ni none; (2) B 0·0—4·32%, Ni none; (3) B 0·0—4·41, Ni 4·7—5·0%; (4) B 0·0—1·21, Ni 10·0—10·7%; (5) B 0·0—0·78, Ni 0—20%; (6) B 0·73—1·04, Ni 0—22%; (7) B 1·21—1·42, Ni 0—25%; (8) B 2·17—2·76,

Ni 0.0—19.81%; (9) B 3.15—3.90, Ni 0—25%; and (10) B 4.24—4.41, Ni 0—10%. Diagrams are given showing the Brinell hardness of the alloys as a function of the boron and nickel content, respectively. In the absence of nickel the hardness increases with the boron content up to 2%, then decreases as the boron is increased to 2.4%, and again increases between 2.4 and 4.32% B. The effect of nickel is to increase the hardness still more, without changing the general form of the curves. Under the pneumatic hammer, only the alloys of highest boron content were brittle when hot. Up to 4.32% B the alloys were still forgeable at red heat; but at 2% B the alloys were brittle in the cold state. The fragility of the iron-boron alloys in the cold was increased by the addition of nickel; but with increasing nickel the alloys became more forgeable owing to the lowering of the forging temperature. The brittleness of the alloys in the cold state is attributed to the presence of a fusible eutectic which increases in proportion with the nickel content; the authors are of opinion that the forgeable alloys will find practical applications by reason of their extreme hardness.

—W. E. F. P.

Cyanide solutions; Solvent power of — [for gold].

H. R. Edmonds. Monthly Jnl. Chamber of Mines of W. Australia, 1916, 143. J. Chem. Met. Soc. S. Africa, 1917, 17, 160.

THE solvent action of zinc sodium cyanide solution on strips of gold in the absence of free lime was found to be only 5—6% of that of sodium cyanide solution of nearly equivalent strength (0.14% KCN). The retarding effect of free lime increased with its concentration, and with about 0.07% of CaO, sodium cyanide was almost without action after 16 hours' agitation, while zinc sodium cyanide dissolved a very small amount of gold. Thiosulphates did not affect the solvent power adversely, but were reduced in contact with zinc dust, with formation of zinc sulphide. Thio-cyanates were not thus reduced.—W. R. S.

Manganese-gold alloys. L. Hahn and S. Kyropoulos. Z. anorg. Chem., 1916, 95, 105. Rev. Mét., 1917, 14, Extr., 27—30.

THE manganese employed in the preparation of the alloys was obtained by the aluminothermic reaction and contained Mn 91.7, Al 5.3, Fe 0.7, Si 0.5, and Cu 0.4%. The curve showing the solidifying points of the alloys has a distinct maximum at 50 atomic % Au, and two minima at 32½ and 77½ atomic % Au. The alloys were grey in colour up to 62.5, but yellow between 75 and 87.5 atoms % Au; all were homogeneous in structure. Dendritic and polyhedral crystallites were present in those containing up to and above 50 atoms % Au, respectively. The dimensions of the latter form increased with the percentage of gold; the manganese content of the dendritic crystallites decreased from the centre towards the periphery. The velocity of diffusion of gold in manganese appeared to be very slow. The alloys were very brittle at about 55, difficultly forgeable between 55 and 62.5, and easily forgeable above 62.5 atoms % Au. Specimens were exposed to the action of hydrochloric acid for periods up to 1157 hrs., and the losses of manganese and gold determined. The results were in general agreement with Tamman's theory of solubility (Z. anorg. Chem., 1914, 90, 297).—W. E. F. P.

"Nichrome"; Analysis of cast —. E. W. Reid. J. Ind. Eng. Chem., 1917, 9, 488—490.

FOR the analysis of cast nichrome, which usually

contains Ni 58—62, Fe 23—26, Cr 8—14, Mn, Zn, and Si 0.5—2.0, and C 0.2—1.0%, the following method is submitted as affording satisfactory results:—*Silicon.* 2.5 gms. of the alloy (turnings) is dissolved in *aqua regia* (6HCl:1HNO₃) and two evaporations to dryness are made to render silica insoluble. The ignited residue is treated with hydrochloric and a little nitric acid, the liquid diluted and filtered, and the "silica insoluble" ignited and weighed. As the latter usually contains particles of undissolved metal and oxides, the silica is removed, and the silicon determined, by two evaporations with hydrofluoric and sulphuric acids; the final residue is boiled with hydrochloric acid, any insoluble matter being fused with sodium peroxide and the melt dissolved in hydrochloric acid. The combined acid solutions are diluted to 500 c.c. and aliquot portions used for subsequent determinations. *Nickel.* The volumetric cyanide process is preferred as being more rapid and accurate than the dimethylglyoxime method in the presence of iron, manganese, chromium, zinc, vanadium, and tungsten. In this process the slightly ammoniacal nickel solution, containing a known amount of silver iodide in suspension and to which excess of tartaric or citric acid has been previously added to prevent precipitation of iron, etc., is titrated first with a standard solution of potassium cyanide (containing free alkali) until the silver iodide is completely dissolved, and then back with standard silver nitrate until a faint opalescence is obtained; the method is an adaptation of Moore's process described in Sutton's "Volumetric Analysis," 9th Ed., 1904, p. 251. *Iron, chromium, and zinc.* The first two constituents are precipitated together by ammonia in the presence of ammonium chloride in excess, the precipitate being filtered off and the filtrate set aside for the determination of zinc. *Iron.* The precipitate is dissolved in hydrochloric acid and the solution made strongly alkaline with sodium or potassium hydroxide, when excess of bromine water is added and the liquid boiled and filtered. The iron precipitate is next re-dissolved in hydrochloric acid and re-precipitated as before, then re-dissolved in hydrochloric acid and re-precipitated by ammonia, and finally re-dissolved in sulphuric acid and the solution reduced with zinc and titrated with standard potassium permanganate. *Chromium.* The combined filtrates from the iron precipitation are acidified with sulphuric acid and cooled to 20° C.; excess of manganous sulphate is then added, followed by excess of standard ferrous ammonium sulphate and titration with standard permanganate. *Zinc.* The filtrate from the iron-chromium precipitation is evaporated nearly to dryness, treated with concentrated nitric acid and evaporated to about half bulk, when excess of potassium chlorate is added and the liquid boiled, diluted, and filtered through a Gooch crucible. The solution is then neutralised with ammonia and heated to boiling, when a slight excess of dimethylglyoxime solution is added and the nickel precipitate removed, the filtrate being subsequently acidified with hydrochloric acid, heated to 70°—80° C., and titrated with standard potassium ferrocyanide. *Manganese.* An aliquot portion of the acid solution is evaporated almost to dryness, treated with nitric acid, and evaporated to about half bulk, when excess of potassium chlorate is added, the liquid evaporated to small volume, and a second addition of chlorate made to complete the precipitation of manganese. The liquid is then diluted and filtered through asbestos, the precipitate being dissolved in excess of standard ferrous ammonium sulphate and the solution titrated back with standard permanganate. *Carbon* is determined by direct combustion in a current of oxygen or by the method described in Blair's "Chemical Analysis of Iron and Steel," 7th Ed., 1912, p. 134.—W. E. F. P.

Phosphorus: Determination of— in zinc phosphide. G. Libéri. *Annali Chim. Appl.*, 1917, 7, 144—151.

THE zinc phosphide is decomposed with dilute sulphuric acid, and the liberated hydrogen phosphide is absorbed in a solution of silver nitrate. The resulting precipitate is decomposed when the liquid is diluted with water: $(\text{PAg}_3 \cdot 3\text{AgNO}_3) + 3\text{H}_2\text{O} = 6\text{Ag} + 3\text{HNO}_3 + \text{H}_3\text{PO}_3$. The decomposition flask is fitted with a funnel provided with a stop cock, and communicates with an absorption tube with 8 to 10 bulbs, followed by a Peligot tube, and with a Kipp apparatus, from which a current of dry carbon dioxide can be admitted. The air is first displaced by this gas, 0.2 to 0.3 grm. of the zinc phosphide introduced, the gas again passed through the apparatus, and about 20 c.c. of water and 50 c.c. of dilute sulphuric acid admitted through the funnel. Reaction takes place in the cold, but it is necessary finally to heat the flask gently for about 30 mins., the slow current of carbon dioxide being meanwhile continued. The contents of the absorption vessels are then transferred to a beaker, and the tubes washed out first with nitric acid and then with water. The silver is precipitated from the solution by means of hydrochloric acid in slight excess, the liquid filtered, and the phosphoric acid in the filtrate precipitated in the usual way and weighed as magnesium pyrophosphate. The weight of the precipitate multiplied by 0.2787 gives the quantity of phosphorus in the zinc phosphide.—C. A. M.

Tin-cadmium and tin-bismuth alloys: Constitution of—. A. Bucher. *Z. anorg. Chem.*, 1916, 98, 97—127. *J. Chem. Soc.*, 1917, 112, ii., 211.

SMOOTH rods were obtained by melting the alloys *in vacuo*, forcing them up into an evacuated glass tube, and subsequently breaking away the glass. The electrical conductivity and its temperature-coefficient, and the thermo-electric force were determined on the rods, silver being used as comparison metal. The results showed that tin and cadmium are reciprocally soluble to the extent of 3% in the solid state, the conductivity and thermo-electric curves being straight between those limits. The solubility of tin in solid cadmium diminishes with falling temperature. These results were in accord with the micro-structure of the alloys. Tin will hold up to 14% of bismuth, and bismuth up to 1.5% of tin in solid solution. The conductivity temperature-coefficient and the thermo-electric curves of the tin-bismuth alloys show strongly marked discontinuities at the eutectic composition. This appears to be connected with the micro-structure, alloys on the tin side of the eutectic point being fine-grained, whilst those containing free bismuth have a very coarse structure.

Ore flotation: Theory of—. H. P. Corliss and C. L. Perkins. *J. Ind. Eng. Chem.*, 1917, 9, 481—488.

FROM a consideration of practical and theoretical data it is concluded that, to be capable of flotation, an ore particle must pass to the interface between oil and water, or completely enter the oil phase. In the absence of oil the particle must pass to the interface between water and air, but the force holding the particle to the bubble is much greater when oil is present. In addition to its value as a lifting agent, the bubble serves to produce a large air surface in contact with the pulp, and as this surface is covered to a greater or less extent by an oil film, a small amount of oil is very efficient. The emulsification of the oil should be sufficient to last during the actual flotation period in pneumatic processes, but should in no case be so com-

plete as to prevent the transference of oil to the bubble surface. The harmful effect of certain colloids and so-called "flotation poisons" is due to their property of causing too stable an emulsion, or of being adsorbed on the oil film at the bubble surface and thus preventing mineral attachment. The froth formed is attributable to the soluble portion of the flotation mixture, which produces a variable surface tension, or to finely divided or colloidal materials. All the above factors are affected more or less by the presence of acids, alkalis, and salts, but with the exception of colloidal charges, electrical effects are not important in flotation. All solids possess the inherent property of adhering to oil or water to a certain degree, and under the conditions of flotation treatment these forces tend to come to equilibrium with the interfacial tension between oil and water at some definite contact angle. If the substance is smooth and shiny (e.g., polished metal or newly fractured sulphide crystal) the liquid first touching it is easily pushed back to the equilibrium position when brought to the interface with another liquid, but if the substance has a dull (i.e., capillary) surface, so that the liquid first wetting it is strongly held in its pores, no interfacial properties may be exhibited although the same material might show even a preference for the second liquid if the particles were smooth.

—W. E. F. P.

Blast furnaces: Air drying for—. L. Canamen. *Proc. Eng. Soc. W. Pa.*, 1917, 33, 199—204.

A 30% SOLUTION of calcium chloride neither gains nor loses water in contact with air at the ordinary temperature, but becomes very hygroscopic when cooled to -9°C . Air is dried by passing it, in counter-current, through the calcium chloride solution maintained at the proper temperature. Having become diluted through absorption of moisture, the brine is concentrated in evaporators and passed through cooling coils, when it is again ready for use. The process is continuous, requires little labour, and obviates the high temperature required for dehydrating the salt. The cost of the necessary machinery is estimated at one-quarter of that required for the dry-cold process.—W. R. S.

Lead blast-furnace slags: Treatment and utilisation of—. F. von Schlippenbach. *Metall u. Erz*, 1916, 13, 437. *Chem.-Zeit.*, 1917, 41, Rep., 78.

THE molten slag is allowed to stand, and to cool partially, in large vessels, whereby matte and lead settle to the bottom or adhere to the walls, the inner liquid slag only being removed. By this means about one-half of the lead and silver contents can be saved. The slag is not suitable for granulation as its sulphur content prevents its use for builder's sand or for concrete buildings; it may, however, be used for the manufacture of slag bricks, or, if broken up, for concrete foundations and for road-making. It is possible that it would pay to recover zinc oxide from it.—E. H. T.

Capillary phenomena and their importance in technical processes [dyeing, etc., and ore concentration]. Shorter. See VI.

Deterioration of refractory materials in the iron and steel industry. Cronshaw. See VIII.

Standardisation of refractory materials used in the iron and steel industry. Cronshaw. See VIII.

Palladium-gold crucibles as platinum substitutes. See XXIII.

Mercury still [for laboratory use]. Duschak and Spencer. See XXIII.

PATENTS.

Steel ingots: Casting of — W. G. Armstrong, Whitworth, and Co., Ltd., and H. H. Ashdown, Newcastle-on-Tyne. Eng. Pat. 105,617, Apr. 20, 1916. (Appl. No. 5802 of 1916.)

INGOTS of large size such as for use in the manufacture of guns and marine forgings, which may weigh 100 tons or more, are cast in a mould having a cooling medium circulating in its walls in such a manner that the sides of the ingot are quickly cooled and the segregation of non-metallic material in the main body of the ingot is prevented. The mould is provided in its walls with pipes through which the cooling medium, such as air or water, is circulated, the piping being divided into independently controlled sections. The metal is admitted by a feeding head of usual construction and generally the sides of the ingot are first cooled and then the metal is cooled from its base upwards. In some cases, especially when very large ingots are being cast, the operation takes a considerable time and the upper portion of the mould becomes hot before the level of the metal reaches it, and it may be desirable to cool this portion of the mould early in the operation. An increase of the life of the mould is also secured by this system of inside cooling, which avoids the heavy stresses otherwise developed by the great differences of temperature between the inside and outside faces of the mould.—J. N. P.

Steel ingots: Manufacture of — G. A. Wilson, Middlesbrough. Eng. Pat. 105,875, Nov. 29, 1916. (Appl. No. 17,119 of 1916.)

To prevent the formation of cavities in the upper part of steel ingots when cast in moulds, the top surface is covered with blast-furnace or other slag wool. A heavy cover of iron plate or brick is used to give a downward pressure and to prevent loss of heat. The top surface of the ingot has a concave depression when solid.—W. F. F.

Steel: Manufacture of — F. D. Carney and L. B. Lindemuth, Bethlehem, Pa. U.S. Pat. 1,223,030, Apr. 17, 1917. Date of appl., Nov. 20, 1916.

BESSEMERISED metal is charged into a basic open-hearth furnace together with sufficient manganese-bearing material to produce a slag of which the manganese content is sufficiently high to cause a portion of the manganese to enter the metal of the bath beneath it. The slag should contain at least 10% and the metal at least 0.15% Mn.—W. H. P.

Metallic coatings: Process for making — by means of a compressed gaseous medium. G. Stolle, Kiel, Germany. Eng. Pat. 12,719, May 23, 1914. Addition to Eng. Pat. 23,289 of 1913, dated Oct. 21, 1912 (this J., 1917, 294).

As an improvement on the original process, in which partly or wholly volatilised metal is blown against the articles in the open, the present addition has for its object the lowering of the vaporising temperature of the coating metal, by the use of a vacuum chamber, so that inflammable or similar articles may be coated without injury. The metal vapour from the volatilising chamber is drawn through a suction nozzle which acts as an ejector and is operated by compressed gas. A partial vacuum is thus formed in the chamber, while the volatilised metal particles are cooled by the gaseous current before impinging on the article under treatment.—W. E. F. P.

Aluminium or aluminium alloys: Coating of — with other metals. Clement Talbot, Ltd., and P. E. Kneil, London. Eng. Pat. 105,971, May 3, 1916. (Appl. No. 6362 of 1916.)

ALUMINIUM articles are heated and cleaned by

abrasion while hot, and the surface is coated with an aluminium solder. A less corrodible metal such as tin is then rubbed on to the coating of solder while still hot. The method is particularly applicable for lining bearings with white metal such as Babbitt metal, the white metal being run in, in the usual way, after coating with solder. A suitable solder consists of tin 81%, zinc 14.58%, aluminium 3.61%, and commercial phosphor tin 0.78%.—W. F. F.

Metals [iron]: Vapour treatment of — [by zinc]. Machine for continuous treatment of metals.

(A) W. A. Darrah and S. Trood, Wilkesburg, (B) S. Trood, New Castle, Pa., Assignors to Industrial Development Co. U.S. Pats. (A) 1,224,339 and (B) 1,224,340, May 1, 1917. Dates of appl., Apr. 4 and June 16, 1914.

(A) THE metal (iron) is heated in the presence of the metal vapour (zinc) under reduced pressure in a chamber from which other gases and vapours have been previously exhausted. (B) The heating chamber of the apparatus is provided with a seal of the liquid coating metal and with a trap for preventing loss of the latter. The seal is designed to control the passage of vapour to and from the chamber and to withstand the pressure of the atmosphere when the chamber is exhausted.

—W. E. F. P.

Tempering metal: Process and apparatus for forming and — The Rockefeller Motor Co., Cleveland, Ohio, Assignees of T. J. Fay, Brooklyn, N.Y., U.S.A. Eng. Pat. 101,142, Apr. 26, 1916. (Appl. No. 6000 of 1916.) Under Int. Conv., Aug. 11, 1915.

THE apparatus is particularly suitable for tempering steel plates in the manufacture of springs. The steel plate is heated to a temperature just above recalcence, e.g., to 1460° F. (793° C.) to 1535° F. (835° C.), and placed in suitable dies which are resiliently pressed together by counterweights through the medium of springs. The dies are each composed of thin parallel plates having their edges serrated so that the area in contact with the spring plate is minimised, and an adjustable cam may be provided at the ends to impart an additional curvature to the spring. Electrically operated means are provided whereby the spring plate is clamped, lowered while still just above recalcence temperature through two jets of quenching liquid directed longitudinally over the plate toward the centre, and then into a tank containing oil above and water below. The plate is then withdrawn after a predetermined interval which may be varied by varying the distance moved through the liquid or by varying the rate of travel. The surface temperature on withdrawal should be about 100° F. (205° C.) and the final uniform temperature about 850° F. (455° C.).—W. F. F.

Metals: Winning — from sea-water or other natural solutions. O. Nagel, Laussingrande, Austria. Eng. Pat. 103,310, Jan. 12, 1917. (Appl. No. 636 of 1917.) Under Int. Conv., Jan. 8, 1916.

IN obtaining precious metals such as gold, silver, platinum, thorium, radium, or the like, from sea water, by precipitation on adsorbents such as fullers' earth, clay, crushed bricks, light granulated blast furnace slag coated with colloidal ferric hydroxide, colloidal ferric hydroxide, infusorial earth, coal, coke, peat charcoal, wood, etc., the water is first filtered or centrifuged to remove suspended matter. Alternatively the adsorbing mass is cleaned intermittently by back washing, or the two methods may be combined.—W. F. F.

Ores; Concentration of — [by flotation]. H. L. Sulman, E. Edser, and Minerals Separation, Ltd., London, Eng. Pat. 105,627, Apr. 20, 1916. (Appl. No. 5851 of 1916.)

IN an agitation-froth process for the concentration of oxide or carbonate ores, a small regulated quantity of soap is used as the frothing agent. Either the metalliferous particles or those of the gangue are floated in preference according to the nature of the ore, and the particular soap and quantity used. The amount of salts present in the water used, which would bring about precipitation of the soap, must be ascertained, or the liquid should, in the first place, be made slightly alkaline to avoid this decomposition. In cases where both the gangue and metallic particles tend to be floated together, the recovery and concentration of the mineral in the froth can be improved by the addition of hydrocarbon oils, sodium silicate, phosphate, or hydroxide, or silicic acid sol. A hot liquor is in some cases favourable to the separation. —J. N. P.

Ores; Washing and classifying apparatus for —. C. R. Pinette, Chalon-sur-Saône, France, Eng. Pat. 105,690, July 31, 1916. (Appl. No. 10,802 of 1916.)

THE ore is fed on to an inclined screen suspended in a tank filled with water. The screen receives a rapid reciprocating motion, and the coarser particles of ore are delivered from the upper edge, which is above the level of the water, into an outlet passage. The finer particles, falling through the screen, are pushed to the sides of the tank by a right and left-handed screw, and then raised by elevators, working in inclined passage-ways, along with a certain amount of water, to overflow outlets. Several apparatus may be mounted in series, with various sizes of screen. The feeding of water to the first tank then suffices for the whole series.

—W. H. P.

Copper; Obtaining [by electrolysis] of — from its ores. A. A. Lockwood, London, Eng. Pat. 105,772, Jan. 21, 1916. (Appl. No. 1900 of 1916.)

PULPED copper ore passes from a reservoir, where it is kept agitated by an air jet, to an electrolysing vessel containing cathodes consisting of iron plates, and anodes of lead. The iron plates are dipped in boiling tar and covered with powdered graphite which may be coated with copper. Alternatively the copper may be deposited on the tarred plates without the use of graphite. The deposited copper may be removed on warming the plates. (See also Eng. Pat. 22,627 of 1911; this J., 1912, 196.)—W. F. F.

Copper; Hydrometallurgical apparatus for the recovery of —. E. R. Weidlein, Thompson, Nev., Assignor to Metals Research Co., New York, U.S. Pat. 1,223,451, Apr. 21, 1917. Date of appl., Feb. 21, 1916.

COPPER-BEARING material is leached with sulphuric acid and the solution passed into a tall cylindrical tank which is provided with an annular jacket through which heated oil is circulated in order to raise the temperature of the charge. The copper is precipitated by admitting sulphur dioxide under pressure, the precipitated metal is withdrawn at the base of the tank, and the remaining solution circulated continuously with the solution in the leaching tank. —J. N. P.

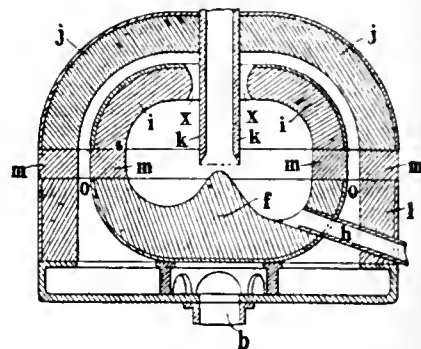
Copper; Hydrometallurgy of —. J. C. Greenway, Warren, Ariz., and H. W. Morse, Los Angeles, Cal., U.S. Pat. 1,221,458, May 1, 1917. Date of appl., June 5, 1916.

ORE containing copper and iron is treated with sulphuric acid, and copper is precipitated from a

portion of the solution by means of metallic iron. The ferric sulphate in another part of the solution is reduced to ferrous sulphate partly by the action of sulphur dioxide and partly by the action of precipitated copper obtained as above. The precipitated copper is thus dissolved, the solution is acidified, and the copper finally deposited by electrolysis. —W. F. F.

Furnace [; Melting —]. A. C. Ionides, jun., London, Eng. Pat. 105,810, May 11, 1916. (Appl. No. 6757 of 1916.)

IN a melting furnace of the reverberatory hearth type, the material to be melted is fed by the tube, *k*, into the annular crucible, *f*, having a removable cover, *i*, and contained in a casing, *l, j*. A combustible gaseous mixture, distributed according to



the system described in Eng. Pat. 102,983 (this J., 1917, 206), is supplied to tangential inlet nozzles passing through both walls of the ring, *m*, into the crucible. The combustion products leave by the aperture, *x*, space, *o*, and pipe, *b*, and the molten metal is drawn off by the pipe, *h*. In a modification, the pipe, *b*, extends upward into the crucible to provide an additional passage for the gases. —W. F. F.

Calcining furnace [; Electric —]. W. R. Clymer, Lakewood, Ohio, Assignor to National Carbon Co., U.S. Pat. 1,223,475, Apr. 24, 1917. Date of appl., Oct. 16, 1915.

A SHARP furnace, with provision for heating the charge by means of electrodes placed horizontally near the base, is provided with a conveyor consisting of an inclined tube which permits the material to slide slowly into the top of the furnace. The inclined tube is surrounded by an enclosed space through which hot gases from the furnace are passed in order to preheat the charge before admission to the furnace. Heat is also supplied by the combustion of volatile products evolved from the charge in the conveyor, which escape through perforations in the central tube and burn on mixing with air in the surrounding chamber. —J. N. P.

Refractory auriferous ores; Treatment of —. J. H. Niemann, Adelaide, S. Australia, U.S. Pat. 1,222,789, Apr. 17, 1917. Date of appl., July 14, 1913.

THE raw ore is treated in the presence of selenium or a selenium compound with a weak cyanide solution in a non-oxidising atmosphere. The gold is precipitated from the resulting selenocyanide solution in the form of a slime. The slime may be distilled to recover values other than gold, and is finally retorted in a reducing atmosphere. —W. H. P.

Smelting furnace; Oil or gas burning—. O. P. Moore, Spokane, Wash. U.S. Pat. 1,225,470, May 8, 1917. Date of appl., Aug. 2, 1916.

ORE is fed through the opening, 21, into the pre-heating and reduction chamber, 18, the wedge, 34, deflecting it on to the ledges, 35. The rods, 30, are reciprocated at intervals to feed the ore through the opening, 26, into the smelting or refining vessel, 9. Two burner jets, 6, are directed on to the surface of the material. A system of air flues and heating flues surrounds the vessel, 9, so that a draught is produced through the discharge chamber, 17. The air and heating flues are so arranged that a partial upward draught is produced in the pre-heating chamber, 18, when the discharge chamber, 17, is closed.

—W. F. F.

Annealing articles; Method of—. A. L. Pollard, Batavia, N.Y. U.S. Pat. 1,222,793, Apr. 17, 1917. Date of appl., Dec. 1, 1916.

A LAYER of articles to be annealed is placed in an oven covered with a layer of protecting material, and heated till malleable. Another layer of articles and another layer of protecting material is added and the heating continued. The process is continued till the oven is filled, and when the last layer is sufficiently heated the whole mass is allowed to cool slowly.—W. H. P.

Fine ores and flue dust; Agglomeration of—. W. Schumacher, Berlin, Germany, Assignor to General Briquetting Co., New York. U.S. Pat. 1,222,893, Apr. 17, 1917. Date of appl., Jan. 26, 1916.

FINELY divided particles of fine ores of which the sintering and melting points are relatively close together, are formed into round or egg-shaped briquettes, which are exposed to a temperature between the sintering and melting points of the ore. While in the sintering or roasting zone the briquettes are maintained in constant movement.

—W. H. P.

Magnetic objects; Apparatus for testing—. F. P. Fahy, Washington, D.C. U.S. Pat. 1,223,377, Apr. 24, 1917. Date of appl., Sep. 23, 1912.

THE effect of heat treatment (e.g., annealing) on a material is determined by electromagnetically comparing the test-piece with another test-piece of the material, of the same shape, but which is in a thoroughly annealed condition. The two test-pieces are subjected simultaneously to different portions of the flux of a changing magneto-motive force, and the differential of the induction produced is measured.—J. N. P.

Vanadium-bearing ores; Method of treating—. R. S. Davis, Newmire, Colo., Assignor to Primos Chemical Co., Primos, Pa. U.S. Pat. 1,223,567, Apr. 24, 1917. Date of appl., July 28, 1911.

THE ore is subjected to a chloridising roast, the roasted ore is leached with water, and the undissolved residue then leached with a solution prepared by dissolving in water the gases evolved during the roasting. The vanadium is thus recovered as soluble vanadate.—J. N. P.

Zinc and iron; Method of recovering—from solutions thereof. C. E. Baker, Chicago, Ill. U.S. Pat. 1,224,657, Apr. 24, 1917. Date of appl., Jan. 26, 1917.

THE method consists in precipitating the two metals simultaneously in the form of a non-compact deposit, and then effecting a separation by vaporising the zinc.—W. H. P.

Aluminium-calcium alloy and process of making the same. H. S. Cooper, Assignor to The Cooper Co., Cleveland, Ohio. U.S. Pat. 1,224,562, May 1, 1917. Date of appl., Sept. 29, 1916.

FOR use in casting, an alloy of aluminium with not more than 8% of calcium is claimed. The alloy is ductile and specifically lighter than aluminium.

—W. E. F. P.

Nickel and nickel alloy; Flux for welding—. R. Samseutheuer, Assignor to Autogenwerk Sirius, G.m.b.H., Dusseldorf-Eller, Germany. U.S. Pat. 1,224,418, May 1, 1917. Date of appl., Dec. 29, 1914.

THE flux consists of a mixture of "alkali, metal chloride and chromium"; part is applied in the form of a paint to the edges of the weld and to the filling wire, and part is incorporated in the filling wire.—W. E. F. P.

Ores; Method of treating [extracting metals from]—. H. L. Friberger, Eureka, Kans., Assignor to V. C. Joslyn and C. H. Keller, El Paso, Tex. U.S. Pat. 1,224,917, May 8, 1917. Date of appl., June 3, 1916. Renewed Mar. 20, 1917.

FINELY-DIVIDED ore containing precious metals is treated with a solution containing cyanide and an alkali resinate, and subdivided air currents are blown through. Part of the ore is thereby "frothed" and the solution is filtered and treated for the recovery of the precious metals. The treating solution is made by dissolving a resinous substance in alcohol, adding alkali till neutral, distilling off superfluous solvent, and adding cyanide solution.—W. F. F.

Soldering compound. F. E. J. Litot, Wilkinsburg, Pa. U.S. Pat. 1,224,941, May 8, 1917. Date of appl., June 5, 1916.

A SOLDERING alloy contains zinc, tin, and lead, the zinc being in smaller quantity than the tin or lead, to reduce the melting point. As an example, the proportions, zinc 25 parts, tin 45 parts, lead 55 parts, are given.—W. F. F.

Lead sulphide ores; Treatment of—[to produce basic lead sulphate]. P. C. H. West, London. U.S. Pat. 1,225,296, May 8, 1917. Date of appl., Nov. 24, 1915.

POWDERED lead sulphide is fed on to a deep bed of incandescent coke at a temperature below that which would be produced by injecting air, and is volatilised at 1000°–1100° C. at reduced pressure. The vapour is partly oxidised and the oxidation is completed at a lower temperature. Basic lead sulphate is obtained.—W. F. F.

Zinc; Method and apparatus for recovering—from zinc-bearing ore. D. B. Jones, Lake Forest, Ill. U.S.A. Eng. Pat. 106,050, Oct. 25, 1916. (Appl. No. 15,180 of 1916.)

SEE U.S. Pat. 1,213,180 of 1917; this J., 1917, 313.

Sulphating materials [ores]; Method of—. H. B. Hovland, Duluth, Assignee of G. B. Frankforter, Minneapolis, Minn. U.S.A. Eng. Pat. 100,488, May 12, 1916. (Appl. No. 6816 of 1916.) Under Int. Conv., May 15, 1915.

SEE U.S. Pat. 1,159,032 of 1915; this J., 1915, 1256.

Nickel ores; Treatment of —. F. A. Eustis, Boston, Mass., U.S.A. Eng. Pat. 101,285, June 28, 1916. (Appl. No. 9100 of 1916.) Under Int. Conv., Aug. 21, 1915.

SEE U.S. Pat. 1,212,334 of 1917; this J., 1917, 390.

Tungsten; Process for producing homogeneous articles of any desired form out of pure —. O. Voigtlander, Essen, Germany. U.S. Pat. 1,224,212, May 1, 1917. Date of appl. Mar. 22, 1913.

SEE Fr. Pat. 455,313 of 1913; this J., 1913, 919.

Refractory-metal tube. W. D. Coolidge, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pat. 1,226,170, May 15, 1917. Date of appl. Feb. 20, 1915.

SEE Eng. Pat. 8702 of 1915; this J., 1916, 850.

Liquid fuel furnaces. Eng. Pat. 106,077. See I.

Tunnel muffle furnaces for burning ceramic ware and heating metals, chemicals, and other materials. Ger. Pat. 295,987. See I.

Non-abrillion process and apparatus for washing and sorting coal [and ores]. U.S. Pat. 1,221,350. See IIa.

Production of pieces of tungsten carbide of any desired size or shape. Ger. Pat. 295,726. See VII.

XI.—ELECTRO-CHEMISTRY.

Current-potential lines; Some particular cases of —. A. H. W. Aten, Proc. K. Akad. Wetensch. Amsterdam, 1917, 19, 653—670, 768—778. J. Chem. Soc., 1917, 112, ii., 163, 190—191.

THE form of the curve connecting the electrode potential with the current density is considered and it is shown that the limiting current is proportional to the ion concentration of the solution and to the diffusion-coefficient and inversely proportional to the thickness of the diffusion layer.

These considerations are applied to the electrolysis of solutions containing halogen ions with a silver anode. The most favourable conditions for the separation of halogen in the form of silver halide at the anode with a minimum loss of silver by anodic dissolution, deduced from the theory put forward, are for the most part those which have been found most satisfactory according to the empirical experiments which have been made by various observers. The fact that the accuracy with which the halogens can be estimated by this method increases with increase in the atomic weight of the halogen, is due to the diminishing value of the ionic insolubility product of the corresponding silver halides. The conditions favourable to the formation of insoluble metallic compounds by the anodic dissolution of the metal are also derived and found to agree with those indicated by practice. The author's views are also applied to the electrolysis of solutions of complex salts, the alkali silver cyanide solution being specially considered, and it is shown that the conditions under which silver cyanide is deposited on the anode, thereby increasing the resistance and reducing the current, may be deduced from the theory. To avoid this in practice, the current density must not exceed a certain value, which, of course, depends to some extent on the concentration of the solution.

Electro-reduction of nitrates of potassium and lithium by alternating current. J. Kliatchko and C. Binggely. Ann. Chim. Analyt., 1917, 22, 81—81.

THE authors have electrolysed solutions of potas-

sium and lithium nitrate with alternating current under various conditions to investigate the factors determining the extent to which reduction takes place. Rotation of the electrodes is always accompanied by more reduction. The electrode materials used vary in effect but can be arranged in the following order of reducing power: cadmium, lead, zinc, copper. Aluminium becomes coated with oxide and the solution becomes heated. Tables are given showing the effect of varying initial concentration of the nitrates, but no general connection is apparent. Reduction is more rapid in solutions containing sulphuric acid, but the electrode is quickly attacked with the formation of a precipitate of sulphate of the electrode metal.—W. H. P.

Electrolytic analysis with small platinum electrodes. Gooch and Kobayashi. See XXIII.

PATENTS.

Gas reactions; Apparatus for effecting endothermic — by means of an electric arc. J. A. Currie, Toronto, Canada. Eng. Pat. 105,953, May 1, 1916. (Appl. No. 6229 of 1916.)

A PAIR of tubular electrodes, with wide, flat, annular arcing surfaces are arranged opposite to one another, and a relatively thick annular arc is produced between the flat ends, by means of a suitable high-tension current. The air or gas is drawn or forced through the electrodes, and also drawn through the annular arc. The electrodes are cooled, the upper one by an external water-jacket, and the lower one by circulation of water in the hollow walls of the electrode.—J. B. C. K.

Generating electricity; Apparatus for —. S. A. Reed, New York. U.S. Pat. 1,225,175, May 8, 1917. Date of appl. Jan. 16, 1914.

AN extended surface of a fused acid electrolyte, containing a metallic oxide, such as a manganese oxide, which is reducible to a lower degree of oxidation, is subjected to a gas containing oxygen in an oxidising region, and to carbon or hydrogen in a reducing region. The carbon or hydrogen is supplied as fuel independently of the electrodes, and the electrolyte is maintained in a fused condition. The two regions are in open communication below the surface of the electrolyte only, and an electrode is in each case in conductive contact with the electrolyte in the oxidising and reducing regions respectively, the electrodes being included in a suitable circuit.—B. N.

Process of securing combustible fluids from carbonaceous solids. U.S. Pat. 1,224,788. See IIa.

Method of producing carbonic oxide. U.S. Pat. 1,225,396. See IIa.

Electrolytic production of metallic sulphides. Eng. Pat. 105,830. See VII.

Device for electrolysis [of alkali chlorides] with a mercury cathode. Ger. Pat. 295,800. See VII.

[Glass] insulator. U.S. Pat. 1,225,147. See VIII.

XII.—FATS; OILS; WAXES.

Fat; Sources of — in Germany in 1916. W. Fahrion. Z. angew. Chem., 1917, 30, 125—126.

INCREASED cultivation of poppy, rape, and to a less extent of flax, has yielded considerable quantities of oil. Linseed oil was used as an edible oil only in certain districts of Saxony and Silesia. Last year the bulk of the oil from this source was used for munitions, and the remainder was used in the

manufacture of margarine. Sunflowers were also extensively cultivated. According to an American report from Dresden, over 300,000 kilos. of sunflower seed oil was obtained in 1915; but this estimate is decidedly too high seeing that in 1916 only 100 tons of seed was obtained from every 77 tons sown. Horse chestnuts contain in the dry condition about 6% of a yellow oil which resembles rape oil and is edible. The extraction of this oil has now been undertaken by a department of the German War Office, and the residue is used as fodder. The expectations of obtaining fat from yeast have not yet been fulfilled. Experiments made at the close of last year on the removal of the germs from cereals with a view to obtaining the oil, have given much more promising results. Wheat contains 2 to 3% of germs; rye, 2.5 to 4%; barley, 2 to 3.5%; oats, 3 to 4%; and maize, 10 to 14%. The germs contain about 12% of fat and about 35% of protein. The annual production of wheat in Germany is 15 million tons, and if only 1% of germs was separated from 10 million tons, and 10% of oil was obtained from these, the total yield of oil would be 10,000 tons. Millers are now compelled to separate the germs and to deliver them to the War Department. Rye is freed from husks in one machine and then crushed in a second machine, and the germs are separated by sifting. In the case of wheat they are sifted from the coarser and medium grains. The grain oil, when refined, is suitable for the manufacture of margarine, and for other edible purposes. In Austria the Oil and Fat Control has bought up all used coffee grounds to extract from them the 12% of oil which they contain. More than 4000 "fat-retainers" have been affixed to the sewage outlets of different towns, but so far these have not fulfilled expectation. A sample of the crude "fat" was found to contain about 50% of water and dirt. When purified by boiling with dilute sulphuric acid it yielded a yellow-grey fat which would be suitable for technical purposes.—C. A. M.

Fish oils [herring oil]; Chemical composition of —.
J. A. B. Svendsen. Tidsskrift for Kemi, 1916, Heft 14-16. Z. angew. Chem., 1917, 30, Ref., 31.

HERRING oil was found to contain the following fatty acids in approximately the proportions given:—Myristic, 6; palmitic, 17; Bull's C₁₆-acid, 12; stearic, 2; oleic, 7 to 8; isolinolic, 6 to 7; gadoleic, 10; erucic, 16; clupanodonic acid and new acids, C₂₆H₅₀O₂, C₂₂H₃₂O₃ and C₂₂H₃₄O₂, together 7; acids not identified, 10%; and residue from the distillation, 6%.—C. A. M.

Seeds of Spartium junceum; Lipolytic enzyme and oil in —. M. Raffo. Annali Chim. Appl., 1917, 7, 157—164.

THE berries of the tree *ginestra* (*Spartium junceum*, Linn.) contain a lipolytic enzyme which hydrolyses oils, very slightly in an acid medium but to a considerable extent in the presence of sodium carbonate. For example, on treating 10 grms. of sesame oil with 0.5 gm. of the powdered seed for 96 hours at 38° to 40° C. in the presence of 12 c.c. of N/10 sodium carbonate solution, the acidity due to the action of the enzyme corresponded with 19.0 c.c. of N/10 alkali. This was the highest degree of hydrolysis reached. Similar results were obtained with arachis and cottonseed oils. The most favourable alkali concentration was from 8 to 12 c.c. of N/10 sodium carbonate. The berries contain about 10% of a greenish oil, with an aromatic odour and a bitter taste. A sample had the following characters:—Sp. gr. at 15° C., 0.9103; refractometer reading (Zeiss) at 25° C., 73.5°; acid value, 9.1; saponification value, 198.6; iodine value, 134; Hehner value, 89.85; Reichert-Meissl value, 0.41. *Fatty acids*:—Sp. gr. at 17° C.

0.9208; m. pt., 26°—27° C.; and solidif. pt., 21.5° C. The oil may be classed among the semi-drying oils.—C. A. M.

Cottonseed oil; Incomplete hydrogenation of —.
H. K. Moore, G. A. Richter, and W. B. van Arsdel. J. Ind. Eng. Chem., 1917, 9, 151—162.

COTTONSEED oil was partially hydrogenated under varying conditions of temperature, pressure, etc., and the changes in its physical and chemical characters were determined. The relative proportions of oleic and linolic acids in the hydrogenated products were determined by the lead-ether method and from the iodine values of the fractions. It was found that while both linolin and olein were hydrogenated more rapidly at a high temperature (200° C.) than at a lower temperature (125° C.), the linolin was hydrogenated relatively more rapidly at the high temperature, so that under such conditions the olein tends to accumulate. In other words there is a more "selective" hydrogenation of the more highly unsaturated glycerides at the higher temperature. Increasing the pressure (e.g., to 20 and 40 lb.) has the opposite effect to increasing the temperature, the action being less "selective" than at a low pressure. The conditions necessary for obtaining a product with the same iodine value as another, but relatively higher in saturated glycerides and linolin, are the use of a lower temperature, higher pressure, more violent agitation, and a larger percentage of catalyst. The linolin may be hydrogenated to olein with only the slightest increase in the saturated glycerides, by working at a high temperature, low pressure, with little agitation, and with only a small amount of catalyst. The speed of hydrogenation of cottonseed oil increases with the increase in the temperature, pressure, agitation, and amount of catalyst. This increase in velocity of hydrogenation is approximately proportional to the increase in the pressure or amount of catalyst, whilst an increase of 10° C. between 160° and 180° C. (the ordinary temperatures in practice) increases the velocity by about 20%. The solidification point ("titer" test) of the fatty acids first falls to a minimum point before rising, which is in accordance with the fact that a mixture of two solid fatty acids melts at a lower temperature than either of its constituents. To reach a given titer at 125° C. requires about four times as long as when the hydrogenation is effected at 200° C., which corresponds with an average coefficient of about 20% for every 10° C. The chromogenetic substance which gives Halphen's reaction was destroyed after 15 mins.' hydrogenation with 2% of nickel catalyst at 150° to 160° C. The iodine value of the oil had then fallen from 104.9 to 97.6. With regard to the effect of various impurities on the activity of nickel catalysts, it was found that nickel chloride, reduced iron, and sodium chloride, sulphate, and nitrate had no effect, but that sodium sulphide gradually destroyed the activity, whilst sulphur destroyed it immediately.—C. A. M.

Hydroxy-fatty acids; Behaviour of the hydroxyl group of — on catalytic hydrogenation by means of nickel. T. Jurgens and W. Meigen. Chem. Umschau, 1916, 23, 99—102, 116—120. Z. angew. Chem., 1917, 30, Ref., 31.

ON hydrogenating the esters of ricinoleic acid, especially castor oil, with a nickel catalyst as in Normann's method, below 200° C., practically only the double bond is saturated, but above that temperature the hydroxyl group is also reduced, sometimes even more rapidly than the double bond. Ricinoleic acid itself is but little affected at the lower temperature; at the higher temperature a pronounced reduction of the hydroxyl group takes place. In the hydrogenation of castor oil

by means of nickel oxides, as in Erdmann's method, the hydroxyl group is reduced much more rapidly than the double bond. In experiments with 2% of nickel catalyst, under high pressure, the reduction of the hydroxyl group, but not that of the double bond, proceeded more slowly than under atmospheric pressure. The explanation of this is afforded by Le Chatelier's rule, according to which the increase in the tension of the steam caused by the decomposition of the hydroxyl group tends to prevent further decomposition of this group. If the steam produced in the decomposition is allowed to escape from the autoclave, the hydroxyl value of the hydrogenated fat will be considerably lower. — C. A. M.

Hardened oils: Analysis of ——. Identification of hardened marine animal oils and rape oil. W. Normann and E. Hugel, Chem. Umschau, 1916, 13, 131—133. Z. angew. Chem., 1917, 30, Ref., 108—109.

The separation of arachidic acid and identification by its melting point is insufficient in some cases to identify hardened marine animal oils or rape oil. If, however, pure stearic acid is added and the melting point again determined, a higher or a lower value will be found according to the relative proportions of arachidic and stearic acids. The authors employ the neutralisation value for a more precise determination. This is best effected by saponifying the fatty acids with excess of alkali and titrating back with hydrochloric acid. A direct determination with $N/10$ alkali is uncertain on account of the separation of these acids with high melting point during the titration.

— H. J. H.

Fats: By-products of the hydrolysis of ——. (Glycerin from waste fats.) Henkel and Co. Seifenfabr., 1916, 36, 769—770. Z. angew. Chem., 1917, 30, Ref., 108.

CRUDE glycerin, made from waste fatty materials which have undergone some decomposition by fermentation, may show abnormalities on analysis. Its specific gravity may be lower than usual and its oxidation value by the bichromate method may exceed 100%. This has been traced to the presence of *n*-propyleneglycol (trimethyleneglycol). It is stated that the quantitative determination of glycerol in presence of the latter can be made by the isopropyl iodide method of Zeisel and Stritar (this J., 1902, 992). — H. J. H.

Soap substitutes and washing powders. M. Battler, Kunststoffe, 1916, 6, 301. Chem.-Zeit., 1917, 41, Rep., 130.

Soap substitutes now on the market in Germany consist of mixtures of clay, chalk, alkali carbonates, sodium sulphate, sodium silicate, and gelatin or other binding material; a small quantity of boric acid or salicylic acid is added as a preservative. Substances containing saponin are sometimes added to the mixture. A material for washing fabrics is prepared from the tryptic enzyme of the pancreas, but this preparation cannot be used at temperatures above 10° C. A solid soap is made by heating together 10 kilos. of resin, 1.5 kilos. of sodium carbonate, and 3.5 litres of water and then adding 70 kilos. of clay, 5 kilos. of sodium carbonate, and 10 litres of water. The washing powders usually consist of mixtures of sodium or potassium carbonate, ammonium chloride, clay, and saponin, and sometimes perborates; sodium peroxide and carbon tetrachloride are also used in these mixtures. One soap powder which is sold contains 17% of soap, 3% of resin soap, and 80% of fillers, the latter including 50% of sodium carbonate and a quantity

of sodium silicate. The use of an extract of linseed has been proposed as a binding material for soap substitutes. — W. P. S.

Detergents containing saponin: Determination of active oxygen in ——. A. Grün and J. Jungmann, Seifenfabr., 1916, 36, 753—751. Z. angew. Chem., 1917, 30, Ref., 110.

The titration of active oxygen with permanganate in the presence of saponin is difficult and uncertain on account of the foam produced. The latter causes no difficulty in the iodometric determination. Extraction of the saponin with carbon tetrachloride increases rather than decreases the difficulty. Even with materials containing little saponin, extraction with carbon tetrachloride is unnecessary.

— H. J. H.

PATENTS.

Corn [maize] oil: Manufacture of ——. A. W. H. Leanders and H. F. Bauer, Cedar Rapids, Iowa. U.S. Pat. 1,225,661, May 8, 1917. Date of appl., Nov. 3, 1915.

MAIZE is steeped in an acid (sulphurous acid) solution, and then crushed and separated from the germs. The latter are washed in water containing sufficient alkali to neutralise the acid remaining from the steeping process, and are then dried and their oil expressed. — C. A. M.

Emulsions of compound waxes: Method of making — and the product of said method. G. W. Miles, Belmont, Mass. U.S. Pat. 1,221,948, May 8, 1917. Date of appl., July 21, 1915.

PARAFFIN wax, preferably in preponderating proportion, is melted with a relatively hard wax of high m. pt., and the resulting mixture is heated with soap and a suitable quantity of water for the emulsification of the paraffin wax with the soap.

— C. A. M.

Colour concentrate for edible oil or fat compositions. U.S. Pat. 1,221,910. See XIXA.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Turpentine: Oil of — recovered in the digestion of sulphate wood pulp. O. M. Halse and H. Dedichen, Ber., 1917, 50, 623—630.

IN the manufacture of wood pulp by the alkali sulphate process, generally from a mixture of spruce and pine woods, a volatile oil is obtained having a very bad odour due to mercaptans. After elimination of the sulphur compounds, either by fractional distillation or carefully regulated oxidation, the refined oil is very similar to ordinary oil of turpentine and serves as a commercial substitute. The yield of oil per ton of cellulose ranges from 1—1.5 kilos. for spruce and up to 10 kilos. for pine wood. On distillation of the crude oil with steam in presence of mercuric chloride, about 8% of a thick brown resinous fluid remains behind. The purified oil has been subjected to an elaborate process of fractional distillation and separated into two main components: α -pinene in large proportion and β -pinene in small quantity; there were probably also traces of dipentene. The β -pinene has been fully characterised and yields no pinic acid on oxidation with permanganate. This oil is therefore very similar to ordinary oil of turpentine, only differing in the fact that the β -pinene contained in the by-product oil is dextro-rotatory whereas that in the natural oil is laevo-rotatory. The α -pinene apparently is capable of passing through the alkaline digestion process without change, whereas

in the bisulphite process it is converted quantitatively into the stable hydrocarbon, *p*-cymene.

—J. F. B.

PATENTS.

(A) *Titanic oxide product and method of obtaining the same.* (B) *Composite titanic oxide pigment and method for producing the same.* (C) *Method for producing basic titanic sulphate products and pure titanic oxide therefrom.* L. E. Barton, Niagara Falls, N.Y., Assignor to The Titanium Alloy Manufacturing Co., New York. U.S. Pats. (A) 1,223,356, (B) 1,223,357, and (C) 1,223,358, Apr. 24, 1917. Dates of appl. (A), July 27, 1915, (B) and (C) Aug. 29, 1916.

(A) TITANIC oxide, containing traces of chloride, is obtained by heating a mixture of 100 parts by volume of titanium tetrachloride, 200 parts of water, and 35 parts of sulphuric acid to expel hydrochloric acid, and calcining the residue. The oxide is very friable, highly absorptive, with sp. gr. 3.5 to 3.65, white by reflected light, yellowish by transmitted light, and yields a bluish-white paint with oil. (B) A base or an "extender pigment" is suspended in a solution of titanium sulphate, the solution is electrolysed and heated, so as to precipitate basic titanium sulphate on the suspended particles, and the composite precipitate calcined. (C) A solution of titanic sulphate which may have been previously rendered basic by treatment with lime and filtering off the precipitated calcium sulphate, is electrolysed and at the same time heated not quite to boiling point, whereby a basic titanic sulphate is precipitated.

—B. V. S.

Paints and pigments; Manufacture of —. H. Wade, London. From The Titanium Alloy Manufacturing Co., New York. Eng. Pat. 105,962, May 2, 1916. (Appl. No. 6298 of 1916.)

SEE U.S. Pat. 1,218,161 of 1917; this J., 1917, 463. Zinc oxide may be used in place of or in addition to white lead.

Floor covering [linoleum substitute]; Composition for use as — or for other purposes. New Shepley Linoleum Co., Ltd., and W. Barton, Manchester. Eng. Pat. 105,864, Oct. 19, 1916. (Appl. No. 14,839 of 1916.)

LEATHER is passed successively through disintegrating and grinding machines which reduce it to a soft, stringy substance or wool. This is put through cleaning or dressing machines, in which the finer material is forced through a sieve by means of a fan. The sifted material is then mixed with boiled linseed oil, or linoleum cement, and any desired colouring matter and/or filler in a pug-mill, and the dough applied under pressure to a canvas or other backing. The best results are obtained by using the following proportions: leather dust, 50; linoleum cement, 16; colouring matter, 16.—E. W. L.

Manufacture of insoluble azo dyestuffs. Ger. Pat. 297,185. See IV.

Manufacture of monoazo dyestuffs suitable for the production of pigments. Ger. Pat. 297,414. See IV.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

PATENT.

India-rubber and india-rubber compounds and substitutes; Vulcanisation of —. G. E. Heyl, London. Eng. Pat. 105,831, July 3, 1916. (Appl. No. 9337 of 1916.)

FINELY ground oil-shale containing sulphur is

employed as a vulcanising agent. The hydrocarbons present in the shale are said to assist the vulcanisation process, and to improve the product by rendering it more homogeneous and preventing blooming.—E. W. L.

XV.—LEATHER; BONE; HORN; GLUE.

PATENTS.

Sizing solution and method of making the same. U.S. Pat. 1,224,125. See VI.

Composition for use as floor covering or for other purposes Eng. Pat. 105,861. See XIII.

XVI.—SOILS; FERTILISERS.

Soil; Organic matter of the —. V. A study of the nitrogen distribution in different soil types. C. A. Morrow and R. A. Gortner. Soil Sci., 1917, 3, 297—331. (See this J., 1917, 226, 227, 696.)

THE distribution of the organic nitrogen of soils, as determined by the Van Slyke method of analysis, is essentially the same for all types of soil. Experiments were made to find the effect of the presence of ignited subsoil upon the relative amounts of the products formed by hydrolysing a pure protein-fibrin from blood, the ratio of ignited material to protein being 20:1. The results for ammoniacal nitrogen were not affected, but the humin nitrogen was greatly increased, and the histidine fraction disappeared completely. Hence the data found for the nitrogen distribution in soils are only useful for comparing one soil with another. The presence of carbohydrates in soils probably accounts for much of the total humin found, for they yield furfural on treatment with acid, and the furfural combines with or adsorbs other nitrogenous compounds, thus causing an apparent increase in the total humin. The true humin nitrogen, which comprises from 22.93 to 28.27% of the total nitrogen, is left in the residual soil after the hydrolysis with acid. The fraction of nitrogen removed from a colourless solution by the addition of calcium hydroxide, representing 3.26—9.21% of the total nitrogen, consists almost entirely of material of non-protein origin; it should be recorded separately. The concentration and volume of the hydrochloric acid used for the hydrolysis are without influence provided that the acid be as strong as that of constant boiling point, and the ratio of acid to soil be at least 2:1. Such acid extracted an average of 72.19% of the total nitrogen of the soils investigated, the minimum being 66.63% and the maximum 77.65%. The results of other workers gave an average of 75.19% for 37 soils of widely different origin.

—E. H. T.

Plant toxins; Soil constituents which inhibit the action of —. E. Truog and J. Sykora. Soil Sci., 1917, 3, 333—351.

THE main conclusion drawn from the investigation of the influence of calcium carbonate, finely divided quartz, and of kaolin, upon the toxic action of copper sulphate, copper nitrate, and sodium arsenite on wheat seedlings, was that the ameliorating effects of these substances is conditioned quite as much by chemical reactions as by physical actions, e.g., adsorption. The artificial cultures used were (a) 250 grms. of quartz sand, (b) 225 grms. of sand and 25 grms. of quartz flour, (c) 225 grms. of sand and 25 grms. of kaolin. These were put in tumblers, treated with a mineral nutrient solution, and then planted with wheat

seedlings. The controls of quartz sand also received the nutrient solutions, and the moisture content of all was kept at 13%. The copper sulphate was used in concentrations varying from N/300 to N/10, and in each case the toxic action was proportional to the concentration; with N/200 to N/50 solutions the plants in (b) and (c) were superior to those in (a), a result explicable on the assumption that the poison was adsorbed on the surface of the quartz and the kaolin. Similar experiments with the addition of calcium carbonate showed the remarkable ameliorating effect of this substance. The tests with copper nitrate confirmed the results obtained with the sulphate. The toxic effects of sodium arsenite, applied in concentrations of N/6400 to N/400, were marked and about equal in (a) and (c), but the plants in (b) were practically unharmed, probably owing to the oxidation of arsenite to the less poisonous arsenate by catalytic impurities present in the quartz flour. The toxicity of sodium arsenite in pure quartz sand was not influenced by the presence of calcium carbonate; the beneficial effect of quartz flour was not enhanced by the carbonates, but with kaolin the carbonate produced a marked stimulation. The toxic effect of cultures containing 200 or more parts per million of guanidine carbonate became evident after 3–5 days, and the plants wilted and died in a short time. Kaolin, on the other hand, exerted a very beneficial effect, particularly upon the root development, which was not enhanced by the presence of calcium carbonate. Seedlings grown in kaolin cultures containing 1000 parts per million of guanidine carbonate, showed roots as good as those of plants grown in sand or quartz flour containing 200 parts per million. This action may be due to the acidic nature of kaolin, which would form an insoluble compound with guanidine. Experiments with guanidine carbonate (in concentrations of 200, 500, and 1000 parts per million) on an acid red clay, both in lined and unlined cultures, showed that the ameliorating effect of the clay was greater than that of pure kaolin. Calcium carbonate had an inhibiting effect on the plants grown in the kaolin culture containing 1000 parts per million of guanidine carbonate, but was without action on the corresponding clay cultures. Experimenting with two field soils contained in large pots, it was observed that vanillin was toxic on a poor sandy soil containing neither nutrients nor limestone; but when nutrients were present, and to a lesser extent when limestone was added, the toxic action was much reduced. Similar tests on an acid silt loam soil, rich in potash and nitrogen, showed that vanillin was apparently harmless; when calcium carbonate was present, a depressing effect was noted.—E. H. T.

Soils; Extraction and saturation of—with volatile antiseptics. J. P. du Buisson. *Soil Sci.*, 1917, 3, 353–392.

The effects of treating a silt loam (Volusia) and a clay loam (Dunkirk) soil with volatile antiseptics was to increase the yields of oats and wheat subsequently grown in them. The order of efficiency was: alcohol (90%), ether, benzene, toluene, commercial gasoline; the last-named usually proved detrimental. The silt loam responded better than the clay loam. The residual effects of the antiseptic treatment upon the second crops (buckwheat following oats, and oats following wheat) were beneficial, but less marked than the effects upon the first crops. Very little difference was observed between the saturation and the extraction methods of applying the antiseptics. By extraction with alcohol, a substance was isolated which proved toxic in water cultures but harmless in the soil itself. The

antiseptic treatment enhances ammonification from the outset, the maximum being reached after 6 weeks; nitrification was inhibited during the same period, but began again after 12 weeks. The water-soluble salts in the soils showed a tendency to increase. After two croppings, the effect of the antiseptics upon ammonification and nitrification disappeared. The beneficial effects of applying volatile antiseptics are not due to a change in the physical nature of the soil, nor to the suppression of toxins, nor to the production of acid by oxidation of the antiseptic; they can only be correlated with biological changes.—E. H. T.

Soil solution obtained by the action of a hydraulic press. G. Ramann, S. März, and H. Bauer. *Int. Mit. Bodenkunde*, 1916, 6, 27. *J. Chem. Soc.*, 1917, 112, i., 311–312.

The authors point out that the analysis of drainage waters from soils does not afford an accurate means of determining the composition of the normal soil solution, as drainage only occurs when the soils are supersaturated. For this reason they adopted the method of forcing water out of the soil with a hydraulic press. Samples of 3 kilos. of soil were taken from the fields and subjected to a pressure of 300 kilos. to the square cm., the liquid expressed being then analysed for calcium, magnesium, sulphates, phosphoric acid, and potassium. The sampling was done on six different occasions over a period lasting from May to October; both surface and subsoil were used. The calcium content was found to vary considerably in the surface soil, but in the subsoil it seemed fairly constant, except for a rise in mid-summer. Potassium, contrary to the generally accepted view, behaved very much like calcium, that is, its content fluctuated according to the general concentration of the soil solution, rising when evaporation took place and being lowered by spells of wet weather. Further, there was evidence of potassium and calcium being transported from the subsoil to the surface during a prolonged period of drought, but no evidence was obtained that adsorption exerted any regulating effect on the concentration of the soil solution. The exchange of bases only occurred when the proportion which the dissolved substances bore to one another was altered. The authors suggest that the selective action of the plant roots, by throwing the soil solution out of equilibrium, would have a considerable effect in bringing fresh supplies of nutrient substances into solution. They state also that the pressure method of obtaining soil water is only applicable in the case of soils made up of very fine particles or containing a considerable amount of humus.

Garbage tankage: its composition, the availability of its nitrogen, and its use as a fertiliser. P. J. Schroeder. *J. Ind. Eng. Chem.*, 1917, 9, 513–518.

In about half of the large cities of the United States the garbage, i.e., household refuse, food waste, etc., is treated for recovery of grease, and the residual matter, known as tankage, is of value as a low-grade fertiliser. In 1914 about 1,200,000 tons of garbage was thus treated, and yielded, besides grease, 173,000 tons of tankage valued at about £230,000. The garbage is first sorted, to remove broken glass, tins, etc., and then treated by one of the following methods:—(1) heating with steam under pressure, pressing out the water and liberated fats as completely as possible, separating the fats from the water by settling and skimming, and in some cases extracting the dried residue with gasoline to recover more fat; (2) crushing to uniform size, drying, extracting with gasoline, and grinding the residue; (3) boiling with gasoline to evaporate moisture and extract fats at the same time. In some plants the aqueous extract obtained by the first method is

concentrated to a syrupy liquid, known as "stick," and mixed with the tankage before the latter is dried. Garbage tankage is a coarse brown powder, either granular or finely fibrous, and usually contains pieces of broken bone, glass, or crockery, the amount of which depends on the efficiency of the sorting of the garbage. The accompanying table shows the average percentage composition of garbage (75 samples) and tankage (20 samples from different plants, 4 of which did not remove fats).

	Moisture.	Ash.	Ether extract.	Potash.	Nitrogen.	P ₂ O ₅ .	Combustible matter.
Garbage	73.78	3.60	5.32	0.27	0.7	0.43	22.65
Tankage.....	3.67	29.15*	4.92*	0.80*	2.78*	3.56*	—

* Percentage referred to dry matter.

Efforts have been made recently to utilise tankage as a cattle food, and flotation processes have been devised to remove particles of hard matters. It is used most extensively, however, as a base in the preparation of mixed fertilisers, for which purpose its physical characters render it well suited. A certain quantity has been used with success as a complete, low-grade fertiliser. Its high content of organic matter increases its value for soils deficient in humus. It commands a relatively low price owing to a widespread belief that its nitrogen is of very low manurial value, but from experiments described the author concludes that this belief is unwarranted. The alkaline permanganate method indicated that 40% or more of its nitrogen is "available" (as compared with 57% in the case of cottonseed meal), and good results were obtained also in experiments on nitrification by Lipman's method (this J., 1916, 1168). Nearly one-quarter of the total nitrogen in tankage is soluble in water, and this proportion could be increased considerably by treatment with sulphuric acid.—J. H. L.

Potash [in fertilisers]: Study of the determination of — chiefly concerned with the Lindo-Gladding method. P. L. Hibbard. J. Ind. Eng. Chem., 1917, 9, 501—513.

THE author has made an exhaustive study of the method of the U.S. Association of Official Agricultural Chemists for the determination of potash in fertilisers (U.S. Dept. Agric., Bureau of Chem., Bull. 107). The method consists in extracting the material (10 grms.) with boiling water, precipitating iron, calcium, phosphates, etc., with ammonia and ammonium oxalate, evaporating an aliquot part of the filtrate (corresponding to 1 gm. of material) with sulphuric acid, and incinerating, and determining the potash in the residue as platinichloride. The following are some of the author's conclusions. Ammonium oxalate should not be added until the liquid is alkaline with ammonia (which should not be used in excess), and if there is more than enough phosphoric acid to combine with the alkaline-earth bases, no oxalate should be added, as it increases the amount of phosphate remaining in solution. When much phosphate is present a special procedure is necessary—either addition of excess of calcium and re-precipitation, or greater dilution, for potash is adsorbed by the gelatinous phosphate precipitate. Addition of a little sugar during evaporation reduces spattering. Carbon should be burnt off at a low temperature and the residue raised to a moderate red heat only for a few minutes. For accurate results in the precipitation of potash, the concentration of the latter should not be sufficient to produce an immediate precipitate with platinum chloride, and the amount of the latter added should not be much more than required for the

potash, as sodium platinichloride is not readily washed out of the precipitate by alcohol. Free sulphuric or nitric acid or organic matter should not be present, but evaporation should be stopped while some free hydrochloric acid still remains. Where much soda is present the potash is best first precipitated as cobaltinitrite. For the collection of the platinichloride an ordinary Gooch crucible with asbestos felt gives more accurate results, though it is less convenient, than a filter

tube. Drying may be carried out between 100° and 140° C., but 1 hour at 120° C. is usually sufficient. The perchlorate method of determining potash was found to be longer, more difficult, and more costly than the platinichloride method. A bibliography of the subject is appended to the paper.—J. H. L.

Extraction of potash from silicate rocks. Ross. See VII.

XVII.—SUGARS ; STARCHES ; GUMS.

Beet molasses: its composition and utilisation. S. J. Osborn. Met. and Chem. Eng., 1917, 16, 436—443.

THE paper opens with some observations on the conventional melassigenic factor of 5 for the ash of molasses which is based on the fact that in both beet and cane molasses the quantity of sugars present is five times that of the ash. In beet molasses sucrose with but a trace of invert sugar is present, whilst cane molasses contain sucrose and invert sugar in approximately equal proportions. The various precipitation processes for the recovery of crystallisable sugar from molasses are described and discussed. The baryta process appears to be only in operation at one place, Wallaceburg, Ont., Canada. It is carried out in iron tanks with false bottoms of 60-mesh wire. The required amount of barium hydroxide is first introduced in the form of a milk, followed by the undiluted molasses; the precipitate forms readily on stirring at 40°—50° C. The pasty mass is drained on the screen, washed first with the sweet water from a previous charge, then with water containing a little barium hydroxide. The washed precipitate is suspended in water, treated with carbon dioxide, and the filtered solution mixed with fresh juice. The main difficulty is the regeneration of the barium oxide, which requires an extremely high temperature in an electric furnace. In Germany the strontia process is employed, being worked at five large factories obtaining molasses from a number of beet factories; the strontia process is combined with the destructive distillation of the mother-liquors. In the United States, Steffen's lime process is worked. Powdered quicklime is added slowly, with mechanical stirring and artificial cooling. The apparatus has a large central well and several hundred cooling tubes, and a propeller draws the liquid down through the well, forcing it up through the tubes. When the precipitate of tricalcium succinate has formed, it is drained in filter-presses, washed with cold water, and used for liming fresh juice. One of the main essentials for satisfactory working is the use of

extremely finely ground lime, graded from the ball mill by means of an air-current so that 98–99% will pass through a 200-mesh sieve. The presence of more than 2% of water in the form of hydroxide is objectionable. Calcium oxide will combine with sugar in preference to water so long as the former is in excess, but if owing to slow stirring, too fast or uneven addition, or too coarse powder, the lime is locally in excess, it becomes hydrated and useless; excessive foaming may cause the same defect. The theoretical quantity of lime required is 49% of the sugar, but 100% is considered good in practice. The temperature must be as low as possible, but good results can be obtained up to 17° C. The economy of lime is greater the higher the concentration of the sugar solution, but the liquid becomes too thick for efficient circulation; in Colorado the molasses is diluted 7–10 times to give a solution containing 5–7% of sucrose. The addition of lime is continued so as to leave about 0.4% of sucrose in the mother liquor; beyond this point the consumption of lime is excessive. Thorough washing of the filter-press cake is difficult because the cake is somewhat soluble, and constant attention is required to avoid "channeling." The great disadvantage of the Steffen process is that certain impurities are co-precipitated with the sucrate and accumulate in continuous work, making it necessary to discard a portion of the molasses at regular intervals, as these impurities render the mass extremely viscous and interfere with crystallisation. A comparison of the "purity" of the juice obtained by decomposition of the three kinds of sucrate shows: barium process 93.65, strontium 88.33, and calcium 81.22%. —J. F. B.

Sorghum juice; Chemical changes caused by defecation of — for syrup manufacture. A. K. Anderson. J. Ind. Eng. Chem., 1917, 9, 492–499. (See also Bryan, this J., 1912, 696.)

In Minnesota, in the larger factories, sorghum juices destined for the production of syrup are defecated by lime; in the smaller ones as a rule no lime is added but impurities are skimmed off from the juice in the course of evaporation. A third method which has been proposed, but not yet adopted, is to heat the juice for 30 mins. with acid calcium phosphate (e.g., 5 lb. per 1000 gallons) and then neutralise with lime. The acid phosphate inverts some of the sucrose present and thus tends to prevent crystallisation of the resulting syrup. Moreover, the precipitate of tricalcium phosphate formed has a clarifying action on the juice. The author has studied the effect of all these methods of defecation. The results are discussed in detail. To judge by the commercial quality of the products the phosphate method gives rather better syrups than the lime method, but, taking into account the cost of working, the lime method is considered preferable. As regards the amount of lime to be used, that calculated from a titration of the juice with sodium hydroxide in presence of phenolphthalein produces proper defecation with the minimum darkening of the juice.—J. H. L.

p-Tolyhydrazones of L-arabinose, rhamnose, fucose, D-mannose, and D-galactose. A. W. Van der Haar. Rec. Trav. Chim. Pays-Bas, 1917, 36, 316–351.

The *p*-tolylhydrazones of L-arabinose, rhamnose, fucose, D-mannose, and D-galactose (m. pts. 160°, 166°, 169°, 190°–191°, and 168° C. respectively) were prepared by heating equal quantities of sugar and purified *p*-tolylhydrazine in 20 parts of 96% alcohol until all the sugar had dissolved and for 15 mins. longer. The cooled liquids in all cases deposited crystals of hydrazone within 24 hours, and the products were re-crystallised from alcohol or water. The characters of these hydrazones are described,

with illustrations. They are all less soluble than the corresponding phenylhydrazones, and might serve for identifying any one of the sugars named, in presence of xylose, levulose, or dextrose, none of which gives a crystalline product within 24 hours under the conditions stated. Mannose, which yields a very insoluble tolylhydrazone of high melting point, can also be similarly detected in presence of other monoses, and arabinose in presence of rhamnose within certain limits.—J. H. L.

Starch; Polarimetric determination of — in the presence of other optically active substances. C. Baumann and J. Grossfeld. Z. Unters. Nahr. Genussm., 1917, 33, 97–103. J. Chem. Soc., 1917, 112, ii, 223–224.

THE method described is particularly useful for the estimation of starch in products which contain starch paste, dextrins, and sugars, and depends on the fact that starch, whether raw or heated, is precipitated completely by lead tannate when the latter is formed in the starch solution. Ten grams of the substance under examination is shaken for 15 mins. (or for 1 hour if dextrins are present) in a 100 c.c. flask with 75 c.c. of water; 5 c.c. of 10% tannin solution is then added, followed by 5 c.c. of basic lead acetate solution, and the mixture is diluted with sodium sulphate solution to 100 c.c. After filtration, 50 c.c. of the clear filtrate is mixed with 3 c.c. of 25% hydrochloric acid and heated for 15 mins. in a boiling water-bath, then cooled; 20 c.c. of 25% hydrochloric acid and 5 c.c. of sodium phosphotungstate solution (12 grms. of sodium phosphate and 20 grms. of sodium tungstate per 100 c.c.) are added, the mixture is diluted to 100 c.c., filtered, and polarised in a 200 mm. tube. Another portion of 5 grms. of the sample is heated directly with hydrochloric acid (compare Ewers' method, this J., 1908, 238) and the solution polarised after the addition of a further 20 c.c. of hydrochloric acid and clarification with sodium phosphotungstate. The difference between the two polarimeter readings is multiplied by 5.441 to obtain the percentage of starch present; this factor is calculated from the average rotatory power of various starches, the average being $[\alpha]_D = +183.7^\circ$. On account of the presence of acetates in the first part of the process, it is necessary to add 3 c.c. of hydrochloric acid, instead of 2 c.c. as given by Ewers, to bring the acidity of the mixture to the required concentration; the additional quantity of hydrochloric acid introduced after the inversion is for the purpose of insuring the complete precipitation of organic bases, alkaloids, etc., which may be present; sodium phosphotungstate fails to effect their entire removal from the more dilute hydrochloric acid solution. The error of the method does not exceed 0.2% when dealing with substances containing from 10 to 60% of starch together with large proportions of sucrose, dextrose, dextrins, milk, etc.

PATENT.

Thickening agent for printing colours and sizing. Ger. Pat. 295,670. See VI.

XVIII.—FERMENTATION INDUSTRIES.

Enzyme actions; Domestic application of — in Eastern countries. H. C. Prinsen Geerligs. Nederland. Chem. Ver., Dec. 28, 1916. Z. angew. Chem., 1917, 30, 256–257.

A MILK-LIKE product produced by grinding soya beans with water contains 6.9% of total solids, 3.13% of proteins, and 1.89% of fat; this product, unless boiled, rapidly undergoes lactic acid fermentation, and a cheese may be obtained by the

addition of a quantity of the fermented liquid to a larger volume of the normal liquid. To prepare an extract resembling meat extract, the cooked beans are subjected to the action of fungi which are found on the leaves of a species of mallow (*Hibiscus tiliaceus*), the mass is then extracted with salt solution, spices are added to the extract, and this is then concentrated to a thick syrup. A similar product is prepared from a mixture of soya beans and rice by the action of fungi. Another food is obtained by submitting soya bean cakes to the action of fungi found on banana leaves, etc. The fungi found in rice meal and rice straw are utilised for converting rice meal into alcohol: rice meal may be saccharified by treatment with the fungi occurring on banana leaves and the liquid obtained is subsequently converted into rice wine. One of the most important results of enzyme action is the production of sugar in the palm: the stem of the latter is free from sugar but contains large quantities of starch: the conversion of the starch into sucrose proceeds in the tree, but laboratory experiments with the separated enzyme resulted in the formation of dextrose alone.

—W. P. S.

Enzymes; Formation of —. M. Jacoby. Biochem. Zeits., 1917, 79, 35—50. J. Chem. Soc., 1917, 112, i., 305. (See this J., 1916, 901, 1269.)

THE following substances were found to stimulate the formation of a urease by bacteria: dextrose, *d*-galactose, glycerol, *dl*-glyceraldehyde, dihydroxyacetone, pyruvic acid, and lactic acid. The stimulating action of these substances was great. A stimulating action was shown, but less markedly, by *d*-lævulose, *d*- and *l*-arabinose. Mannose, *d*-sorbose, rhamnose, heptose, the polysaccharides, glucosides, and the sugar alcohols were without action.

Enzyme action. I. Enzymic degradation of polypeptides. E. Abderhalden and A. Fodor. Fermentforschung, 1916, 1, 533—596. J. Chem. Soc., 1917, 112, i., 306—309.

THE authors have investigated the action of enzymes on synthetic polypeptides which are formed from such amino-acids as occur naturally. All comparative experiments were performed with one and the same solution of the enzyme prepared in a definite manner. Uniform conditions were also maintained in other respects, and it is emphasised that the results obtained are only valid under these conditions and do not apply, for example, to processes within the cell. Solutions of the enzyme were prepared from dried yeast according to Lebedev; it was found that different consignments of the preparation from the same firm showed considerable differences in activity. Strictly comparable experiments were therefore always carried out with the expressed juice of yeast from a single consignment. The juice was fairly acid to litmus, and was therefore nearly neutralised, since otherwise the desired regulation of the solutions could not be obtained. The yeast-juice was preserved until constant in its behaviour towards glycyl-*l*-leucine as substrate. The greatest stability of peptase occurs with a hydrogen-ion concentration of about 3×10^{-7} : variation in either direction caused a distinct decomposition after one hour at 25° C. and the sensitiveness was greater towards an increase in the hydrogen-ion than towards an increase in the hydroxyl-ion concentration.

The rate of fission of a number of dipeptides by yeast was studied. The course of the degradation at different H^+ and OH^- concentrations (usually within the limits $p_H=6.5-8.5$) was followed: it was found that not merely the rate of reaction but also its nature is dependent on them. Increase in the concentration of the yeast extract greatly

diminishes the rate of reaction, but this depends also on the acidity or alkalinity and on the amount of yeast peptase present. It is true for glycyl-*l*-leucine in very dilute acid or faintly alkaline solution ($p_H=6.20-7.50$) in the presence of an excess of yeast extract, whilst increase of an originally very small amount in this interval increases the amount hydrolysed. Beyond $p_H=8$, a quantity of yeast extract which previously diminished the reaction velocity, is found to cause a further increase. The amino-acids which are formed as products of hydrolysis can exert a powerful retarding action: glycine behaves thus in alkaline, *l*-alanine and *l*-leucine only in acid solution. The optimum hydrogen-ion concentration has been determined for a number of polypeptides with the following results, the values of p_H being enclosed within brackets: glycyl-*l*-leucine (8.41, 8.50); *l*-leucylglycine (7.50, 7.56); *d*-alanyl-*l*-leucine (7.30—8.13); glycyl-*d*-alanine (7.30—7.91); *d*-alanyl-*l*-leucine (6.76, 6.85); *l*-leucyl-*d*-alanine (6.80—7.89); *dl*-leucyl-*l*-aspartic acid, 2% (6.76); *dl*-leucyl-*l*-aspartic acid, 10% (6.80); *l*-leucylglycylglycine (7.26); *l*-leucyldiglycylglycine (7.29); *l*-leucyltriglycylglycine (7.28); *l*-leucylpentaglycylglycine (6.24). The results which have been obtained support the view that enzymes act as colloidal catalysts and are closely connected with the work of Bredig and his co-workers on "inorganic ferments." The assumption that an enzyme is active towards a definite grouping of atoms is not supported by the authors' experiments.

Pyruvic acid; Production of — by biochemical oxidation of lactic acid. P. Mazé and M. Ruot. Comptes rend. Soc. Biol., 1916, 79, 706—710. J. Chem. Soc., 1917, 112, i., 310. (Compare Mazé, this J., 1913, 503; Fernbach and Schoen, this J., 1914, 97, 707.)

Amphomyces Roucii (a mould related to *Mucor*) and another undetermined fungus, parasitic on maize, oxidise lactic acid to pyruvic acid in a solution containing no other carbon compound, and ultimately also destroy the pyruvic acid formed. The yield is better with free lactic acid than with calcium lactate, for in the latter case the solution becomes alkaline and growth is inhibited. As may be foreseen, the respiratory quotient is low (0.77—0.90). Similar effects may be obtained with sucrose in thin layers of a solution not more concentrated than 1% (in order to avoid the formation of alcohol).

Pentoses and compounds of pentoses; Utilisation of certain — by *Glomerella cingulata*. L. A. Hawkins. Amer. J. Botany, 1915, 2, 375—388.

PREVIOUS investigators have shown that pentoses and pentosans are of some value as food for higher animals, but the latter appear to secrete no enzyme capable of hydrolysing pentosans, this transformation being probably effected by intestinal bacteria. Some of the invertebrates utilise pentoses readily and can probably hydrolyse some pentosans. Pentoses have been found to be a good source of carbon for certain fungi, and there is evidence of decomposition of pentosans by enzymes secreted by fungi, though the products of such decomposition have apparently not been identified. In experiments with *Glomerella cingulata* the author found that this fungus can utilise dextrose, xylose, arabinose, xylan, or arabin as sole source of carbon. The three sugars are most efficiently utilised, xylose perhaps best of all. The pentosans are much less readily assimilated, and arabin less readily than xylan. The presence of a pentosanase in filtered aqueous extracts of the fungus mycelium, was also demonstrated by the conversion of xylan into xylose, the latter being isolated in crystalline form.—J. H. L.

Glycerol; β -Monoglucoside of — obtained by biochemical synthesis. E. Bourquelot, M. Briet, and A. Aubry. *Comptes rend.*, 1917, 164, 831—833.

A PRODUCT of the action of emulsin (β -glucosidase) on dextrose and glycerol, obtained in a non-crystalline form two years ago, has since crystallised on prolonged contact with alcohol and ether at low temperatures. It is a monoglucoside of glycerol, very soluble in alcohol; m. pt. 130°—135° C., and $[\alpha] = -28.16^\circ$. It is non-reducing, and is hydrolysed by acids and by emulsin.—J. H. L.

Polarimetric determination of starch in presence of other optically active substances. Baumann and Grossfeld. See XVII.

Experiments with pepsin to replace rennet [in cheese-making]. Stuart. See XIXa.

Relationship between antiseptic power and valency. Friedberger and Joachimagnu. See XIXb.

XIXa.—FOODS.

Proteins: Chemistry of the —. E. Herzfeld and R. Klinger. *Biochem. Zeits.*, 1917, 78, 349—353. *J. Chem. Soc.*, 1917, 112, i, 300—301.

WHEN serum is dried in a film on a glass plate, a product is obtained which is soluble in water. If, however, the product is ground up in a mortar, a powder is formed which is no longer completely soluble. The following explanation is offered of this "mechanical denaturation" of the protein. The scale preparation is considered to consist of spheres of the protein surrounded by a layer of protein degradation products, to the presence of which the disaggregation of the protein in water is due (this *J.*, 1914, 707; 1915, 811). By grinding in a mortar, the spheres are broken up, and fresh surfaces are exposed on which there are no degradation products, and owing to the exposure of surfaces of protein without these products, complete solubility is no longer possible.

Amino-acids [from proteins]: Improvements in the copper method for determining —. P. A. Kober. *J. Ind. Eng. Chem.*, 1917, 9, 501—504.

THE author has previously described (see Kober and Sugiora, *J. Amer. Chem. Soc.*, 1913, 35, 1516) a method for determining amino-acid nitrogen, in which a solution of the amino-acids containing sodium borate as "buffer salt" is treated with a suspension of cupric hydroxide. The latter combines with the amino-acids (and polypeptides) forming complexes, some of which are soluble and are determined after filtration by titrating the filtrate with thiosulphate in presence of potassium iodide, whilst others are insoluble and require to be freed from excess of cupric hydroxide by treatment with potassium bicarbonate before their amount can be determined. A further modification is designed to make allowance for the presence of polypeptides the free amino groups of which react with the copper hydroxide. In the present paper some modifications of a practical nature are suggested which are of general interest. In using weighed quantities of copper sulphate crystals for standardising the thiosulphate solutions, the somewhat variable moisture content of the crystals introduces a possible error. The author suggests drying the crystals to the stage of monohydrate in a tared tube through which a current of air dried by calcium chloride is passed, the tube meanwhile being immersed in paraffin at 250° C. Suspensions of

cupric hydroxide which retain for months their blue colour and their original reactivity towards amino-acids, may be prepared by precipitating copper sulphate solutions with slightly less than the calculated quantity of alkali, with the precautions previously indicated (*loc. cit.*). A saturated solution of potassium iodide containing soluble starch and acetic acid can be kept colourless for months when covered with a layer of mineral oil in a flask fitted tightly with a siphon tube, the outer and lower end of which is provided with an automatic pipette for drawing off small quantities of solution as required, and with an air inlet tube fitted with a trap containing strong alkali to wash the entering air. At the outset the solution in the flask is treated with a few c.c. of copper sulphate solution and after half an hour carefully rendered colourless by means of thiosulphate solution and then boiled for half an hour.—J. H. L.

Arginine in proteins: Determination of —. B. C. P. Jansen. *Chem. Weekblad.*, 1917, 14, 125—129. *Z. angew. Chem.*, 1917, 30, Ref., 114.

THE arginase for use in the method described (this *J.*, 1917, 562) is prepared from the liver of a recently killed dog or cat. This is rinsed with water, and triturated to a thin paste with quartz sand, water, and toluene. The paste is submitted to dialysis, centrifuged for a short time, and the resulting turbid liquid treated with 2 vols. of alcohol and 1 vol. of ether. The precipitate is centrifuged, washed with alcohol, and suspended in water. The arginase preparation thus obtained will keep unaltered for 3 months in an ice-chest. Arginase can be used for the determination of creatine as well as of arginine.

Lime: Detection of — when used as a neutraliser in dairy products. H. J. Wichmann. U.S. Dept. of Agric., Bull. No. 521, May 7, 1917, 1—22.

THE ash of milk, of unneutralised cream, and of unsalted butter made from the same contains from 21 to 23% of calcium oxide; when lime has been added to the cream in the process of manufacture, the quantity of calcium oxide in the ash increases to above 25%, the increase varying with the amount of lime added and the degree of washing. The same holds good with salted butters, provided that the calcium oxide is calculated on the salt-free ash. Some dairy salts contain calcium sulphate and this increases the calcium content of the ash, but a determination of the sulphate in the ash would allow a correction to be made for this impurity. The ash of milk, cream, or butter is determined in the usual way, and, in the case of salted butter, the quantity of salt in the ash is determined gravimetrically. To determine the calcium oxide in the ash, the latter (obtained from 10 to 50 grms. of the sample) is dissolved in dilute hydrochloric acid, the solution neutralised with sodium hydroxide, acetic acid is added, and the calcium precipitated from the hot solution by addition of ammonium oxalate.

—W. P. S.

Pepsin: Experiments with — to replace rennet [in cheese making]. D. W. Stuart. *J. Bd. Agric.*, 1917, 24, 57—59.

IT was found that 1 oz. of pepsin powder (1—3000) was equivalent, in cheese making, to 12 oz. of standard rennet extract, and that it was impossible to detect any difference between cheese made with pepsin and that made with rennet. To prepare the pepsin solution for use, 2 lb. of common salt and 3 oz. of boric acid should be dissolved in 1 gall. of water, the solution boiled, cooled to 104° F. (40° C.), and 13½ oz. of the pepsin powder then added.—W. P. S.

Sources of fat in Germany in 1916. Fahrion. See XII.

Polarimetric determination of starch in presence of other optically active substances. Baumann and Grossfeld. See XVII.

Domestic applications of enzyme actions in Eastern countries. Prinsen Geerligs. See XVIII.

Enzyme action. Enzymic degradation of polypeptides. Abderhalden and Fodor. See XVIII.

Utilisation of certain pentoses and compounds of pentoses by Glomerella cingulata. Hawkins. See XVIII.

PATENTS.

Eggs; Method of preserving —. M. J. Davis. Brooklyn, and H. A. Metz. New York, U.S.A. Eng. Pat. 105,840, July 19, 1916. (Appl. No. 10,202 of 1916.)

A PRESERVING liquid is prepared consisting of tung oil in which resin and magnesia have been dissolved. The eggs are rubbed with this solution in the cold, or are dipped in the heated solution after it has been thinned with a volatile oil.—J. H. J.

Edible oil or fat compositions; Colour concentrate for —. C. Ellis, Montclair, N.J. U.S. Pat. 1,224,910, May 8, 1917. Date of appl., Oct. 21, 1916.

A BUTTER colour concentrate consists of the liquid constituents of butter fat freed from water, butyric acid, and casein, and saturated or substantially saturated, with yellow colouring material, all in a sterile condition.—E. W. L.

Blood; Preparation of an easily digestible, water-soluble, stable material from —. F. Sgalitzer. Munich. Ger. Pat. 296,925, Jan. 16, 1916.

BLOOD from which the fibrin has been separated to retard coagulation is converted into an easily digestible, water-soluble mass by freezing it, allowing it to thaw, and evaporating it to dryness *in vacuo*, at about 30° C., on surfaces heated above the coagulation temperature of the albuminous constituents. The dried material should not be heated above 40° C.—F. Sp.

XIXB.—WATER PURIFICATION; SANITATION.

Water analysis; Contributions to —. L. W. Winkler. Z. angew. Chem., 1917, 30, 113—116.

Standard caustic soda solutions. To prevent standard solutions of caustic soda from undergoing change, the solution should be made up with one-third of its volume of glycerol. *Hardness.* The modern method of ascertaining the hardness of a water is to determine the alkalinity and to subtract the "carbonate" hardness calculated from this, from the total hardness. For these results, the terms "carbonate" hardness and "remaining" hardness should be used, and the terms temporary and permanent hardness reserved for the results of the soap test. The reason for this is that the two methods give different results for the same water. *Determination of bromine.* The residue from a litre of the water is distilled after oxidation with permanganate in presence of manganous sulphate, and the bromine in the distillate titrated with arsenious acid. *Determination of iodine.* The residue from a litre of the water evaporated with caustic soda is ignited and dissolved, the solution acidulated and shaken with carbon tetrachloride. The depth of the colour produced is proportional to the amount of iodine present. *Determination of arsenic.* 100 c.c. of the water, or 1 litre concentrated to 100 c.c., is introduced into a flask with

zinc and sulphuric acid, the neck plugged with cotton-wool soaked in lead solution, and the mouth of the flask tied over with white linen moistened with gold chloride solution. The reddish-blue colour produced is proportional to the amount of arsenic present. *Mineral analysis.* The results of a complete mineral analysis should be checked by dividing the weights of each anion and cation found by its equivalent; the resulting quotients for the anions are added together, also those for the cations; the two sums should equal one another.—J. H. J.

Antiseptic power and valency; Relationship between —. E. Friedberger and G. Joachimaghu. Biochem. Zeits., 1917, 79, 135—151. J. Chem. Soc., 1917, 112, i., 306.

IN experiments with bacteria and protozoa it was found that compounds of trivalent arsenic (sodium arsenite and salvarsan) have a greater toxic effect than the compounds of quinquivalent arsenic (sodium arsenate and atoxyl). A similar difference was observed between the compounds of trivalent and quinquivalent antimony (tartar emetic and potassium pyroantimonate respectively). Arsenites inhibit the action of yeast to a greater extent than do arsenates.

Role of inorganic agencies in the deposition of calcium carbonate. Johnston and Williamson. See VII.

Garbage tankage; its composition, availability of its nitrogen, and its use as fertiliser. Schroeder. See XVI.

PATENTS.

Water; Method for obtaining pure — from salt water. F. T. Evans, Assignor to G. H. Benjamin. New York. U.S. Pat. 1,225,118, May 8, 1917. Date of appl., July 1, 1913.

SALT water in a state of agitation is heated by a steam coil, and the vapour given off, containing a little salt, is passed into a vessel in which it is superheated by another steam coil at a higher temperature and thus expanded. In the second heating, the salt is deposited. The superheated vapour is subsequently condensed.—J. H. J.

Water for drinking and industrial purposes; Removal of iron and manganese from —. Permutit-Filter Co., G. m. b. H., Berlin. Ger. Pat. 297,300, Feb. 14, 1911. Addition to Ger. Pat. 211,118.

NATURAL waters which contain iron or manganese in organic combination are usually yellow or brown in colour, have an inky taste, and may remain clear for several days. The iron or manganese may be removed by treating the water with a quantity of permanganate insufficient to precipitate the total iron or manganese content, and passing it over higher oxides of manganese deposited on natural or artificial zeolites.—F. Sp.

Septic tank. W. C. Ferguson. St. Louis, Mo. U.S. Pat. 1,221,913, May 8, 1917. Date of appl., Nov. 16, 1916.

A VERTICAL cylindrical chamber is provided near the middle of its length with a conical throat piece, the walls of which slope downward and inward. Lugs project inward from the throat piece and support an upright conical partition, thus forming a settling chamber above and a digesting chamber below. Solid particles in the sewage introduced into the settling chamber escape into the digesting chamber through the constricted passage between the throat piece and the conical partition.—W. F. F.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Opium; Identification of—with the aid of meconin and meconic acid. O. Tunnmann. *Apoth.-Zeit.*, 1916, 31, 499–500, 503–501. *J. Chem. Soc.*, 1917, 112, ii., 226.

Zinc chloro-iodide is a suitable reagent for the microchemical detection of opium in broken pieces and dust; when the preparation is gently warmed with the reagent, the polygonal epidermal cells of the poppy capsule are well defined, the secondary membranes being coloured violet-blue, the primary deep yellow. The meconic acid content of opium may fall as low as 1.5%. In using Autenrieth's method of testing for meconic acid, it is necessary to filter the solution of magnesium meconate at the boiling point. In addition, it is frequently advisable to decolorise the aqueous solution of the residue obtained from the alcoholic extracts by means of benzene previous to boiling with magnesium carbonate. The maximum meconin content in opium in seven cases investigated was 0.112%. Little reliance can be placed on the sulphuric acid test for meconin. The copper, silver, ferrous, and pyridine salts of meconic acid are suitable for its microchemical detection. The copper salt forms 3–5–10 μ long, pale yellow, intermingled needles and rods with occasional nodules. Limit of sensitiveness, 40–50 μ g. In spite of their smallness, the crystals shine brightly between crossed nicols. The silver salt appears under the microscope as yellow, occasionally almost black, needles (diameter, 15–25 μ) grouped in clusters, less frequently as colourless crystals, of length up to 20 μ . In polarised light, the smaller nodules show a dark cross, the larger groups appear grey and greyish-brown. Extinction in the single crystals is parallel to the long axis. The limit of sensitiveness is 5 μ g. The ferrous salt is prepared by adding a grain of dehydrated ferrous sulphate to a drop of meconic acid; the mixture is warmed until a pale red solution is formed. After five to ten minutes, the formation of reddish-brown nodules and single crystals is observed, the latter gradually forming aggregates. All the crystals glow red in polarised light and show strong pleochroism. Limit of sensitiveness, 15–20 μ g. The pyridine salt forms long, fine, colourless, single, prismatic needles, occasionally grouped in sheaves; the mean length of the needles is 60–120 μ and mean breadth 2.3 μ . Between crossed nicols they appear pale grey. Limit of sensitiveness, 50 μ g. Lastly, the reactions with zinc chloro-iodide, potassium bismuth iodide, and potassium iodide-iodine can be used. The former yields a yellow, amorphous precipitate, whilst the other reagents give yellow or yellowish-brown nodules and sun-like crystal aggregates which, with the last-named reagent, attain a diameter of 300–400 μ .

Ipecacuanha; Alkaloids of—II. P. Karrer. *Ber.*, 1917, 50, 582–586. (See also this J., 1916, 1177).

In the previous paper the production of the iodide of a quaternary base, dehydroemetine, was recorded as the result of the oxidation of emetine with iodine. This is identical with the rubremetine of Carr and Pyman (this J., 1911, 761); its salts are not decomposed by sodium hydroxide. The revised formula for the iodide is $C_{25}H_{43}N_2O_4I$; the base thus contains 7 hydrogen atoms less than emetine and it is suggested that in the oxidation two tetrahydroisoquinoline rings are oxidised, one with a secondary N-atom and the other with a tertiary N-atom forming part of two contiguous rings. Dehydroemetine may be reduced both in alkaline and acid media, giving different products

in the two cases. On reduction with zinc dust and sulphuric acid it yields a white substance, $C_{25}H_{40}N_2O_4$, which is not identical with emetine and has therefore been named isometine. Neither isometine nor its salts, nor the product of its complete methylation, $C_{29}H_{52}N_2O_4 \cdot CH_3 \cdot (CH_3)_2$, with methyl iodide and sodium carbonate, show any tendency to crystallisation. Emetine and isometine behave differently in their colour reactions with diazotised sulphanilic acid:—Emetine couples with this reagent only in alkaline solution in presence of sodium carbonate; if the liquid be acid it remains yellow. Isometine coagulates in neutral solution; on the addition of sodium carbonate the liquid clears but if this solution be then acidified the colour changes to a deep violet-blue. Isometine is rather less toxic than emetine.—J. F. B.

Aconite alkaloids. Pyraconiline and pyraconine H. Schulze and A. Liebm. *Arch. Pharm.*, 1916, 254, 567–583. *Z. angew. Chem.*, 1917, 30, Ref., 124.

ACONITINE and japaconitine yield the same pyraconitine, and also, contrary to the statement of Dunstan and Read (this J., 1899, 1153), the same pyraconine. Of the nine oxygen atoms of pyraconitine, $C_{39}H_{43}(11)NO_9$, four are present in methoxyl and two in hydroxyl groups and two in a benzoyl group; the remaining one is probably in the form of an ether (alkylene oxide) linkage. Pyraconitine is an N-methylated tertiary base. It yields pyraconine, $C_{25}H_{38}(37)NO_8$, and benzoic acid when heated with alkali or water. Pyraconine is not identical with pseudaconine. Its hydrochloride crystallises with 24 mols. H_2O , melts at 135°C., and has $[\alpha]_D^{20} = -121.6$ (see also Dunstan and Carr, this J., 1894, 172).

Sparteine; Anomalous solubility of—A. Valeur. *Comptes rend.*, 1917, 164, 818–820.

A MIXTURE in equal volumes of sparteine sulphate and sodium carbonate solutions remains clear at ordinary temperatures but forms a milky precipitate on raising the temperature to 30°C., and the solution clears again on lowering the temperature. The precipitate may be due to the formation either of a basic sulphate of sparteine or the free base. A saturated aqueous solution of sparteine gives a precipitate on slight elevation of temperature, and at other concentrations, down to 0.14 gm. per 100 c.c., the more dilute the solution, the higher is the temperature necessary for precipitation. The base is less soluble in sodium carbonate than in water, so that even at a concentration of 0.01% in 12.3% sodium carbonate solution, turbidity occurs by immersion in boiling water. Similar anomalies are shown by several piperidine bases.—J. N. P.

Tobacco leaves; Critical examination of the methods of estimating nitrogenous substances in—G. Paris. *Staz. sperim. agrar. ital.*, 1916, 49, 405–421. *J. Chem. Soc.*, 1917, 112, ii., 227.

AMMONIA-NITROGEN is not completely precipitated by phosphotungstic acid in sulphuric acid solution, but is partly contained in the amino-nitrogen estimated by difference. The general methods of estimating amino- and protein-nitrogen also yield inexact results. The volumetric estimation of nicotine is accurate if certain precautions are taken. The following methods are proposed: Water, total nitrogen, and nicotine are estimated in the tobacco itself, total nitrogen, protein nitrogen, nicotine nitrogen, ammonia nitrogen, nitric acid nitrogen, and amino-nitrogen in the aqueous extract. The latter is obtained by agitation for six hours with water at 30–35°C. Total nitrogen is estimated by the Kjeldahl method, nicotine by Bertrand and Javillier's method (by

precipitation as silicotungstate and weighing the silica and tungsten oxide after ignition, etc.), soluble protein-nitrogen according to Stützer, ammonia-nitrogen by distillation under diminished pressure, nitric acid nitrogen by the Schlesing-Wagner method. For the estimation of amino-nitrogen, the protein nitrogen in the extract is removed by basic lead acetate, the filtrate freed from lead by sulphuric acid, and the bases precipitated by phosphotungstic acid (10%), care being taken to avoid any excess. A portion of the filtrate is freed from sulphuric and phosphotungstic acids by means of baryta; the solution is made up to a definite volume and filtered; after removal of excess of baryta with carbon dioxide the filtrate is concentrated to 50–60 c.c. at a low temperature, care being taken to maintain neutrality by periodical addition of very dilute nitric acid. The solution is finally precipitated by freshly prepared, clear mercuric nitrate solution, an excess of the reagent being avoided. The precipitate is collected, decomposed with sulphuric acid according to Kjeldahl, and the nitrogen estimated. The filtrate from the mercury precipitate contains traces of asparagine and other amides and aspartic acid which have escaped precipitation. It can be made alkaline and the liberated ammonia distilled under diminished pressure.

Phloretin; Synthesis of— and preparation of the nitriles of phenolcarboxylic acids. E. Fischer and O. Nouri. Ber., 1917, 50, 611–623.

PHLORIDZIN is hydrolysed by dilute acids to dextrose and phloretin, which latter is resolved by dilute alkalis into phloretic acid and phloroglucinol. A method devised by Hoesch (this J., 1915, 952) for the synthesis of phenol-ketones by means of nitriles has been applied by the authors to the synthesis of phloretin. The methyl ester of phloretic acid was converted into the amide by heating with methyl alcoholic ammonia under pressure; this was acetylated in order to fix the phenolic group and then converted into the nitrile by warming with phosphorus oxychloride in chloroform solution. The nitrile of acetylphloretic acid when treated in ethereal solution with phloroglucinol and zinc chloride and saturated with gaseous hydrogen chloride, according to Hoesch's method, yields a keto-imide which may be isolated in the form of its crystalline sulphate. This, on warming in aqueous solution, yields acetylphloretin, which is readily saponified by cold alkali giving phloretin in all respects identical with that prepared from phloridzin. The nitriles of *p*-coumaric acid and of gallic acid have been prepared in a similar manner from the amides of their acetyl derivatives. The product of the combination of *p*-coumaric acid nitrile with phloroglucinol was not identical with naringenin, but an isomeride differing in melting point and solubility, and lacking the ferric chloride reaction. The product obtained from phloroglucinol and the nitrile of cinnamic acid also lacked this property and is regarded as a derivative of hydrocumarin.—J. F. B.

Emodin-bearing drugs; Identification of—. W. S. Hubbard. J. Ind. Eng. Chem., 1917, 9, 518–521. (See also this J., 1917, 565.)

THE following methods for identifying aloes, cascara, rhubarb, and senna in medicinal preparations, have been in use for some time at the U.S. Bureau of Chemistry. An ether extract of the material is prepared after acidification with sulphuric or hydrochloric acid. If addition of ammonia gives a red colour (Bornträger's reaction), and phenolphthalein is absent or has been removed (see this J., Warren, 1914, 1171; Bailey, 1914,

501), a portion of the ether extract is treated with an equal volume of saturated borax solution. Aloes produce a green fluorescence, sometimes only perceptible after half an hour, rhubarb an old rose colour, cascara a brown, and senna sometimes a light brown but usually no colour at all. According to the indications of this borax test special confirmatory tests may be applied, a number of which are described and discussed. If rhubarb is present, an aqueous solution of bleaching powder, added to a portion of the ether extract, produces a red ring, or a red colour in the aqueous layer, or even a red precipitate (calcium chloride or lime gives a pink to red colour with all the drugs mentioned). If a saturated solution of ferric or ferrous sulphate is used instead of bleaching powder, a blue colour, sometimes faint but always recognisable against a white background, is formed in presence of rhubarb. No known substance besides rhubarb answers to both these tests, though samples of senna have responded to the first. A preparation of 1:8-dihydroxyanthraquinone ("Istizin"), used for the same general purposes as these drugs, gives the Bornträger reaction and that with bleaching powder, but does not respond with borax or iron salt. The brown coloration in the borax test is distinctive for cascara provided rhubarb is absent. Senna responds to none but the Bornträger test, and not always readily to that, so it cannot be identified in presence of any of the other drugs. Some colour reactions of the four drugs (ether extracts) with solutions of ammonium thiocyanate, ammonium molybdate, and uranium acetate are mentioned.—J. H. L.

Antipyrine; Determination of—. J. Bougault. J. Pharm. Chim., 1917, 15, 337–339.

THE following modifications are suggested for rendering the volumetric and gravimetric methods for the determination of this substance more trustworthy (see François, this J., 1917, 353). *Volumetric method.* Ten c.c. of a 1% aqueous solution of antipyrine is treated with 1 gm. of potassium bicarbonate and excess of N/10 iodine solution is added. After 1 hour, the mixture is acidified with 1 c.c. of acetic acid, 10 c.c. of chloroform is added, and the excess of iodine is titrated with thiosulphate solution. This method yields 99.6% of antipyrine when dealing with the pure substance. *Gravimetric method.* A quantity of about 0.5 gm. of antipyrine is dissolved in 50 c.c. of water, 2 grms. of potassium bicarbonate is added, and 20% iodine solution is run in drop by drop. The brown turbidity which forms with the addition of each drop should disappear before the next drop is added, otherwise a pasty black precipitate of iodoantipyrine mixed with iodine is formed. Colourless crystals of iodoantipyrine begin to appear soon after a slight excess of iodine has been added (this should require 30 minutes), but become blackened by the excess of iodine. After 1 hour, the mixture is decolorised by the addition of sodium thiosulphate, the precipitate is collected, washed with a few c.c. of water, dried, and weighed. The filtrate and washings from the precipitate are extracted with chloroform to recover a quantity of iodoantipyrine which remains in solution. This method yields about 99% of the antipyrine present.—W. P. S.

Acetic anhydride; Testing of—. C. E. Sage. Perfumery and Ess. Oil Rec., 1917, 8, 162–163.

IN estimating the value of acetic anhydride the total acidity is determined by direct titration with alkali hydroxide solution, and also the residual acidity after treatment with aniline in the cold, by which the anhydride is decomposed with the production of equimolecular parts of acetanilide

and acetic acid. From these two titration numbers the amount of anhydride is calculated, the remaining acidity being due to acetic acid or to acetic and butyric acids if the latter is present, which is determined by a preliminary qualitative analysis; the relative proportions of these two acids may also be calculated from the same titrations. It is suggested from the figures obtained and the large scale results when using anhydride containing butyric acid, that other anhydrides than acetic may also be present (see also H. D. Richmond, this J., 1917, 519; Radcliffe and Medofski, page 628).—B. V. S.

Ether for anaesthesia: Determination of alcohol and water in —. R. L. Perkins. J. Ind. Eng. Chem., 1917, 9, 521—523.

The author has studied the influence of 0–4% of alcohol and 0–1% of water, separately and together, on the specific gravity of pure ether at 25° C., and constructed graphs by means of which the alcohol- and water-contents of ether for anaesthesia can be found from the specific gravities before and after drying with potassium carbonate. This avoids weighing the carbonate as required by the method of Mallinckrodt and Alt (this J., 1916, 1081).—J. H. L.

Preparation of carbon suboxide from malonic acid and phosphorus pentoxide. Stock and Stoltzenberg. See VII.

β-Monoglucoside of glycerol obtained by biochemical synthesis. Bourquelot and others. See XVIII.

Relationship between antiseptic power and valency. Friedberger and Joachimagu. See XIX.

PATENTS.

Acetic anhydride; Manufacture of —. H. Dreyfus, Basle, Switzerland. Eng. Pat. 100,452, May 8, 1916. (Appl. No. 6600 of 1916.) Under Int. Conv., Apr. 28, 1915. Addition to Eng. Pat. 100,450 (this J., 1917, 611).

In the process described in the principal patent, the acetic anhydride should be distilled off *in vacuo* at temperatures below 150° C., otherwise it is partially decomposed by the free sulphur with formation of acetic acid.—F. Sp.

Liquid pharmaceutical preparations: Method of solidifying —. C. A. Cofman-Nicoresti, Snarebrook. Eng. Pat. 105,949, May 1, 1916. (Appl. No. 6198 of 1916.)

SOLUTIONS of potent drugs in alcohol or liquid paraffin are solidified by the addition of salts of the higher fatty acids, for the purpose of manufacturing suppositories, pessaries, bougies, etc. *Example.* To 100 c.c. of an alcoholic solution of iodine is added 5–6 grms. of sodium stearopalmitate or animal soap. The mixture is heated above 50° C. until the soap is incorporated, and then poured into moulds and allowed to cool. Solidification may be accelerated by adding 1 grain of hard paraffin or wax to 1 oz. of the solution. (Reference is directed in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pats. 961 of 1892, 12,446 of 1893, and 2343 of 1901; this J., 1893, 31; 1901, 495.)—F. Sp.

Chlorinating [hydrocarbons]; Process of — and *products thereof.* G. Mersereau, New York. Assignor to Chemical Development Co. U.S. Pat. 1,221,485, May 1, 1917. Date of appl., Mar. 27, 1913.

PETROLEUM oil is cracked to yield a mixture of unsaturated hydrocarbons. After separation of "condensable matter," the residual gas is treated

with chlorine in successive stages at increasing temperatures, *e.g.*, one treatment may be at 15° C., and another at 100° C.—F. Sp.

Tobacco: Method of dehydrating and curing —. G. H. Benjamin, New York. U.S. Pat. 1,224,703, May 1, 1917. Date of appl., Sep. 23, 1914.

TOBACCO is dehydrated and cured by heating it in a current of hot air to 110° C. for 1–2 hours, then to 120° C. for 2–5 hours, and then to 140° C. until the original moisture content is so reduced as to permit endosmotic action through the cell membrane but is insufficient to react with the enzyme of the tobacco to produce fermentation or mould. Finally the tobacco is heated to 200° C. for 2–10 hours, with or without exposure to electric light, in order to develop the aromatic character of the essential oils of the tobacco, and progressively to change its colour.—F. Sp.

Hog-cholera antitoxin; Process of treating —. J. Reichel, Philadelphia, and H. Werner, Norwood, Pa., Assignor to H. K. Mulford Co., Philadelphia, Pa. U.S. Pat. 1,221,860, May 1, 1917. Date of appl., Jan. 19, 1917.

HOG-CHOLERA antitoxin treated with the usual preservatives, *e.g.*, phenol or tricresol, is mixed with not more than 0.5% of an aldehyde, *e.g.*, formaldehyde, and heated for a sufficient length of time to kill the foot-and-mouth disease virus. The addition of the aldehyde prevents coagulation and produces sterility. The heating process may be carried out in the vessels in which the preparation is finally to be sold.—F. Sp.

Camphor; Production of concentrated solutions of — *in fatty oils, stable in the cold.* J. D. Riedel. A.-G. Ger. Pat. 297,084, Oct. 28, 1914.

CASTOR oil or the fatty acids from castor oil are added to olive oil or similar fatty solvents of camphor, in order to increase their solvent power. More concentrated solutions of camphor for therapeutic use can thus be obtained which do not deposit camphor in the cold.—F. Sp.

p-Aminophenyl salicylate; Manufacture of a bromo-derivative of —. I. Abelin, Berne, and S. Lichtenstein-Rosenblat, Berlin. Ger. Pat. 297,243, Dec. 30, 1915. Addition to Ger. Pat. 291,878 (this J., 1916, 867).

p-AMINOPHENYL salicylate is treated with an α-bromodithylacetyl halide, instead of an α-bromo-isovaleryl halide as in the original patent. The new product has a stronger sedative, antirheumatic, and soporific action, and is tasteless.—F. Sp.

Process of transforming mineral oils [into terpenes]. U.S. Pat. 1,224,787. See IIa.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

Lithographic key on zinc and aluminium; Photographic production of a —. J. I. Crabtree, Comm. No. 48 from Eastman Kodak Research Laboratory. J. Franklin Inst., 1917, 183, 635–636.

A PRELIMINARY treatment is given with a 1% solution of citric acid for zinc, and oxalic acid for aluminium, followed by quick drying. The plate is then coated with a sensitising mixture of 3 parts of a solution of 30 grms. of ferric ammonium citrate (brown scales) in 150 c.c. of water with 1 part of a solution of the same strength of potassium ferriyanide. After exposure the image is developed in water or in a solution of 0.5% potassium ferriyanide and 0.5% citric acid (for zinc) or

oxalic acid (for aluminium). With this treatment there is no danger of the final image washing off the metal plate.—B. V. S.

Negatives and prints; Scientific washing of——. A. W. Warwick. From American Photography. Brit. J. Phot., 1917, 44, 261—4.

THE hypo solution retained by a fixed photographic negative or print is partly on the surface and partly in the film, and in the case of a print partly in the base. In subsequent washing by changes of water, the former, the "surface solution," will naturally obey Bunsen's Rule,

$$1/A = \left(\frac{v}{v+V} \right)^n \text{ where } 1/A \text{ is the fraction of hypo}$$

after n washings, v and V being the volumes respectively of the residual solution and the added water for each washing. The latter, or "absorbed solution," follows the same rule only if sufficient time is allowed at each washing for the attainment of equilibrium, which takes about 5 mins. A factor, K , was determined experimentally for the departure from the rule for a certain set of conditions, by determining the amounts of hypo left in and on the film after each washing. In the case of N.C. film K varied from 1.37 to 1.04, with an average of 1.25 for the

$$\text{logarithmic form of the rule } n = K \frac{\log A}{\log \left(1 + \frac{V}{v} \right)}$$

The conditions for plates are similar to those for N.C. films except that there is less hypo to remove; for prints the difference in the rate of obtaining equilibrium in the base as compared with the film complicates the problem. In the case of washing in running water, assuming that the conditions are such as to keep the water over the film constantly free from hypo the rule $\log A = Kt$ applies, where A is as before, t is the time (in minutes), and K an experimentally determined factor. For an ordinary tank washer for plates K was found to be 0.129 and for Windoes' shelf washer (Amer. Phot., Apr., 1914) 0.14. For prints K drops to about 0.65. A value of 1/50000 for A is suggested as being quite safe and this is reached in about 5 washes of 900 c.c. each for 6 mins. for a $5'' \times 4''$ N.C. film, in about 35 mins. for a shelf washer, and a little longer for a tank washer for plates, and in about 72 mins. in a tank washer for prints.

—B. V. S.

PATENTS.

Sulphur acids from fixed photographic media; Process of eliminating salts of the weak——. S. H. Weinhandler, New York, and J. S. Simson, Philadelphia, Pa. U.S. Pat. 1,224,981, May 8, 1917. Date of appl., Sept. 9, 1916.

THIOSULPHATES or salts of other weak sulphur acids are eliminated by the action of hypochlorite, which may be produced by the electrolysis of a bath of common salt containing the negatives or prints to be treated. By working in strongly alkaline solution the gelatin is rendered porous and the action of the hypochlorite on the sulphur salts extends right through the film before bleaching of the image sets in. Easily soluble salts are formed which are removed by washing with water.—B. V. S.

Colour photography. H. Hess, Assignor to Hess-Ives Corporation, Philadelphia, Pa. U.S. Pat. 1,225,246, May 8, 1917. Date of appl., Mar. 26, 1914.

IN the preparation of multicolour prints from a multicolour diapositive, a series of negatives is taken by exposure through the diapositive to lights of various suitable colours. Colloid relief

prints are taken from these negatives, stained in colours complementary to those used in taking the negatives, and combined in register.—B. V. S.

Photographic images; Methods of bleaching and dyeing——. Brewster Film Corporation, Assignees of H. Miller, New York. Eng. Pat. 100,098, Feb. 2, 1916. (Appl. No. 1,560 of 1916.) Under Int. Conv., Feb. 26, 1915.

SEE U.S. Pat. 1,214,940 of 1917; this J., 1917, 403.

XXII.—EXPLOSIVES; MATCHES.

Guncotton; Sand fusions from [exploding]——. C. E. Munroe. Amer. J. Sci., 1917, 43, 389—390

A CAST-IRON shell with walls $1\frac{1}{2}$ in. thick, after being charged with 3 slabs of wet guncotton, one dry primer, and an igniting charge of 4 oz. gunpowder, was buried to a depth of 3 feet in compact sea-sand. On firing, the base plug of the shell was projected to a short distance and the shell broken into large fragments which remained embedded. In some cases no crater was formed, the wet guncotton was incompletely burned, and the surrounding sand was fused or sintered together in the form of a tube resembling *fulgurites* (i.e., vertical tubes with fused walls formed in sand by the action of lightning).—J. N. P.

Fulminates and azides; New——. L. Wöhler and F. Martin. Ber., 1917, 50, 586—596. (See also this J., 1917, 570.)

IN addition to sodium fulminate, the hitherto unknown simple cadmium, thallous, and cuprous fulminates have been prepared by the action of an amalgam of the metal on silver or mercury fulminate in presence of ethyl or methyl alcohol and precipitation of the new fulminate with ether. Treatment with the amalgam is carried out in a rubber-stoppered bottle in a shaking machine, not more than 1—2 grms. of mercury or silver fulminate being treated at one time, and all the operations being performed in an atmosphere of dry hydrogen. Cadmium amalgam is prepared by electrolysis of the sulphate with mercury cathode; the amalgam containing 20% of cadmium is washed with water and methyl alcohol and lastly with methyl alcohol distilled over barium oxide. Two grms. of mercury fulminate with the addition of 30 c.c. of anhydrous methyl alcohol, cooled by ice, is shaken with the amalgam for about 25 mins. until a test of the filtered solution shows no reaction of mercury with stannous chloride. The product is passed through a filter into dry ether, in a current of hydrogen, and the washing of the fulminate with ether is conducted with the same precautions. After drying *in vacuo* the fulminate still retains about 2% of methyl alcohol from which it is not completely freed even by heating at 55° C. over phosphorus pentoxide *in vacuo* for 24 hours. The analysis of the soluble fulminates is made by Vollhard's method, in methyl alcoholic solution, using alcoholic silver nitrate. Cadmium and thallium fulminates are soluble and subject to hydrolytic decomposition in presence of moisture; cuprous fulminate is insoluble and can be prepared by shaking the amalgam with mercury fulminate in presence of water in an atmosphere of hydrogen. Soluble azides of the heavy metals, of normal composition, have been prepared by the action of azoimide (hydrazoic acid) on the carbonates or basic azides in presence of ether. Normal azides of nickel, cobalt, zinc, and manganese are described. The azoimide may be prepared without danger by gradually introducing 5 grms. of finely powdered sodium azide into a mixture of 100 c.c. of ether and 2 c.c. of concentrated sulphuric acid.

shaking, and filtering off the sodium sulphate. The treatment with the metallic carbonates requires 3–4 days in the shaking machine; the material must be dry and very finely powdered. The end of the reaction is indicated by solubility in water; the suspended azide is filtered off and washed with ether. In the case of manganese it is necessary to start from the basic azide because the reaction proceeds too slowly with the carbonate; basic zinc azide may also serve for the preparation of the normal zinc azide. Nickel azide is particularly sensitive to rubbing and explodes violently. The solutions of all these normal azides are readily hydrolysed giving basic deposits. Ferric and chromic azides of normal composition could not be obtained.—J. F. B.

PATENTS.

Toluols containing paraffins; Process of nitrating — B. J. Flürscheim, Fleet, England, Assignor to Aetna Explosives Co., Inc., New York, U.S. Pat. 1,225,321, May 8, 1917. Date of appl. Mar. 23, 1916.

NITRATION is carried out in two stages, the mononitrotoluene first formed being separated from the paraffins by solution in about an equal volume of sulphuric acid.—B. V. S.

[Paraffin] wax tapers for matches or other purposes; Manufacture of — W. H. Dixon, London, Eng. Pat. 106,071, Jan. 18, 1917. (Appl. No. 929 of 1917.)

A COMPOSITION for wax tapers for matches consists of paraffin wax of m.p. 110°F . (60°C .) 400 parts, aluminium stearate 25 parts, gum dammar 10 parts, calcium sulphate 75 parts. When artificial thread is used, zinc or magnesium stearate or palmitate may be substituted for aluminium stearate. The calcium sulphate may be replaced by talc, wood dust, or cork dust. The paraffin wax is heated to a temperature slightly above its melting point and the other ingredients mixed and then added as a dry powder.—W. F. F.

Apparatus for nitration and sulphonation. Eng. Pat. 105,775. See I.

Nitro aromatic compound and process of making same. U.S. Pat. 1,225,347. See III.

XXIII.—ANALYSIS.

Viscosity of very viscous media; Measurement of the absolute — S. E. Sheppard, J. Ind. Eng. Chem., 1917, 9, 523–527.

THE rate of fall of a spherical body through a liquid, after uniform velocity has been attained, furnishes data for the calculation of the absolute viscosity of the liquid, in accordance with Stokes' law, thus: $K(\text{viscosity}) = 2R^2T(s - s')g/9S$, in which R is the radius and s the density of the spherical body, s' is the density of the liquid, g the acceleration due to gravity, and T is the time taken for the body to fall through a vertical distance S (all values being expressed in c.g.s. units). In the author's experiments steel ball bearings ($\frac{1}{8}$, $\frac{3}{16}$, and $\frac{1}{4}$ in. diam.) were allowed to fall axially in glass cylinders 40 cm. high, filled with the liquid and kept at $20 \pm 0.2^{\circ}\text{C}$. by water jackets. The time taken for a ball to fall between two fixed marks distant about 10 cm. from the top and bottom of the liquid column respectively, was measured to within $\frac{1}{2}$ sec. with precautions against parallax. To correct for the impeding influence of the walls of the cylinder it was found necessary to substitute for T in the above equation $T - C(r - 1)^2$, in which C is a constant and r is the ratio of the diameter of the cylinder to that

of the ball. The values for K thus obtained required a further correction for the ratio of the height of the liquid column to the radius of the ball. With these corrections the method is considered satisfactory for very viscous media.

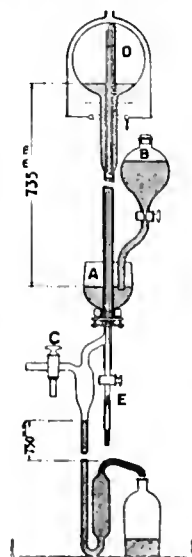
—J. H. L.

Palladium-gold crucibles as platinum substitutes. Met. and Chem. Eng., 1917, 16, 533.

AN alloy of palladium and gold known as "Palau," which has been prepared as a substitute for platinum, has the surface colour of pure palladium and is similar to, but slightly darker than, hammered platinum. Tests at the U.S. Bureau of Standards showed that a crucible formed of the alloy is not so easily deformed as one of pure platinum though not so rigid as a crucible made of platinum with about 8–10% rhodium. The sp. gr. of the alloy is 17.22 and the melting point 1370°C . The E.M.F. against pure platinum is 8.5 millivolts at 960°C . and 7.2 millivolts at 860°C . A crucible of the alloy was heated to 1200°C . in a furnace free from metal vapours, for two periods of 4 hrs. each, and weighed before and after each heating. The weighings to determine the loss due to heating were followed by treatment for 5 mins. with boiling hydrochloric acid (HCl to HCl_2O) and the loss in weight due to the acid treatment was determined. The solutions obtained from this crucible contained less than 0.01 mgrm. of iron. The tests indicated that the "Palau" crucible, as far as resistance to loss on heating to 1200°C . is concerned, is superior to platinum containing about 2.4% iridium. The comparative freedom from iron is an improvement over most platinum ware now in use. The alloy compares favourably with platinum in resistance to hydrochloric, nitric, hydrofluoric, and sulphuric acids, ferric chloride and sodium hydroxide solutions, and fused sodium carbonate. The "Palau" crucible is not as suitable for potassium pyrosulphate fusions as platinum. Both this alloy and platinum are seriously attacked by fused sodium carbonate and nitrate mixture, though the "Palau" crucible is the more resistant.—J. N. P.

Mercury still [for laboratory use]. L. H. Duschak and S. O. Spencer. J. Phys. Chem., 1917, 21, 311–313.

MERCURY is placed in the cup, A, with a reserve supply in the reservoir, B, by which the level in the cup is automatically maintained constant.



The horizontal branch of the three-way stopcock, C, is joined to a water aspirator or other suction device whereby mercury is raised in the annular space between the extended neck of the flask, D, and the condenser tube within. This flask, which may be of soda lime glass, although Pyrex or Jena glass is preferable, will ordinarily have a capacity of 1000 to 1500 c.c., and is supported by a strong wooden clamp (not shown), which grips the neck just below the gas burner. The elevation of the flask above the cup should be such that the difference in mercury levels will be 20 to 30 mm. less than the barometric pressure. A stream of air is adjusted to enter through the capillary tip at E, so that several bubbles per

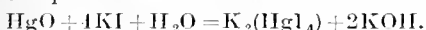
second pass up through the mercury in D; a plug of cotton wool prevents dust from altering the size of the orifice. The rate of distillation is so regulated that the condensation of the mercury vapour in the upper part of the tube, F, is practically completed 10 to 15 cm. above the mercury level in the cup, A. From time to time it is necessary to remove the flask, D, in order to wash out the accumulated impurities with nitric acid. As shown in the sketch, the still may be heated by gas, using a piece of "nichrome" gauze and an asbestos hood, or by an electrical heater, and a rate of distillation of about 750 grms. per hour obtained. The presence of the small partial pressure of oxygen causes oxidation of the common metals contaminating the mercury, which are thus separated more effectively than by ordinary distillation.

—J. N. P.

Yellow mercuric oxide as a standard in alkali-metry.

G. Ince. *Z. anal. Chem.*, 1917, **56**, 177—191.

YELLOW mercuric oxide is a trustworthy substance for use in standardising acid solutions; it is readily obtained in a pure state, is free from water of crystallisation, and is not hygroscopic. Its use depends on the reaction:



At least 9 mols. of potassium iodide must be added for each mol. of mercuric oxide; in practice, it is advisable to add a somewhat larger proportion of iodide, for instance, 10 c.c. of 60% potassium iodide solution to 0.4 gm. of the oxide. As soon as the oxide has dissolved in the iodide solution, the mixture is titrated with the acid solution to be standardised, using methyl-orange, phenolphthalein, or methyl-red as indicator. The yellow mercuric oxide as bought is usually pure, but if desired it can be made by dissolving 100 grms. of mercuric chloride in 1 litre of warm water, cooling the solution, and then adding 625 grms. of 6.4% sodium hydroxide solution, the mixture being well stirred during the addition of the alkali. The precipitate is collected, washed until the wash-water is no longer alkaline to phenolphthalein, then air-dried and stored in black glass bottles.—W. P. S.

Analysis: Electrolytic— with small platinum electrodes. F. A. Gooch and M. Kobayashi. *Amer. J. Sci.*, 1917, **43**, 391—394.

A ROTATING electrode was made of a piece of platinum gauze, 1.2 cm. square, in the central meshes of which the tapered end of a lead glass rod was fused. Electrical connection was made by means of a doubled and twisted platinum wire, 0.03 cm. in diameter, wound about the glass rod and welded to a copper wire which during rotation made a sliding contact with a shaft connected with one of the poles of the source of current. The stationary electrode consisted of a strip of thin platinum foil, 5 cm. \times 0.5 cm., welded to the connecting wire by means of which it was suspended against the sides of a thin glass beaker of about 120 c.c. capacity. In order to collect particles which became detached on account of the non-adherent nature of the deposit resulting from the high current density on the small electrode surface, a small filtering tube was made by fusing the flanged end of a lead glass tube to a small disc of platinum gauze and coating the disc with a filtering mat by dipping it in an emulsion of asbestos and applying suction. The beaker, both electrodes, and the filtering tube, which may be ignited without difficulty, were first dried and weighed together, the total weight amounting to about 20 grms. The electrode, which was arranged to rotate at 600 revs. per min., was suspended vertically in the beaker containing the solution to

be analysed. After electrolysis, the liquid remaining was drawn off by suction through the filtering tube and the washed beaker, electrodes, and filtering tube were dried and again weighed together. The copper in an electrolyte of 100 c.c. volume containing 0.5 gm. of crystallised copper sulphate and free sulphuric acid, was completely precipitated within an hour by means of a current of about 0.2 amp. (15 amps. per sq. dm.) with a potential of 4 volts between the electrodes. It was found necessary to allow the cathode deposit, after superficial washing, to stand for a few minutes in distilled water in order to remove occluded sulphuric acid. With nickel, 0.1 gm. of the metal was deposited completely in 1½ hrs. from 100 c.c. of solution containing ammonia and ammonium sulphate by means of a current of 0.8 to 1 amp. at 10 to 12 volts. For the determination of lead, the electrolyte consisted of lead nitrate and 30 c.c. of concentrated nitric acid in 100 c.c. of solution, when lead peroxide is deposited on the electrode on arranging this as anode and rotating at a rate of 150 revs. a minute. As the content of lead is reduced, the peroxide deposit becomes more adherent, and it was found necessary to continue the electrolysis until no detached peroxide, which is gradually redissolved by the nitrous acid present in the electrolyte, remained in suspension in the solution. Twenty minutes before the termination of the electrolysis, urea was added to destroy the nitrous acid and prevent the solvent action of the electrolyte on the deposit on stopping the current. The electrolysis was continued for two hours with a current of 3 to 4 amps. at 5 to 7 volts. The beaker, electrodes, filtering tube, and deposit were finally dried at 200° C. and weighed.—J. N. P.

Water; Determination of— by distillation. A. A. Besson. *Chem.-Zell.*, 1917, **41**, 346—347.

AN apparatus is described in which water can be determined in such substances as soap, cheese, etc. From 5 to 15 grms. of material is heated in an oil bath in a Kjeldahl flask, together with about 200 c.c. of xylol or paraffin oil. The water and the vapour of the distilling medium pass into a Soxhlet apparatus with a graduated lower portion, in which the water can be collected and measured. —W. H. P.

Detection and determination of sulphur in petroleum. Francis and Crawford. *See* II A.

Determination of free carbon in coal tar. Falcicola. *See* III.

Effect of adsorption on the physical characters of precipitated barium sulphate. Weiser. *See* VII.

Standardisation of refractory materials used in the iron and steel industry. Cronshaw. *See* X.

Analysis of cast nichrome. Reid. *See* X.

Determination of phosphorus in zinc phosphide. Liberi. *See* X.

Analysis of hardened oils. Identification of hardened marine animal oils and rape oil. Normann and Hugel. *See* XII.

By-products of the hydrolysis of fats. [Glycerin from waste fats.] Henkel und Co. *See* XII.

Determination of active oxygen in detergents containing saponin. Grün and Jungmann. *See* XII.

Study of the determination of potash [in fertilisers] chiefly concerned with the Lindo-Gladding method. Hibbard. See XVI.

p-Tolyldihydrazones of l-arabinose, rhamnose, fucose, d-mannose, and d-galactose. Van der Haar. See XVII.

Polarimetric determination of starch in presence of other optically active substances. Baumann and Grossfeld. See XVII.

Improvements in the copper method for determining amino-acids [from proteins]. Kober. See XIXA.

Determination of arginine in proteins. Hansen. See XIXA.

Detection of time used as a neutraliser for dairy products. Wichmann. See XIXA.

Contributions to water analysis. Winkler. See XIXB.

Identification of opium with the aid of meconin and meconic acid. Tunnmann. See XX.

Critical examination of the methods of estimating nitrogenous substances in tobacco leaves. Paris. See XX.

Identification of emodin-bearing drugs. Hubbard. See XX.

Determination of antipyrine. Bougault. See XX.

[Testing of] acetic anhydride. Sage. See XX.

Determination of alcohol and water in ether for anaesthesia. Perkins. See XX.

PATENTS

Viscosity of fluids [liquids]: Method of measuring — A. L. Collins, San Francisco, Cal. U.S. Pat. 1,221,142, May 1, 1917. Date of appl. Aug. 26, 1914.

THE viscosity is determined by measuring the time taken for a bubble of air or gas to rise a pre-determined distance through the liquid. In one form the air bubble may be introduced into the bottom of a vertical tube open at the top and filled with the liquid, and in another form the tube may be closed at the top, filled with the liquid, and the lower end immersed in the liquid. —W. F. F.

Combustible gases: Detector of — A. Philip and L. J. Steele, Portsmouth. U.S. Pat. 1,224,321, May 1, 1917. Date of appl. Nov. 26, 1912. SEE Eng. Pats. 3002, 4003, and 4004 of 1913; this J., 1913, 455.

Apparatus for testing magnetic objects. U.S. Pat. 1,223,377. See X.

XXIV.—MISCELLANEOUS ABSTRACTS.

Copper ferrocyanide membrane: Selective properties of the — F. Tinker. Proc. Roy. Soc., 1917. A. 93, 268—276.

COLLOIDAL copper ferrocyanide was prepared by

mixing solutions of potassium ferrocyanide and copper sulphate, centrifuging and washing with water to remove the excess of the dissolved salts, and again centrifuging. By partially drying, the precipitate was prepared with a varying content of water and then shaken with sugar solutions for two days, at a temperature maintained at 15° C. Changes produced in the concentration of the sugar through the absorption of water by the copper ferrocyanide, or its liberation from the moist precipitate to the solution, were determined by polarimetric measurement. Equilibrium in the partition of water between the solution and the precipitate was attained within a few hours. The amount of water absorbed or retained by 100 grms. of ferrocyanide when placed in solutions of sucrose of varying concentrations in 100 grms. of water was found to be approximately constant for different samples of the ferrocyanide and, down to a certain limiting value, to decrease as the concentration of sugar increased. With pure water, 30 grms. was absorbed and with a sugar solution of 60% concentration and above, a constant value of 13 to 14 grms. was approached. This result indicates that the ferrocyanide forms the hydrate, $\text{Cu}_2\text{Fe}(\text{CN})_6 \cdot 3\text{H}_2\text{O}$, which corresponds to a moisture content of 15.7 grms. of water per 100 grms. of dry ferrocyanide. With more dilute solutions, the excess of water above this amount absorbed by the ferrocyanide can only be attributed to adsorption on the surface of the colloidal particles, as there was found to be no simple relation between the amount of water taken up and the concentration of sugar, and by varying the weight of ferrocyanide in a solution of given strength the amount absorbed was not a constant as it should be if the water were either dissolved or hydrate water. In the osmotic action of the copper ferrocyanide membrane, the colloidal particles of the hydrated compound are consequently to be regarded as adsorbing water selectively from sucrose solutions, in inverse proportion to the concentration of the sugar, without taking up the sugar to any appreciable extent. The permeability of the membrane is thus due to the pressure of adsorbed moisture, which is greater on the water side than on the solution side, resulting in a continual flow across the membrane as long as there is a concentration difference on the two sides. —J. N. P.

Books Received.

INDUSTRIAL RESEARCH IN THE UNITED STATES. By A. P. M. FLEMING. H.M. Stationery Office. 60 pages, 9½ × 7¼ in. Price 1s. (See p. 030.)

THE CHEMISTRY OF DYESTUFFS. By M. FORT and L. L. LLOYD. Cambridge University Press, Fetter Lane, London, E.C. 311 pages, 8 × 5½ in. Price 7s. 6d.

FOLLOWING a brief historical introduction, the authors give a short account of the distillation of tar and the conversion of tar products into intermediate compounds. Chapters on the application of dyestuffs and on colour and constitution are followed by descriptions of the principal dyes classified according to constitution. The descriptions are clear and concise, and the book is well printed and appears to be quite suitable for the purpose for which it was written, namely, as a manual for students of chemistry and dyeing.

Journal of the Society of Chemical Industry.

No. 13, Vol. XXXVI.

JULY 16, 1917.

No. 13, Vol. XXXVI.

Official Notices.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY.

The first volume of these reports is now ready. As the issue is strictly limited, those who desire to obtain copies are advised to apply for them without delay. The price is 3s. to members and 5/6 to non-members, including postage.

PROHIBITED EXPORTS.

An order-of-Council, dated 22nd June, 1917, orders that the Schedule to the Proclamation, dated 10th May, 1917 (see this J., 1917, 523), prohibiting the exportation from the United Kingdom of certain articles to certain or all destinations,* should be amended as follows:—

The following headings are deleted:—(C) Asphalt; (C) Asphalt, coal tar; (C) Bitumen, liquid or solid; (B) Paraffin, liquid medicinal; (B) Ferro-manganese; (A) Ferro-tungsten; (C) Glue, osseine and concentrated size, fish glue, isinglass, finings and other kinds of gelatin; (C) Iridium and its alloys; (A) Ivory, vegetable; (B) Lubricants and articles and mixtures containing lubricants; (B) Mica, mica splittings, mica powder, micaite, and articles made from, and insulating materials containing, them; (B) Mineral jellies; (A) Molasses; (B) Motor spirit (except benzol); (B) Oil fuel, except oil fuel allowed by the Commissioners of Customs and Excise to be shipped; (B) Oil fuel, shale; Oils, vegetable, the following, and articles and mixtures containing such oils—(B) All other vegetable oils except essential oils; (C) Osmium and its alloys; (C) Palladium and its alloys; (B) Paraffin oil; (B) Petroleum, fuel oil; (B) Petroleum, lighting oil; (B) Petroleum, gas oil; (B) Petroleum spirit and articles containing petroleum spirit; (C) Petroleum and its products not otherwise specifically prohibited; (C) Yeast and articles, mixtures, and preparations containing yeast; (C) Rhodium and its alloys; (C) Ruthenium and its alloys; (A) Tallow; (B) Turpentine substitute, and articles containing turpentine substitute; (B) Varnishes containing shellac, oil, turpentine or turpentine substitute.

The following headings are added:—(B) Asphalt; (B) Asphalt, coal tar; (B) Bitumen, liquid or solid; (C) Adrenaline; (C) Atypin; (C) Aloe juice; (C) Amylene; (C) Anchusa; (C) Anchusin; (C) Apiol; (C) Chlorides, metallic and metalloidal, not otherwise prohibited; (B) Citrates; (C) Digitaline; (C) Ergotine; (C) Eryngo; (C) Eserine; (C) Exalgin; (C) Hydrastis canadensis; (A) Hydrocyanic (prussic) acid and solutions thereof; (A) Lactates, not otherwise prohibited; (A) Lactic acid; (C) Liquorice roots and juice; (C) Lithium compounds; (C) Lycopodium; (A) Manna; (A) Mannite; (A) Paraffin, liquid medicinal; (C) Pepsin; (C) Peptone; (C) Pilocarpine; (A) Potassium carbonate, and mixtures containing potassium carbonate; (C) Saffron; (B) Sodium peroxide; (C) Sulphocyanides, not otherwise

prohibited; (C) Sulphorinates; (C) Tannalbin; (C) Tannigen; (C) Vaccines; (C) Valerianates, not otherwise prohibited; (C) Valerianic acid; (A) Ferro-manganese; (B) Glue, osseine and concentrated size, fish-glue, isinglass, finings and other kinds of gelatin; (B) Gum fragacanth; (C) Insecticides, not otherwise prohibited; (C) Iridium and its alloys, and manufactures containing iridium; (A) Ivory, vegetable, and manufactures thereof; (C) Lithium; (A) Lubricants, mineral, and articles and mixtures containing mineral lubricants; (B) Lubricants not otherwise specifically prohibited, and articles and mixtures containing such lubricants; (A) Mica block and mica splittings; (B) Mica sheets, mica waste, mica powder, micaite, and articles made from and insulating materials containing mica in any form; (A) Mineral jellies; (A) Molasses, and articles, mixtures, and preparations containing molasses; (A) Motor spirit; (A) Oil fuel, except oil fuel allowed by the Commissioners of Customs and Excise to be shipped for use on board the exporting ship; (A) Oil fuel, shale; Oils, vegetable, the following and articles and mixtures containing such oils—(A) Linseed; (B) All other vegetable oils, not otherwise prohibited; (C) Osmium and its alloys, and manufactures containing osmium; (C) Palladium and its alloys, and manufactures containing palladium; (A) Paraffin oil; (A) Petroleum fuel oil; (A) Petroleum gas oil; (A) Petroleum lighting oil; (A) Petroleum spirit, and articles containing petroleum spirit; (A) Petroleum and its products not otherwise specifically prohibited, and mixtures thereof; (A) Levulose; (A) Milk sugar (lactose); (A) Yeast, and articles, mixtures, and preparations containing yeast; (C) Rhodium and its alloys, and manufactures containing rhodium; (C) Ruthenium and its alloys, and manufactures containing ruthenium; (C) Silicon; (A) Tallow and articles, mixtures, and preparations containing tallow; (C) Tar, oil, not otherwise specifically prohibited; (A) Tungsten alloys; (A) Turpentine substitute, and articles containing turpentine substitute; (C) Vanillin; (B) Varnishes containing shellac, oil, or turpentine not otherwise prohibited.

CASTOR OIL AND PALM OIL PRICES. MINISTRY OF MUNITIONS ORDER, JUNE 19TH, 1917.

The Minister of Munitions hereby orders that as on and from June 29th the maximum prices specified in the Schedule to this Order for purchases and sales of and dealings in castor oil and palm oil shall be substituted for those specified in the Schedule to the Order of the 9th May, 1917 (see this J., 1917, 523), for purchases and sales of and dealings in such oils and the Orders of the 1st May (this J., 1917, 497) and 9th May, 1917, shall have effect in all respects as if the prices specified in the Schedule to this Order had originally been specified in the Schedule to the Order of the 9th May as the maximum prices for purchases and sales of any dealings in castor oil and palm oil.

SCHEDULE.

	Per ton.
	£ s. d.
Castor oil (pharmaceutical) ..	88 0 0
Castor oil (ordinary) ..	80 0 0
Palm oil (bleached) ..	50 0 0
Palm oil (unbleached) ..	11 0 0

The above prices are for oil net naked ex ship, mill or warehouse in the United Kingdom.

* The prohibition of exports is as follows:—

Goods marked (A), to all destinations;

Goods marked (B), to all ports and destinations abroad other than ports and destinations in British Possessions and Protectorates;

Goods marked (C), to all destinations in foreign countries in Europe and on the Mediterranean and Black Seas, other than France and French Possessions, Russia, Italy and Italian Possessions, Spain and Portugal, and to all ports in any such foreign countries, and to all Russian Baltic ports.

Packages may be charged extra at current market rates but not exceeding £1 per ton on the oil, or (in the case of castor oil sold for any special purpose in special packages) such higher sum per ton (if any) as may from time to time be authorised to be charged by the Controller of oils and fats.

Edinburgh Section.

Meeting held on Tuesday, December 12th, 1916.

PROF. JAMES WALKER IN THE CHAIR.

THE PURCHASE AND CONTROL OF FACTORY SUPPLIES.

BY B. D. PORRITT, B.Sc. (LOND.), F.I.C.

Many of the more important industrial supplies are limited in variety, fairly uniform in quality, and subject to market control. The organisation necessary to purchase and control supplies of this kind, of which plantation rubber may be cited as an example, are of a simple character, limited to the official responsible for the duty—generally known as the buyer—and the staff necessary for ascertaining the requirements of the factory, certifying the deliveries being correct in quantity, and conducting the clerical work of the purchasing department. Under such conditions little need is likely to be experienced for scientific assistance. When, however, as is generally the case, the factory supplies comprise materials liable to wide variations in quality, due either to the nature of the raw materials or to differences in the processes employed in their preparation, the problem confronting the purchaser is much more complicated, since price is no longer the sole consideration.

The discussion which follows will be limited to instances in which improvements in either the price or the quality of supplies may be effected by judicious purchasing combined with efficient laboratory examination, and the conditions which obtain in a factory devoted to the manufacture of rubber goods will be selected for special consideration.*

A manufacturer will desire his supplies to be of uniform and satisfactory quality. The materials, moreover, will have to be purchased at prices equal to or less than those paid by rivals. The manufacturer will, in addition, require his stocks to be maintained at the lowest quantity consistent with safety.

The control of factory supplies should be divided between three officials, namely, the buyer, responsible for the price and the source of the material; the stores superintendent, answerable for the quantity ordered and the correctness of the delivery; and the factory supplies chemist, entrusted with the duty of determining the standard of quality to be ordered and the suitability of the material supplied.

One of the first steps to be taken in developing and systematising such a factory supply organisation should be the creation of a self-contained department in which the deliveries of goods can be checked, tested, and, if satisfactory, stored until required by the manufacturing departments. In order that the Costing and Sales Department may issue their price lists and quotations, it is customary in most businesses for the Purchasing Department to issue yearly or half-yearly statements giving the prices at which standard materials

will be supplied by the store to the factory. This procedure will also furnish an indication of the efficiency of the work of the buyer and the stores superintendent.

In addition to specifying the quality to be ordered and verifying the correctness of the material supplied, the laboratory will be required to assist the buyer in selecting suitable sources of supply by examining and reporting on the samples received.

In order that the buyer may be at liberty to concentrate his attention on the study of the markets, he should be as free as possible from the distractions of routine clerical work and the petty enquiries and complaints which are inevitable in a large factory. To the stores superintendent, therefore, should be delegated such tasks as seeing that contract deliveries are coming forward to time, investigating complaints and the like.

The duties of the laboratory in connection with the purchase and control of supplies may be said to fall under the following headings:—

(1) The standardisation of all the more important supplies together with the elimination of any unnecessary, unsatisfactory, or unduly expensive materials, and the reduction of the number of standards to the minimum consistent with factory efficiency.

(2) The testing of deliveries from contractors to ensure conformity to the specified standard of quality.

(3) The examination of samples submitted to the purchasing department by would-be suppliers.

Until the work included under the first heading is complete, that falling under the second and third categories obviously can be carried out only to a limited extent. Unfortunately, the amount of work involved in standardising the factory supplies generally will be very considerable, and in some instances three or four years may elapse before every item has been satisfactorily investigated and adjusted. Though the system has to be introduced gradually, its advantages, however, should begin to be experienced as soon as the more important materials have received attention. In order to hasten the completion of the preparatory work the factory supplies chemist should be relieved from the responsibility of devising the necessary analytical and physical tests, which should be assigned to the research section of the laboratory.

The first step towards the standardisation of the supplies should consist in compiling statements showing the materials employed in each department of the factory, the quantity used, the price paid, together with particulars of the purposes for which each is used, and any information available regarding past or present manufacturing troubles attributed to particular supplies. From these lists a summary can be prepared showing all the departments which are interested in particular supplies, together with the total annual cost of each item.

This preliminary work having been accomplished, a conference between the members of the staff responsible for the supplies—the buyer, the factory supplies superintendent, and the chemist, who will together constitute what may be termed the Factory Supplies Committee—should be held in order to discuss the results and determine the order in which the items should be investigated.

Having already obtained all the information available from the factory, the laboratory staff can proceed to elaborate their methods for the analysis of the particular supply. The results will be specially interesting when the material is one supplied under some fancy trade name: in such cases the price will generally be found to be far higher than is justified by the actual composition of the substance. When these analyses have

* "Some Notes on the Raw Material used by the Rubber Manufacturer." This Journal, 1916, p. 986.

been completed, it will remain to consider whether the material is satisfactory in quality and price or whether some other less expensive substance could not be substituted with advantage. At this stage, therefore, it will probably be necessary for the purchasing department to send out inquiries for quotations and samples to a number of suppliers. In certain cases, however, before sending out inquiries, it may be advisable to consider whether it would be advantageous for the firm to produce or manufacture the particular material themselves. Such a proceeding will, in general, be profitable only on a large scale which will enable the plant to be kept running constantly at full capacity or with a view to preventing the disclosure of works' processes or plant. Most of the large rubber works manufacture their own "reclaimed" rubber, and a few of the largest possess their own rubber plantations and weave their own fabrics. The advent of the organic "accelerator" of vulcanisation may induce some rubber manufacturers to undertake the manufacture of organic chemicals in order to prevent the disclosure of their special "compounds" to competitors.

The samples and quotations received by the Purchasing Department as a result of its inquiries should be carefully numbered and all the available information recorded for reference. The samples should then be sent to the laboratory for examination with all these particulars. Those thought promising for various reasons by the buyer should be indicated for special attention. The examination of this range of samples, probably differing considerably in quality, will enable the laboratory to perfect their analytical methods and to form an opinion regarding the standard which is satisfactory for factory use. Such conclusions should be confirmed, first by small scale factory experiments, and secondly, if successful, by manufacturing tests on a larger scale. When as a result of this preliminary work a material has been selected as a standard by the Factory Supplies Committee, the laboratory can proceed to elaborate their routine methods for the examination of samples and the control of supplies respectively. At the same time a specification can be drawn up for the use of the Purchasing Department.

In compiling a "Reference Book" for the use of the factory supplies chemist, each individual supply should be considered very thoroughly and all the information obtained during the preliminary investigations just considered should be recorded for future use. It should, therefore, be possible to ascertain at a glance the departments making use of a particular material and the purpose to which it is put in each. Important references in scientific and technical literature should be noted, together with information regarding the source of the supply or the methods employed in its manufacture which may serve as a guide either to the impurities or defects to be sought during testing or to the conditions likely to influence its price. Full details should be given both of accurate methods of analysis and of the more rapid tests designed to verify the quality of the deliveries received from contractors. Finally the specification or guarantee to which such deliveries will be required to conform should be included, together with the average tests or analyses obtained on the standard supply.

As some of the information in such a complete record is likely to be of a confidential nature, a "Laboratory Method Book" should be prepared for the use of the junior staff and unqualified assistants carrying out the routine work of the laboratory, containing merely the methods employed for examination of the supplies, together with the specifications.

A specification must be regarded merely as a guide to the contractor as to the quality of the

finished article desired and not as an instruction as to how he should carry on his business. Consequently, while it should give clear and concise information regarding the usage to which the material will be subjected, the results desired, and the tests to which it will be submitted, the nature of the raw materials to be used and the methods of manufacture which should be adopted in order to secure a satisfactory result should be left as far as possible to the judgment and experience of the contractor. Any departure from this procedure will, in the event of the goods supplied proving defective in use, largely relieve the contractor from responsibility. Whenever possible specifications should be submitted to a reputable supplier for criticism before they are definitely passed as satisfactory. The adoption of a specification based on an existing satisfactory standard quality evidently should not result in any advance in the prices quoted to the purchasing department in response to their inquiries. For articles which do not lend themselves to rapid or conclusive laboratory tests and which can be proved satisfactory only by actual usage, a carefully worded and legally sound guarantee clause will have to be inserted in the contract as a safeguard against the delivery of inferior goods.

In general, the specification represents all the initial information required by the purchasing department, but in certain cases it may be supplemented with advantage by a certain amount of general information. In many instances the buyer is in a great measure unacquainted with the composition and origin of the products with which he is dealing and frequently is not conversant with the other trades making use of the same or similar materials. The laboratory, therefore, can often supply information which will enable him to obtain a clearer insight into the factors which may influence the market quotations. The importance of such knowledge must have been realised in many businesses during the past three years of abnormal conditions, and perhaps in the near future the post of buyer may be added to the list of positions for which the chemist possessing business capacity and experience is considered eligible.

The successful examination and control of supplies purchased on a specification basis is almost entirely a question of accurate sampling combined with rapid and reliable methods of testing. The difficulties incidental to securing an average sample, as is well known, will vary greatly from industry to industry. They may be very considerable as, for example, with moist wood pulp, pyrites, and crude rubber, or may be comparatively slight as in the case of the majority of the "fillers" employed by the rubber manufacturer. Where difficulties are likely to be experienced an understanding regarding the methods of sampling and analysis to be employed should exist between the buyer and seller and be embodied in the specification. Before a delivery of material is sampled by the laboratory it should be examined by the store to determine whether the quantity is in accordance with that stated on the invoice. If correct in this respect it should be stored entirely separate from approved factory supplies until the laboratory report is received.

A range of standards should be collected in the laboratory for ready reference, and must be kept up to date as modifications occur in consequence of changed conditions of manufacture or alterations in the sources of supply.

The samples submitted for report by the purchasing department to the laboratory should be accompanied by all the available information likely to be of assistance, especially the price quoted and the names of the suppliers. If the cost is greatly in excess of the standard the sample

in general may be dismissed after a brief examination, and a few preliminary tests together with a comparison with the standard material will serve to eliminate a further proportion of those remaining. At this stage a search should be made through the laboratory reports for the results of the examination of any similar samples previously received from the same source. The information thereby secured will frequently well repay the trouble, since many firms send out samples of their standard products at short intervals to all likely customers. Any laboratory report dealing with this work should be entered on a card index both under the name of the supplier and the nature of the article. Copies of these reports should be issued to the purchasing and stores department, so that they may be discussed at the periodical meetings of the Factory Supplies Committee, and further action agreed on to determine fully the merits of those samples which appear promising as a result of this preliminary examination.

The foregoing duties will evidently involve the laboratory in a large amount of routine work when once the methods of analysis and testing are established on a satisfactory basis. The greater part of this work will therefore call for care and thoroughness rather than originality, and should be within the capacity of the unqualified laboratory assistant. The part of the mill supplies chemist in this connection, therefore, should be limited to securing correct samples and interpreting the results of the analyses, so that he may be able to devote his time to investigations of a more difficult character arising out of the discussions of the Factory Supplies Committee.

Few technical processes exist which can be claimed as perfect and there are generally places, even in the best managed businesses, where modification of either plant or methods seems possible with a view to either the total or partial saving of some expensive supply or its substitution by a relatively cheaper material. Investigations with these objects in view will probably result in failure more frequently than in success. Failures of this kind, however, should be regarded as tokens of the efficiency of the factory and not as proofs of the inutility of the chemist.

All the varied work carried out by the laboratory in connection with the factory supplies will require to be systematically reported, and copies of these reports should be sent to the buyer, the stores superintendent, and the factory manager. The manager, moreover, should be supplied with a résumé of the matters discussed at the Supplies Committee meetings, and any proposal involving alteration in either the quality or the source of any particular supply should be submitted for approval to him and those responsible for the direction of the business before any definite action is taken.

In order to carry out the scheme of control which has been outlined above a manufacturer must offer liberal salaries in order to secure the services of an adequate and efficient staff. This outlay must be considered as a percentage of the total sum spent annually in the purchase of the factory supplies. Calculated in this manner and judged merely as a means of ensuring the correctness of supplies, both in quality and quantity, the expenditure should require little or no additional justification. When, however, allowance is made for the savings which can be effected both by purchasing on a competitive basis and by economies in factory use, together with the reduction in manufacturing troubles and the enhanced sales resulting ultimately from a more uniform product, no reasonable doubt can exist that, as usual, efficiency is the truest form of economy.

London Section.

Meeting held at Burlington House on Monday, June 18th, 1917.

MR. A. R. LING IN THE CHAIR.

THE UTILISATION OF THE SULPHUR CONTENTS OF ZINC ORE.

BY H. M. RIDGE.

Spelter was formerly made only from calamine, which is the carbonate of zinc, but as the world's supply of this mineral is limited it became necessary, particularly about the middle of the last century, to use zinc sulphide ore, and the demand increased very rapidly.

The main source of spelter to-day is zinc blende. When pure this consists of zinc sulphide with 67% zinc and 33% sulphur and is a white transparent mineral. The pure mineral is rarely found; zinc blende is generally black or brown and contains several per cent. of iron as amorphous FeS , and frequently also some manganese. In consequence of impurities, the sulphur content is usually less than the above-mentioned figure, but if pyrites, FeS_2 , is present, the sulphur assay rises.

In the ore deposits zinc blende is usually associated with galena and occasionally with copper pyrites, but it is found with most sulphide ores. No particular kind of gangue predominates; in addition to quartz, calcite, strontianite, magnesite, ankerite, siderite, barytes, and fluorspar are frequently present. Quartz and calcite are lighter than blende, barytes is heavier; the differences in specific gravity are sufficient to allow of separation by ordinary wet methods of concentration. If fluorspar is present wet concentration should be carried out carefully because it is desirable to remove fluorine, as far as possible. Siderite and ankerite have been taken out efficiently on the Continent on magnetic separators after a preliminary flash roast to form magnetic Fe_3O_4 .

The utilisation of the zinc contents of the big deposit of argentiferous zinc and lead ore at Broken Hill presented unusual difficulty, because of the presence of garnet and rhodonite of about the same specific gravity as zinc blende. This was first overcome by the use of the Wetherill electro-magnetic separator with an intensely strong magnetic field. When I started the first of these plants at Broken Hill in 1899, we lifted the garnet and rhodonite out of the ore with one set of machines and then passed the residue through an even stronger field which separated the zinc blende from the galena, quartz, and calcite. The process was too expensive to be able to compete permanently and was superseded by the modern methods of flotation; to-day the whole of the zinc concentrates at Broken Hill are produced by flotation. Unfortunately, flotation methods are not, up till now, effective for separating fluorspar or carbonates from blende.

The rapidly-increasing consumption of spelter threatened to cause a shortage of ore as long as calamine was the main source of supply, but improved methods of concentration and of smelting have resulted in making available enormous resources of sulphide ore and there is an adequate supply of suitable concentrates to cope easily with all prospective demands.

I propose, in dealing with the utilisation of the sulphur contents of zinc ore, to divide the subject into:—

1. The extraction of the sulphur from the mineral.
2. The utilisation of the sulphur.
3. Statistics and economics.

The sulphur can be separated from the zinc by:—

(a) Smelting with a metal having greater affinity for sulphur.

(b) Treatment with the oxide of a strong base.

(c) Heating in the presence of oxygen.

Zinc sulphide is decomposed by molten metallic iron or copper and a sulphide is formed, while metallic zinc vapour is driven off. Considerable experimental work has been done on this process, but without success, because of the expense of roasting the iron or copper sulphide and the possibility when copper is used of losing some of this metal in the process. The operation has to be carried out in a retort or crucible at a high temperature. This has some similarity to the ancient methods of brass manufacture by smelting copper ore and zinc carbonate together with carbon.

Zinc blende can be smelted with lime and carbon to form zinc, carbon monoxide, and calcium sulphide; this has been carried out in an electric furnace but it entails a continuous fresh supply of lime, while the resulting impure sulphide of lime quickly oxidises to sulphate and has to be run to waste.

The usual method of separating the sulphur from blende is to roast the ore with a sufficiency of air to form zinc oxide and sulphur dioxide. This is the method in general use.

The further treatment of the zinc concentrates after roasting consists in heating the zinc oxide in retorts, with suitable reduction material, to reduce the oxide and distil the reduced metallic zinc which is cooled and condensed to liquid metal.

In roasting zinc blende the sulphur is oxidised to SO_2 with a small amount of SO_3 , and sufficient oxygen is required for the formation of zinc oxide. The reaction is exothermic, but it is not possible to obtain a sweet roast without the application of heat. Sulphates are formed in roasting and these have to be decomposed; this necessitates additional heat units.

The heats of formation are:—

$$\begin{aligned} (\text{Zn} + \text{S}) &= 43,000, \\ (\text{Zn} + \text{O}) &= 84,800, \\ (2\text{S} + \text{O}) &= 69,260. \end{aligned}$$

If 97 kilos. of zinc sulphide is oxidised completely with air containing 48 kilos. of oxygen, 81 kilos. of zinc oxide and 64 kilos. of sulphur dioxide, equal to 22.22 cubic metres, are obtained. 208 kilos. of air with 160 kilos. of nitrogen will be used.

The reaction gives:—

$$\begin{aligned} \text{Formation of 81 kg. ZnS} &+ 84,800 \text{ calories.} \\ \text{Formation of 64 kg. SO}_2 &+ 69,260 \text{ "} \end{aligned}$$

$$\begin{array}{rcl} \text{Total} & 154,060 & \text{"} \\ \text{Decomposition of 97 kg. ZnS} & - 43,000 & \text{"} \end{array}$$

$$\text{Net heat evolution} \quad 111,060 \text{ "}$$

In practice this result is not obtainable; the ore and the air have to be heated up, while the roasted ore and the sulphur fumes are discharged at a high temperature and as the heat units cannot all be retained in the furnace, coal has to be burnt to maintain the temperature and to remove the last units of sulphur.

If the sulphur has to be used for technical purposes, the fumes must not be contaminated and diluted with fire gases.

Constructional difficulties were encountered in the design of furnaces for this purpose. Muffled furnaces have to be used in which the fire gases do not come into contact with the ore, and the heat units have to be passed through fire brick in order to maintain the heat while the last units of sulphur are being oxidised and while any sulphates, which may have been formed, are decomposed.

In Germany and Belgium prolonged efforts were made to prevent the emission of large quantities of sulphur fumes into the air and the consequent destruction of vegetation in the neighbourhood of the works, and the first practical results were obtained about 1855 by Hasenclever, who, after a series of experiments, built a furnace at the Rhenania works. This is shown in Figure 1.

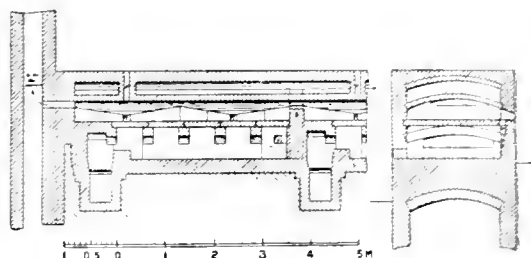


FIG. 1.

The furnace has two roasting hearths, of which only the top hearth is muffled, and after the ore has been rabbled along this hearth and has given off some of its sulphur, it is dropped to the bottom hearth to complete the roasting in direct contact with the fire gases. The arches of the furnaces were too high for practical work and the fumes were low in SO_2 .

In 1865 a much improved furnace was built by the Rhenania Co., and this is illustrated in Figure 2. The results improved, but the capacity

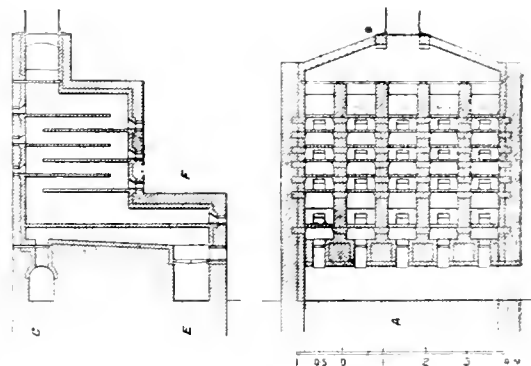


FIG. 2.

of the furnace was small and the strength of the gas continued deficient; it is worthy of note that the designer realised that it was only necessary to heat the ore during the last stages of oxidation, because there is enough heat at the commencement of roasting, but this point was overlooked for many years. The general idea of the construction of the furnace is very similar to that of "Delplace," which will be referred to later.

An effort to reduce the amount of labour was made in 1872 with the furnace shown in Figure 3. A number of these furnaces were built at various works in Germany, but they again laboured under the disadvantage of the final roast being carried out in contact with the fire gases. The furnace had 215 square feet of area on the bottom direct fired hearth and above this a muffle of the same size was heated from above and below by the fire gases. The incline had an angle of 13° , which had been determined by experiment, and baffles were placed in this, so as to spread the ore in a fairly uniform thin layer. Openings were arranged for access in case of blockage. The ore travelled a total distance of about 90 feet in the furnace.

Much labour was required for breaking up lumps of ore which formed, and the furnace had to be very carefully tended. During the period when much sulphur is being given off the ore will run like water if the temperature rises too high, and if iron or lead are present in appreciable quantity, the overheated ore will set hard. This frequently

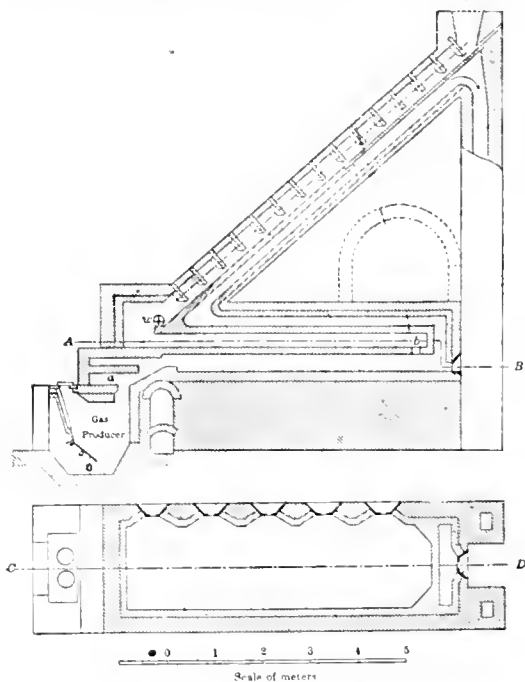


FIG. 3.

occurred on the incline and the design was finally discarded, because more labour was required for freeing the incline than is necessary for working a horizontal hearth. The output of the furnace per 24 hours was about 3 tons of roasted ore with a coal consumption of 15 cwt., and three men were necessary per shift, so that the output per man per shift with a 12-hour shift was only 10 cwt.

In the furnaces which were designed for part of

the work to be done in the muffle and the balance in a reverberatory, only about two-thirds of the sulphur contents were available for further use, while the remaining one-third was so diluted by the fire gases that it had to be allowed to escape into the atmosphere.

In England attempts were also made to roast zinc ore in muffled furnaces, but they were not entirely satisfactory. It is remarkable that the first roasting of blende appears to have been done here. In 1758 John Champion of Bristol obtained a patent for using blende or black jack in the manufacture of brass.

The first of the furnaces of the so-called Rhenania type is shown in Figure 1; this was built in accordance with a German patent of 1882. The furnace is provided with one fire box, and the fire gases travel four times the length of the furnace, which has nine muffles each 2 ft. 5½ in. wide and four hearths in which the ore is rabbled by hand at right angles to the direction of the travel of the fire gases. The air for the muffles is preheated and the sulphur fumes leave the furnace with about 6% SO₂. The capacity is 3 to 3½ tons of roasted ore with a coal consumption of 27%; the ore remains in the furnace about 48 hours. Improvements were made in this furnace by cutting out the division walls between the muffles, so that the ore could be rabbled sideways along the hearths in the opposite direction to the travel of the fire gases; later it was found unnecessary to heat the upper parts of the furnace because the oxidation of the ore gives off sufficient heat, but before this stage was reached furnaces were built embodying almost every conceivable variation in the arrangement of the fire flues and the muffles.

Twelve years ago I still built furnaces with three superimposed muffles, the fire gases travelling beneath and above the bottom muffle, whereas it is only necessary, with proper design, to pass the fire gases under the bottom muffle. I found that in one part of the furnace, the fire gas was no longer heating the ore but that heat units were being transferred from the ore to the gas.

For the sake of completeness I illustrate one of the later modifications of the Rhenania furnaces in Figure 5. This furnace is 47½ feet long by 17½ feet wide, so that the ore travels a distance of 118 feet along the hearths. With a 12-hour shift a total of 8 men were required for the pro-

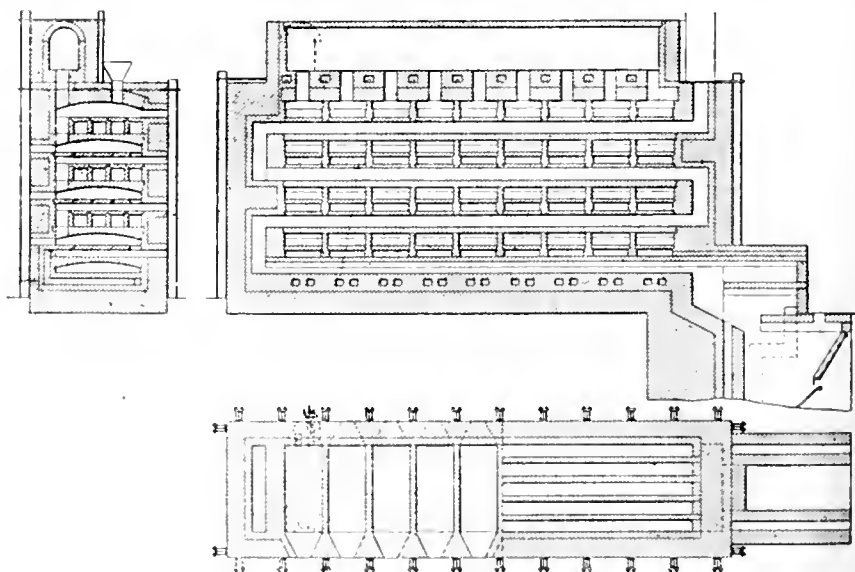


FIG. 4

duction of 6 tons of roasted ore per 24 hours. By working with 8-hour shifts only 6 men were required and the production per man per shift rose from 14 or 15 cwt. to 18 or 19 cwt. The coal consumption is about 25%.

These furnaces have been generally built together in blocks of four and have been more largely used than any other type of furnace.

Owing to high price of fuel, "Delplace" furnaces have, since 1895, been largely built in Belgium; Figures 6 and 7 show the details of this furnace,

have also been erected in this country and in Germany. Experienced labour is required to work them satisfactorily and the men prefer to work on the Rhenania furnaces in which the ore is rabbled sideways, whereas in the Delplace type it has to be alternately pushed from and drawn towards the worker.

Work on zinc ore-roasting furnaces is most laborious, and even on the Continent continuous efforts have, ever since the start of the industry, been made to replace hand labour by machinery.

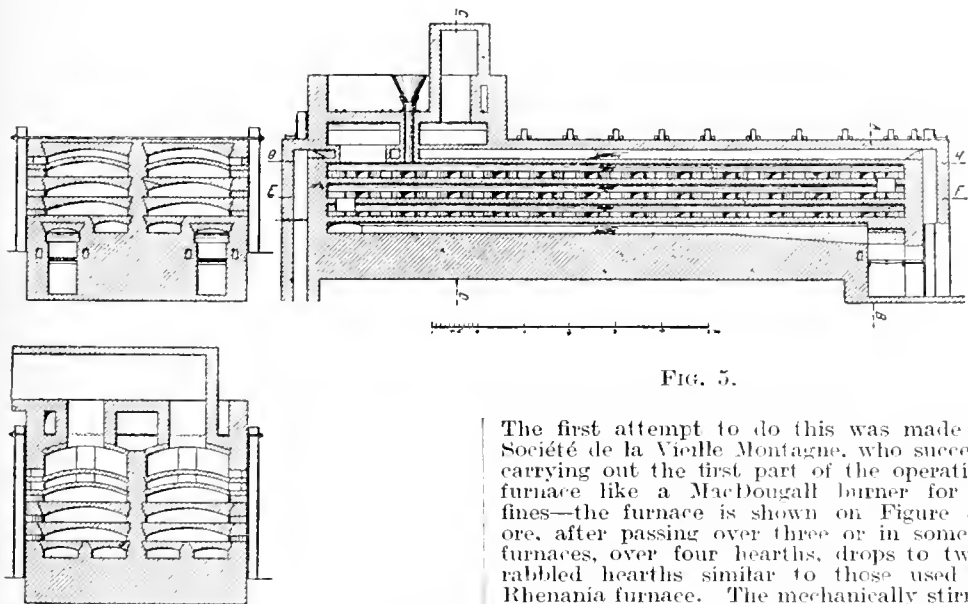


FIG. 5.

The first attempt to do this was made by the Société de la Vieille Montagne, who succeeded in carrying out the first part of the operation in a furnace like a MacDougall burner for pyrites fines—the furnace is shown on Figure 8. The ore, after passing over three or in some of the furnaces, over four hearths, drops to two hand rabbled hearths similar to those used in the Rhenania furnace. The mechanically stirred part had a diameter of 8 feet, but although various modifications of this furnace were tried it was not much used, mainly because of mechanical difficulties, which 40 years ago proved insuperable. The furnace is stated to have been able to treat $3\frac{1}{2}$ tons of ore in 24 hours with 17% of coal and $\frac{3}{4}$ horse-power.

In America, where hand labour was even more difficult to obtain, it was impossible to use hand

which, with good labour, and if carefully built, gives satisfactory results. The travel of the ore on the 7 superimposed hearths is only 40 feet, but the ore is exposed thoroughly to the air because the arches are low and only a thin bed of ore is maintained on each hearth. Only 16% of coal is required for heating. These furnaces have been built mainly in Belgium and in France, but a few

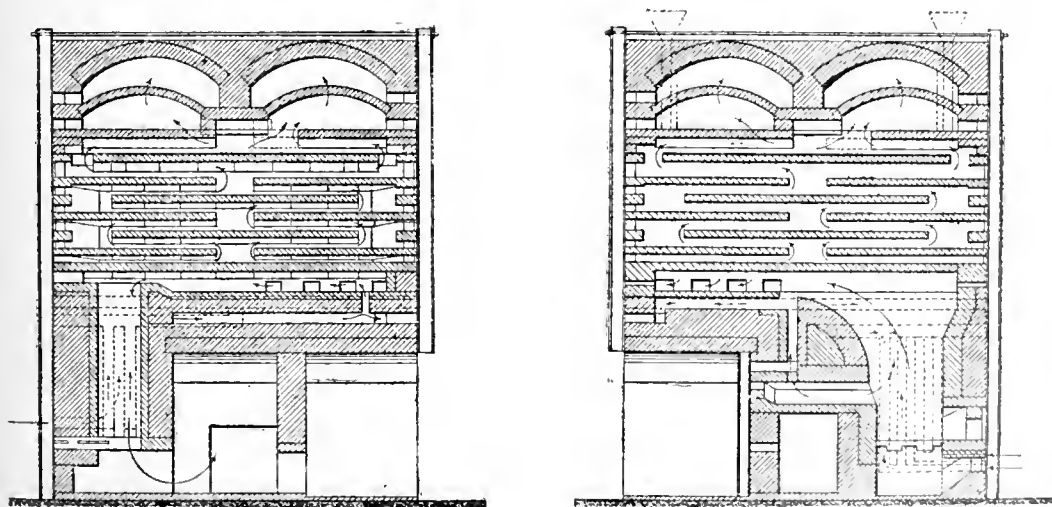


FIG. 6.

down and put out of commission. I understand that on the Continent it has only been possible to work a furnace continuously for a maximum of three months before the arches have to be removed and overhauled, because no repairs can be carried out while the furnace is working.

Figures 15, 16, and 17 illustrate the general

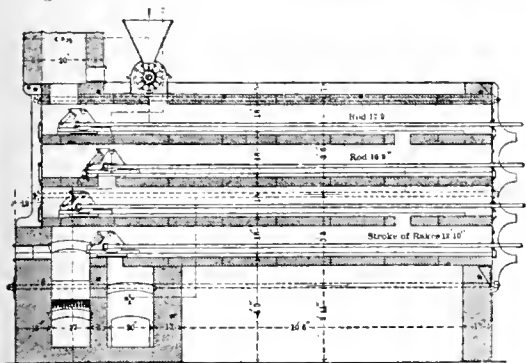


FIG. 9.

design of the Ridge mechanical zinc blende furnace, in which, after experiments extending over many years, the mechanical arrangements have been so far worked out that freedom from mechanical difficulties is assured, while the whole furnace is accessible. The shafts are each made in one piece and are water-cooled; about 15,000 gallons of cooling water is passed through the shafts in 24 hours to prevent overheating. The rabblers which stir the ore are easily and quickly renewed and the part to be replaced weighs only 5 lb. The ore is fed continuously to the drying hearth on top of the furnace and passes over three roasting hearths and finally to the cooling hearth, where it serves to preheat the air required for the oxidation. The mechanism of each furnace is driven by a separate electric motor which takes 8 to 10 horsepower. The motor and all the gearing are on a solid foundation beneath the furnace and fully accessible. The discharge opening is separated from the gearing by a brick wall to keep out all dust. The furnace runs noiselessly, the only sound being the hum of the motor. It is gas-fired and the gas is burnt only under the bottom roasting hearth. Broken Hill zinc concentrates are roasted down to 0.75% total sulphur with a feed of 12 tons of ore per day of 24 hours and a coal consumption of 10%. The sulphur fumes leave the furnace with 6½ to 8½% sulphur dioxide and at a temperature of 380° C. so that they can be used satisfactorily in the lead chamber process. One man per shift can attend to the furnace and the producer.

Zinc concentrates with 14% lead have been satisfactorily treated and also concentrates with 17% iron; when roasting an ore, high in lead or iron, it is essential that a mechanical furnace be kept working continuously, because half an hour's stoppage means that the ore on the hearths sets hard and forms lumps which have to be broken up. It has been found possible in this furnace to use the rabblers for breaking up the lumps, and the gearing can, if necessary, be run alternately backwards and forwards till the hearths are free.

I have dealt at length with the design of furnaces for roasting the ore, because this question has played such an important part in the past history of the art, and the utilisation of the sulphur contents of the ore, and, in fact, the treatment of zinc blende has only become possible in consequence of the development of furnace design.

In some ores the presence of substances which interfere with the desulphurising is important; lime, magnesia, strontia, and baryta, if combined with sulphur, retain it in the roasting furnace; if combined with carbonic acid, this is driven off and in some cases the lime, etc., will take up sulphur from the ore. In considering the sulphur contents of roasted blende, allowance must be made for this combined sulphur. Lead becomes a nuisance in hand-rabbled furnaces, but in a properly designed mechanical furnace I have found no trouble; if ore high in lead is treated continually an accretion will form on the hearths, but the rabblers can be made to remove this. High iron content is found in some Spanish and German ores and makes complete roasting in hand furnaces almost impossible; in Germany, I was able, in a mechanical furnace, to reduce the sulphur left in

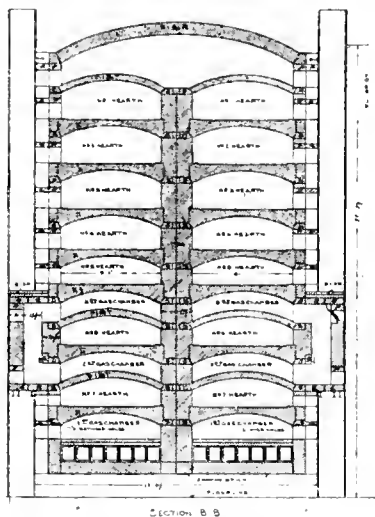


FIG. 10.

the roasted ore to more than 1% less than had been possible in hand furnaces.

The sulphur dioxide given off in roasting is utilised for making sulphites, liquid SO_2 , or sulphuric acid.

Aluminium sulphate has been made at Flone in Belgium by passing the roaster gases into large chambers excavated in the hill side and filled with alum shale. At Anspin this method was also used for making alum with gas from reverberatory furnaces; it seems that sulphite is formed and this readily oxidises to sulphate.

The manufacture of liquid SO_2 was started by Grillo at Hamborn in Westphalia, because the fumes from the roasting furnaces were low in SO_2 .

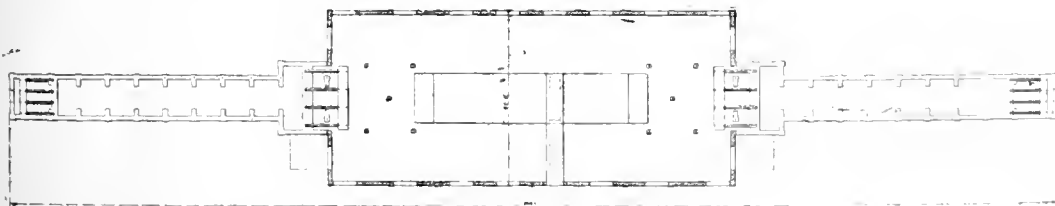


FIG. 11.

and it was, at that time, considered impossible to utilise them for making sulphuric acid. The furnace gases pass to a scrubbing tower sprayed with water, which dissolves the sulphur dioxide, and the liquor gravitates to a series of pans, which are placed over the burners, the heat of which is sufficient to drive off the SO_2 gas, which, after being cooled, is compressed and liquefied at a pressure of 7 atmos. In Germany two plants are in operation, viz., one at Hamborn and another at Lipine in Silesia, but, in this country, the method has not been employed on the fumes from zinc ore. The demand for liquid SO_2 is limited.

The main commercial use for the sulphur fumes is the manufacture of sulphuric acid and this can be carried out in lead chambers, or by the contact process.

ores, to circulate the tower acids, the fluorine contents seem to remain in the circuit so that the attack on the packing of the towers gradually increases, but, contrary to expectation, I have not found increased corrosion of the lead work of the chambers by fluorine. Many efforts have been made to overcome the trouble with the packing. Glover towers have been built entirely of lead, and with lead sheets as a packing, so as to avoid the use of silicious material, but it is found necessary in this case to use two Glover towers in series, the first one being an empty tower followed by a tower filled with suspended lead sheets. I have found it preferable to overcome the trouble by passing the whole of the chamber acid through the towers instead of only circulating the tower acids, and by this means

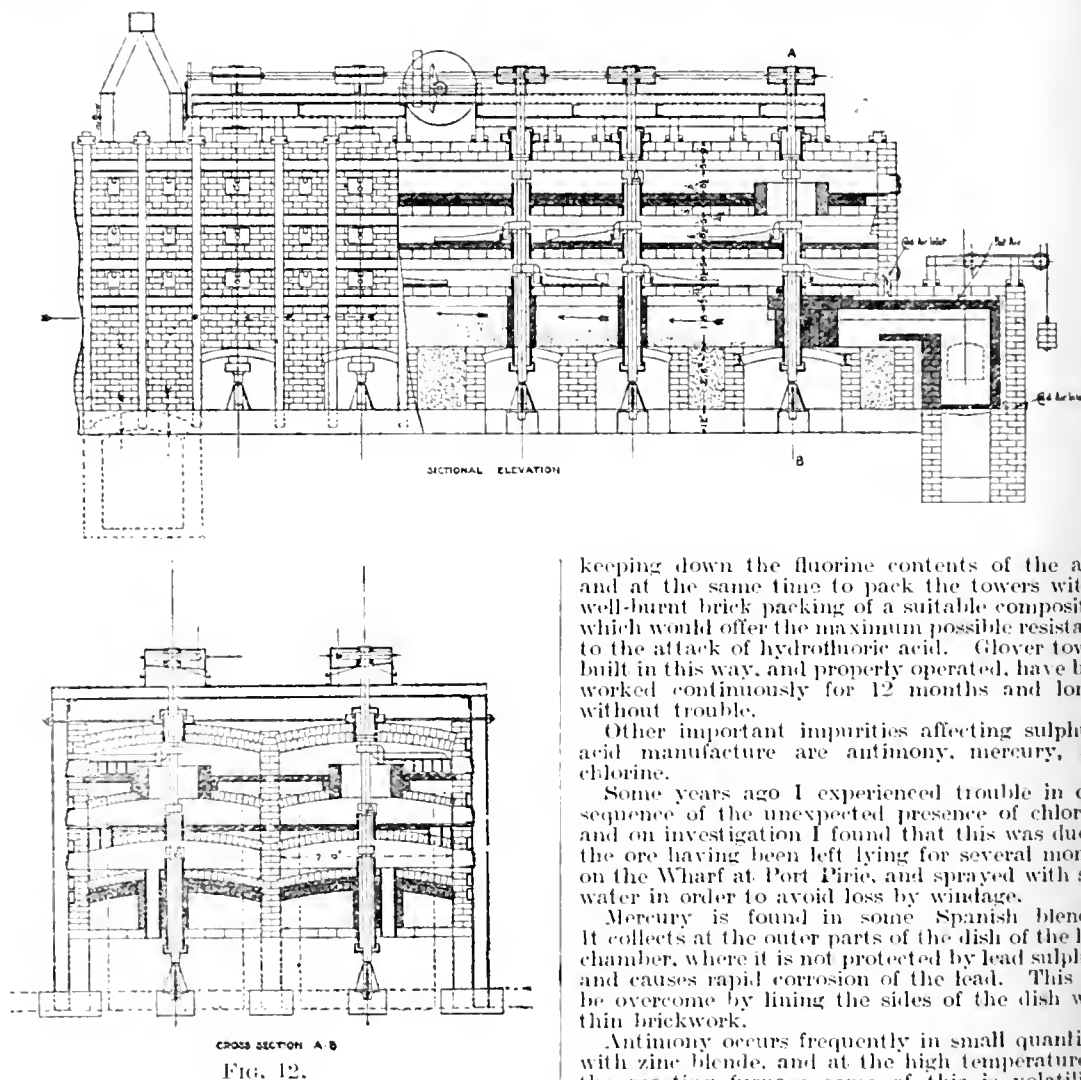


FIG. 12.

Most zinc ores offer the advantage of being free from arsenic, but on the other hand they frequently contain fluorine of which even as little as 0.01 to 0.02% becomes noticeable. Fluorine occurs with the ore as calcium fluoride, which is decomposed in the roasting furnace in the presence of silica and forms silicon fluoride. If this gas passes into the Glover tower it is decomposed and hydrofluosilicic acid is formed; this, in turn, appears to split up. As it is usual, when treating zinc

keeping down the fluorine contents of the acid, and at the same time to pack the towers with a well-burnt brick packing of a suitable composition which would offer the maximum possible resistance to the attack of hydrofluoric acid. Glover towers built in this way, and properly operated, have been worked continuously for 12 months and longer without trouble.

Other important impurities affecting sulphuric acid manufacture are antimony, mercury, and chlorine.

Some years ago I experienced trouble in consequence of the unexpected presence of chlorine, and on investigation I found that this was due to the ore having been left lying for several months on the Wharf at Port Pirie, and sprayed with seawater in order to avoid loss by windage.

Mercury is found in some Spanish blendes. It collects at the outer parts of the dish of the lead chamber, where it is not protected by lead sulphate and causes rapid corrosion of the lead. This can be overcome by lining the sides of the dish with thin brickwork.

Antimony occurs frequently in small quantities with zinc blende, and at the high temperature of the roasting furnace some of this is volatilised and passes into the acid. On one occasion I received serious complaints about the presence of arsenic, but found, on examination, that antimony was the cause of the trouble. Antimony was found in the zinc concentrates from Broken Hill when treating ore from the upper levels in one of the mines, but the quantity present was less than 0.03%.

Most zinc ores have lead associated with them, and some of this is generally driven off with the sulphur in the roasting furnace together with the silver which is combined with the lead, but both

the lead and the silver are deposited in the chamber sludge.

The lead chamber process, when working with hand furnaces, has to be carefully watched because of the intermittent evolution of sulphur dioxide in consequence of intermittent rabbling of the ore. In Germany it has been usual to reduce this difficulty by arranging for the furnace hands, working on the different furnaces, to start their shifts at different times, but, in spite of this, it is not possible to obtain a continuous current of uniform gas throughout the 24 hours, and, unless the process is watched carefully, loss of nitre is the result. With modern mechanical furnaces this trouble does not occur.

The design of the chamber plant does not call for special comment. It is in every way similar to that used when burning pyrites.

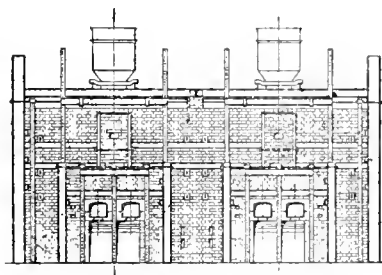
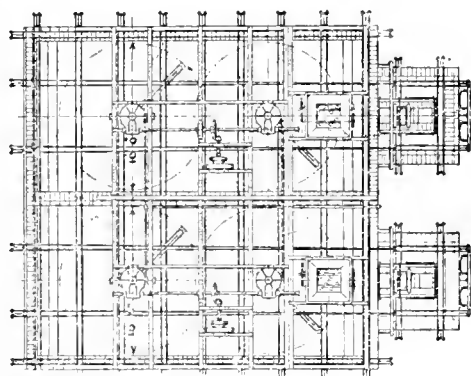
The nitre consumption, and working cost of the plant, are not higher than with pyrites.

Here and in Belgium lead chamber plants have been used exclusively for making acid, and in Germany this is also the rule, but there are several

The average price realised in 1915 was \$8.85 per short ton.

The use of the contact process for fumes from zinc ore made the biggest strides in the United States, because there the smelters are largely able to rely for their ore supplies upon the produce of one or more mines, and are not dependent upon small parcels of ore shipped from various parts of the world, as has been the case here and on the Continent. They have consequently been able to make provision for eliminating any harmful ingredients which may be present in the raw material which they expected to be treating over a long period. The American smelters also have the advantage of having practically no hand-rabbed furnaces.

The various contact poisons can be eliminated if the tonnage to be treated warrants the initial expenditure on the plant. Fluorine, arsenic, antimony, and lead can be removed by first scrubbing the gas with a suitable liquid, and when this is done the conversion offers no greater difficulties than when brimstone or pyrites is burnt.



Merton Duplex Furnace with Drying Hearths, erected at the Irtlysh Corporation Works, Ekibastous, Russia.

FIG. 13.

contact acid plants at work as well. In America 14 zinc smelters make sulphuric acid, but they mainly use the contact process.

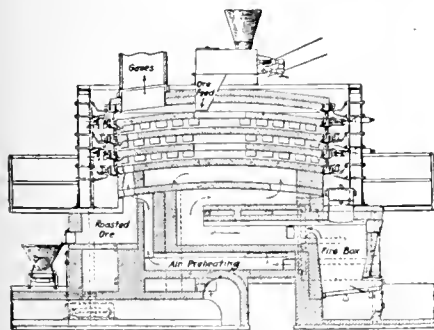
Calculated as 60° B. acid, the American production from zinc blende was—

In the year 1911—	230,643 short tons.
1912—	292,917 short tons.
1913—	296,218 short tons.
1914—	111,911 short tons.
1915—	484,912 short tons.

In England acid has only been made from zinc ore in three plants, and I estimate that their output does not exceed 25,000 tons a year of 140° Tw. acid. This tonnage corresponds to a production of about 10,000 tons of spelter. In 1913 31,290 tons of virgin spelter was made in the country. Part of this was made from calamine, but the available supplies of this ore are steadily decreasing, and it is only a question of a short time, when the whole of the metal will have

to be smelted from zinc blende. The position is really worse than is indicated by these figures, because it has been customary to roast the sulphide ore in reverberatory furnaces from which the fumes cannot be used, so that the sulphur is wasted and the atmosphere polluted.

To illustrate the importance of the utilisation of the sulphur of zinc ores I will refer to the figures for Upper Silesia. The district produces about 60% of the spelter made in Germany, but a good deal of calamine is still available there, so that the maximum production of sulphuric acid from blende has not been reached; the tonnage of calamine treated steadily decreases, but the increased amount of blende compensates for this, and allows of an



Vertical Section through the Spiral Roasting Furnace.



View of one of the Hearths of the Spiral Furnace.

FIG. 14.

increasing spelter and acid production. The last figures available are for 1911, and the accompanying table shows the results for every fourth year since 1887.

Statistics from Upper Silesia.

Year.	Raw blende roasted.	Sulphuric acid refined to 50° B.	Sale value.	
	Metric tons.	Metric tons.	Total marks.	Metric ton of 50° B. acid.
1887	53,882	21,013	479,000	22.81 marks.
1891	66,236	32,676	746,000	22.85 "
1895	84,857	33,229	778,000	23.43 "
1899	123,602	64,029	1,074,000	16.77 "
1903	187,596	104,268	1,728,000	16.62 "
1917	421,006	139,840	2,187,000	15.65 "
1911	411,352	213,317	3,025,000	14.18 "
1912	—	274,908	—	—

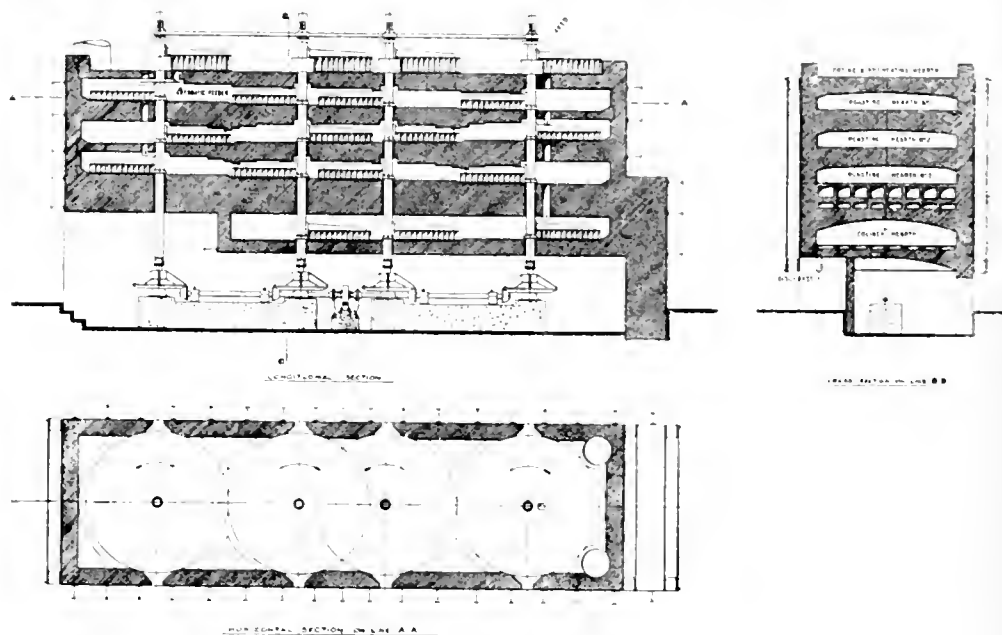
Six works still used their old reverberatory furnaces, so that not all the sulphur could be utilised, but for some years factory legislation has prohibited the emission of noxious fumes and as the plants become worn out they have

The position in the zinc smelting districts in Western Germany is analogous, but the make of acid there is larger in proportion to the production of spelter, because there is no local supply of calamine. The newer smelting works have been placed on navigable waterways so that freights on raw materials and finished products are low. The chamber process is used in all the works except one which has a contact plant; there is also one installation making liquid SO_2 .

In 1913 in Germany 554,760 metric tons of blende was roasted for making sulphuric acid; of this 87,639 tons was imported from Australia and 56,181 tons from other countries.

In Belgium blende is mainly roasted by the chemical manufacturers, who retain the sulphur and receive from the zinc smelter in addition a payment of 6 to 8 francs per 1000 kilos. for roasting the ore. This was facilitated by the low freights on the canals, which reduced transit charges to a very low figure. In Belgium 65% of the total production of sulphuric acid is made from blende; the amount of zinc acid is nearly 400,000 tons.

The most important and serious factor for consideration here in England is the shortage of zinc smelting capacity in the country. In 1913



Figs. 15, 16, and 17.

to be replaced by modern installations. The fumes from the reverberatory furnaces are scrubbed with milk of lime which is sent to waste. Five plants have lead chambers and make acid of 50°—55° B.; this is generally concentrated in cascades or Kessler apparatus and in recent years largely in Gaillard towers. Three works have contact plants as well as lead chambers. There was in 1912 a total of 48 lead chambers.

Of the total production of acid, 11,055 metric tons was sold as acid of 50° B., 111,316 metric tons was sold as acid of 50°—60° B., 42,319 metric tons was sold as acid with 98—100% H_2SO_4 , 216 metric tons was sold as oleum with 20% SO_3 , 1771 metric tons was sold as SO_3 , and in addition 28.55 metric tons of liquid SO_2 was made.

The acid is used for making superphosphates, sulphate of ammonia, dynamite, and gun cotton, and for refining mineral oil. It is distributed by rail over a wide area, some going into Russian Poland, Austria, Hungary, and even to Roumania.

our consumption of spelter amounted to no less than 224,000 tons of which 74% was imported. After allowing for the metal made by the refiners, we imported about 166,000 tons of spelter and zinc in other forms. If this quantity were all made from blende, the roasting fumes could be used to produce annually 400,000 tons of 110° Tw. acid. There is no reason why this should not be done and the corresponding quantity of brimstone and non-cupreous pyrites displaced as well as a portion of the pyrites which is low in copper.

Before the war the cost of making 140° Tw. acid from zinc ore fumes in this country was only between 8s. and 9s. per ton so that the operation is remunerative and profitable.

Zinc ore must be treated because spelter is required, and if the work is not done here, it will be done elsewhere. Cheap sulphuric acid has always been an important factor in the chemical industries and unless we use the resources of the Empire, others will do it for us and we

shall be obliged to continue to look on while the foreign subsidiary industries using the acid abroad go ahead.

Several of the illustrations reproduced in this paper are taken from Liebig's "Zink und Cadmium," Ingalls' "Metallurgy of Zinc and Cadmium," Prost's "Cours de Métallurgie de Métaux autres que le Fer," and "The Engineering and Mining Journal."

Manchester Section.

Meeting held at the Grand Hotel on Friday, May 7th, 1917.

MR. J. H. ROSEASON IN THE CHAIR.

COTTON SEED PRODUCTS.

BY KAPILRAM H. VAKIL, B.A., B.SC.TECH.

The first mention of cotton seed oil was made in 1783, when it was pointed out to the Society of Arts that oil might be extracted from cotton seeds. To encourage the manufacture of this oil the Society offered a prize, but as no application was made for it, although the offer was repeated for six years, no award was made. The seed oil was not expressed successfully till 1847 and no satisfactory progress was made till after the Franco-German war. Since then the growth of this industry has been phenomenal, especially in America. The industry, as will be shown later, has attained enormous proportions in this country and occupies to-day one of the foremost positions among staple British industries.

The following tables will indicate the position of the industry in the United Kingdom.

It will be seen that the bulk of seeds crushed in this country comes from Egypt and India. For nearly fifty years after the establishment of this industry Indian seeds were not known to the crushers, and, as will be shown in Table III., the English demand dates from 1900. Since then the business in Indian seeds has assumed very large proportions, and if the attempts of the Government and the cotton growers prove successful in the near future, India will be the chief country in the world to supply not only cotton but cotton seeds to the British Empire. Considering then the importance both present and prospective of the Indian seeds, I propose to treat in detail certain aspects of the cotton seeds of India. The total area under cotton in India has been of late nearly 23,000,000 acres, and the total estimated output of cotton from this acreage is 4,500,000 bales of 100 lb. each, or about 800,000 tons of cotton. From these figures the quantity of seeds produced during the year may be roughly calculated on the basis of 30% lint and 70% seeds, which amounts to nearly 1,870,000 tons. The amount of seeds required for agricultural purposes would be, at the rate of 11 lb. per acre, about 190,000 tons, leaving 1,680,000 tons for feeding cattle and for crushing. In 1901, when Indian seeds were first introduced into England, there was then produced in India 1,260,000 tons of seeds. This huge quantity of seeds was practically wasted, and, as will be seen from the following figures, the value of these seeds in the Indian market was very low. From the following table it will also appear that although large quantities are shipped to England the export is very small compared with the total production. In 1912 a movement was on foot in this country to send a commission to India to enquire why so small a pro-

TABLE I.
Imports of cotton seeds into United Kingdom.

	1911.	1912.	1913.	1914.	1915.
From—	Tons.	Tons.	Tons.	Tons.	Tons.
Egypt	298,359	335,621	238,788	213,879	393,922
India	220,995	175,872	244,393	335,128	70,582
Brazil	35,826	39,531	47,629	31,792	9,481
Turkey	9,194	26,704	26,639	13,476	—
Peru	7,938	8,984	12,745	11,394	3,843
Uganda	2,275	4,885	5,142	6,056	1,855
Russia	3,526	22,525	17,770	7,053	—
*Other countries	18,846	24,995	22,226	20,794	14,902
Total tons	596,959	630,117	615,332	639,572	494,585
Value	£4,598,875	£4,800,116	£4,648,617	£4,420,307	£4,122,493

* Other countries include Nigeria, East Africa, Colombia, San Domingo, Hayti, America, China, and Germany.

TABLE II.
Imports at different ports in United Kingdom.

	1911.	1912.	1913.	1914.	1915.
	Tons.	Tons.	Tons.	Tons.	Tons.
*Hull	282,558	281,336	283,261	325,354	218,384
Liverpool	74,787	95,794	100,392	81,467	34,938
London	76,998	91,419	88,724	78,148	65,590
Bristol	55,728	46,841	45,855	43,206	33,167
Leith	23,858	32,054	27,682	36,465	30,324
Gloucester	28,841	25,768	24,272	25,123	26,966
Dundee	10,578	12,634	10,238	12,485	8,866
Southampton	6,987	11,959	6,764	6,496	8,243
Manchester	1,813	7,486	7,487	7,846	6,065
Glasgow	4,500	4,156	5,031	7,973	3,072
Ipswich	11,397	3,978	2,076	—	6,833
Other Ports	19,714	18,492	13,551	15,009	22,137
Total	596,859	630,117	615,334	639,572	494,585

* In 1864, 42,034; 1903, 299,189.

portion of the total output of seeds appeared in the markets of Great Britain.

TABLE III.
Indian exports of cotton seed.

Year.	Tons.	Total value. £	Value per ton in India. £
1897-98	1,118	5,087	3.6
1900-01	11,240	36,939	3.3
1905-06	199,567	681,160	3.6
1910-11	299,011	1,539,173	5.1
1911-12	203,605	1,012,752	5.0
1912-13	130,568	685,127	5.2
1913-14	284,326	1,416,743	5.0
1914-15	207,788	1,001,524	5.0

Practically the whole of this export trade is with the United Kingdom, mainly from the port of Bombay; *e.g.*, of the 284,326 tons shipped from India in 1913-14 the share of Bombay was 260,121 tons. In short, the whole trade may be said to be between Bombay and Hull.

From Table I, it will be seen that there are principally two varieties of seeds crushed in the United Kingdom, the Egyptian and Indian. The composition and characteristics of these seeds vary considerably. I do not propose to classify the seeds botanically—since the controversy regarding the number of species of cotton seeds is still undecided. For all practical purposes, and particularly from the oil-crushers' standpoint, Buchanan-Hamilton's classification of all cotton seeds into black or naked seed and the white or fuzzy seed will be quite sufficient. The Egyptian seed belongs to the former class. The treatment of this seed for the expression of oil differs considerably from that of the Indian, which belongs to the second division. The Indian seed has on it a double layer of fibre, the under layer or fluff or lint as it is called by the seed-crusher, and the outer layer of the cotton fibre proper. The seeds as they come into the market contain considerable quantities of foreign matter, *e.g.*, dust, sand, dried leaves, stalks, cotton-balls, etc. In addition, they contain broken, diseased, and lighter seeds, which are useless to the miller. Bulletin No. 53 of 1912 of the Indian Department of Agriculture gives the following percentages of sound seeds obtainable from the bazaar seeds:—

TABLE IV.

	Light seeds.	Foreign matter.	Sound seeds.
	%	%	%
Poona Bazaar	13.5	14.0	72.5
Khandesh	21.8	6.7	71.5
Nadiad	15.6	6.4	78.0
Iroach	16.9	7.2	75.9
Dharwar	13.5	4.8	81.9
Average	16.2	7.8	76.0

These percentages for sound seeds seem to be too low. From hundreds of samples examined in my laboratory during the last five seasons I find that on an average there are 92% of sound seeds and 8% of damaged, including foreign matter. The presence of damaged seeds is highly objectionable in seeds that have to be sent abroad or stored during the monsoon. Damaged seeds result mainly from the carelessness of the ginner or from his attempts to increase the output of the gins. This is very much to be regretted, for to my mind the bad reputation of Indian seeds in the foreign markets is due mainly to the ginner's total disregard of what happens to the seeds by

his rough handling of them. It may be mentioned in passing that the type of gin used determines also to a certain degree the percentage of damaged seeds. Saw gins are not much used in India, and their use is limited to the Dharyar district. Roller gins are generally used all over the country, and the best results, so far as sound seeds are concerned, are obtained by Platt's gins. Dobson's coming next to them. It is not possible to go into details in this paper with regard to the composition of Indian seeds, for from my experience I find that no two samples of seeds are alike. Seeds from the same district, from the same ginning factory, even from the same field, have differed so widely that to attempt to draw any general conclusion from the analysis of a few samples would be entirely incorrect and misleading. A very large number of analyses are recorded by Mollison in the Agricultural Ledger, No. 9, 1903, published by the Department of Agriculture of the Central Provinces, and in Noel-Paton's "Indian Cotton Seed," published by the Government of India. The figures given there are fairly accurate and may be safely taken as representing the average composition of Indian seeds. The following typical analyses which I have made give a general idea of the average composition of Indian seeds.

TABLE V.

	Oil.	Med. ex oil.	Husks and lint.	Sound seeds.
	%	%	%	%
Amalner	29.17	35.33	41.50	87.40
Yeotmal	19.64	36.66	43.70	84.50
Nagpur (Platt's gin)	20.03	35.47	44.50	96.00
Akola	22.98	34.02	43.00	94.60
Hingenghat I.	18.80	38.19	43.00	90.00
Hingenghat II.	19.62	35.53	44.85	89.00
Warora	18.98	37.02	44.00	92.35
Wardha	19.00	41.00	40.00	92.75
Chanda (Platt's gin) ..	19.13	27.37	53.50	97.25
Pandher Kavda	18.36	26.19	55.45	95.85
Average	19.67	34.68	45.65	91.77

Indian seed is valued in this country on the basis of 18% of oil. As the trade conditions prevail at present this figure may be taken as fairly correct, but a large amount of work in this direction has convinced me that the percentage of oil in the Indian seed is capable of being raised by co-operation between the Departments of Agriculture, the farmer, and the ginner. As it is, the seeds from the central Provinces have shown an oil content as high as 23% and on an average 19.5%, and as such they compare favourably with good American seeds. Seeds from the Central Provinces are quoted a little higher in the bazaars and are highly valued by the seed-crushers. The hulls with the lint and moisture form about 43 to 55% of the seeds and on an average 48%. The lint from Indian seeds, removable by American de-linting processes, forms about 1.5% of the seed. This includes lint obtained by reginning the cotton balls which are found in the seeds sold in the bazaar.

On a manufacturing scale the following products are obtainable:—Lint, 1%; decorticated cake, 40%; hulls, 14%; oil (crude), 13%; wastage, 2%. In the report of one of the oil mills now operating successfully in India the following figures of its working on a large scale were given:—Refined oil, 12%; decorticated cake, 42%; hulls, 38%; lint, 1%; soap stock (foots), 2.5%; wastage, 4.5%. This means that the process followed by them is not the "pure" process—which will be discussed later.

American "Uplands" seeds resemble the Indian seed in many respects. The Indian seed, however, has more lint or short fibre remaining on it after ginning. This condition of the seed requires very

careful handling in the extraction process as the fuzzy mass which forms the covering of the seeds absorbs oil very readily from the meal during the preliminary processes of hulling or crushing, this oil being lost to the miller. The Indian seeds are much smaller than the Egyptian and American.

	Length in mm.	Diameter in mm.
Indian	7.0	4.0
Egyptian	8.5	4.5
American	11.0	6.0

This difference in size is specially to be noted as its consideration is important in decorticating by the American process.

When the Indian seeds were first investigated there was a good deal of doubt expressed as to the adaptability of American decorticators for Indian seeds. Experience has shown that if in the American decorticators the clearance between the "breast knives" or concave knives and the cylinder knives be well adjusted to suit the requirement of the Indian seeds, the percentage of whole seeds dropping out undecorticated is almost nil. The small size of the seed no doubt makes it very difficult to handle during this process, but a little skill and the use of a secondary disc-huller removes all the difficulties and the working is made quite satisfactory. There is still much to be desired in the designing of decorticators for small seeds by way of easier or automatic adjustment of knives, their sizes, concavity, speed of the cylinder knives, etc. The husk of the Indian seed is also different from the American, which is less tough and easily manageable in the decorticating process.

There is a very marked difference between the hulls of Indian and Egyptian seeds. The former contains a brown colouring matter easily extracted with water, and on this property and the behaviour of this colouring matter with sodium hydroxide and nitric acid a means of detecting the presence of Indian seed hulls in Egyptian cakes has been suggested (Oil and Colour Trades Journal, 1905, p. 1815). The chief points of difference in the crude oils obtained from these different seeds are: (1) There is a higher percentage of free fatty acid, colouring and albuminous matters in the Indian oil than in the Egyptian or American oils, which gives rise to a greater loss in refining, sometimes exceeding from 16 to 20%. (2) The oil from Indian seeds is poorer than American and Egyptian oils in the solid "stearin" obtainable from it, and not quite so well suited for margarine making. Egyptian and Indian oils are inferior in colour to American oils. (3) The oil from Indian seeds retains a peculiar fishy odour which it is very difficult to get rid of even with drastic treatment. (4) The greatest drawback to the oil from Indian seeds as an edible oil is that the refined oil shows a bluish-green fluorescence. This fluorescence is not removed by the ordinary process of refining. If the traces of fishy odour and the fluorescence could be removed easily and at small cost the oil would find a ready market in India as an edible oil. At present, though sold in large quantities as edible oil, it does not command as high a price and is not valued so much as the best grades of cold pressed TII oil. (5) The refined oil from the Indian seeds has a higher iodine value—112 to 116—than the oil from Egyptian seeds, which varies from 106 to 108, or the American, which varies from 105 to 110. This higher iodine value may be due to the fluorescent substance in the oil.

Before concluding this part of the paper on the special features of Indian cotton seeds, I will refer briefly to the position and prospects of the cotton seed oil industry of India. With the opening of the English demand for Indian cotton seeds a suggestion was made in 1903 at the Upper India

Chamber of Commerce to utilise the seed that was practically wasted. This suggestion was followed by the setting up of a small oil mill by the Government for experimental purposes in Cawnpore. The interest of Indian manufacturers was stimulated by the wide publication of the Government of India's bulletin and by the success of the oil mill set up in Burnah by Messrs. Jamal Bros. It was then that the late Mr. Tata, to whose foresighted enterprise India owes her great cotton and iron and steel industries, decided to enquire into the possibilities of this industry in India. The large experimental plant set up near Bombay handled thousands of tons of seeds from all parts of India, and the results obtained by this mill proved beyond doubt the immense potentiality of this industry in India and of the high grade of products that could be obtained when the seeds are pressed fresh on the spot. The result of this experimental working of the Tata oil mill for four seasons was made the basis of a new undertaking at the end of 1913, starting with a capital of £200,000. This scheme unfortunately was not carried through on account of the great banking crisis in India which was followed by the war. The scheme, however, will be taken in hand as time and circumstances permit. As the Tata oil mill was only meant for experimental purposes it had to be closed down on the completion of the experiment, but about a year after the commencement of the working of this mill another mill was set up in 1912 on a proper commercial basis, and though it had the advantage of the market created by the former mill it had to do a great deal of spade work, which, however, resulted in success. This mill, the Indian Cotton Oil Mill, of Naosari, near Bombay, recently added a considerable amount to its capital for extension. Its cotton seed cakes are now quite well known in the London market.

It was my intention at first to confine the subject matter of this paper to my experience of the Indian seeds, but as it was found that the literature on this very important subject was very scattered and as there was no detailed and connected communication to this Society on the different products of cotton seeds, I have extended the scope of this paper.

The storage of black or naked seeds, like the Egyptian or long staple Sea Island, does not present Egyptian difficulties, but in the case of the fluffy or woolly varieties—the Indian, the American "Upland," woolly Brazilian, etc.—the question of the storage of seeds is of the greatest importance. The presence of fluff on the seed causes the heating of the seed so well known to the millers. The susceptibility of the fluffy varieties to heating is due to fermentation or bacterial action, in presence of the moisture in the fluff and hull. This action is accelerated by the presence of broken and damaged seeds. The action at first is slow, but with the rise in temperature a very rapid heating results. E. H. R. Barrow (J. Ind. Eng. Chem., 1915, 7, 709—712; this J., 1915, 913) has noted that seeds containing over 10% of moisture are unsafe for storage. J. B. Rather (J. Ind. Eng. Chem., 1916, 8, 604; this J., 1916, 898) has shown that even a short period of heating causes hydrolysis of 10% of the fat. A long period of heating will result in hydrolysis of 70% of fat and 33% of protein, increasing the acidity to seven times the original. Increase in acidity is due to heating and to ageing of the seeds. During the four months of the monsoon in India the high temperature of the air (over 85° F.) and the moisture due to heavy rains set up a very rapid fermentation of seeds, especially in "go-downs" which are not kept dry by a high plinth and well ventilated. Similar conditions prevail during the transit of seeds in the holds of ships, and seeds which were quite healthy and free from mould when shipped from Bombay have been frequently

received in this country in a highly damaged condition. This heating of seeds must be prevented with scrupulous care, since the products obtained depend to a very large extent on the condition of the seeds. The quality of the crude oil suffers on account of the fermentation, giving rise to a larger loss in refining. The colour of the refined oil is poor. Other products are also inferior in quality. A number of processes have been suggested to prevent this fermentation and keep the seeds clean. Wilson (Eng. Pat. 1057 of 1887; this J., 1888, 126) suggests treating the seeds by air heated to 200—300° F. Noel-Paton ("Indian Cotton Seeds") proposes to remove the fluff by singeing. There are a number of processes in which by chemical means the fluff is entirely carbonised and removed. According to Stead's Eng. Pat. 13,831 of 1884 (this J., 1885, 585) the seeds are treated with 4% of sulphuric acid and neutralised with lime. J. J. Green (Eng. Pat. 12,539 of 1902; this J., 1902, 1336) also proposes to carbonise the fluff with sulphuric acid. Other acids besides sulphuric acid are also used. Stead (this J., 1891, 820) suggests hydrochloric acid. Silcock (Eng. Pat. 24,516 of 1893; this J., 1894, 945) uses sulphuric acid but neutralises with mineral phosphates and passes the seeds through cylinders revolving at high speed and lined with emery powder blocks to rub off lint acted upon by acid. Dudley (U.S. Pat. 344,951; this J., 1892, 619) proposes to subject the seeds to fumes of N_2O_4 and SO_2 either in the order named or in mixture, sufficient air accompanying them to regenerate nitric oxide; the fibres powder rapidly and fall off. Zinc chloride has also been used to free the hulls from lint by Kitsee (U.S. Pat. 858,075; this J., 1907, 868); MacFarlane and Reinohl (Eng. Pat. 6634 of 1902 and U.S. Pat. 695,474—695,476; this J., 1902, 918 and 1081) suggest fermenting the fluffy matter with alkali and saccharine substances like molasses. These chemical processes are drastic in their treatment and destroy the valuable lint, and for this reason they have found no wide application. Besides, the destruction of the fluff is objectionable on the ground that in the separation of meats from hulls the felting action of the lint helps in a thorough separation of meats from hulls. This is not possible in the Egyptian or naked variety and in seeds treated chemically. In these cases there is always lost a certain percentage of meats with the hulls. E. H. R. Barrow (this J., 1915, 913) proposes to mix the seeds with 5% of sodium chloride, 2% of starch, and 2% of magnesium carbonate; these substances remove the excess of moisture which causes fermentation. The salt, which is partly absorbed by the hulls, kernel, and lint, acts as an antiseptic and prevents the fermentation of mould on the seeds and so prevents their heating. The most effective treatment would be to delint the seed immediately after ginning, remove all light and broken seeds, and thoroughly clean them and sterilise them by hot-air blasts in a vertical cylinder or spiral conveyors on the counter-current principle. Seeds thus treated and stored in a dry go-down or in silos, keep well for a very long time and yield excellent products. Here I must emphasise the need of stringent measures to stop the dishonest practice of intentionally mixing foreign matter like fine sand, dust, etc., in the seeds that come to the Indian bazaars mainly for export. It seems that importers in this country have allowed this sort of evil practice to continue by permitting a certain percentage of foreign matter, known as "refraction" in trade, in the contracts they make with Indian sellers. Seeds coming to Bombay are systematically mixed in the go-downs with foreign matter up to the limit required by the contracts. The poor reputation of Indian seeds is traceable to this dishonest practice permitted by the trade to con-

tinue. If the quality of seeds is to be improved and better results obtained this practice must be stopped at once. I do not see why it was ever encouraged, as the high freights from India payable on a low oil-bearing seed should have required the imposition of more stringent conditions by the English buyers as to the purity of seeds from Indian sellers.

The seeds are subjected to two different methods for the extraction of oil. The English practice is to crush the entire seed with the lint and husk. The American practice is to remove the lint, decorticate the seed, and then crush the kernels separately. This process is modified by the admixture of a certain percentage of ground hulls with the kernels. These processes are called the undecorticated, the pure decorticated, and the mixed decorticated. The yields of products obtained by these three processes are very different, as will be seen from the following table:—

TABLE VI.

Percentage yields of products by different processes.

	Undecorticated.	Pure.	Mixed.
	%	%	%
Refined oil	12.0	11.0	12.0
Cake	84.0	49.0	46.0
Hulls	nil	44.0	37.0
Lint	0.5	1.6	1.6
Feet	2.0	1.4	1.7
Waste	1.5	2.0	1.7

There should be no lint by the undecorticated process; the small amount shown above is from the regaining of cotton balls obtained in screening. Tattersail and Pearson (Eng. Pat. 17,808 of 1893; this J., 1891, 893) and Stanley (Eng. Pat. 22,954 of 1900; this J., 1901, 710) make use of carding machines to comb or card the lint from the hulls. These carding machines are formed of a concave tapered dish, perforated from outside so as to leave projecting burr edges in the interior, whilst they are acted upon by a tapered cone roller with card teeth and revolving at high speed. The seed is first crushed between high rolls, the meal separated on shaking sieves, and the hulls with the adhering meal passed to carders. This process, though it gives bright products, is the most irrational and uneconomical process I have seen. The first crushing of seeds with lint between high rolls causes a very large absorption of oil by the hulls and lint from the kernels. The cakes and oil obtained by this process are similar to those obtained by the best American decortivating process. The hulls in particular are in a very finely-ground condition, suitable for feeding cattle, and have no sharp edges as found in American type decorticators. I cannot go into the merits and demerits of the different processes in this paper. Each process has its staunch advocates. My own experience has been that the mixed process is in every way most satisfactory.

The very small oil content of the cotton seed has made it necessary to devise means to obtain a maximum yield of oil from the seeds. Numerous methods have been suggested by the combined ingenuity of the chemist and the engineer. Of these the best is that of Johnson (U.S. Pat. 691,312 of 1902; this J., 1902, 263), which is the mixed decorticated process and consists in the addition of a certain proportion, generally about 10%, of ground hulls to the meal before or at the end of the cooking process. The presence of the ground hulls, without in any way deteriorating the quality of the oil, increases the consistency of the cake and makes it more porous, which facilitates the exudation of oil during extraction. A larger yield of oil is thus obtained. Johnson's claim of

an increased yield of from 1—1½% is fully justified by results and by the general adoption of the process all over America. This process, combined with Van Winkle's process (U.S. Pat. 690,331 of 1901; this J., 1902, 263), in which the mass of meal is tempered by heat or live steam before being passed through crushing rolls, yields the most economical results. These two processes mark a very important stage of development in the cotton seed crushing industry. Borax (Oil and Colour Trades J., 1908, 39) has been used to cause the oil to flow more freely and produce a greater yield of oil. The seed is sprinkled with a solution of 30 lb. of borax in 100 gallons of water, using 1½ gallons of the solution to a ton of seed. Borax also acts as an antiseptic, preventing bacterial and mouldy growth, and thus keeps the resulting cake in a bright condition.

Economical production of the oil depends as much on the increased yield of oil as on the refining of the crude oil. A very interesting and suggestive contribution in this connection is that of J. Longmore (this J., 1886, 200). The principal object in refining is to remove the large proportion of colouring and albuminous matter together with the free fatty acids associated therewith.

The properties of the colouring matter have been studied by Longmore (*loc. cit.*) and in greater detail by Marchlewski, Wilson, and Stewart (Eng. Pat. 9477 of 1896; this J., 1897, 530) and Marchlewski (this J., 1897, 906). This colouring matter has been called gossypol; it has the empirical formula, $C_{15}H_{14}O_4$. It is insoluble in water but readily soluble in alcohol, benzene, and other organic solvents and dilute salt solutions. It is insoluble in dilute acids and strong brine solutions but very readily soluble in boiling acetic acid and aqueous alkalis. A very large number of methods, based on the solubility of the colouring matter in aqueous alkali, have been suggested for the isolation or removal of the colouring matter, but it seems that none of them has received as universal an approval as the caustic soda method. Tall and Thomson (Eng. Pat. 15,647 of 1887; this J., 1888, 756) suggested the use of normal sodium carbonate instead of caustic soda, as it has little saponifying action on oil during the refining process. Hunt (Eng. Pat. 17,870 of 1889; this J., 1890, 1045) and Aspinall (Eng. Pat. 11,324 of 1894; this J., 1895, 665) use sodium chloride with caustic soda to salt out the soap formed during refining. Though the graining out is better, the presence of sodium chloride interferes with the removal of the colouring matter. The resulting oil is found to be poorer in quality and deeper in colour. J. C. Chisholm (U.S. Pat. 1,007,612 of 1911; this J., 1911, 1396) makes use of alkali silicate instead of caustic soda. He also uses "metal substituted" bases with an alkali solution (U.S. Pat. 1,010,017 of 1911; this J., 1912, 33). These patents are further modified by him by U.S. Pats. 1,056,261—1,056,264 of 1913 (this J., 1913, 434). In these he proposes to use with alkali silicate substances which produce alkali soap, such as hydroxides, carbonates, and other alkali compounds. Holbrook (U.S. Pats. 1,169,154 and 1,169,155; this J., 1916, 317) first neutralises with caustic alkali and then fixes the colouring matter with silicate. I have tried Chisholm's process repeatedly but without obtaining satisfactory results. The foots no doubt settle down very rapidly and retain very little refined oil in them, but the refined oil is poor and similar to the oil obtained by the process in which sodium chloride is used with caustic soda. C. Baskerville (U.S. Pats. 1,105,743, 1,105,741, and 1,114,095; this J., 1914, 930 and 1162) uses inorganic absorbent material like fuller's earth in presence of an electrolyte, or fibrous vegetable or cellulose matter impregnated with a slight excess of alkali to neutralise the free fatty acids (see also Baskerville, U.S. Pat. 1,130,698; this J., 1915, 434,

and this J., 1916, 477). The cellulose converts the colloidal mass containing precipitated colour and albuminoid matter into a mass which is easily separated from refined oil by filtration. A reference should be made here to the elaborate and detailed tables drawn up by the chemists of the Interstate Cotton Seed Oil Refiners, for official tests of refining cotton seed oil. The tables will prove extremely useful to the refiner (this J., 1913, 797, and 1914, 1069). The loss in refining, and the character and quality of the foots and of the refined oil also depend to a large extent on the mechanical appliances of the refining tank. The great difference between the specific gravities of the oil and the alkali solutions makes it necessary to maintain a thorough mixing of the oil and the alkali. To prevent the heavy alkali solution from settling down rapidly during the refining process, Hunt (Eng. Pat. 17,870 of 1889; this J., 1890, 1045) emulsifies the oil first with water by bringing the two liquids in streams into a rapidly revolving basin, and then adds the alkali solution. Air agitation is also practised, but it is not very desirable.

Considerable difference of opinion exists as to whether better results are obtainable with horizontal or vertical agitators. I have obtained the best results from very poor oils by horizontal agitators. In any case the agitation should not be below 15—20 revolutions per minute and should be started a few minutes before the first spraying of the alkali. This speed should be increased, if possible, till the "break-point" is reached sharply, and then continued for nearly half an hour to minimise the chances of uncombined alkali settling down in the foots.

In the final process of drying refined oil the use of the finely powdered salt in a thoroughly dry condition assists in removing traces of moisture and improving the flavour of the oil. The oil may be further treated with advantage with plaster of Paris.

At this stage the oil-crusher's work was supposed to have ended, but the large quantities of by-products that were wasted soon engaged the attention of chemists, and year after year new substances were made from them and placed on the market. It will not be possible to deal in this paper in detail with the various processes suggested by the different investigators, but I shall summarise the principles underlying their suggestions in the hope that this part of the paper may prove useful to those engaged in the industry. First in importance are the hulls, which form, as shown above, nearly 45% of the whole seed. In the decorticating process the economical disposal of the hulls forms a very serious problem. The following analyses of the hulls will be found useful in this discussion.

TABLE VII.

	1.	2.
Moisture.....	11.36	12.75
Fat.....	2.22	0.50
Albuminoids.....	4.18	3.16
Carbohydrates.....	34.19	48.93
Fibre.....	45.32	32.35
Ash.....	2.73	2.31

1. Harrington and Fraps; this J., 1904, 832.

2. C. Beadle and Stevens; this J., 1909, 1015.

Three distinct uses of the hulls are made, viz., (1) as fertiliser, (2) as feeding stuff, (3) as raw material for paper making.

The following two analyses will show their richness as a cheap fertiliser, and as such they are largely used both in India and in America. In

the latter country they are used as a cheap source of potash manure by tobacco growers.

TABLE VIII.
Analyses of cotton seed hull ashes.

	1.	2.
	°	°
Moisture.....	7.70	9.00
Potash.....	23.72	23.40
Phosphoric acid.....	10.02	9.08
Magnesia.....	14.81	9.97
Lime.....	11.96	8.85
Insoluble.....	6.32	8.85

As a fertiliser, one ton of ashes is equal to 4½ tons of hard wood ashes (this J., 1889, 432). In regard to its use as a feeding stuff, considerable work has been done in America, where the value of this by-product has been fully established. In India the use of hulls was made popular by the Tata Oil Mill and then by the Navsari Oil Mill. The hulls are largely used in Government dairies and on farms and in large towns for feeding both cows and buffaloes. The Indian army transport and commissariat departments have also used these hulls in very large quantities with excellent results. During famines or times of scarcity of fodder this food has also been found very valuable. There has thus been created a large and growing demand for this new feeding stuff in a conservative country like India, and if a little effort is made in this country there is no reason why it should not come into favour, as it did in Germany (this J., 1909, 1017). Ground hulls mixed with molasses, as suggested by the Molassine Co. and Whalley (Eng. Pat. 7687 of 1913; this J., 1914, 498), forms an excellent cattle food, readily taken by the animals. Hydrolysed hulls have been put on the market for use in the manufacture of compound cake (Eng. Pat. 14,588 of 1904; this J., 1905, 853). The following is an analysis of hydrolysed hulls: Moisture, 10%; oil, 4.4; protein, 5.2; carbohydrate, 48.1; hydrolysed cellulose, 29.6; ash, 2.7%. Food value, 72.

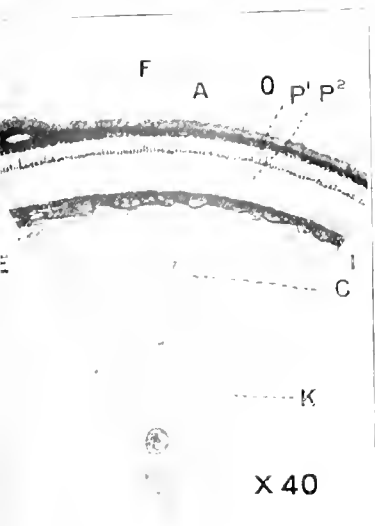
Apart from these uses the utilisation of the hulls as a raw material for paper-making has engaged the attention of chemists both here and in America. The process consists mainly in the removal of colouring and resinous matter by boiling the hulls with alkali, thereby separating the fibrous matter in a condition required for paper making (cf. Bockmeyer, U.S. Pat. 759,800 of 1904; this J., 1904, 605). C. F. Cross (Eng. Pat. 8545 of 1904; this J., 1905, 288) obtained from the hulls two forms of cellulose differing in length of fibre. The longer fibre can be used in a variety of ways, but the shorter fibre is characterised by giving on hydrolysis considerable quantities of crystallisable sugar. Furfural may be obtained from the liquor, after crystallisation of sugar, by distillation with 30% sulphuric acid; Knopf and Baumwoll-Werke (Eng. Pat. 12,650 of 1905; this J., 1906, 217) suggest the use of alkalis, alkaline earths, dilute acids, alkali sulphites, calcium, magnesium, potassium, or sodium bisulphites in the boiling process. Wilbuschewitsch (Eng. Pat. 27,950 of 1909; this J., 1911, 80) passes the boiled mass into a hollander to be beaten, and bleaches the resulting pulp with sodium hypochlorite. This pulp is suitable for making rough papers and cardboard.

A very valuable contribution to this subject has been made by Clayton Beadle and H. P. Stevens (this J., 1909, 1015); a full treatment of the subject will also be found in the "Chemical News" (95, 193). In their opinion attempts to make paper from hulls by the wet method have not resulted in success. The best method, however, of separating the fibrous matter from hulls

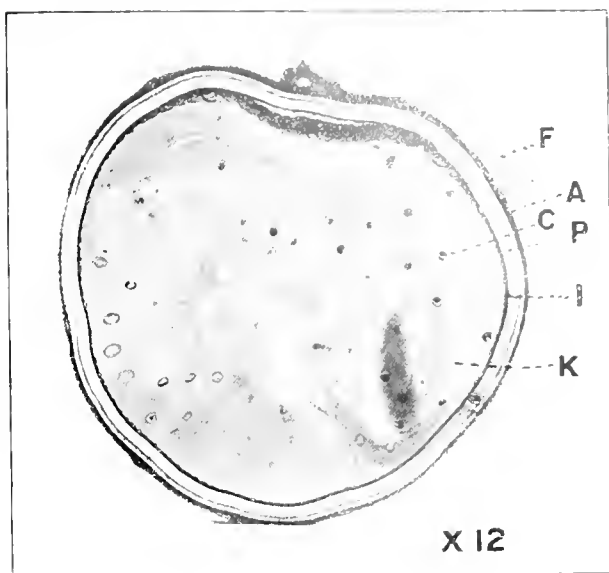
was not the boiling and bleaching process, but the mechanical separation effected by beaters in vertical cylinders in Minck and de Segundo's machine. By this means the following results were obtained:—Husks, 65%; meal, 7%; cotton, 25%; loss, 3%. The paper obtained by this means was equal to a good quality of rag paper. The length of fibres obtained from Brazilian seed hulls was 2.27 to 3.34 mm., whereas the Indian seed only gave a fibre of half the length of the Brazilian fibre. The latter fibre was also very suitable for nitration. The palisade cells were found to be useless both for paper and for nitrating into gun-cotton. A corporation—the National Paper Making Co.—with a capital of £1,000,000, was formed in America in 1902 (Oil and Colour Trades J., 1902, 685) to make paper out of hulls. The paper pulp made by their process from hulls was stated to keep white and not turn yellow as wood pulp does. The cost of the pulp was £5 per ton against £15 for wood pulp.

Next in importance is the utilisation of foots. Longmore's work, mentioned above, details the process of separating the soap from the colouring matter. The niger, that is the extremely offensive smelling liquid containing most of the colouring matter and albuminous substances, has been investigated thoroughly and the claim that the colouring matter can be used as a valuable dye has not been substantiated. D. Wesson (this J., 1907, 595) has shown that this dye is of no value when compared with cutch and catechu. The colouring matter, however, combines with both nitrosodimethylaniline and nitrosodiethyl-aniline, forming dyes which give yellow-brown shades on cotton and wool mordanted with iron, chromium, and tin (Marchlewski, Wilson, and Stewart; this J., 1897, 530). These dyes are insoluble in water. On sulphonation of the gossypol and combination with α -nitroso- β -naphthol in concentrated sulphuric acid solution, a product is obtained which dyes mordanted or unmordanted wool brown.

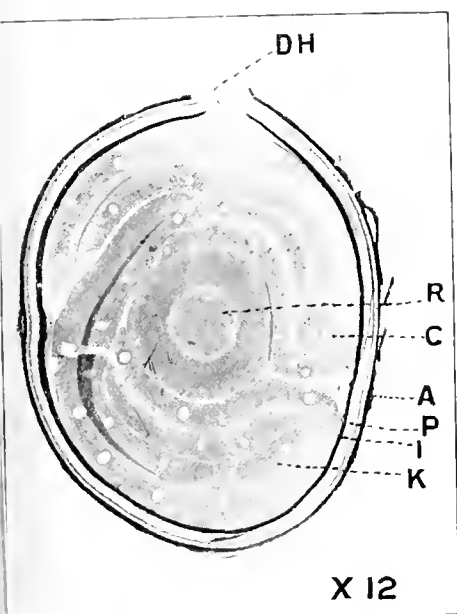
Wesson gives the following analysis of foots: water, 36%; fatty anhydrides, 48.5% (fatty acid, 50%); glycerol, 3.98%; caustic soda, 3.20%; colouring matter, 2.42%; organic matter, 5.80%. The fatty substances are removed by heating and further addition of caustic soda. The resulting liquors contain a large proportion of colouring matter, organic matter, and glycerin. On acidifying, the colouring matter is precipitated, and there remains in the liquor a quantity of glycerin which can be recovered by the usual methods. The peculiar offensive smell, similar to decomposed fish, in the niger is due to methylamine (Wesson, *loc. cit.*). Wesson, has also noticed the fermentation of foots due to the presence of over 40% of water, especially in hot weather. I have had considerable difficulties in the handling of foots in a warm climate, as at Bombay, where the strongest casks were unable to resist the fermentation of foots. This fermentation was found mostly in foots from very poor qualities of seeds. J. Wolff (Ger. Pat. 20,483; this J., 1883, 182) prepares a leather-like substance from foots by mixing the dry foots with non-volatile solvents such as grease, oil, paraffin wax, etc., in various proportions, and with powdered mineral substances like black lead, vermilion, etc.; the mass is then heated with sulphur or carbon bisulphide. Loeschigk (Ger. Pat. 220,582 of 1909; this J., 1910, 610) prepares by the oxidation of foots an amorphous resinous substance resembling shellac. An American Co. in Savannah makes paint of dark green, red, and black colours from foots for covering roofs and exposed surfaces; thousands of gallons of this paint are sold in the Southern States at 75 cents to \$1 a gallon (Oil and Colour Trades J., 1909, 21). The method of utilising the foots mostly adopted is, however, the distillation process, by which the



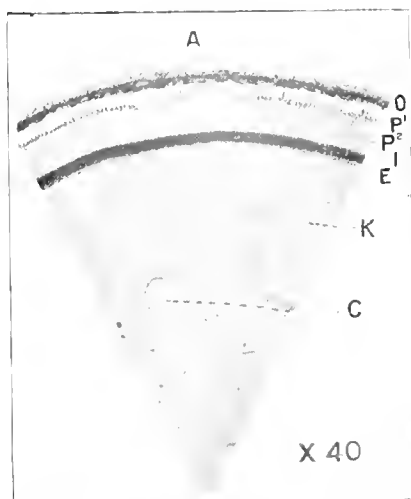
American. 1



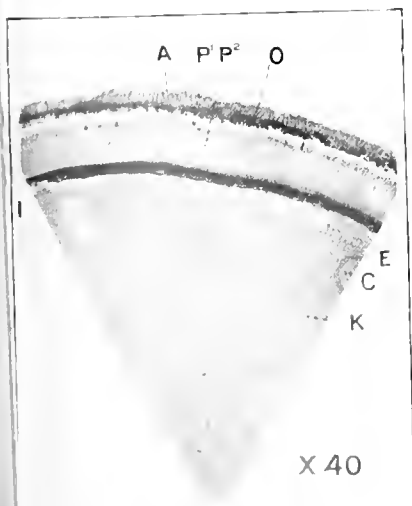
American. 1



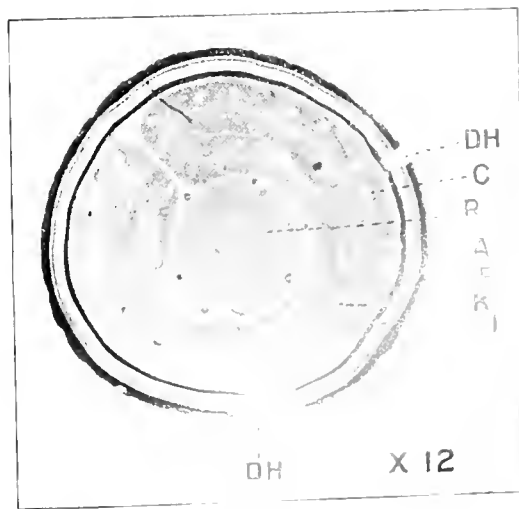
Egyptian. 2



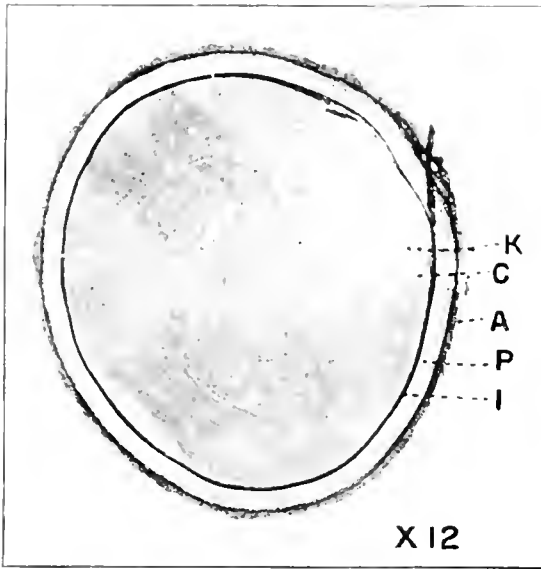
Egyptian. 2



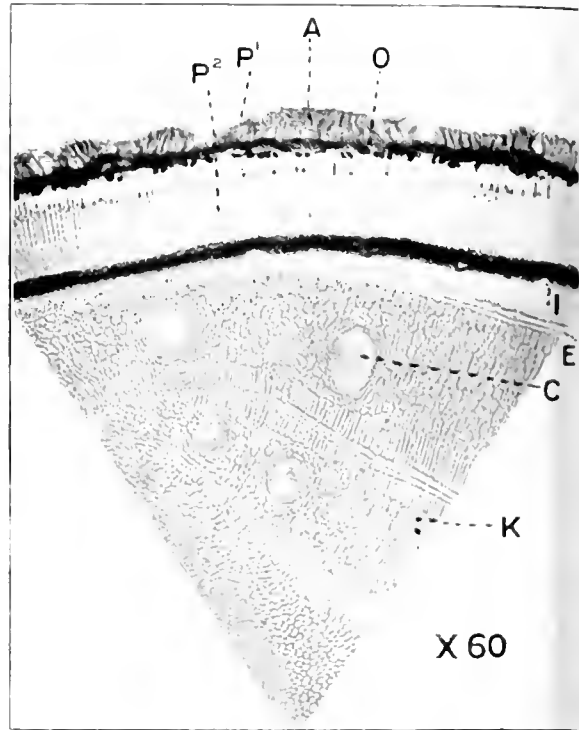
Sea Island. 3



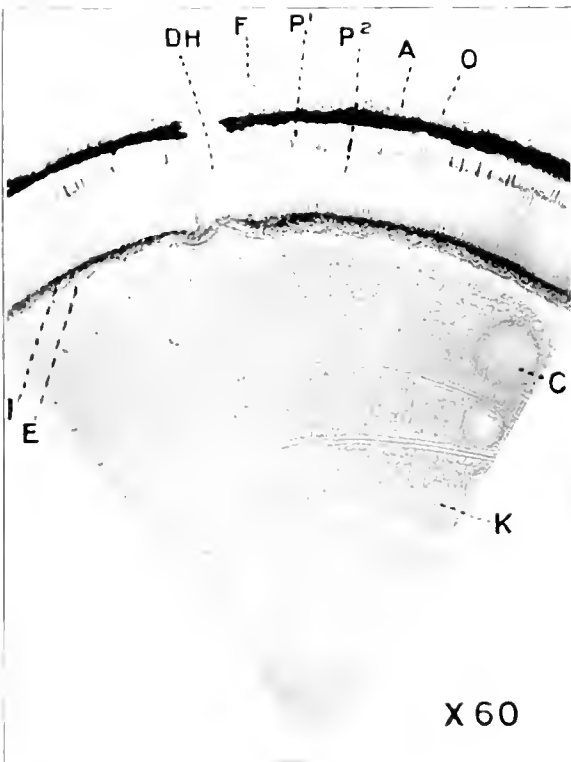
Sea Island. 3



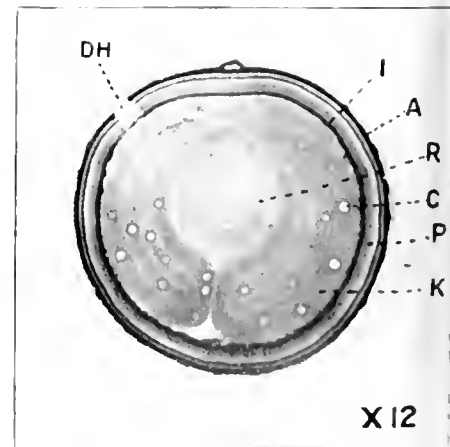
Gincolium.



Gincolium.



Indon.



Indon.

most important constituent of the foots, viz., the fatty acids, is obtained in a very good condition for making soap stock. In this process the mucilage is first acidified, the oily layer of fatty acids separated, and then distilled separately after one or two washings to remove traces of mineral acids.

It remains now only to mention the use of lint separated in the preliminary process. This lint is used in paper making, in the making of cotton-wool for surgical dressings, in the manufacture of gun cotton, celluloid, artificial silk, and a number of other articles in which cheap fibre of a good quality without regard to length is necessary.

Recently cottonseed cake meal has been prepared as an adulterant for flour used for human consumption. Fraps (Texas Agr. Bull. No. 128, 1910; this J., 1910, 972) shows that the meal freed from hull is of pleasant odour and sweetish taste, and contains 48% protein, 12% fat, 23% sugar (raffinose), 4% fibre, and 5.5% ash. It is richer in protein than meat, which it resembles more in composition than cereals. Bleaching agents used in the whitening of flours improve the appearance of this meal.

Before concluding, I will mention a few of the problems which require to be solved in connection with this industry, especially in reference to Indian seeds. The Indian seed is generally lower in oil content than the American or Egyptian, but it has been found that seed from the Central Provinces, where the rainfall is less than in Surat and Broach districts, has a higher oil content. This matter requires careful investigation with a view to obtaining an Indian seed richer in oil. From a large number of analyses of Indian seeds it is also found that the increase in the oil content of seeds is obtained with a lower percentage of cotton fibre. This also requires investigation. The fluorescent substance found in Indian oils should be isolated and a means of separation determined. Garner, Allard, and Foubert (J. Agr. Res., 1914, 3, 227; this J., 1915, 236) have noticed the effects of nutrition of cotton plants on oil content and size of seeds. This matter also requires further investigation, especially in the case of those Indian seeds which have so low an oil content. These authors have found that the addition of a complete fertiliser to an unproductive soil causes a larger cotton seed to be produced with an increased percentage of oil.

Another matter for investigation is the effect of crude cotton oil on press cloths of different types. The expenditure on press cloth forms one of the chief items in the total cost of crushing, and the high consumption of press cloth in the pressing of this oil calls for investigation. Our experience in India is that the consumption of press cloth under the Indian climatic and other conditions is 2 to 2½ lb. per ton. This is certainly 2 to 3 times higher than in this country.

Unlike other oil-pressing industries, the cotton seed oil industry is essentially a chemical industry, and its future development rests with the chemist more than with the engineer. The future of the industry in this country is also of a very doubtful character. The great progress of this industry in America, where there are nearly 900 mills, as compared to 25 to 30 mills in England, is due mainly to the favourable conditions arising from natural causes. The case of England is different; it has to depend for its raw product on foreign markets like Egypt and India. In Egypt this industry has made great progress. Nearly one-third of the crop is pressed, and oil exported to Turkey, England, and other countries. The quantity pressed in India is negligible, but there is an ever-increasing trade with this country in the seeds. This trade is looked upon both by the Indian Government and the public as a great economic drain on the country. That the Indian

Government is fully alive to this impoverishing of the agricultural resources of the country can be seen from the efforts made to promote the oil pressing industry in India. When, year after year, the cotton fields are deprived of their fertility by the inadequate return to the soil of fertilising materials by the poor peasants, the question assumes a serious aspect. The cost of production of cotton per acre is Rs. 21, of which nearly Rs. 6 is spent in fertilisers: the peasant invariably tries to do without it, with the result that in five years the production of cotton begins to decline. Therefore in the interests of the cotton growers the fertilising constituents of the seed must be retained in the country by pressing the seeds in India itself, and only foreign trade in the oil be permitted. British manufacturers have gone out to foreign countries for their requirements, and they will sooner or later have to come to India for their oils. Typical instances in which British enterprise has been obliged to found industries in the countries of origin of the raw materials are palm oil, tea, rubber, indigo, coconut oil, tobacco, jute, etc. The same will happen in the case of this industry.

The following notes will explain the photomicrographs:—

- A. Epidermis—outer skin of the seed which has no fluff on it in the "naked" variety of seeds like the Egyptian.
- E. Perisperm—a loose thin skin which separates the hull from the kernel and which makes possible the separation of the hull after decortication.
- O. Outer brown coat, containing the colouring resinous matter.
- I. Inner brown coat, also containing the colouring resinous matter.
- P₁. Palisade cell—outer portion mainly pure cellulose.
- P₂. Palisade cell—inner portion mainly lignified cellulose.
- K. Cotyledons containing oil cells.
- C. Cells containing resinous colouring matter surrounded by mucilaginous walls. The colouring matter of the crude oil and the mucilaginous substance found in the foots are derived from these cells.
- DM. Damaged hull.
- R. Radicle.
- F. Fluff or lint.

The photomicrographs are of the following varieties:—(1) American, (2) Egyptian, (3) Sea Island, (4) Brazilian, (5) Indian.

DISCUSSION.

Mr. J. ALLAN was not inclined to accept the suggestion that the fishy odour and characteristic fluorescence of Indian cotton seed oils were associated. From examination of a large number of cotton seed oils he had ascertained that it was not infrequent to find Indian oils which gave a pronounced "hexabromide" reaction, indicating the presence in the oils of at least 2½% of fatty acids of the linolenic type. Fatty acids of that kind were peculiarly prone to oxidation, and on exposure to the atmosphere developed a fishy odour, as also did linseed oil. Assuming that such unsaturated acids existed in Indian cotton seed oil, attempts to refine it by ordinary methods so as to procure a perfectly odourless edible oil would probably prove unsuccessful. The difficulty Mr. Vakil had noticed of refining Indian oil was undoubtedly contributed to in a considerable measure by the defective character of the manipulation of the seeds. If seeds could be obtained in a whole state before they were treated for the expression of the oil the resulting product would be of much better quality. The disruption of the cells and the admission of air to the kernel was undoubtedly provocative of fermentation which set up hydrolysis of the fats. Refining necessitated the removal of the whole of the free acidity of the oil and consequently the loss increased as the acidity became greater.

Professor E. KNECHT said he had been for some years associated with Mr. Hunt in an investigation on the colouring matter in cotton seed oil and the question of its possible commercial value. He had formed the opinion that the colouring matter

did not possess tinctorial properties which could be regarded as of any value on the commercial market. Did Mr. Vakil use an emulsifier or "smasher" working at a high speed for his emulsifying process? He would also like some information as to the effect of hydrogenating on the smell of Indian cotton seed oil.

Mr. L. G. RADCLIFFE said it was well known that oxidation increased the fishy odour of cotton seed oil. Both Indian and American cotton seed oils were "blown" with air for the purpose of thickening them; "lardine" was manufactured by this means. Lardine was used for thickening and mixing with mineral oils to form lubricant. The so-called "blown" or "thickened" oils made from Indian oil were easily distinguishable from those made from American oil by the increase in their odour, and when mixed with mineral oil and used on a hot bearing the smell was nauseating. In the "blowing" of both Indian and American cottonseed oils, the products that were apparently volatilised were distinctly toxic, making the workpeople very sick.

Mr. F. H. TERLESKI said that owing to careless ginning British farmers had in the past formed a prejudice against oilcake prepared from Indian cotton seed as it caused the cattle to suffer from digestive troubles. If any attempt were made to export the meats of the seed the result would be even worse as fermentation would set in. This had been clearly shown to be the case with regard to castor oil seed. It was possible that legislative action might effect improvement.

Mr. WILLIAM THOMSON enquired whether American seed could be cultivated in India.

Mr. VAKIL, in reply, said he had dealt fully with the points of odour and fluorescence of the oil in his paper. The suggestion to get rid of the fishy odour by hydrogenation of the unsaturated fatty acids was a good one, though he had no personal experience in that direction. He quite agreed that the tinctorial value of the dye product was practically nil from the commercial point of view. The toxic properties of choline and betaine found by Maxwell (this J., 1892, 372) in the oilcake had no bearing upon the subject matter of the paper and had therefore not been referred to. There was certainly a bad effect in the case of young cows and other animals, but what the result would be with human beings he was not able to say. The oilcake meal had been officially recommended by the American Government as a good substitute for meat and as a wheat diluent. He had not adopted the "smasher" process, the tests being merely on a technical laboratory scale. He had not suggested that the meals alone should be exported, though this was done to a large extent locally in America. This method of exportation was attended by certain disadvantages. The rapid oxidation of the oil in the meal, and the possibility of the meal being exposed to moisture and variations of temperature during transit, made the trade a very risky one. If climatic conditions permitted, and the distance from the decorticating plant to the oil presser was not very great, such a trade was possible. Indian peasants held their land on a tenure somewhat similar to the English leasehold, and this resulted in a considerable amount of laxity in returning the fertilising constituents to the ground, there not being the incentive of proprietorship to keep it at as high a state of fertility as practicable. The British Government had encouraged the planting of American seed in India, but much yet remained to be done in that direction. This was evidenced by the discussion which took place at a recent meeting of the Imperial Legislative Council in India, the Government being urged to take immediate steps to secure the improvement of

the Indian variety, not only with regard to fibre which was short, but also to raise the standard of the growing quality.

Communications.

A MODIFIED SOXHLET EXTRACTOR.

BY D. F. TWISS AND W. MCCOWAN.

On account of the fragile nature of the ordinary Soxhlet form of continuous extractor, a modification was desired which should be stronger and better capable of resisting hard use, and after considering various possibilities the arrangement represented in the diagram was adopted.

There has since been brought to our notice a description of a similar idea published many years ago by Blount (Analyst, 1888, 13, 127), of which we were in ignorance, but as the present form possesses one or two additional advantages, a brief description may be useful.

In Blount's apparatus there are two or more apertures of indefinite size by which the vapour passes into the inner compartment. In the modification now described, only one aperture, A, is recommended, of approximately 0.7 cm. diameter; this restriction causes a very slight excess of pressure and temperature in the outer jacket, sufficient, however, to maintain the liquid in the extractor cup in gentle ebullition.

Another advantage is that whereas in Blount's extractor the double jacket extends right to the top, in the form now represented the double jacket is shorter and the neck formed by an additional glass collar. Apart from the fact that this type of neck is stronger and may be still further strengthened by making the single neck of stouter glass, the smaller surface of the outer jacket causes a reduction in the amount of air-cooling by which vapour is condensed before it can reach the entrance aperture, A, to the inner extractor cup, and so renders the extractor somewhat more rapid in action.

The tendency of the extractor to roll when placed on the working bench can easily be checked by tightly fitting a suitably bored square piece of stiff rubber or cardboard over the neck just above the outer jacket.

That this type of extractor can give very satisfactory service has been proved by a thorough test in the chemical laboratory of Messrs. the Dunlop Rubber Company, to whom we are indebted for permission to publish this note.

THE ESTIMATION OF FREE SULPHUR TRIOXIDE IN FUMING SULPHURIC ACID BY TITRATION WITH WATER.

BY R. G. PARKER, B.Sc.

The following appear to be the methods used or suggested for the estimation of free sulphur trioxide in fuming sulphuric acid:—

1. Titration with standard alkali.



2. Measurements of viscosity.
3. Measurements of electrical conductivity.
4. Measurements of specific gravity.
5. Measurements of rise of temperature on dilution.
6. Titration with water.

No. 1 would appear to be the most generally used, but has the disadvantages:

- i. That the standard solution has to be carefully prepared and standardised.
- ii. That every error is multiplied approximately four times in the final result.
- iii. That a correction must be made for the acidity due to dissolved sulphur dioxide.

It therefore becomes very possible that under ordinary conditions the content of free sulphur trioxide is determined with no greater accuracy than $\pm 0.5\%$, and in some cases this limit of error is considerably exceeded.

Sulphuric acid of 100% strength does not fume at the ordinary temperature, but commences to do so at 30° – 40° C.; it is therefore possible to estimate the free sulphur trioxide in the fuming acid by adding water until the acid just ceases to fume when damp air is blown on to the surface.

After the experiments described below had been carried out it was found that the method was, in fact, not new; it has been described by Setlik (Chem.-Zeit., 1889, 13, 1670), but Lunge's remarks on it ("Sulphuric Acid and Alkali," 4 Ed., Vol. I., Pt. 1., p. 366) would lead one to suppose that the method was not sufficiently accurate for fairly exact work.

It was found, however, that the end-point which could be obtained in this way was exceedingly sharp, and that series of titrations of the same sample could be obtained, showing a maximum difference of 0.025 c.c. of water required.

Method of procedure.

For an acid containing 20–40% of sulphur trioxide, 50 to 75 grms. is a convenient amount. This is weighed into a 50 c.c. stoppered cylinder of thin glass (a large stoppered test tube is most suitable). In weighing, a rough balance only, weighing to 0.05 gm., is sufficiently accurate. Distilled water is then run in slowly from a burette, with frequent vigorous shaking. After each shaking the white fumes, which increase on the addition of water, are completely absorbed. The cylinder is then opened, and air blown through a glass tube on to the surface of the acid. While any free sulphur trioxide remains, this will cause fuming, which decreases towards the end of the titration, and suddenly vanishes. The operation must be carried out in a good light; and the temperature of the acid must be kept below 45° C.

If 50 grms. of fuming acid requires 3.55 c.c. of water, then the free sulphur trioxide present is

$$3.55 \times \frac{80}{18} = 15.78 \text{ grms.}$$

and the acid contains 31.56 % of sulphur trioxide. Assuming a possible error of 1 drop (that is 0.05 c.c. for the burette used) or ± 0.025 c.c., this result becomes $31.56 \pm 0.22\%$.

The estimation can be made very rapidly, but more important advantages are:—

1. Absolute accuracy of the standard used, namely, water.

2. The fact that the sulphur trioxide is titrated directly.

3. Avoidance of the necessity of estimating the sulphur dioxide present to apply a correction.

Repeated titrations of the same sample agree very closely, as shown by the following results for four different ones.

Sample I.			Sample II.		
Acid.	Water.	Sulphur trioxide.	Acid.	Water.	Sulphur trioxide.
grms.	c.c.	%	grms.	c.c.	%
88.9	6.03	30.15	50	2.45	21.8
44.45	3.00	30.0	50	2.45	21.8
50	3.36	29.9			
50	3.36	29.9			
By another observer.					
50	3.38	30.1			
100	6.78	30.15			

Sample III.			Sample IV.		
Acid.	Water.	Sulphur trioxide.	Acid.	Water.	Sulphur trioxide.
grms.	c.c.	%	grms.	c.c.	%
50	2.74	24.37	50	2.48	22.05
50	2.75	24.45	50	2.47	21.95
50	2.72	24.40	50	2.47	21.95
50	2.72	24.40	50	2.46	21.88
50	2.72	24.40			
50	2.75	24.45			

In order to ascertain the magnitude of the error caused by undue rise of temperature, three titrations were made, using 75 grms. of Sample I. and omitting cooling; the titrations were carried out fairly rapidly, and the temperature of the acid rose through a maximum of 90° to a final value of 80° C.

Apparent content of sulphur trioxide in Sample I. at 80° C.

		Error.
75 grms. = 5.42 c.c. H_2O .	Sulphur trioxide = 32.1%	+2.1% SO_3 .
75 grms. = 5.40 c.c. H_2O .	Sulphur trioxide = 32.0%	+2.0% SO_3 .
75 grms. = 5.35 c.c. H_2O .	Sulphur trioxide = 31.7%	+1.7% SO_3 .

Lunge (*loc. cit.*) states that Setlik's results differ by as much as 0.9 % for the same sample, and therefore that the method is only suitable for internal use in a works, and not when buying and selling. The experiments here described, however, indicate that the method is much more accurate than this, being probably more accurate than the average results obtained with standard alkali.

Comparison of alkali and water titrations.

In order to compare the results obtained by this method with those obtained by the usual method of titration with standard alkali, one sample (No. IV.) was titrated with freshly prepared N/1 sodium carbonate solution; the graduations of the burette used were carefully checked.

	Acid.	N/1- Na_2CO_3 required.	Sulphur trioxide.
	grms.	c.c.	%
1	2.1830	46.75	21.6
2	2.2228	47.55	21.3
3	0.5947	12.73	21.95
4	1.7578	37.64	21.96

If in the fourth titration 37.598 c.c. of sodium carbonate had been used, this would have agreed with the second titration. The largest difference is therefore $37.64 - 37.598$, or, 0.042 c.c. (which is equivalent only to one drop) in about 40 c.c. The mean result is 21.70%.

The two methods, when carefully employed, give therefore substantially the same value for the free sulphur trioxide. (The above value is not corrected for the sulphur dioxide present, since this was found to be only 0.015%.)

The author's best thanks are due to British Dyes, Ltd., for permission to publish the above results.

DETERMINATION OF THE NITROTOLUENES.

BY E. KNECHT.

In a paper delivered before the Nottingham Section of the Society by Mr. Colver and Dr. Pridcaux on the estimation of the nitrotoluenes (this Journal 1917, 180), reference is made to the process worked out by Miss Eva Hibbert and myself for the estimation of nitro compounds by means of titanous chloride, but the authors discarded it, firstly because they considered it "more than doubtful" whether reduction could take place in the presence of alcohol, and secondly that titanous chloride was not always obtainable at short notice.

The authors are not justified in their first objection and adduce no evidence in its support. As a matter of fact we have found that the method gives theoretical results in the cases of nitrobenzene and *p*-nitrotoluene. With regard to the second objection, neither we nor anyone else that I know have had the slightest difficulty in obtaining titanous chloride, which the makers supply *gratis* for scientific or analytical work.

Our process has been in extensive use for some years for controlling the composition of nitro compounds and is not only rapid but *quantitative*, giving results which can be relied upon within the ordinary limits of accuracy in volumetric analysis. The detailed results of our work in this connection have not been published for obvious reasons.

Industrial Notes.

REPORT OF H.M. INSPECTORS OF EXPLOSIVES FOR 1916.

[Cd. 8609.]

The Inspectors report that there has again been a large increase in the number of licensed factories, 23 having been added during the year, making a total of 48 factories added since the outbreak of war. The general condition of the factories, having regard to the exceptional circumstances now obtaining, is highly satisfactory. There has been considerable difficulty, however, in impressing on the picric acid manufacturers the necessity for strict observance of the requirements in regard to cleanliness and freedom from grit in danger buildings. These factories, as a rule, are offshoots of chemical factories which are of necessity difficult to keep clean, and this, no doubt, has a tendency to cause slackness on the part of employees when they are transferred to the picric acid works. Many cases of excessive quantities of picric acid being present in packing sheds have also come to notice.

In March a Committee was appointed to test the value of dry powder fire extinguishers as compared with water and other first-aid fire appliances for extinguishing or effectively controlling fires such as are likely to be caused by bombs. The general conclusion arrived at by the Committee was that a plentiful supply of water is by far the best extinguishing agent, and that dry powder extinguishers are practically useless for extinguishing or effectively controlling fires likely to be caused by bombs.

Reference is also made to the appointment of the Committee on Dissolved Acetylene (see this J., 1916, 1097).

The Chemical Advisers to the Department report that the total number of samples examined during 1916 amounted to 306 only, about the same as in 1915. The total number (53) of rejections was fairly normal, but the number (35) of rejections for faulty composition was somewhat high. This is, no doubt, partly due to the increased complexity of permitted explosives as a whole, but also, possibly, to some extent because, owing to war work, the manufacturers have not the time for quite such careful supervision of blasting explosives as before. The use of sodium nitrate in the place of potassium nitrate still appears to be causing some difficulty in connection with the heat test, but not to such an extent as last year. The number of new explosives examined (15) was the smallest for a good many years, and consequently the number of samples examined in connection with the Home Office Testing Station was also very low.

The total number of accidents with explosives reported during the year is 511, as compared with 485 for 1915. Of these, 363 occurred in manufacture, causing 195 deaths and injuries to 598 persons; no less than 144 deaths were due to two accidents, namely, 106 in one accident on the 2nd April, and 38 in another on the 21st August. Of the remaining 51, seven were killed at the Roburite Works on the 15th May, and seven at the Rainham Factory on the 14th September, and it is hardly too much to say that all these 158 fatalities might have been avoided if, instead of engaging in futile efforts to extinguish the fires, the factory officials concerned had cleared everyone away from the neighbourhood. Of the 363 accidents, 146 caused no loss of life or bodily injury, and of those injured a very large proportion received very trifling wounds.

In connection with the conveyance of cordite paste from one factory to another, a proposal was made by those chiefly interested that, instead of being packed in wooden barrels, this material should be forwarded in packages, each consisting of a double bag, the outer one being of stout canvas and the inner of a waterproof insertion material. The reasons given for this suggestion were, first, that barrels are now difficult to obtain, and, secondly, that after arrival at the factory, the barrels are the more dangerous to handle in contact with the very dusty explosive. The question was very carefully considered with special regard to the danger of freezing in cold weather, and it has been finally arranged that the vans in which this material is consigned by rail shall be steam-heated under conditions which will eliminate all danger from overheating, and this arrangement appears to give satisfaction.

In November, Messrs. Dupré carried out some tests to ascertain whether the addition of 2 or 3% of moisture to a fulminate composition would appreciably diminish its sensitiveness and render it safer for filling detonators than the dry composition. The results of their experiments indicated that the addition of as much as 5% of moisture to a mixture of fulminate of mercury and potassium chlorate gives no practical increase of safety either against explosion by shock or communication of the explosion of a portion of the mixture to the remainder, and that such mixtures should be treated with the same precautions as are usual when dealing with dry fulminate composition.

CHEMICAL INDUSTRY IN CANADA.

Addressing a meeting of the American Chemical Society at Kansas City on April 12th, 1917, Mr. H. E. Howe said that in one locality of Canada, destined to become an electro-chemical centre of some magnitude, there will ultimately be available

approximately 500,000 24-hour horse power. Here acetone is being made by a new process and the production of metallic magnesium in quantity is going forward, the metal being supplied in bars and also in the variety of powders so necessary on the battlefields to-day for star shells. Aluminium, and carbon electrodes are also made, and other chemical products are now under consideration.

Explosives are being produced on a large scale. Trinitrotoluol is produced at one plant by a process involving crystallization from a medium which yields crystals of great uniformity and unusual purity.

Heavy chemicals are produced in sufficient quantities, the plants being located principally in the Province of Ontario. Sufficient potassium chlorate to meet the requirements, together with a considerable supply of phosphorus, are produced, utilising hydro-electric power. There is the usual by-product recovery from coking plants. The electric furnace and electrolytic industries are established in Canada, producing bleach, caustic, cyanamide, abrasives, and carbides. Ferromolybdenum is manufactured in the electric furnace, and in many localities the electric furnace has been brought into play in the production of steels. Steps have been taken for the electrolytic refining of nickel matte produced in Ontario (see this J., 1917, 490).

In pharmaceutical chemistry a large number of the finer preparations are manufactured in Canada. Phenacetin has been produced since the war started, as has also acetylsalicylic acid; there is one plant with a capacity of over a ton a day making acetylsalicylic acid. *p*-Aminophenol is also being produced. Bismuth salts, iodine preparations, resublimed iodine, iodides, and iodoform, are being made in quantities sufficient for domestic use as well as for export. Hydrogen peroxide by the barium process is manufactured in quantity, and many sodium and potassium salts are purified and recrystallised. Alkaloids are prepared, and salvarsan of a grade equal to the best German product is now being prepared commercially. Aniline, phenol, and salicylic acid may be added to the list.

A few dyes are now being made in Canada, but the economic conditions are such as to make it improbable that any extension of the work can be carried out.

In regard to research, mention is made of the Advisory Council on Scientific and Industrial Research appointed by the Government, and to the work being carried out by the Forest Products Laboratory (see this J., 1916, 255).

Under the auspices of the Canadian Pacific Railway, a survey of the natural resources is being made in order that data regarding them may be made quickly available for practical application and for those interested in industrial development work.

The question of utilising plants which have been erected primarily for war purposes, when peace comes, is receiving attention. The production of nitrates from the air is strongly advocated, especially in those locations where plants have their own hydro-electric development works.

In regard to agriculture, many problems will present themselves relative to preparing the produce from mixed farming, in order that it may reach the markets in a condition to command a good price. Methods for drying to avoid high freight costs enter in, as well as the establishment of suitable plants in the vicinity of growth to work upon products of agriculture as raw materials.

In 1916, nearly \$22,000,000 worth of paper was exported from Canada, of which 88% went to the United States; the daily production of sulphite pulp approaches 1500 tons daily and that of paper exceeds 2000 tons daily. There is considerable

activity in hardwood distillation, and the Forest Products Laboratory is now carrying on softwood distillation experiments, hoping to produce oils suitable for use in the oil flotation processes.

The minerals of Canada already yield an annual income approaching \$200,000,000, and yet vast areas have not been prospected. Many of the deposits are inaccessible at present. There is said to be one deposit of gold-bearing gravel in British Columbia containing 3,000,000,000 cubic yards running 10 cents per yard. The geologist of the Stefansson expedition reports an ore body of 6,000,000,000 tons bearing copper distributed through the mass, in a quantity, however, which is not commercially attractive, but the indications are that more careful prospecting will disclose concentrations that may make it feasible in future to commence mining operations on the shores of the Arctic Ocean. The wonderful mineral resources of Northern Ontario are just being uncovered, while in the vicinity of Cobalt another gold mining camp is already establishing itself. The nickel deposits in the vicinity of Sudbury, Ontario, are also a part of the great Pre-Cambrian Shield which conforms to Hudson Bay and which continues into practically unexplored portions of the extensive Province of Quebec. Eighty per cent. of the world's supply of asbestos is mined in the Province of Quebec. Canadian apatite cannot be mined by steam shovel as are the phosphate deposits in Florida, and consequently at present it is not a commercial factor but may be looked upon as a reserve supply of this important substance. Some of the material contains from 83 to 87% phosphate, but it is enclosed in a hard Laurentian rock; that now used for phosphorus compounds of a chemical grade occurs with the mica and may be considered a by-product of this industry.

There are two varieties of soda rock which are interesting as being nearly identical with the German phonolith extensively used in the manufacture of Apollinaris water bottles. It is high in soda, contains very little iron, and approaches a natural fused glass in its composition.

Canadian magnesite has already come to the aid of steel manufacturers in providing a satisfactory refractory and is the source of much of the magnesium now made in the United States as well as all of that made in Canada.

The water powers of Canada are more abundant than in any other country; 1,712,193 24-hour horse power has been developed, and of the 18,000,000 24-hour horse power which is in sight 8,000,000 is within reach of present markets. In the central portion of Canada 2,000,000 sq. miles of territory lies at an average elevation of 1500 ft. This area drains into rivers emptying into the St. Lawrence or the sea and affords water power of dimensions difficult to compute. There are water powers which can be developed at a price per horse power which may make it possible to produce nitrates from the atmosphere in competition with the low prices in Norway.

At present the domestic fuels in use are principally the coals of eastern and far western Canada, including the anthracite in the vicinity of Bank Head, Alta. The tremendous tonnage of lignite which exists in Alberta, Saskatchewan, and Manitoba, has been limited in its use, due to its slacking during drying, but work is now under way which gives promise of making this lignite a satisfactory fuel for power purposes and the prairie provinces thereby more attractive for fields of industry. Research work looking toward the utilisation of cereal straws for fuels in certain areas is also under way with considerable promise of ultimate success. There is also a great quantity of oil shale in New Brunswick and smaller deposits in the western provinces which may be considered reserve supplies of oil.

STEELS USED IN AERO WORK.

Dr. W. H. Hatfield, in a paper read recently before the Aeronautical Society, dealt with the steels used in aeronautical construction, their composition and properties, methods of testing, and thermal and mechanical treatment. He emphasised the importance of using high-class material and of employing scientific methods in works practice. Accurate heat-treatment, based on the thermal phenomena associated with each steel, is essential, and this necessitates in works practice the use of satisfactory and properly standardised pyrometers. The best types of furnace, efficiently constructed and worked, are also required if homogeneous results are to be anticipated in the final product.

Though it has often been pointed out that the term "factor of safety" is misleading, yet its erroneous use continues. A true "factor of safety" should be the ratio between the stress which may be safely applied indefinitely under the actual working conditions to the stress actually employed. The actual values of this factor employed in modern design have been arrived at largely by the method of trial. Better results might be obtained, and fewer mysterious failures result, if the various contingencies to be allowed for were carefully examined and the "factor" placed on a more definite basis.

Among these contingencies is low elastic limit as compared with maximum stress. The difficulty of measuring the true elastic limit militates against this fundamentally important figure being determined as frequently as it should be. Our ignorance as regards the properties of steels below the yield-point is considerable, while of the properties between the yield and the breaking stress it is still greater. Variation of temperature, too, has a marked influence upon the physical properties of steel, and the influence of the ranges of temperature to which the parts have to be submitted in practice should be carefully studied. Corrosion might be carefully and profitably considered, particularly as regards seaplanes. Other items which require attention are the internal stresses left after forging and probably also after heat-treatment, and non-uniformity of material, especially as regards conditions produced by unskilful methods of manufacture and heat-treatment. Inclusions of slag, exaggerated sulphide inclusions, defects caused by unsatisfactory treatment in the forge, and last, but not least, hardening cracks, are also extremely important.

Parts not subjected to shock should be produced from material having a high elastic limit with just sufficient ductility to ensure non-brittleness, whereas for parts subjected to severe shock toughness is the more important feature. The division between these two classes of stresses is not very sharp, and in many cases a compromise would appear to have been made between two types of material. All the parts under consideration are of relatively small section, and lend themselves to very careful heat-treatment.

There is such wide divergence of opinion as to the best constructional material for pistons that cast-iron, steel, and even aluminium alloys are all in use at the present time. The author records having had definite indication that piston-heads had spent a considerable time in service above the critical point, 730° C. Generally speaking, the fluctuations of temperature during a cycle of operations take place too rapidly for such changes materially to affect the temperature of the piston or cylinder walls, except just at the skin of the material. The possibility of attainment of extremely high local temperatures at the skin depends largely on the thermal conductivity and specific heat of the material, high values in these tending to reduce the fluctuation in temperature.

For many steels the yield-point is not a definite value. If yield-point is to be taken as a guide as to the value of "true elastic limit," and if elastic limit is to be taken as the basis of design, then this quantity must have much more attention than it usually receives.

The use of impact tests of the Izod and Charpy type is not justified in view of the anomalous results obtained in practice. The torsion test is of particular interest to aero engineers, since any shaft which transmits power suffers torsion, and the natural way of testing the strength of such a shaft or of the material of which it is made should be by torsion.

In discussing the properties of a number of typical steels used in aero work, the author described air-hardening steels as extremely important, and predicted that when they are more completely understood they will be used to a much greater extent than at present. An air-hardening steel heated to temperatures of 800°—850° C. and allowed to cool in air will have great hardness, whereas the hardness introduced by the same treatment in an ordinary carbon or even a high-tensile steel is in no way comparable. It is the presence of a high percentage of nickel, as well as chromium, that induces the specific property. Such steel, on air-hardening from 800°—850° C., gives 100 tons per square inch maximum stress and upwards, accompanied by an elongation in the neighbourhood of 10%. Such results should be extremely valuable to engineers designing aircraft parts. "Stainless steel," a low carbon steel with 11 to 15% of chromium, is air-hardening, and has the property of successfully resisting the ordinary corrosive action of the weather, change from wet to dry atmospheric conditions, organic acids, oxidising influences, and sea-water. It should, therefore, have a large application to sea-plane work. At present it is used for aero valves, and would appear to be a possible material for stream-line wires.

A considerable tonnage of sheet steel is employed in aero work, e.g., for manufacturing clips, etc. The steel used for such purposes has usually a low tensile strength, say, 28—30 tons. A higher class of sheet steel is being used containing nickel, which gives approximately 35 tons tensile with a considerably higher yield-point than the mild steel. A drawback against this latter steel is that there is some difficulty in working it.

JAPANESE GOVERNMENT INDUSTRIAL COMMITTEE.

According to *The Chemical Technology* (March issue), the Japanese Department of Agriculture and Commerce has recently appointed a Committee to institute researches in connection with Japanese industries. The Minister of the Department, M. Nakashoji, states that the work of the Committee will include a thorough examination of the natural resources of the country, e.g., coal mines, iron ores, agricultural and forest products; encouraging the further development of the chemical, textile, and other industries which have expanded so largely since the outbreak of war; collecting detailed information in regard to foreign markets with a view to the expansion of Japanese export trade; and co-operating with Government and other Committees which have for their object the promotion of Japanese industries and commerce.

SOCIETY OF GLASS TECHNOLOGY.

At a joint meeting of the Faraday Society and the above Society, held in the Department of Applied Science at the University of Sheffield on June 20th, Prof. W. G. Fearnside gave an address on "The

Resources of Refractory Materials available for Glass Manufacture." The problem of refractories was common to both the steel and the glass industries. In the manufacture of steel, furnaces were run at a much higher temperature than in the case of glass, and so from the point of view of withstanding heat, a refractory useful in steel would be quite good for glass. In the manufacture of the latter, however, the severest test on the refractory was its power of withstanding chemical action. Refractory substances are to be found in different geological formations, but many of the most used refractories are in the vicinity of coal measures. The occurrence and relative importance of various ganister and fireclay beds were discussed and their positions indicated, special mention being made of silica from Meltham, near Huddersfield, ganister from the neighbourhood of Sheffield, and fireclay from the the Halifax district. The relative values of the "Wooden Box" clay from Church Gresley, in the Leicester coalfield, of the clay from South Wales, and from Glenboig, in the south-west of Scotland, were also commented upon. The address ended with a discussion of the kaolins and ball clays of Cornwall, Devon, and Dorset.

An address on "Refractory Materials" was delivered by Mr. J. H. Davidson. The analyses of various clays were given and their likenesses and differences were discussed. In addition, a stone from Durham used in building glass tank furnaces had been analysed, together with several similar local stones. The stones differed little amongst themselves in analysis, but were widely different from clay as they contained considerably more silica and less alumina. It was shown that the percentage of water taken up by a clay in working was a measure of its plasticity, and methods of testing the plasticity of clay were given. From the numbers obtained it was found that "Wooden Box" (Church Gresley) clay was anomalous in its behaviour. The Leeds fireclay required 18% of added water for plasticity, Halifax 18½%, Stourbridge 18%, "German" 19½%, whilst "Wooden Box" required as much as 25%. Most clays contract 5% to 6% in drying, but "Wooden Box" is again unique, as it contracts 6½%. In the firing tests blocks were fired at a temperature of 1000° C., when a contraction in length of ½% to 1% was noted, with the exception of "Wooden Box," which contracted as much as 1½%. Under the same firing conditions the stones increased about 1% in length. A second firing to 1450° C. was given, and the following total contractions were observed:—Halifax clay 8½%, "German" clay 10%, Leeds clay 10%, Stourbridge clay 11%, "Wooden Box" 17%. At this temperature it was found that stones increase 3½% in length. In all the tests carried out it will be observed that "Wooden Box" clay is anomalous in its behaviour. Since clays contract so much on firing, the necessity for the admixture of "grog" in potmaking is at once apparent. In the opinion of the author, the present day potmaker uses too little "grog," and also "grog" of the wrong type. Instead of using ground broken pots, he advocated the use of fresh burnt raw clay which, although requiring great care and some trouble in preparation, would be most efficacious.

Dr. Walter Rosenhain pointed out that the desiderata of a good refractory were (1) non-solubility, (2) resistance to chemical action, (3) facility of manufacture, (4) availability, (5) correct thermal conductivity. Unfortunately all these points could not be combined in one substance. Most glasses are "acid" fluxes, and so liable to attack basic materials in the refractory. Thus it is that clays with increasing alumina content are so resistant to glasses. One great obstacle in the glass trade was the time taken in building

and drying pots, and he hoped that in the near future pots would be made by a casting process. Regarding "grog" in pot building, he was of the opinion that slate could be used as a binding material and to alleviate shrinkage, giving as it would a sharp-edged particle and also being very refractory. He also advocated the measuring of the plasticity of clay by means of the "penetrometer." He also spoke of the virtue of coating fireclay and pot clay by specially refractory materials; in particular he mentioned the use of carborundum and of zirconia as being likely to yield satisfactory results.

Dr. P. G. H. Boswell spoke of the need of further investigation in the behaviour of pot clays, and hoped that glass manufacturers themselves would experiment. In addition, little was known yet as to the effect of small amounts of impurities in pot clay. For example, might not titanium oxide have a deleterious effect? He discussed the purification of clay on a large scale, and also spoke of the future of surface combustion in glass manufacture.

Mr. Spiers, the Secretary of the Faraday Society, appealed to glass manufacturers to make known their difficulties regarding refractories.

ROPINESS IN BREAD.

Since the Government regulations in regard to the milling of wheat and the addition of other materials to wheat flour came into force, complaints of the inferior quality of the bread have been rife. That bread made with flour of the type now used should be particularly susceptible to ropiness is what might have been anticipated from consideration of the known facts in regard to this disease. The production of ropiness in bread was thoroughly investigated by E. J. Watkins some years ago, and the results of the investigation were communicated to the London Section of the Society (see this J., 1906, 350). In view of the Government regulation that bread must not be exposed for sale until it is at least 12 hours old, it is important to note that the disease usually becomes evident only after from 12 to 48 hours from the time the bread has left the oven. It appears to develop at the centre of the loaf and progress gradually outwards. The bread acquires, at first, a faint sickly odour, and brownish spots appear in the crumb and gradually extend, the central portion of the loaf ultimately becoming moist and sticky, so that it can be drawn into long gummy threads. Under specially favourable conditions the disease develops to such a degree that the whole of the crumb is converted into a slimy brownish mass, having a strong valerian-like odour. Bread made from flour containing bran is much more liable to the disease than that made entirely from white flour. Watkins succeeded in isolating the micro-organism responsible for the disease and identified it as *Bacillus mesentericus fuscus* (Flügge), which is frequently found in soil and on vegetables, etc. It was shown conclusively that the bacillus is introduced into the bread by the flour, probably on the bran coating. The bacillus is a prolific spore-former, and the spores are capable of resisting relatively high temperatures for prolonged periods, and hence cannot be destroyed by baking the loaves for a longer time than usual. Increasing the time of baking, however, produces a drier bread, and is advantageous in this respect, since dryness tends to inhibit the development of the spores. Watkins found that development could be prevented completely by adding a small quantity of acetic acid to the dough, but it is doubtful whether such a method would prove acceptable. He also described a simple bacteriological test by which the presence of *Bac. mesentericus* in flour

could be detected, and recommended that when the flour was found to be contaminated it should be used under conditions most unfavourable to the development of the bacillus, *i.e.*, the dough being made slightly acid and the bread quickly cooled and kept at a low temperature and as dry as possible during storage.

REPORT ON RESOURCES AND PRODUCTION OF IRON AND OTHER METALLIFEROUS ORES.*

(Prepared for the Advisory Council for Scientific and Industrial Research.)

The Advisory Council for Scientific and Industrial Research has thought it desirable that a Report should be compiled summarising the latest information available regarding the iron ore resources of the United Kingdom as well as those of other countries. The aim of the writer of this Report, Mr. G. C. Lloyd, of the Iron and Steel Institute, has been to collect and present in a summarised form the main facts concerning the resources of iron ores and of other metalliferous ores necessary to the metallurgy of iron and steel, and to indicate their composition and character, giving as many analyses as possible of the minerals in every locality, with indications as to their geographical position and accessibility. The Report is divided into three main parts, of which Part I. deals with the iron ores of Great Britain

and Ireland and of the British Dominions. The ores of the United Kingdom are described in approximately the following order:—Red hematites, brown hematites, and magnetites (Cumberland, Lancashire, Cornwall and Devonshire, Forest of Dean); carbonate ores or ironstone (Cleveland, Northampton, Rutland, Leicester); the calcareous ores of the lower and middle lias (Lincolnshire, Oxfordshire, Wiltshire, Somerset); iron stone of the coal measures (Scotland, Northumberland, Staffordshire, Derbyshire, Shropshire, South Wales); the aluminous iron ores of Antrim, and the various smaller deposits of hematite and limonite in Ireland. A brief note is also given on the siliceous ores lately opened out in Kent. The resources of the British Dominions are then referred to, the principal deposits at present known being those of Newfoundland, Canada, India, and Australia. Part II. gives information of the same kind and as far as available with regard to most of the other countries of Europe, Africa, Asia, and North and South America. In Part III. notes are given of the principal uses, occurrence and composition of the ores of metals other than iron but used in the iron industry—namely, chromite, cobalt, manganese, molybdenum, nickel, titanium, tungsten, vanadium, and zirconium, including references to the composition of ferro-alloys manufactured from some of these ores.

For the purposes of the Report no new investigations of any special kind have been undertaken, but the most recent reports on the mineral deposits of the various countries have been briefly reviewed and references to the original sources of information have been given in every case.

* To be purchased through any bookseller, or directly from H.M. Stationery Office, Imperial House, Kingsway, London, W.C.2, price 2s. net, post free 2s. 2d.

Journal and Patent Literature.

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Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

PATENTS.

Separating immiscible liquids [oil-water emulsions]; Apparatus for.—J. L. Sands, London, and J. Gourlay, Glasgow. Eng. Pat. 106,165, June 6, 1916. (Appl. No. 7993 of 1916.)

To facilitate the cleaning and operation of the separator described in the application for Eng. Pat. 14,217 of 1914, which consists of annular filter screens that allow only one of the constituents of the emulsion to pass through, the outer casing is made removable and the discharge of the water is regulated by a float valve working in a chamber connected with the separator proper by water-sealed tubes.—W. H. C.

Conveying [corrosive] liquids in bulk; Vessel for.—H. N. Morris and N. K. Turnbull, Manchester. Eng. Pat. 106,351, June 14, 1916. (Appl. No. 8370 of 1916.)

THE claim is for an approximately cylindrical inner tank to hold the corrosive liquid, spaced apart from an outer shell which forms the body of a barge or other vessel. (See also this J., 1916, 1243.)—W. H. C.

Cooling water and other liquids; Apparatus for.—C. C. Thomas, Baltimore, Md. U.S. Pat. 1,225,889, May 15, 1917. Date of appl., Sep. 14, 1915.

WATER from a central spray producer, directed upwards, falls on to a series of superposed cooling surfaces, each in the form of a frustum of a cone,

The inclination of the conical surfaces increases from below upward and the spaces between them diminish from the centre outward. A screen of wide mesh, in the form of an inverted cone, is placed centrally at the entrance to the spaces so that the spray passes through it. Cooling air flows upward through the conical spaces over the water films.—W. F. F.

Desiccating apparatus.—C. E. Rogers, Detroit, Mich. U.S. Pat. 1,226,011, May 15, 1917. Date of appl., Oct. 18, 1913.

LIQUID to be desiccated is sprayed into a number of parallel branch conduits for hot air extending from a pair of supply pipes into a large chamber on opposite sides. The streams of hot air carrying the liquid spray impinge on one another in the chamber, and pass from it in a direction at right angles to that of their entry, into a pair of exhaust chambers, one on each side, which are exhausted so that the main chamber is not above atmospheric pressure. A pivoted screen, having an area greater than the combined cross-section of the air conduits, is mounted at the entrance to each exhaust chamber in such a way that it may be slowly displaced and then jerked back to its normal position.—W. F. F.

Grinding-ring for attrition mills.—W. Van Nostrand, Dalton, N.Y. U.S. Pat. 1,226,032, May 15, 1917. Date of appl., July 21, 1916.

MATERIAL, such as grain, is fed to the centre of a pair of coaxial grinding rings placed face to face, and passes first through a set of crushing

ribs at the inner edges of the rings. The intermediate portion of the ring is provided with radial grinding ribs and with a number of pairs of circumferential rows of grading ribs between and flush with the grinding ribs. The ribs of each pair of rows are not in alignment and the radial spaces between them diminish from the centre outwards. The material passes finally through a pair of finishing ribs at the outer edge of the rings.—W. F. F.

Tube-mill. F. E. Marey, Salt Lake City, Utah. U.S. Pat. 1,226,555, May 15, 1917. Date of appl., Jan. 18, 1917.

THE head of the rotary drum is provided with a grating fixed in position by a surrounding ring which has recesses engaging with corresponding lugs projecting from the peripheral wall of the tube-mill.—W. H. C.

Furnace or stove construction. G. C. Kidder, Salt Lake City, Utah. U.S. Pat. 1,226,082, May 15, 1917. Date of appl., Mar. 27, 1916.

A RELATIVELY large supply of fuel is fed to a pair of retorts on each side of a combustion chamber, the hot combustible gases passing into the combustion chamber. Conduits for the supply of air for combustion are disposed below the inner walls of each retort and are divided into separate chambers, one above the other, by partitions. Each air chamber is provided with openings of different sizes for discharging the air to the combustion chamber.—W. F. F.

Furnace for heating or annealing. Furnace. A. Smallwood, London, Assignor to American Incandescent Heat Co., Portland, Me. U.S. Pats. (A) 1,226,266 and (B) 1,226,267, May 15, 1917. Dates of appl., Sept. 21, 1914, and June 19, 1915.

(A) THE fuel is partly burnt in a preliminary combustion chamber, and the gases pass to a main combustion chamber connected to a heat-radiating chamber having a radiating surface extending the length of the heating chamber. The gases finally pass into the heating chamber through a number of flues connected to the radiating chamber and adjustable by dampers. (B) In a furnace as in (A) a number of heating chambers are provided with common preliminary and main combustion chambers, and a separate heat-radiating chamber for each heating chamber.—W. F. F.

Caleining furnaces; Process for facilitating the descent of the charge in—. Bergwerblische Industrie G.m.b.H., Metz. Ger. Pat. 297,115, May 29, 1915.

THE furnace consists of a vertical shaft with a water-cooled tube of diamond-shaped section fixed transversely near the base. At intervals water is driven out of this under pressure into the body of the hot charge, which is thereby suddenly chilled, and broken up into small pieces, which readily fall down to the discharge openings.

—H. J. H.

Measuring and mixing device. G. J. Olney, Westernville, N.Y. U.S. Pat. 1,226,108, May 15, 1917. Date of appl., Feb. 7, 1916.

TWO separate hoppers are mounted over openings in a cylindrical casing, within which a cylinder provided with measuring pockets rotates. The pockets are filled as they pass under the hoppers and emptied as the cylinder rotates. Liquid is fed by a pipe into the hopper feeding one series of pockets and liquid is fed by another pipe into the cylinder for the other series of pockets at a point before they reach the outlet from their hopper. An outlet is provided in the cylindrical

casing opposite the second series of pockets for the escape of air from the pockets being filled, without passing through the hopper.—W. F. F.

Mixing slimes; Process for— by means of compressed air. G. Polysius, Dessau. Ger. Pat. 296,210, June 6, 1914.

THE tank containing the slime is furnished with a number of tubes through which compressed air can be directed to different parts of the tank. By a mechanical device the air is supplied to each of these tubes in turn, so that all parts of the material are subjected to mixing action. A suitable device is a multiple-slide valve, or a multiple-way tap which on rotation brings the air supply in turn in communication with all the distribution tubes arranged radially round the tap.—H. J. H.

Lubricant. C. F. Axtell, Assignor to O. P. Amend, New York. U.S. Pat. 1,226,165, May 15, 1917. Date of appl., July 19, 1916.

THE lubricant is composed of a 30% solution of calcium chloride mixed with graphite and alcohol.—W. H. C.

Refrigerating apparatus. T. Carrigan, New York, and A. J. Sweeney, Bayonne, N.J. U.S. Pat. 1,226,186, May 15, 1917. Date of appl., May 5, 1916.

IN an absorption refrigerating apparatus, the weak liquor is withdrawn from, and the strong liquor delivered to the generator by a rotary pump, and the gaseous refrigerating agent is withdrawn from the evaporator by a pump and compressed to such a degree that it is absorbed by the weak liquor without the necessity of cooling the latter.—W. H. C.

Melting-pot. C. A. Fraser and F. M. Henry, Assignors to C. K. Spears, Minneapolis, Minn. U.S. Pat. 1,226,496, May 15, 1917. Date of appl., Oct. 19, 1916.

A MELTING pot is connected with an auxiliary melting pot at a higher level by means of a pipe provided with a valve. The latter is operated by a rod depending from one arm of a rocking bar, the other arm of which is connected by a rod with a float in the melting pot proper. The rod connected with the float is provided with a spring to give a quick "snappy" action of the valve.—W. H. C.

Precipitation apparatus. A. E. Vandercook, Oakland, Cal., Assignor to California Macvan Co. U.S. Pat. 1,226,611, May 15, 1917. Date of appl., Nov. 9, 1915.

A CYLINDRICAL precipitating chamber is mounted above a conical feed chamber from which it is separated by a perforated plate. The shredded solid precipitant rests upon the perforated plate and is compressed by a perforated weight which rests on the top of the precipitant. The liquid to be treated is delivered to the bottom of the conical feed chamber by a central pipe, rises through the precipitant, and overflows into an annular gutter which surrounds the precipitation chamber.—W. H. C.

Precipitation and separation of material from one liquid by another; Process for continuous—. E. Hausbrand, Berlin. Ger. Pat. 297,365, July 24, 1914.

THE apparatus consists of a train of vessels, those for mixing precipitant and liquid to be treated, and those to act as settling tanks being placed alternately. The liquids, well mixed, pass from the bottom of one mixing tank into the side of a settling tank where separation according to specific gravity occurs. The tanks are so arranged that the lighter liquid can rise up a pipe to a level above that of the contents of the next mixing

tank. The apparatus can thus be worked continuously, liquid to be washed and precipitant being sent through in counter-current.—H. J. H.

Distillation and the like; Column for—W. E. Lammus, Lynn, Mass. U.S. Pat. 1,226,898, May 22, 1917. Date of appl. Aug. 19, 1911.

THE column is composed of superposed sections, each being a parallelogram in horizontal cross-section. The upper and lower faces are flat except for two lugs projecting upward from two opposite faces, and two lugs projecting downward from the other two faces. The lugs maintain the units in alignment and retain the packing material in position between them. The units are bolted together by means of lugs projecting outward.

—W. F. F.

Nickel catalyst; Process of making—J. J. Burchenal, Assignor to The Hydrogenation Co., Cincinnati, Ohio. U.S. Pat. 1,226,945, May 22, 1917. Date of appl. Feb. 23, 1912.

A SOLUBLE nickel salt is precipitated by a soluble carbonate and the precipitate is calcined and then reduced whilst free from admixture with non-reducible substances.—W. H. C.

Gases; Apparatus for purification of—G. Zschocke, Kaiserslautern. Ger. Pat. 296,209, May 23, 1911.

THE washer is of the disintegrator type, the gas with a spray of water passing an annular space in which two sets of bars are disposed radially, one fixed to the outer case and the other rotating. The free ends of the bars run in grooves cut in the drum of the moving part of the washer and in the wall of the fixed case. These grooves serve a double purpose of providing a channel for the escape of the wash water thrown outwards and also a seal to prevent gas from passing through the washer untreated.—H. J. H.

Separation of foreign bodies from pasty masses prior to drying; Process for continuous—J. Jung, Cöln-Ehrenfeld. Ger. Pat. 296,228, Jan. 31, 1915.

THE pasty material is forced into the space between a revolving perforated cylinder and a plate which bears on the wall of the cylinder under the action of a spring. The pasty material passes through the perforations into the drum, while foreign bodies are carried past the spring plate and fall or are scraped off the drum. The sifted material inside the drum is forced by a screw conveyor to one end against a rapidly rotating disc where coarse particles are reduced in size and incorporated.—H. J. H.

Heat; Process for facilitating transmission of—by surfaces (boiler or condenser tubes). C. Hülsmeier, Düsseldorf-Grafenberg. Ger. Pat. 296,285, Feb. 2, 1916.

DEVICES of various kinds, made of materials of low thermal conductivity, are introduced into the current of water so as to throw it into eddies. The devices are arranged to float or are suspended loosely so that by their motion they may prevent the accumulation of boiler scale. Suitably shaped wires and strips of leather, ropes, objects of various forms, with and without vanes attached, are suggested.—H. J. H.

Treating solids and liquids with steam; Process for—G. Voigtmann, Berlin. Ger. Pat. (A) 296,596, Apr. 28, and (B) 296,597, May 6, 1916.

(A) THE substance to be treated is placed in a cylindrical vessel of porous material which acts as a filter medium. This is enclosed in a perforated case hanging inside another vessel. The whole stands in a steam boiler so that the contents

of the filter chamber are subjected to the influence of steam but under such conditions that any liquid draining out of the filter can be collected and prevented from entering the boiler water. (B) A cylindrical vessel with a belt of perforations round the walls and a filter medium above and below the perforations, is fixed inside a steam boiler. In this way material passing through the filters is subjected to the action of steam and collects finally in a chamber below, without the possibility of escaping into the boiler. By means of a wick dipping into the lower chamber, the liquid there can be raised by capillary action above the upper filter layer and so subjected to repeated steaming.—H. J. H.

Mixing and spraying of liquids; Process for intimate—M. Emmerich, Kiel. Ger. Pat. 297,271, June 25, 1912.

THE apparatus consists of a metal collar into which two tubes are screwed so as nearly to touch one another, the gap falling at the point where a circular groove is cut round the inside of the collar. The liquid under pressure is forced into this groove and escapes in a radial direction through the gap to impinge on a cylinder of hard material—glass or agate—placed axially in the tubes. It is thus broken up into a state of fine division and is turned through 90° and passes out through one of the tubes.—H. J. H.

Packing materials for absorption and reaction towers. F. Raschig, Ludwigshafen. Ger. Pat. 297,379, Feb. 19, 1916. (See also Eng. Pat. 6288 of 1911 and Ger. Pat. 292,622; this J., 1914, 907; 1916, 916.)

THE packing may be made from metal plate, strips, or tubes, of cast iron or ceramic materials, and may be used in absorption or reaction towers, still-heads, dephlegmators, mixing or heat-exchange apparatus. The packing materials, which are loosely and irregularly piled in the apparatus, may be of a variety of shapes, e.g., coils of polygonal shape such that at least two angles are not right angles; cylinders which have either one or both ends inclined to the axis; cylinders with ends of screw form, conical bodies so arranged as to prevent one from being pushed into another; double cones; or cones with inclined bases.—H. J. H.

Filter-plates. C. Greiner, Heufeld. Ger. Pat. 297,132, Jan. 6, 1916.

THE plates have either parallel or concentric circular corrugations, along the ridges of which holes are cut. Tight packing of the filter-cake is minimised, the plates are easily cleaned, and lodgment of bacterial growths is avoided.—H. J. H.

Revivifying and decarbonising bone-black and other filtering media; Apparatus for—J. Wetter, London. From M. Weinrich, New York. Eng. Pat. 106,519, May 20, 1916. (Appl. No. 7219 of 1916.)

SEE U.S. Pat. 1,181,398 of 1916; this J., 1916, 823.

IIa.—FUEL; GAS; MINERAL OILS AND WAXES.

Fuels; Rational utilisation of—N. Caro. Chem.-Zeit., 1917, 41, 393–395.

THE rational utilisation of fuel has excited much attention in Germany recently, especially in connection with proposals for taxation of fuel and electrical power. In some quarters the carbonisation or gasification of the whole of the coal used is advocated, with prohibition of the

combustion of raw coal. For many purposes the latter can be regarded as an unnecessary and old-fashioned process, while the former, by reason of the by-products obtainable and the hygienic and other advantages which follow, should certainly be widely developed in the interests of true national economy. A note of caution, however, is sounded against the rash generalisations from special cases which are frequently current. If all coal were carbonised or gasified, the production of by-products would exceed any demand that can be anticipated at present. After the war there will be available large supplies of synthetic nitrogen compounds which will inevitably prevent the maintenance of the price of ammonia at the pre-war level. The question of the rational utilisation of fuel is to be studied from an economic standpoint. There are cases where on this ground the direct combustion of coal is preferable and more economical in fuel than gasification or carbonisation. In carbonisation there is a thermal loss of 10–15%, in simple gasification of 15–20%, and in gasification for by-products, using steam, the loss may rise to 30–50%. These losses must be reckoned with in comparing the thermal efficiency of methods of utilising coal. As a result, the fuel consumption in raising steam or heating certain furnaces may be increased by substituting gas firing for coal firing. Nevertheless there are numerous cases where gas firing shows such marked superiority in the performance of a particular operation or sometimes an exceptional thermal efficiency, that this heat loss in gasification becomes of minor importance. Thus where cleanliness of operation is essential, or where high temperatures must be developed, or where the grade of fuel is unusually low, gas firing may be preferable. For boiler firing these factors are inoperative and no economy of fuel is normally effected by the previous gasification of the coal. Owing to the greater heat loss in the producer, gasification with by-product recovery leads to still smaller thermal efficiency in heating operations and then the choice is decided by the value of the by-products—a very uncertain factor, perhaps, in the near future. This and the lack of a supply of suitable cheap coal has militated against the development of the Mond gas process in Germany though it has established itself in a few places under specially favourable conditions. Even in England (South Staffordshire) where conditions are exceptionally favourable, the central generation and distribution of Mond gas made only slow progress for many years.

The gas engine is thermally more efficient than any form of steam engine, so that fuel economy can be effected by gasification of the coal combined with the use of the gas engine as prime mover. This economy can be increased by using the exhaust gases from the engine in the producer, when the thermal efficiency of the latter rises to 80–85% (with by-product recovery). Unfortunately the capital cost of the gas engine is so high and its flexibility under load so low that it cannot for the present compete favourably with the steam turbine for power production. This may be changed in the future especially if the problem of the gas turbine is solved. The author concludes that no saving of fuel will be achieved by central gasification and in view of the possibility of fuel taxation, proposals to carry this out at the present are premature. He regards it as preferable to allow the question of gasification of fuel prior to burning to be decided by the unfettered judgment of industry following its normal technical development. The expenditure of heat in carbonisation is less than in gasification and to that extent it can contribute more to fuel economy. Furthermore, the range of by-products is greater. Wherever circumstances—

technical and economic—permit, national economy will be promoted by this treatment of coal. It must be remembered, however, that low temperature carbonisation, liquefaction of coal under pressure by means of oxidising and reducing agents (compare Bergius, Eng. Pat. 18,232 of 1914; this J., 1916, 167), and the physical and chemical treatment of coal may possibly bring in the future new methods of utilising fuels which can advantageously be adopted in the interests of national economy.—H. J. H.

Refractory materials committee of the Institution of Gas Engineers: Report of the —. Gas J., 1917, 138, 502–504.

IN addition to work dealing with materials from different makers, the committee has found it essential to employ bricks made from known materials under exactly defined conditions. Clay from six sources, representing varieties of material found in the United Kingdom, has been obtained and bricks made therefrom under widely varying conditions in such a manner that their "life-history" is known.

The hot-to-cold measurements of bricks on the market are given in an appended report by J. W. Mellor, and the results show that the true thermal expansion is obscured by effects due to the after-expansion or after-contraction of the fire-brick occurring whilst the bricks are being measured. Tests on this after-expansion or contraction appear to show that ordinary silica bricks tend to give less expansion, and fireclay bricks greater contraction, in a reducing than in an oxidising atmosphere.

Tests on the refractoriness of whole bricks under load presented much unforeseen difficulty, and to ensure uniform temperature throughout the test-piece, a size of about 3 in. × 3 in. appears most suitable.

It has not been found opportune to make any change in the standard specifications for bricks, but two alterations have been made in those relating to retort material. Silica material is now permitted, and in addition to a minimum porosity of 18% a maximum porosity of 30% has been inserted. During the last year steps have been taken to co-ordinate the research work of various societies on refractory materials (see this J., 1917, 370).

The Council of the Institution of Gas Engineers have drawn up the following schedule of the special problems and requirements of the gas industry:—Effect of loads on refractoriness of fire-bricks. Variation in size of fire-bricks under hot and cold conditions. Study of clay for jointing. Effect of oxidising and reducing atmospheres. Effect of firing temperatures. Influence of flue dust and mineral constituents of coal carbonised. Thermal conductivity at different temperatures. Effect of admixture of silica material. Further investigation of the methods of manufacture of carbonising retorts. In respect to retort material, gas-works and coke-ovens have special requirements in that the material must withstand exceptionally rapid and great fluctuations of temperature.—J. E. C.

Peat, wood, and lignite in gas making. Soc. Technique du Gaz, June 8, 1917. Gas J., 1917, 138, 578–579.

TESTS on the carbonisation of peat at the La Villette works from 1861 to 1866 showed that 100 kilos. of crude unpurified peat yielded 45 to 50% of coke, 12% of tar, 7300 cub. ft. of gas per ton, and 38 galls. of ammoniacal liquor per ton. With purified peat the results showed 60% coke, 15% tar, 7500 cub. ft. gas, and 46 galls. of liquor per ton. Experiments were resumed in 1887 and gave results showing a variation in gas yield of 8760

to 12,191 cub. ft. per ton, and in ammonia yield from 2 to 4.1 kilos. per 1000 kilos. The proportion of carbon dioxide in the gas varied from 16 to 25%. In trials in Switzerland and Bavaria, the carbonisation of wood in cast-iron retorts gave a yield of 10,800 cub. ft. of gas per ton, 26% of good charcoal, and 5 to 7% of tar. Results of tests at Romarantin are also given (see this J., 1917, 538). When used in a pure state the wood gas required a readjustment of the burners, but when mixed with coal gas it gave good results. Wood gas contains an appreciable quantity of acid, although very little sulphur, and the proportion of wood used along with coal is limited by the condition that the acids shall be neutralised by the ammonia of the gas, or corrosion of the works plant will result. In dealing with lignite it has been found practicable to use only a retort plant of the Woodall-Duckham type, the powdery nature of the residue necessitating a low temperature for its removal from the retort. The gas contains much sulphur and carbon dioxide. Up to 15% of lignite gas with coal gas presents no difficulties in purification or consumption. As in the case of peat and wood, the nearness of a gas-works to deposits of lignite is the factor influencing the possibility of employing this material.—J. E. C.

Gas meters: Report of the Joint Committee of Institution of Gas Engineers and Society of British Gas Industries on the life of —. Gas J., 1917, 138, 504—508.

OWING to difficulties occasioned by the war, the Committee decided to suspend the branch of the investigation dealing with the chemical aspect, confining their attention to the practical and mechanical aspects. A series of questions relating to the conditions under which meters are used, tested, stored, etc., was sent to 1600 different undertakings, but only 301 replies have been received. The report of R. Lessing brings to light instances of spent oxide being carried forward from the works purifiers and being deposited in the meters, and the possibility of dust passing the meters, gasholders, and valve systems and being carried for miles in the mains is by no means negligible.—J. E. C.

Naphthalene [in coal gas]: Determination of — by picric acid. Knublauch, J. Gasbeleucht., Oct. 11 and 21, 1916. Gas J., 1917, 137, 64—66.

The author recommends the following method of determining naphthalene:—A sufficient volume of gas to give about 0.08 gm. of naphthalene is passed at the rate of 50—55 litres per hour through two wash bottles containing 110 c.c. and 25 c.c. respectively of 1% picric acid. If much ammonia is present, the first bottle is charged with a mixture of 40 c.c. of the picric acid solution, 40 c.c. of N/1 sulphuric acid, and 30 c.c. of water. The gas rate may also be raised to 80—85 litres per hour. Precipitated naphthalene picrate is filtered off, a 0.2% solution of picric acid being employed for washing; 100 c.c. of this should suffice even when sulphuric acid is present. Any particles of picrate remaining in the second bottle are washed with a little neutral water into the first to which also is transferred the filter and precipitate. Methyl orange is added and the contents are titrated with N/10 alkali. In titrating, a deduction (0.1 c.c. for an 8 cm. filter) is made for the picric acid absorbed by the filter paper. The result multiplied by 0.0128 gives the weight of naphthalene.—H. J. H.

Methane and air: Influence of pressure on the ignition of a mixture of — by the impulsive electrical discharge. R. V. Wheeler, Chem. Soc. Trans., 1917, 111, 411—413 (see also this J., 1917, 378).

THE experiments upon the ignition of a mixture of

methane and air by impulsive electrical discharge, have been extended to pressures higher than atmospheric. The results obtained by Thornton (this J., 1916, 682), when plotted, showed well-defined steps, and above 2000 mm. pressure, the direction of the stepped curve was reversed, showing a decrease in "ignitibility" of a given mixture as its pressure was increased. These observations have not been confirmed, the "ignitibility" gradually increasing until it becomes practically constant at 4000 to 5000 mm. It is suggested that Thornton's records disclose in reality merely the increased difficulty of passage of the discharge with increased pressure of the gas.—B. N.

Sulphur in petroleum oils. F. M. Perkin, J. Inst. Petrol. Tech., 1917, 3, 227—242.

THERE is a great variation in the sulphur content of oil from different regions. If combined with mineral matter in shale, etc., this portion will not pass into the oil on distillation, but if present in the "kerogen" or organic matter a considerable portion will appear in the distillate. The sulphur may be due to decomposition of vegetable or animal albuminous matter or, in case of very large contents of sulphur, may be produced by reduction of inorganic matter such as gypsum. The removal of sulphur compounds depends on their stability. They are generally distributed between all the fractions of the oil, but in greater proportion in the higher fractions, consecutive fractions from American crude oil showing the following percentages, 0.02, 0.10, 0.38, 0.41, 0.37, 0.37, 0.51. It is difficult to isolate these compounds owing to the proximity of the boiling points to those of the various hydrocarbons, and the only method of procedure, in some cases, is to combine the sulphur with some reagent, such as mercury chloride. Thiophene has been found in Russian and German oils, thiophanes, which may be looked upon as saturated thiophenes, and alkyl sulphides having been isolated from Canadian petroleum. Mercaptans seem only to have been noticed in Baku oils. Occasionally carbon bisulphide is found in petroleum. Unsaturated sulphur compounds may be removed by treatment with sulphuric acid, but under certain conditions the acid acts also on the unsaturated hydrocarbons and the method may be too costly. Moreover sulphonic acids soluble in paraffin oils may be formed, giving off sulphur dioxide on heating, and actually adding sulphur to the oil. Sulphur in petrol should be reduced to the lowest limit. Kerosene and lamp oils should be free from sulphur. Sulphur is allowable in greater quantity in fuel oils, but if present in unduly large quantities is said to cause pitting in the boiler plates and tubes. Attempts to desulphurise oil on a working scale appear to have originated in Canada in 1869. Oils from Ohio are desulphurised by cupric oxide. The volatile portion may be passed through the oxide, or the oil may be distilled to separate the light spirit, etc., from the heavier oil, each portion being then separately mixed with finely divided cupric oxide, agitated, and heated in a still. The distillate is free from sulphur and the cuprous sulphide may be re-oxidised to copper oxide. In the Frasch process (see this J., 1912, 169) a mixture of 75 parts of copper oxide, 10 parts of lead oxide, and 15 parts of iron oxide is used. Robinson (U.S. Pat. 910,581; this J., 1909, 198) states that sulphur compounds can be eliminated by using 98% sulphuric acid. Blackmore (Fr. Pat. 340,275 of 1901; this J., 1905, 127) treats the oil with calcium carbide, whilst in the Edeleanu process (Eng. Pat. 11,140 of 1908; this J., 1908, 974) liquid sulphur dioxide is used. On mixing the latter with a petroleum distillate, at about 5°C., two liquid layers are formed, the bulk of the

sulphur compounds being found in the lower layer. The author does not consider the Edeleanu method suitable for shale oils, particularly Kimmeridge shale oil, and is doubtful as to its suitability for heavy oils. The author, in conjunction with Lucas and Palmer, proposes to treat oil at high temperatures with gaseous ammonia, the temperature being sufficiently high to cause the ammonia to commence to dissociate. Oils treated in this manner are found to give off hydrogen sulphide. It is unfortunate that the sulphur in the very extensive beds of so-called Kimmeridge shale is present in such a form that a very high percentage passes into the oil on distillation, the amount varying from 5 to even 8%. The sulphur in this shale is found in all the fractions and in spite of the evolution of hydrogen sulphide the amount in the distillate is not much less than in the crude oil. Hall (Eng. Pat. 26,756 of 1913; this J., 1915, 167) proposes to remove sulphur from this shale by passing in sulphur dioxide gas and then distilling. Kimmeridge shale oil would be of immense value if this sulphur could be removed, owing to the high yield of oil per ton of shale. The oil retains water in a remarkable degree, one ton of shale giving 64.75 gallons of a crude oil containing 30.25 gallons of water and 3.74% of sulphur. The dry oil would probably contain over 7% of sulphur. In retorting shales sulphur might be eliminated by: (a) removal in the process of retorting, (b) passing the oil vapours before condensation through a desulphurising agent, (c) desulphurising the oil by chemical means. Obviously the first method is preferable. There is no objection to adding some material such as lime, and by previous treatment a larger yield of ammonium sulphate might follow. In the second case there is a danger of carbonisation, carbon being deposited upon the desulphurising material, stopping its action. The third method presents considerable difficulty, owing to the risk of loss by action of the purifying agents on the oil itself.—J. E. C.

Liquid fuel and its combustion. J. S. S. Brame. J. Inst. Petrol. Tech., 1917, 3, 194—216.

THE liability to interference with supplies of sea-borne petroleum oils and the attendant wide fluctuation in prices must tell against the wider introduction of such oil as fuel in this country. Suitable fuel oils may be obtained from Russia, Galicia, Roumania, Borneo, Burma, Persia, California, Texas, Mexico, and Trinidad. Fuel oil should possess a high calorific value, should be fluid at moderately low temperatures, free from solid matter, and of a satisfactorily high flash-point. According to the specification drawn up by the U.S. Bureau of Mines (Tech. Paper No. 3, 1911) the oil should have a closed flash-point of 140° F., it should not congeal at 0° C., it should not contain more than 2% water or 1% sulphur, and not more than traces of sand, clay, or dirt. The calorific value should not fall below 18,000 B.Th.U. per lb. The Admiralty specification does not include calorific value. Provision is made for testing the viscosity at freezing point. The flash-point should be over 175° F. close test, but for oils of low viscosity, such as shale oils, the flash-point should be over 200° F. Water should not exceed 0.5% and sulphur 3%. Acidity, calculated as oleic acid, should be below 0.05%. The author gives ultimate analyses of four typical oils, the following being an average: carbon, 84.7%, hydrogen, 11.5%, sulphur, 0.35%, oxygen and nitrogen, 3.49%. The average of the calorific values of thirteen varieties of fuel oils is 19,200 B.Th.U. (bomb calorimeter). Coal tar products are likely to play a far more important part as fuel oils in the future, as in normal times we shall produce far more tar than is required to furnish

the special by-products for which there is a market. In addition a large supply of fuel oil may be forthcoming from low-temperature carbonisation. Petroleum oils possess a superiority over tar or tar oils largely due to the higher oxygen content in the latter (13.6% as against 1.5%).

Among the earliest methods used for the combustion of oil fuel, were the open Nobel troughs and percolation over a porous bed of non-combustible material. Attempts were next made to gasify the oil, but difficulties arose owing to the choking of the vaporisers by carbon deposits, and attempts were then made to burn the oil in the form of a fine spray. It cannot be too strongly emphasised that no particular type of atomiser possesses superlative superiority, success depending mainly on the general design of the whole oil-burning system. Atomisation may be carried out by spraying with steam or air and by direct mechanical breaking up of an oil stream escaping under pressure. Full details, and illustrations of the principles of various modifications of each type are given. Usually steam atomisers do not respond so well as air or pressure systems, when boilers have to be forced. Air may be truly termed the natural atomising agent, because in addition to its spraying effect, it ensures each oil-globule being carried forward with the requisite air for combustion. Atomisation by air at low pressure is more economical than when higher pressures are used. Atomisers giving a long narrow cone of flame are more suited to the Lancashire type of boiler, the wider cone of flame from a pressure spraying burner being more suitable for the wider combustion space of the water-tube type of boiler. It is an advantage to heat the oil to assist the proper atomisation by reducing the viscosity, this point being essential with pressure sprayers. Philip (Eng. Pat. 14,778 of 1913; this J., 1914, 824) has found that the addition of 8% of naphthalene greatly reduces the viscosity of thick oils. The essential conditions for satisfactory combustion of oil are sufficiency of oxygen, proper admixture, and avoidance of contact of the flame with any cool surface before this stage is reached. The use of a heated air supply is beneficial with oil. Steam has a disadvantage owing to the considerable amount of heat carried away in the hot flue gases by reason of its high specific heat. In burning oil fuel ample combustion space is necessary. The author gives details and illustrations showing furnace arrangements in the Scotch marine-type boilers and in water-tube boilers. Proper baffling between the rows of tubes is advocated. The advantages of firebrick arches are discussed. Flames are low in radiating power, whilst highly heated firebrick provides a splendid radiating surface and catalytically promotes combustion. The author looks forward to oil attaining increased importance in the future, especially in internal combustion engines, but most marine engineers have every confidence in the future of the oil-fired boiler and steam turbine, and in locomotive practice oil fuel has proved its value probably more than in any other commercial application.—J. E. C.

Vapour pressures of various compounds at low temperatures. Burrell and Robertson. See VII.

Method of testing corrosive action of slags [from coal ash] on firebrick. Brown. See VIII.

PATENTS.

Pulverised fuel burners. L. H. Bergman, Philadelphia, U.S.A. Eng. Pats. (A) 106,248 and (B) 106,249, Jan. 18, 1917. (Appl. Nos. 933 and 942 of 1917.)

MEANS for the propulsion and combustion of

powdered fuel, utilising only one source of air supply, are claimed. The burner consists of concentric inner and outer pipes. In (A) the fuel is admitted to the inner pipe and is conveyed by a portion of the air from a common box, the air for combustion passing down the annular space between the pipes. In (B) the fuel is carried down the outer annular space, the air for combustion passing through the inner pipe.—J. E. C.

Coking-oven. M. Marshall, sen., Vancouver, B.C. U.S. Pat. 1,227,060, May 22, 1917. Date of appl., Dec. 13, 1916.

THE floor of a coke-oven of the beehive type is formed of perforated bricks and has a space below filled with permeable material and connected with a flue, so that the volatile matter given off during the coking may pass to suitable condensers.—W. H. C.

Coke-oven. E. J. Crossen, Joliet, Ill. U.S. Pat. 1,227,518, May 22, 1917. Date of appl., Sept. 25, 1915.

A LONG, narrow coke-oven having vertical flues, is provided with a regenerator chamber situated immediately beneath and divided by transverse partitions into a number of sections, each of which has a separate air connection. Gas is supplied to the combustion chambers of all the vertical flues of a battery of the ovens and means are provided to regulate the supply of air to the regenerators and from the latter to the combustion chambers.—W. H. C.

Gases under pressure; Storing of —. Acetylene Illuminating Co., Ltd., and R. J. McL. Whibley, London. Eng. Pat. 106,378, Aug. 21, 1916, (Appl. No. 11,868 of 1916.)

THE receptacle in which the gas is to be stored is provided with a fibrous lining and is filled with large pieces of porous material, and the interstices between the large pieces are filled with smaller pieces of suitable material which may be porous or not.—W. H. C.

Gases under pressure; Storing of —. Acetylene Illuminating Co., Ltd., and A. Stephenson, London. Eng. Pat. 106,406, Sept. 26, 1916, (Appl. No. 13,676 of 1916.)

THE receptacle containing the solvent or absorbent material is subjected to a low temperature and the gas is then admitted at such a pressure that it will liquefy at the temperature obtaining in the receptacle. Alternatively the gas may be liquefied before it is allowed to enter the receptacle and the cold produced by the evaporation of the liquefied gas used to cool the receptacle and the solvent or absorbent material. A separator is provided through which the gas passes on its way to the receptacle to remove impurities.—W. H. C.

Gasolene and other light oils; Method of obtaining — from heavier hydrocarbons. U.S. Jenkins, Chicago, Ill., Assignor to Jenkins Petroleum Process Co., Milwaukee, Wis. U.S. Pat. 1,226,526, May 15, 1917. Date of appl., July 13, 1916.

HEAVY hydrocarbons are heated in a still under pressure, and "the vapours of greater average density than that of the lowest produced in the still" are withdrawn at different points below the top of the chamber, condensed, and replaced by forcing fresh heavy hydrocarbon into the still.—J. E. C.

Oils; Process for refining —. W. M. Parker, Oklahoma, Assignor to Parker Process Co. U.S. Pat. 1,226,990, May 22, 1917. Date of appl., Apr. 4, 1916.

OIL is forced under relatively high pressure through

a coil heated to about 400° F. (205° C.) and mixed with a small proportion of high-pressure steam. The mixture is heated to about 1000° F. (about 540° C.) and vaporised, and simultaneously forced at high pressure through a long cylinder containing a coaxial helix, at a velocity not less than 100 feet per sec. The vapour is cooled to about 350° F. (177° C.) and the condensed liquid separated.—W. F. F.

Oil; Distillation of —. Apparatus for oil distillation. Revolvable retort for distilling oil. S. M. Herber, Inza, Mo. U.S. Pats. (A) 1,227,558, (B) 1,227,559, and (C) 1,227,560, May 22, 1917. Dates of appl., Aug. 7, 1915, Apr. 5, 1916, and Sept. 26, 1916.

(A) A HORIZONTAL cylinder, revolvable in either direction and supported by hollow trunnions mounted in bearings in a casing, is heated externally and oil and steam are fed to it by a perforated pipe passing through the retort and mounted within the trunnions. A perforated trough is supported by the feed pipe within the retort so that it receives the heavier residue. The distillate passes out at each end by the hollow trunnions to separating chambers from which the gaseous products are withdrawn, and the liquid residue is returned to the retort. (B) In a retort as in (A), condensers are connected to the separating chambers and the latter are resiliently supported on the trunnions to diminish vibration. (C) The retort is provided with external concentric rings having internal flanges which are attached to the retort, and external flanges which are provided with means for sealing the joint with the casing. Projecting ribs, also carried by the ring, rest in grooved wheels for supporting the retort, and one of the rings carries a sprocket wheel whereby the retort is driven.—W. F. F.

Apparatus for purification of gases. Ger. Pat. 296,209. See I.

Apparatus for detecting the presence of combustible gases. Eng. Pat. 106,427. See XXIII.

HB.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

PATENTS.

Peat and other materials; Apparatus for carbonising — and obtaining distillates therefrom. C. Whitfield, Kettering. Eng. Pat. 106,121, May 6, 1916. (Appl. No. 6534 of 1916.)

PEAT or other material is fed from a hopper on to a series of revolving trays in a vertical carbonising chamber and is heated by gaseous products of combustion. Steam and vapours evolved are condensed in an apparatus in which the liquid products, after passing through an independent cooling coil, are re-introduced and act as cooling agents.—J. E. C.

Destructive distillation of carbonaceous materials. S. Glover, St. Helens, J. West, Southport, and J. Hargreaves, Widnes. Eng. Pat. 106,189, July 27, 1916. (Appl. No. 10,630 of 1916.)

A RETORT for the destructive distillation of carbonaceous materials is provided with a series of concentric gas collectors, tapering towards their lower edges, and extending into the relatively cool central area of the retort. A single distributing cone is also provided to direct the incoming material towards the internal periphery of the retort, the larger lumps rolling down to the region of the concentric gas collectors.—J. E. C.

[Wood] charcoal; *Process of making — and apparatus therefor.* S. Iwamoto, Osaka, Japan. U.S. Pat. 1,227,148, May 22, 1917. Date of appl., Aug. 28, 1915.

Wood is distilled in a closed retort, which is heated by a furnace connected with heating flues in the walls of the retort, and the distillation products are drawn off and recovered. The heating gases and air are then admitted into the retort so that the charcoal is further heated by partial combustion, thus rendering it more dense. The charcoal is removed while at a high temperature and rapidly cooled.—W. F. F.

X-ray tube. W. Robinson, West Lynn, Mass. U.S. Pat. 1,226,383, May 15, 1917. Date of appl., July 18, 1916.

AN X-ray tube has glass pockets formed in the walls of the tube, with mercury electrodes sealed in the pockets, one in the end and the other in the side of the tube, and a window at the other end permeable to X-rays.—J. E. C.

III.—TAR AND TAR PRODUCTS.

Benzene and toluene; Proposed manufacture of — in Australia. Board of Trade J., June 28, 1917.

THE Defence Department of the Australian Government proposes to erect plant for the production of benzene and toluene in the Commonwealth. The crude benzol will be obtained from the various Australian gas companies.

Catechol, quinol, and resorcinol; Biochemical reactions for differentiating —. J. Wolff. Ann. Chim. Analyt., 1917, 22, 105—107.

THE reaction of certain diphenols with laccase in presence of hydriodic acid and starch (this J., 1915, 738) may be utilised for the purpose of identifying the three isomeric diphenols, the result of the test being different according to whether it is carried out in presence of acetic or a mineral acid. The reagents required are a solution of 2% soluble starch and 3% potassium iodide; a glycerol infusion of *Russula delica* or other fungus rich in laccase; N/1 acetic acid and N/1 sulphuric acid. The fresh fungus is chopped into pieces the size of a nutmeg and steeped in about an equal volume of glycerol; the extract is filtered through glass wool for each series of tests. The solutions of the diphenols contain 1 grm. per litre. In the case of catechol, 2 c.c. of the solution is treated in a test-tube with 2 drops of the fungus extract, 5 drops of the starch-iodide solution, and 3 drops of acetic acid. An intense blue colour is rapidly developed. Under similar conditions a solution of quinol shows no reaction but if the acetic acid be replaced by sulphuric acid the blue colour gradually appears. With resorcinol no coloration is developed with either acid.—J. F. B.

Determination of naphthalene [in coal gas] by picric acid. Knublauch. See 11A.

PATENTS.

Benzenemonosulphonic acid; Preparation of —. Comp. des Produits Chimiques d'Alais and de la Camargue, Salindres, France. Eng. Pat. 101,973, Oct. 23, 1916. (Appl. No. 15,067 of 1916.) Under Int. Conv., Oct. 21, 1915.

BENZEMONOSULPHONIC acid is prepared by passing benzene vapour into sulphuric acid of any concentration, preferably at 120°—130° C. Water is eliminated as steam, and benzenesulphonic acid crystallises on cooling. *Example.*

The vapour of benzene is passed for 27 hours through 100 parts of sulphuric acid of 62° B. (sp. gr. 1.753), at 120° C. and the excess of benzene is removed by a current of hot air; 130 parts of crystalline benzenemonosulphonic acid is obtained on cooling. A suitable plant consists of a boiler from which the vapour of benzene passes into a receiver containing sulphuric acid heated to 120° C. by a steam jacket. The benzene vapour and steam passing away are condensed and flow into a separator, where the water is removed. The upper layer of benzene passes through a drying chamber, containing quicklime or calcium chloride, etc., and thence returns to the boiler.—F. SP.

Benzenedisulphonic acid; Method of separating — from sulphuric acid and converting it into a salt. L. M. Dennis, Ithaca, N.Y. U.S. Pat. 1,227,252, May 22, 1917. Date of appl., July 14, 1916.

THE mixture of benzenedisulphonic and sulphuric acids is treated with an organic solvent, e.g., benzene, which dissolves the sulphonic acid but not the sulphuric acid, and the solution is treated with a suitable compound to form a salt of the sulphonic acid, which is relatively insoluble in the solvent employed.—J. F. B.

Benzols; Process and apparatus for extracting — from heavy oils. E. Barbet et Fils et Cie. Eng. Pat. 100,493, May 17, 1916. (Appl. No. 7051 of 1916.) Under Int. Conv., Sept. 5, 1913.

SEE Fr. Pat. 473,082 of 1913; this J., 1915, 485.

IV.—COLOURING MATTERS AND DYES.

Colour-lakes; The theory of —. I. O. Baudisch. Z. angew. Chem., 1917, 30, 133—135.

THE author discusses the lake-forming azo dye-stuffs in their relation to Werner's theory of mordants (this J., 1908, 439). According to this theory the colour-lakes belong to the class of metal-complex salts, and the lake-forming dye-stuffs are characterised by the presence of a salt-forming group and a group capable of forming a co-ordinative combination with the metal atom in such a position that an internal metal-complex salt can result. The *o*-hydroxyazo dye-stuffs are typical mordant dye-stuffs which conform to this rule. The introduction of certain substituent groups in these and in the nitrosoarylhydroxylamines and the position of these groups in the benzene or naphthalene ring has a powerful influence on the pigment-forming properties through the effect of the substituent radicals on the internal complex salt-forming group. It has been shown that side chains which are able to bring spare valencies into play possess a particularly strong influence on this group. Instances are quoted where colour changes are determined by the spare valencies available in the dimethyl-amino, the toluenesulphonyl, and the aldehyde groups influencing internal copper-complex salt-forming groups. Further, the influence of the side chains is considerably stronger in a position *ortho* to the azo nitrogen than in the *meta* and *para* positions. The influence of the sulphonic group in the *ortho* position is illustrated in the case of the important lake-forming dye-stuffs Lake Red P and Lithol Red as compared with the corresponding isomeric *m*- and *p*-dye-stuffs. Pigment Scarlet 3 B is a lake-forming dye-stuff with a COOH group in the *ortho*-position; this exerts an influence on the complex-forming residue in virtue of spare valencies equivalent to those of an aldehyde group. A methyl group in the *ortho*-position to the nitrogen is antagonistic to lake formation, whereas a sulphonic group

attached to an *ortho* side chain is strongly favourable. Examples of a similar kind are found in the azo dyestuffs coupled with pyrazolone derivatives. In the anthraquinone series Werner's theory is consistent with the observation that the most valuable lake-forming dyestuffs are those containing *m*- and *o*-hydroxyls in positions contiguous to each other.—J. F. B.

Chromophors with auxochromic functions. II. Kauffmann. Ber., 1917, 50, 515—529.

FROM the facts that the nitro-derivatives of stilbene are coloured, whereas those of benzonitrile are colourless, and that stilbene itself possesses a violet fluorescence, it has previously been concluded (Kauffmann, "Die Valenzlehre," 1911, p. 496) that the styryl radical confers auxochromic properties. The influence of styryl on the fluorescence has been further investigated, and it has been found to be a typical auxochrome displacing the ultraviolet fluorescence of benzene into the visible spectrum. *p*-Distyrylbenzene (m.pt. 258° C.) has been prepared from terephthalic aldehyde and magnesium benzyl chloride; it is a coloured hydrocarbon with very powerful fluorescent properties, as distinct from *p*-dicyanobenzene. The luminophor is the central ring of the compound, as on gradual replacement of the two styryl groups by true auxochromes the fluorescence remains; thus replacement of one stilbene group gives *p*-dimethylaminostilbene, a substance possessing a very high fluorescence. In addition to its auxochromic character, styryl is also a chromophor, as shown by the introduction of true auxochromes, e.g., 2,4-diaminostilbene is light yellow. The more powerful the auxochromic properties of the styryl, the weaker are its chromophoric functions developed; thus *p*-dimethylaminostilbene is white and 1,3-distyryl 2,4-diaminobenzene (containing the styryl chromophor twice) is only light yellow. The entrance of a cyano-group increases considerably the chromophoric function of styryl, e.g., *p*-dimethylamino- α -phenylcinnamic nitrile is lemon yellow.—F. W. A.

Dyeing materials in the Philippines. J. Roy. Soc. Arts, 1917, 65, 553—554.

PROBABLY more than one hundred species of plants containing valuable colour principles are found in the Philippines, and many more could be readily cultivated. As these plants grow wild and often are widely scattered, the supply is unreliable and insufficient. Little has been done towards developing the manufacture of local colouring materials, and until there is an intensive cultivation of the necessary plants, and the capital necessary for the enterprise can be secured, there is little prospect of commercial success.

Only two Philippine dye plants are commercially important. These are indigo and sappan or sibucao. Others are used locally, but scarcely enter into domestic commerce.

Indigo (*Indigofera tinctoria*, Linn., and *I. suffruticosa*, Mill.) has been in the past extensively cultivated in some parts of the Philippines, and the prepared product entered extensively into the export trade. The cultivation of indigo as a commercial crop in the islands has now, however, practically ceased. Indigo is still cultivated on a small scale in some parts of Northern Luzon, but only to supply a limited local demand.

Sappan or sibucao (*Casalpinia sappan*, Linn.) is widely distributed in the settled areas of the Philippines at low and medium altitudes. It is not systematically cultivated, yet in a few districts it is found in great abundance. Exports of sappan wood from the Philippines to China (exclusive of Hong-Kong) in 1914 amounted to 1,515,756 lb., valued at £1343, and to Hong-Kong

amounted to 621,597 lb., valued at £586. No exports to other countries are on record. This wood yields about 2% of red colouring material by extraction with water. The wood contains brazilin, the colouring matter found in brazil-wood.

Brown dyes are obtained from numerous plants, chiefly from the shrub or small tree known as bancado or nino (*Morinda indica*, Linn.), certain mangrove trees, such as ceriops and bruguiera and the bark of *Nylocarpus* (tabigue or nigui). Many of these barks are useful in tanning as well as dyeing. Bancado is the well-known *al* dye of India. It dyes dark red shades on cotton mordanted with tannin. Black dyes are secured from *Heritiera litoralis*, Dry. (dongon late), a common coastal tree, and from some species of *Hibiscus*, *Semecarpus*, *Terminalia*, and *Diospyros*. Yellow dyes of minor importance are secured from the seeds of *Bixa orellana*, Linn. (achuete); from the wood of *Neuclea* (baucal); from *Carthamus tinctorius*, Linn., which is occasionally cultivated as a dye plant; from the bark of the common mango; from some species of *Vitex* (molave); and from ligtang, a woody vine having yellow wood rich in berberine. Berberine is found in several plants of the Philippine Islands. Turmeric (*Curcuma longa*, Lam.) does not occur in sufficient quantities in the Philippines to yield a useful supply of the rhizomes. The herbaceous plant, *Peristrophe tinctoria*, Nees, is widely scattered in the settled areas in the Visayan Islands and is sometimes cultivated on a small scale. It yields a beautiful red dye, which is locally used in the Philippines. It is doubtful whether the plant can be obtained in sufficient quantities or whether its commercial utilisation is possible.

PATENT.

Chromium compounds of the gallocyanine series and a process of making same. G. Engi, A. Grob, and J. Würzler, Assignors to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,227,407, May 22, 1917. Date of appl., Nov. 27, 1915.

SEE Eng. Pat. 15,751 of 1915; this J., 1916, 733.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Wool; The elasticum reaction of—. K. Naumann. Z. angew. Chem., 1917, 30, 135—137.

THE "elasticum" reaction described by Von Allwörden (this J., 1916, 416) for the detection of damaged wool, based on the change of microscopic structure on treatment with chlorine water, has been submitted to a thorough investigation. It is still too early to attach a practical significance to the results of this test because they vary with different kinds of wool, but with certain limitations it may be said that they are more or less the same for the same kind of wool. It is, however, most important to extend the examination over the entire length of the fibre, the reaction being different in different parts of the same fibre. A typical wool fibre, when treated with chlorine water under the prescribed conditions, will show no elasticum globules at the end furthest from the skin for a distance of 4—5 mm.; beyond this point a few isolated globules are found, increasing in closeness until they form a continuous chain. The swellings are most regularly continuous about the middle of the fibre and decrease in regularity and continuity towards the basal, clipped end of the fibre, without, however, ceasing altogether as at the point end. All varieties of wool show the reaction but in different degrees. The largest divergence from the typical reaction was shown

by a very coarse Australian cross-bred wool; this showed no swellings from the point to the middle of the fibre and thence only occasional globules to the base; total length 114 mm. Somewhat similar results were obtained with two samples of lamb's wool; no swellings were observed at the point and only a few near the base; at the middle occasional single globules alternated with short chains. A preliminary extraction with benzene in a Soxhlet apparatus makes the elasticum reaction much clearer and finer than with wool simply scoured with sodium carbonate. Dyeing operations in sodium sulphate-sulphuric acid or acetic acid baths and after-treatment with chromic acid do not affect the elasticum reaction, but dyeing in neutral sodium sulphate baths causes it to disappear. The action of caustic soda with increasing temperature has a greater effect on the elasticum reaction than with increasing concentration, and treatment with caustic soda at 50° C. under similar conditions to indigo vat dyeing does not destroy the reaction. The addition of formaldehyde moderates the action of caustic soda so that wool may be treated with the alkali in presence of formaldehyde without destruction of the elasticum under conditions which remove it entirely in the ordinary way. In the case of yarn a shrinkage of about 3% was observed without formaldehyde and no shrinkage when formaldehyde was present. Both samples of wool behaved equally well in fulling and it would appear that the elasticum reaction does not afford an indication of the fulling quality of the wool.—J. F. B.

Sulphuric acid on cotton; Action of —. H. Wilkinson. J. Soc. Dyers and Col., 1917, 33, 148—151.

DETERMINATION of the strength of unbleached cotton yarn after treatment with sulphuric acid and drying in air indicated that the tendering action increased the longer the acid remained on the fibre, and that on washing in water or alkali the cotton regained in strength an amount approximately equal to the strength in the acidified condition. Cotton which had been subjected to the acid treatment behaved like ordinary cotton on mercerising, gaining further in strength. —F. W. A.

Bleaching of cellulose; Determination of the degree of — by means of the copper value. M. Freiberger. Z. angew. Chem., 1917, 30, 121—122. (See also Schwalbe, this J., 1915, 23.)

To obtain trustworthy results in the determination of Schwalbe's copper value for cellulose certain precautions are essential. The alkaline tartrate solution should be freshly prepared, since traces of sodium silicate dissolved from the glass will materially increase the copper value. For preparing the solution pure sodium hydroxide made from metallic sodium should be used. It is dissolved in a polished iron vessel, which has previously been freed from fat by treatment with alcohol and ether, and the potassium sodium tartrate is added to the cold solution. Old copper sulphate solutions give too high results, and this solution should also be freshly prepared. To avoid solution of silica the distilled water should be kept in a stoneware instead of a glass vessel, and rubber stoppers, which yield particles to the liquid, should not be used. The method of boiling the Fehling's solution in Gnehm's apparatus has an influence on the results. The sides of the flask should be protected against over-heating, by means of an asbestos screen, and the liquid should always show numerous steam bubbles. After removal of the burner the supernatant liquid is at once poured into a beaker, and the fibres in the flask are rapidly washed several times by decantation with water at about 80° C., and allowed to stand covered

with warm water while the Fehling's solution and washings are being filtered. In this way the further deposition of copper which takes place when dilute Fehling's solution is heated is prevented. Finally the fibre residue is repeatedly washed and removed from the flask. Filtration through paper (No. 595 Schleicher and Schüll) gives more uniform results than filtration through asbestos in a Gooch crucible. The copper is dissolved in nitric acid, and the solution allowed to stand for 1 to 2 days, and filtered shortly before electrolysis. A blank determination should also be made, and the amount of copper obtained should be deducted from the copper value, but only a slight quantity of copper should separate in the blank test.—C. A. M.

Preparation of substances equivalent to chonile, celluloid, or gutta-percha. Ostromyslenski. See XIV.

Occurrence of raffinose in the seed of the jute plant. Annett. See XVII.

Reducing matter extractable from filter paper. McBride and Scherrer. See XXIII.

PATENTS.

Textile fabrics used in aircraft. J. Turner, Preston, and I. Turner, Blackburn. Eng. Pat. 106,113, Nov. 13, 1916. (Appl. No. 5270 of 1916.)

TEXTILE fabrics to be used in aircraft are strengthened to resist ripping by strands of gut or gut-substitute (imitation gut formed from plaited silk) introduced therein at suitable intervals (2—6 ins.) both in the warp and the weft during weaving.—J. F. B.

Viscose; Process of producing glossy threads from —. M. Biroli. Pavia, Italy. U.S. Pat. 1,226,178, May 15, 1917. Date of appl. Nov. 18, 1916.

GLOSSY threads are produced by passing viscose threads into a bath of sodium bisulphate to form the xanthogenate, and then into a bath containing an organic acid, with or without the addition of suitable salts, to fix the threads.—F. Se.

Acetylcellulose; Solvent for —. W. G. Lindsay, Caldwell, N.J., Assignor to The Celluloid Co., New York. U.S. Pats. (A) 1,226,339 and (B) 1,226,340, May 15, 1917. Date of appl., May 23, 1912.

(A) A MIXTURE of 54—61 parts by weight of benzene and 46—39 parts of methyl alcohol, the latter containing 3.5—7% of water, is a solvent for acetone-soluble acetylcellulose. (B) A mixture of epichlorhydrin and methyl (or ethyl) alcohol in about equal proportions is a solvent for acetone-soluble acetylcellulose, and the combination of these with *p*-ethyltoluenesulphonamide, with or without triphenyl phosphate, and acetone-soluble acetylcellulose, is claimed.—F. Se.

Acetylcellulose plastic compounds; Process of making —. W. G. Lindsay, Caldwell, N.J., Assignor to The Celluloid Co., New York. U.S. Pats. (A) 1,226,341, (B) 1,226,342, and (C) 1,226,343, May 15, 1917. Date of appl., July 10, 1915.

(A) A PLASTIC material is produced from acetone-soluble acetylcellulose by gelatinising it at ordinary temperatures with a mixture of water, benzene, and methyl alcohol, adding *p*-ethyltoluenesulphonamide and manipulating the mass in the usual manner. (B) Acetone-soluble acetylcellulose is mixed with *p*-ethyltoluenesulphonamide, with or without the addition of triphenyl phosphate, and gelatinised by a mixture of methyl acetate and methyl alcohol. (C) Acetone-soluble acetylcellulose is mixed with *p*-ethyltoluenesulphon-

amide, with or without the addition of triphenyl phosphate, and gelatinised by a mixture of epichlorhydrin and ethyl or methyl alcohol.

—F. Sp.

Duplicating paper ["carbon paper"]; *Manufacture of* —. H. Wade, London. From B. B. Goldsmith, New York. Eng. Pat. 106,167, June 7, 1916. (Appl. No. 8081 of 1916.)

THE sheet is first impregnated or coated on one or both sides with any waxy or greasy material, and a pigment composition containing a fat, oil, or waxy substance is applied to the foundation sheet of waxed paper on one or both sides.

—J. F. B.

Pulp, paper, cardboard and the like; Arrangements for heating and draining the cylinders of machines for making and treating —. W. A. Aitken, Gravesend. Eng. Pat. 106,228, Nov. 3, 1916. (Appl. No. 15,721 of 1916.)

THE drying cylinders of a paper machine are divided into two or more groups and the whole of the steam required for drying is admitted at the dry end and caused to flow towards the wet end of the series. Each group of cylinders has a separate main supply pipe and a separate main discharge pipe, and the outlet main of each group is connected with the inlet main of the next group. The inlet main of the latter group is placed at a higher level than the outlet main of the previous group which feeds it, and the latter is provided with a drainage pocket at its closed end. The outlet main of the last group of cylinders discharges into a hot water tank and the drainage pockets of the previous groups also discharge into the pipe leading to the water tank in such a manner that the drainage water acts as an ejector for the water passing from the last outlet main.

—J. F. B.

Ink-removing and bleaching compound [for treating paper-stock]. I. J. Wright, Kalamazoo, Mich. U.S. Pat. 1,226,735, May 22, 1917. Date of appl., June 29, 1916.

A composition for removing ink from paper stock is prepared with 4 lb. of sodium carbonate, $\frac{3}{4}$ lb. of bleaching powder, 1 gall. of kerosene, and 6 lb. of soap, combined with water.—J. F. B.

Acids or metallic salts [from vulcanised fibre]; *Process of eliminating and recovering* —. H. E. Tiffany, Assignor to The Continental Fibre Co., Newark, Del. U.S. Pat. 1,226,279, May 15, 1917. Date of appl., Jan. 5, 1916.

THE acids or metallic salts employed in the hardening of fibre are recovered by placing the fibre saturated with the hardening material in a bath containing an electrolyte and subjecting it to electrolytic action in order to remove and recover the acid or metallic salt, employing the saturated fibre as one of the electrodes.—J. F. B.

Pulp; Process of separating suspended —. W. Hoskins, Chicago, Ill. U.S. Pat. 1,226,333, May 15, 1917. Date of appl., Oct. 15, 1915.

PAPER pulp is separated from a liquid containing a chemically active substance, e.g., an acid, by passing the liquid over an immersed solid, e.g., a carbonate, which is acted upon by the chemical substance in the pulp liquid to evolve gaseous products. The liberated gases, rising through the liquid, carry with them the suspended particles of pulp to form a scum on the surface which is then removed. Suspended pulp is recovered from the waste waters of sulphate pulp digestion by passing the waters over immersed limestone and removing the pulp-carrying surface-stratum.—J. F. B.

Production of white silica [for finishing paper]. Eng. Pat. 106,232. See VII.

Fertiliser [from sulphite-cellulose waste liquor] and *process of making same*. U.S. Pat. 1,225,825. See XVI.

Process for moulding compressed gunpowder and similar materials. Ger. Pat. 296,245. See XXII.

[Cellulose ester] *composition for waterproofing the striking or abrasive surfaces of match boxes and the like*. Eng. Pat. 156,375. See XXII.

VI.—BLEACHING ; DYEING ; PRINTING ; FINISHING.

Electrolytic bleaching liquors; "Twaddelling" of —. G. G. Hepburn. J. Soc. Dyers and Col., 1917, 33, 135—137.

THE utility of estimating the strength of bleaching powder solution and especially electrolytic bleach liquors by a method based on the use of a hydrometer is emphasised. A method is outlined for correlating a burette reading obtained on titrating with thiosulphate with degrees Twaddell (of good quality bleaching powder solutions), and the term "chlorimetric-degree Twaddell ($^{\circ}$ Tw. Cl)" is suggested for the value 2.70 grms. of available chlorine per litre ($=1^{\circ}$ Tw. bleaching powder solution).—F. W. A.

Sodium sulphide in sulphide dye baths; Estimation of —. H. Swann. J. Soc. Dyers and Col., 1917, 33, 146—148.

THE sodium sulphide solution is distilled with ammonium chloride solution containing 5% of ammonia and the ammonium sulphide collected in an excess of standard iodine acidified with acetic acid, the excess being determined by means of standard thiosulphate or arsenite.—F. W. A.

Cotton; Tendering of — in dyeing half-woollen goods in baths of weak acids. W. Zünker and O. Mann. *Färber-Zeit.*, 1916, 27, 355. *Chem.-Zeit.*, 1917, 41, Rep., 161.

CASES of tendering of cotton have been observed in half-woollen piece goods dyed in baths containing acetic acid and Glauber's salt. In studying the causes of such damage account must also be taken of the possible effect of hot pressing, calendering, and finishing of the goods. Even small quantities of acetic acid cannot be washed out from cotton with pure water so that no reaction to litmus remains. Complete elimination can be obtained by leading strongly superheated steam at about 200° C. over the moist cotton for about an hour, which can be done without damage provided no air be present. Tensile tests on cotton boiled with water, acetic acid, and formic acid under the conditions of half-wool dyeing and then submitted to the usual finishing operations showed a loss of strength of 40—45% for acetic acid and 50—55% for formic acid as compared with water. With the addition of Glauber's salt, owing to the resulting decrease of hydrogen ion concentration, the loss of strength with acetic acid was reduced to 20—25% and with formic acid to 25—30%. With the presence of wool in the bath, intimately mixed with the cotton, the results were reversed, the loss of strength with acetic acid in presence of Glauber's salt being 50—55% and with formic acid 30—60%. In practice, the nature and type of weaving of half-woollen piece goods has a considerable influence, since narrow-ribbed goods have proved resistant, while broad-ribbed goods of the same material have been damaged under identical treatment; in the one

case the wool acts on one warp thread and in the other its action is divided between two. The finishing also affects the thick-ribbed material more strongly. The dyeing and finishing always have a more pronounced influence in the case of goods in which the cotton forms a smooth, extremely thin layer on the surface of the material, finished with a high gloss. Dyeing with acetic acid and Glauber's salt or with acetic acid alone is the best means available for treatment of half-woollen piece goods.—J. F. B.

Acid colours on cotton: Process for the fixation of —, F. W. Weeks. J. Soc. Dyers and Col., 1917, 33, 130—134. (See Eng. Pat. 102,291 of 1916; this J., 1917, 80.)

THE following printing colour for acid dyestuffs is recommended: To 50 grms. of acid dyestuff, 50 grms. of acetic acid, and 200 grms. of water are added 425 grms. of thickening, 350 grms. of aniline salt solution (4:10), and 125 grms. of hexamethylenetetramine solution (equal vols. of 20% ammonia and 40% formaldehyde). The amount of aniline salt must be determined for each dyestuff. Easily reduced dyestuffs are not suited to the process, reduction taking place slowly in the printing colour. Difficulties were met with in endeavouring to dye goods on the jigger, but the padding process has been found to be of considerable value. The fastness to light of dyeings produced from acid colours in this manner appears to approximate to the fastness of the same dyestuffs on wool. The process may be used in combination with ordinary chrome printing colours.—F. W. A.

PATENTS.

Textile fabrics: Process of rendering — "antique," M. B. Adom, White Plains, N.Y. U.S. Pat. 1,227,361, May 22, 1917. Date of appl., June 28, 1915.

THE fabric is treated in a warm bath containing the reaction products of sodium hydroxide, sodium bisulphite, and sodium peroxide, until the colours of the fabric have been subdued to the desired point; it is then washed in "chlorinated water" to clear the whites, then with hot water and a potassium soap, and finally treated in an acid bath containing Acid Violet or other blueing agent.

—J. F. B.

Fast tints on animal fibres: Process for producing —, G. Engi, A. Grob, and F. Straub, Assignors to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,227,406, May 22, 1917. Date of appl., Nov. 27, 1915.

SEE Eng. Pat. 15,456 of 1915; this J., 1916, 1255.

Production of white silica [for finishing textiles]. Eng. Pat. 106,232. See VII.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Sulphur in pyrites: Volumetric determination of —, T. J. I. Craig. Chem. News, 1917, 115, 253—255, 265—268.

FIVE grms. of finely-ground pyrites is treated with a mixture of 50 c.c. of nitric acid (sp. gr. 1.42) and 50 c.c. of water; when all action has ceased, the solution is cooled to 50° C., 3 c.c. of bromine and 20 c.c. of nitric acid (sp. gr. 1.42) are added, the mixture is boiled, evaporated to dryness, the residue moistened with water, again evaporated, and then heated at 110° C. for 1 hour. The dry residue is now heated for 30 minutes with 50 c.c. of water, diluted to 100 c.c., filtered, and the insoluble portion washed until free from acid; the filtrate

and washings are made up to 250 c.c. Fifty c.c. of this solution is treated with a slight excess of *N/1* sodium hydroxide solution, the mixture is boiled, transferred to a 200 c.c. flask, diluted to 200.3 c.c. (allowance for volume of precipitate), and filtered; 100 c.c. of the filtrate is added to a quantity of water free from carbon dioxide and acidified with a definite quantity of *N/1* sulphuric acid and the solution is titrated, while boiling, with *N/1* sodium hydroxide solution, using phenolphthalein as indicator. The quantity of available sulphur in the pyrites is then calculated from the volume of alkali solution actually used, after allowing for the dilutions and the quantity of sulphuric acid added. The nitric acid used for dissolving the pyrites is expelled completely by the above treatment; when *aqua regia* is employed it may be necessary to remove the last traces of hydrochloric acid by means of moist silver oxide.

—W. P. S.

Saltpetre: its origin and extraction in India. C. M. Hutchinson. Bull. 68, Agric. Research Inst., Pusa. 24 pages.

THE extraction of potassium nitrate from soil can only succeed in countries where a large amount of nitrate can be extracted from a comparatively small amount of earth, and these conditions are allied with those which favour the nitrification of nitrogenous organic matter, and the accumulation of the resulting nitrate in the soil. The following appear to be the conditions which favour the production of nitrates in concentrated form:—1. *Nitrifiable organic matter*, in suitable proportion, in the soil. 2. *Lime*. 3. *Water*; not only in sufficient amount for nitrification, but also distributed in the soil in such a way as not to interfere with aeration, and to provide for continual capillary rise to the surface. 4. *Soil*, of such a texture as to allow of continuous upward movement of water from the subsoil to the surface. 5. *Climate* ensuring a provision of adequate moisture and temperature during part of the year, and complete or nearly complete absence of rainfall, coupled with low humidity, during a sufficiently long period to ensure the capillary rise of subsoil water, consequent on rapid surface evaporation. The saltpetre at present extracted in India is obtained principally in the immediate neighbourhood of human habitations, where accumulation of organic refuse and excreta has occurred—and practically the whole supply of the nitrate earth, "chihua," is derived from village-sites, either old or new. No special bacterial action is needed to explain the accumulations which occur, nor do the nitrifying bacteria which are found associated with these earths possess any abnormal nitrifying powers. The process of extraction is fully described and is illustrated by photographs and diagrams. The general conclusions arrived at from study of the facts are:—(1) The present sources of saltpetre are not fully utilised, on account of the drawbacks at present associated with the industry, and the low price of crude saltpetre. 2. Artificial nitre-beds, on account of the favourable soil and climatic conditions in Bihar, would probably form a useful added source of saltpetre. 3. The present methods do not allow of recovery of all the nitrate present in the earth. Investigation is required to determine whether a better method of extraction could be devised, capable of being carried out by the present workers, and whether the efficiency of this method would necessarily depend upon some relaxation or revision of the restrictions at present imposed by the Salt Department. 4. The present conditions of trade in saltpetre require examination, to determine whether a greater demand for Indian saltpetre would result from organised efforts to improve these conditions, such as the elimination of the middle-man and the standardisation of the product.—J. B. C. K.

Kelp industry in British Columbia.

For several years the question of utilising the supply of raw material to be found in the kelp beds along the British Columbia coast, for the manufacture of potash and other products, has occupied the attention of Vancouver capitalists. A company was organised in 1915, and a plant established at Sydney, British Columbia, for the production of potash and algin. This company is now utilising from thirty to forty tons of raw kelp daily in the manufacture of a fertiliser. The product is a fine, dry, but heavy powder. Plans are being made to enlarge the plant and instal special machinery for the extraction of other materials from kelp. It is believed that the manufacture of iodine and potash, without the production of by-products, would not prove very profitable in normal times, but the increase in the price, especially of potash, on account of the war, will enable the British Columbia Company to include these and other by-products in the output of the factory at Sydney. The value of potash imported into Canada annually is about £200,000. It is estimated that the kelp beds on the coast of British Columbia contain sufficient material to manufacture potash, not only for the local market, but for export also. An Act relating to the licensing of kelp-reduction works, designed especially to encourage the development of the industry and for the protection of persons or companies desiring to engage in the business, was passed by the 1915 session of the Provincial Legislature. The industry is under the jurisdiction of the Minister of Fisheries. A licence protects the operation of any reduction factory for an area extending fifty miles along the coast.

Dissociation points [of calcium carbonate and hydroxide and gypsum]: Note on the determinations of —. E. T. Montgomery and M. M. Groves. *Trans. Amer. Ceram. Soc.*, 1916, 18, 214—222.

The material to be examined was heated in a platinum capsule in an electric furnace. The capsule was suspended by a short platinum wire and a longer steel one from the arm of a delicate balance placed directly above the furnace, the wire passing through a hole in the bottom of the balance case. The mouth of the furnace was closed by a fire-clay plug with two holes—one for the suspending wire just mentioned and the other for a thermocouple, the junction of which was placed just outside and near the bottom of the capsule. The holes in the clay cover were large enough to prevent any pressure developing in the furnace when gases were evolved from the materials under investigation. Calcium carbonate lost weight at the rate of 2.35% per hour at 620°–627° C., and at the rate of 4% per hour, gradually falling to less than 1% per hour, at 647° C., the whole of the carbon dioxide being expelled in 15 hrs. Calcium hydroxide lost about 1% of mechanically-held water at 400° C. and dissociated at 430°–439° C., any calcium carbonate present dissociating at 617° C. Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) lost all its water at 105°–107° C. No hemi-hydrate, such as is supposed to correspond to plaster of Paris, was produced and the authors question its existence. In the discussion, W. E. Emley suggested that the authors had overlooked the influence of the pressure of the gases in the capsule and also the time required to reach equilibrium. The latter is particularly shown by their failure to produce the hemi-hydrate at 80° C.—A. B. S.

Oxidation-reduction reactions [ferrous salts and potassium bichromate]: Conductivity measurements upon —. G. Edgar. *J. Amer. Chem. Soc.*, 1917, 39, 914–928.

MEASUREMENTS of the change of conductivity of

solutions of ferrous salts during oxidation by potassium bichromate, lead to the conclusion that the end point of the reaction may be determined in this way with a degree of accuracy equal to or greater than that of the usual volumetric method.

—W. H. P.

Metal oxides; Action of sulphur dioxide on —. D. L. Hammick. *Chem. Soc. Trans.*, 1917, 111, 379–389.

Two distinct types of reactions have been distinguished among the metals dealt with. Cuprie, bismuthic, and mercuric oxides, together with manganese peroxide, may be classed with lead peroxide, and, whilst the oxide in these cases may be reduced entirely or partially to a lower oxide or to metal, the sulphur dioxide is oxidised. At the same time, the original, or a lower, oxide may combine with the sulphur trioxide to form a normal salt such as CuSO_4 , MnSO_4 , etc., or a basic salt, such as $4\text{Bi}_2\text{O}_3 \cdot 3\text{SO}_3$. Stannous, lead (PbO), ferrous, and manganous oxides have given reactions similar to those of the alkaline-earthis. The production of sulphite has not been observed, but the formation of sulphide and sulphate, accompanied sometimes by the production of free sulphur and sulphur trioxide, indicates that the intermediate formation of sulphite has occurred. Whatever the first step may be, there is in these cases an indication of the reduction of sulphur dioxide.

—B. N.

Lead; Arsenates of —. C. C. McDonnell and C. M. Smith. *J. Amer. Chem. Soc.*, 1917, 39, 937–943. (See also this J., 1916, 1154 and 1258.)

THE basic arsenate of lead first prepared by Strömholm (this J., 1904, 252) has the formula $8\text{PbO} \cdot \text{As}_2\text{O}_5 \cdot \frac{1}{2}\text{H}_2\text{O}$, and can be prepared in a crystalline state by dissolving di-lead arsenate in 10% potassium hydroxide to saturation, and then pouring the filtered solution into about 5–8 times its volume of boiling water. A basic arsenate prepared by the action of ammonia on di-lead arsenate can also be obtained in crystalline form. Crystallographically it is similar to mimetite, and analytical data suggest the formula, $\text{Pb}_4(\text{PbOH})(\text{AsO}_4)_3 \cdot \frac{1}{2}\text{H}_2\text{O}$. A new basic arsenate has been prepared with the formula, $\text{Pb}_3(\text{PbOH})_2(\text{AsO}_4)_4$. The method of preparation is similar to that given for the first basic arsenate mentioned above, except that a large excess (20 or more vols) of water is used.

—W. H. P.

Basic salts of zirconium; Properties and constitution of some new —. E. H. Rodd. *Chem. Soc. Trans.*, 1917, 111, 396–407.

A BASIC zirconium sulphate may be prepared by partly neutralising an impure dilute solution of zirconium sulphate in sulphuric acid by means of ammonia. From this basic sulphate, a new basic chloride, $\text{Zr}_5\text{O}_8\text{Cl}_4 \cdot 22\text{H}_2\text{O}$, named 5:4 basic zirconium chloride, has been obtained, where $\text{Zr}:\text{Cl}=5:4$. It is a crystalline salt, very readily soluble in water, and can be recrystallised unchanged from a hydrochloric acid solution. Soluble sulphates precipitate from solutions of it an insoluble 5:2 basic sulphate, $\text{Zr}_5\text{O}_8(\text{SO}_4)_2 \cdot x\text{H}_2\text{O}$, where x is probably 14. By the action of ammonia on either the 5:4 chloride or the 5:2 sulphate, a hydroxide is obtained which is distinct from the normal hydroxide, as in hydrochloric acid it is again dissolved, forming the 5:4 basic chloride. By adding sulphuric acid to a boiled solution of zirconium oxychloride, $\text{ZrOCl}_2 \cdot 8\text{H}_2\text{O}$, a basic sulphate is obtained, identical in composition with the 5:2 basic sulphate, but quite distinct from it in properties. Constitutional formulae are suggested for the new and other basic zirconium salts. The formation of the many complex zirconium

salts is attributed to hydrolysis of the simpler salts, followed by condensation in dilute solution and at high temperatures, brought about by the weak basicity of zirconium hydroxide and its amphoteric character. The final product of these changes is metazirconic acid, which has probably a very complex molecule.—B. N.

Zirconia; Compounds of — with sulphuric acid. E. Chauvenet. *Comptes rend.*, 1917, 164, 864—865.

ZIRCONIA and sulphuric acid were mixed in various proportions, all water expelled by heating to 200° C., and the specific gravities of the resultant solids determined. The curve obtained from these data indicates the existence of the following compounds: $\text{Zr}(\text{SO}_4)_2$; $\text{ZrO}_2 \cdot \text{Zr}(\text{SO}_4)_2$; $7\text{ZrO}_2 \cdot 5\text{Zr}(\text{SO}_4)_2$; $5\text{ZrO}_2 \cdot 3\text{Zr}(\text{SO}_4)_2$; $2\text{ZrO}_2 \cdot \text{Zr}(\text{SO}_4)_2$ and $3\text{ZrO}_2 \cdot \text{Zr}(\text{SO}_4)_2$. No evidence was obtained of the existence of various other sulphates which have been described in the literature.—W. H. P.

Rare earth compounds; Study of some —. A. J. Grant and C. James. *J. Amer. Chem. Soc.*, 1917, 39, 933—937.

THE double oxalates of a number of rare earths and methylamine, ethylamine, or triethylamine have been prepared, but their solubilities do not appear to be sufficiently divergent to allow of advantageous fractional crystallisation. In the group of yttrium earths fractional precipitation of the ferrieyanides appears to afford the most rapid method of purification known.—W. H. P.

Nitrogen trichloride; Experiments with —. C. T. Dowell and W. C. Bray. *J. Amer. Chem. Soc.*, 1917, 39, 896—905.

NITROGEN trichloride is conveniently prepared by the action of hypochlorous acid on ammonium chloride solution in the presence of an inert solvent. The solvent preferred by the authors is carbon tetrachloride which does not react with the nitrogen trichloride or with chlorine. Solutions prepared in this way can be preserved in the dark for several weeks without serious contamination with chlorine. The decomposition of nitrogen chloride appears to be autocatalytic and to become more rapid in the presence of chlorine. The reaction of nitrogen trichloride solution with reducing agents leads usually to the formation of a certain amount of nitrogen as well as ammonia. The only reagent found which gives ammonia and chloride quantitatively is sodium sulphite and this is therefore used for the analysis of stock solutions. With arsenious acid nitrogen is evolved, the amount increasing rapidly with dilution, and also with the concentration of sulphuric acid present. Hydrogen sulphide solutions caused the evolution of nitrogen (about 5.5% of the whole) in quantity independent of the acid concentration. Potassium iodide in acid solution also yields nitrogen, the quantity being apparently independent of the concentration of iodide or of acid. Sodium hydroxide causes rapid decomposition with formation of a little ammonia and much nitrogen. Nitrogen trichloride reacts slowly with dilute ammonium chloride and more rapidly with a concentrated solution giving nitrogen and hydrochloric acid.—W. H. P.

Chlorine and ammonia; Reactions between —. W. C. Bray and C. T. Dowell. *J. Amer. Chem. Soc.*, 1917, 39, 905—913.

AFTER summarising the experimental data available the authors consider in particular the reaction of Noyes and Lyon (this J., 1901, 243) in which chlorine gas treated with slightly less than 2 mols. of ammonia in 0.5% solution gives equimolar quantities of ammonium and nitrogen chloride: $12\text{NH}_3 + 6\text{Cl}_2 = \text{N}_2 + \text{NCl}_3 + 9\text{NH}_4\text{Cl}$.

They conclude that this is probably not a true stoichiometrical reaction, and suggest that monochloramine, NH_2Cl , is probably the primary step in the formation of nitrogen by reaction of chlorine and ammonia in alkaline solution, and possibly also in the formation of nitrogen chloride in acid solution.—W. H. P.

Vapour pressures of various compounds at low temperatures. G. A. Burrell and I. W. Robertson. U.S. Bureau of Mines, Techn. Paper No. 142, 1916. 30 pages.

THE compounds studied were ethylene, isobutylene, propylene, ethane, propane, isobutane, sulphur dioxide, nitrous oxide, ammonia, and acetylene, at pressures from 1 to 760 mm. The substance was maintained at a constant temperature in a glass bulb immersed in gasoline from natural gas contained in a Dewar flask. The temperature could be maintained to within 0.04° C. by passing in liquid air from a larger Dewar flask in which the pressure could be adjusted by means of a water column. A special manometer was used for the measurements and temperatures were read on a pentane thermometer which was specially calibrated. The results are tabulated and equations for the vapour pressure curves were deduced with the aid of Nernst's formula. Approximate values for the heats of evaporation were also obtained from the Clausius-Clapeyron equation. The boiling points (760 mm.) obtained are: ethylene, -103.9° C.; ethane, -89.3° C.; acetylene, -84.0° C.; isobutane, -13.4° C.; ammonia, -34.6° C.; propane, -41.1° C.; propylene, -47.8° C.; butane, -0.3° C.; sulphur dioxide, -11.0° C.; and nitrous oxide, -88.7° C.—W. H. P.

Twaddelling of electrolytic bleaching liquors. Hepburn. See VI.

Fusion study of the mineral systems: feldspar-calcite and feldspar-magnesite. Kirkpatrick. See VIII.

Assimilation of nitrates and nitrites [by plants]. [Separation of nitrates from nitrites.] Baudisch. See XVI.

Properties of barium sulphate. Karaoglanow. See XXIII.

Determination of potassium and sodium in the form of sulphates by platinum chloride. Turkus. See XXIII.

PATENTS.

Sulphuric anhydride; Process of making —. C. Ellis, Montclair, N.J., Assignor to Ellis-Foster Co. U.S. Pat. 1,227,044, May 22, 1917. Date of appl., June 13, 1916.

GASES containing sulphur dioxide and oxygen are brought into contact with tin chromate at a temperature at which this compound acts as a catalyst. The products of the reaction are passed through sulphuric acid in order to absorb the sulphuric anhydride produced, and the residual gases are then passed through a second mass of the tin chromate material. The catalyst should be free from fixed alkalis.—J. B. C. K.

Caustic soda; Process of making [purifying] —. H. B. Kipper, Solvay, N.Y., U.S. Pat. 1,227,453, May 22, 1917. Date of appl., Mar. 31, 1915.

SOLUTIONS of caustic soda containing from 50 to 60% Na_2O are subjected to electrolysis with a steel

cathode at temperatures from 80° to 175° C. Oxygen is liberated at the anode, and the metallic impurities are precipitated. The oxygen is collected and led away, to prevent any further action upon the body of the solution.—J. B. C. K.

Silica: Production of white—[for finishing paper, textiles, etc.]. R. G. Varcoe, Trentham, Staffs. Eng. Pat. 106,232, Nov. 22, 1916. (Appl. No. 16,728 of 1916.)

THE quartz which is left as a residue after the extraction of china-clay from clay-stone, is screened to remove sand and other foreign matter, and is then ground, washed, and dried. The resulting powder is white and contains a certain proportion of alumina in addition to the silica. The proportion of alumina can be increased, if desired, by adding the required amount of china-clay to the quartz, either before or after grinding. The white silica obtained by this process may be used for finishing paper, textiles, and other materials.—J. B. C. K.

Soluble glass; Manufacture of—R. M. Caven, Nottingham. Eng. Pat. 106,247, Jan. 17, 1917. (Appl. No. 874 of 1917.) Addition to Eng. Pat. 11,848, Aug. 21, 1916.

A FINELY-SUBDIVIDED alkaline silicate, which has been ground in the dry state, is mixed with from 25 to 38% of its weight of water, and heated to a temperature above 70° C. but below 100° C., until the mass becomes vitreous and miscible with water. The product is a hard solid, almost as vitreous as the original silicate, which can be ground to powder, and when stirred up with water mixes with it easily, only about 1.5% remaining insoluble.—J. B. C. K.

Alkali percarbonates; Process of manufacturing—O. Liebknecht, Frankfurt, Germany. Assignor to Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,225,832, May 15, 1917. Date of appl., Jan. 27, 1917.

HYDROGEN peroxide is allowed to react with an alkali carbonate in the presence of a restricted proportion of water, and common salt is added to bring about the direct separation of the crystalline percarbonate from the aqueous solution. A silicate of magnesium is also employed as a stabilising agent in the process.—J. B. C. K.

Alkali percarbonates; Process for rendering stable. A. Schaidhauf, Frankfurt, Germany. Assignor to Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,225,872, May 15, 1917. Date of appl., Jan. 16, 1917.

SOLID alkali percarbonates and solutions of the same, are rendered stable by incorporating with the percarbonate, during manufacture, silicic acid combined as a silicate, and gum-arabic.—J. B. C. K.

Potassium cyanide; Process of securing from water-insoluble potassium-containing minerals. J. H. Reid, Newark, N.J. U.S. Pat. 1,226,811, May 22, 1917. Date of appl., Sept. 30, 1915.

MINERALS containing potassium silicate, such as feldspar, are mixed with a carbide, and are then exposed to the action of an electric current, in the presence of nitrogen. The potassium cyanide which forms as a result of the electro-thermal action, is volatilised and condensed.—J. B. C. K.

Potassium compounds; Process of securing water-soluble—from water-insoluble potassium-containing minerals. J. H. Reid, Newark, N.J. U.S. Pat. 1,226,812, May 22, 1917. Date of appl., Sept. 30, 1915.

MINERALS containing potassium silicate, such as feldspar or orthoclase, are mixed with calcium chloride, or some other chloride capable of reacting

with the silicate at high temperatures, and are then submitted to the action of an electric current of sufficient intensity to produce and volatilise potassium chloride.—J. B. C. K.

Hypochlorous acid; Manufacture of—W. N. Haworth and J. C. Irvine, St. Andrews, Scotland. U.S. Pat. 1,227,049, May 22, 1917. Date of appl., Feb. 19, 1916.

SEE Eng. Pat. 12,912 of 1915; this J., 1916, 1059.

Zinc sulphate; Process for producing from zinc ores. R. B. Llopert, Cordoba, Argentina. Eng. Pat. 100,245, Feb. 19, 1916. (Appl. No. 2506 of 1916.) Under Int. Conv., Apr. 2, 1915.

SEE U.S. Pat. 1,112,795 of 1915; this J., 1915, 834.

Titanic oxide; Manufacture of from a substance containing it. H. Wade, London. From The Titanium Alloy Manufacturing Co., New York. Eng. Pat. 106,428, Nov. 22, 1916. (Appl. No. 16,766 of 1916.)

SEE U.S. Pat. 1,206,798 of 1916; this J., 1917, 84.

Titanic oxide; Manufacture of from titaniferous-ferruginous substances. H. Wade, London. From The Titanium Alloy Manufacturing Co., New York. Eng. Pats. 106,584 and 106,585, Nov. 22, 1916. (Appl. Nos. 16,764 and 16,765 of 1916.)

SEE U.S. Pats. 1,206,797 and 1,206,796 of 1916; this J., 1917, 84.

VIII.—GLASS; CERAMICS.

Barium glasses; Notes on—A. E. Williams and S. F. Cox. Trans. Amer. Ceram. Soc., 1916, 18, 315—342.

THE influence of barium compounds in glasses has been reviewed by A. Silverman (this J., 1915, 399), who showed that barium may replace lime or lead to any extent and that it imparts a greater brilliancy and plasticity than lime. The authors made 42 glasses varying in composition from 1.0RO, 2.5SiO₂ to 1.0RO, 5.5SiO₂, i.e., from a Jena soft crown glass to a dense barium crown glass, from a mixture of flint, zinc oxide, 58% soda ash, potash, and precipitated barium carbonate. The soft glasses were melted and kept for 6 hrs. at 1450° C. and the harder ones at 1550° C. and were then poured into a hot iron mould and annealed from 500° C. to atmospheric temperature in 12 hrs. The potash-barium glasses showed a decided increase in brilliancy with increased proportions of barium; those with no soda and 0.5BaO have a better lustre than some high-class cut glasses. As the SiO₂ and BaO increase, the glasses become more refractory and those containing 1.0RO, 5.5SiO₂ were too viscous to be poured from the crucible at 1550° C. Glasses high in BaO poured best and remained viscous longer than others. The most workable glasses contained 0.1—0.5 BaO in 1.0RO and 2.5—4.5 SiO₂. The highest density was obtained in conjunction with high BaO and low SiO₂, which agrees with Winkelmann and Schott's general formula for calculating the density of glasses. The expansibility of all the glasses was low for boron-free glasses. For determining the solubility of the glasses, accurately ground plates, 8 cm. × 4 cm. × 0.35 cm., were used. The surface-area of these was measured and the pieces were then cleaned thoroughly and soaked in distilled water for 48 hours. They were then placed in porcelain dishes with 200 c.c. of distilled water and kept at 80° C. for 24 hours, the atmosphere of the oven being kept saturated with moisture so as to prevent evaporation. The water

was then transferred to a platinum dish and evaporated to dryness and the residue weighed. Most of the glasses containing 0.1 to 0.5 BaO in 1.0 RO and 2.5—5.5 SiO₂ were sufficiently insoluble, all those containing 0.3—0.5 BaO in 1.0 RO and 2.5—5.5 SiO₂ being highly insoluble. Increasing the BaO lessens the solubility much more than raising the SiO₂.

To determine the devitrifiability, pieces of glass were placed on asbestos and heated to 500° C. in a muffle. They were then cooled at a predetermined rate, examined, re-heated to 600° C., cooled as before, and again examined, this process being repeated until they had been heated five times, each time to a higher temperature than before. None of the glasses showed complete devitrification, but some of those containing 4.5—5.5 SiO₂ were devitrified superficially after being re-heated to 700° C. or above, this being attributed to the partial volatilisation of soda or potash. Hence BaO does not cause devitrification. The softening point of the glasses was determined by noting the temperature at which a vertical platinum rod weighted to give a load of 6.39 grms. per sq. cm. began to penetrate the surface; a gradual increase in the refractoriness of the glass accompanied increased BaO, this oxide hardening the glass much more than SiO₂.

The change of viscosity with temperature was estimated from the rate at which the platinum rod just mentioned penetrated the glass whilst the temperature was rising steadily, the rate of dropping being plotted against the rise in temperature on a graph. The "viscosity range" was taken as the difference in temperature between the softening point and the point at which the tangent of the curve had a slope of 60°, as at this point each glass reaches the same degree of viscosity and changes it at a constant rate. The "viscosity-range" does not vary regularly with any constituent, but decreases and increases alternately. The figures obtained for the rate of change of viscosity (*i.e.*, the amount the rod dropped when the temperature rose the equivalent of 1 millivolt) are more reliable than those for the viscosity itself. It was found that replacing sodium by barium decreases the rate of change of viscosity and increases the "viscosity range" except when all the sodium is replaced, when a slight decrease of "viscosity range" is shown.—A. B. S.

Boric acid; Determination of — in special glasses
P. Nicolardot and J. Boudet. Bull. Soc. Chim., 1917, 21, 97—101.

A MODIFICATION of the method which has been attributed to Hönl and Spitz (this J., 1896, 742), but which, in reality, is much older (see Klein, Bull. Soc. Chim., 1878, 29, 195) is recommended:—One gm. of the powdered glass is gently fused in a platinum crucible with 5 grms. of a mixture of alkali carbonates, and the melt disintegrated with hot water, and boiled for 5 mins. with 5 grms. of ammonium chloride. The silica is then precipitated by means of a current of carbon dioxide (10 mins.), and the liquid is boiled to remove ammonia, and then allowed to stand. The precipitate will contain the silica and all the metallic oxides (ZnO, CaO, Al₂O₃, MgO), whilst the boric acid remains in solution. The precipitate is washed with water containing a little ammonium chloride, and the filtrate and washings are mixed with 5 grms. of pure sodium hydroxide, then heated to remove ammonium salts, and evaporated to 100 c.c. The liquid is transferred to a 500 c.c. flask, and neutralised with hydrochloric acid, with methyl orange as indicator, after which it is boiled for 15 mins. beneath a reflux condenser to remove carbon dioxide. After cooling, one drop of methyl orange solution is added, and the liquid is titrated with N/10 sodium hydroxide solution free from carbon dioxide until yellow again, when

10 c.c. of glycerol, or of a freshly prepared solution of mannitol (0.8 grm.) in boiling water, is added, and the titration completed, with phenolphthalein as indicator. The presence of magnesia or alumina does not interfere with the determination of boric acid by this method, nor by the method of distilling it as methyl borate.—C. A. M.

Kaolin refining. I. E. Sproat. Trans. Amer. Ceram. Soc., 1916, 18, 767—811.

ONLY a portion of the discolouring particles is removed by the customary methods of refining kaolin, as they are small enough to pass even a 260 mesh sieve and are often so coated with clay that they cannot be separated by simple blunging. The suggested method consists of a preliminary crushing of the moderately dry clay (wet clay is very difficult to treat if the proportion of dry clay in it is not accurately known) through corrugated rolls, followed by a thorough blunging or grinding in ball mills with water and caustic soda. Two or even three blungings may be necessary and the soda must be added at a constant rate of about 10 c.c. per sec. The slip is passed through concrete troughs, each at least 125 ft. long, 2 ft. wide at the inlet end, and sufficiently wide at the outlet for the slip to be only about 1 in. deep. These troughs must be quite level, with smooth sides and a slightly rough but uniform bottom. The liquid which flows from the troughs is mixed with exactly sufficient sulphuric acid to neutralise the soda originally added; this flocculates the clay. The fluid is then run through a riffled trough, 50 ft. × 1 ft. × 1 ft., with a slope of 1:50, so as to cause a rapid flow, and then through a rotary screen of 120-mesh and into concrete settling tanks, each 75 ft. × 25 ft. × 5 ft. The clay settles within 24 hrs., and after the supernatant water has been run off, the thick slip is filter-pressed, the resulting cakes being dried by steam. The cost of the treatment is stated to be 1s. 6d. per ton. The following precautions are important:—The clay and water must be fed at a uniform rate. Double blunging is essential; insufficient blunging causes failure. The amount of caustic soda added must be adjusted to the clay. A constant viscosity of about 1.068 (referred to that of water as 1) must be maintained in the slip at the head of the trough. The slip should be agitated before it enters the final trough. Only just sufficient acid to neutralise the soda should be added.

Georgia kaolin treated by this process can be substituted for all the English china-clay and a portion of the ball clay used in American pottery.—A. B. S.

Ball clays; Physical properties of some — and their effects on porcelain bodies. T. A. Klinefelter. Trans. Amer. Ceram. Soc., 1916, 18, 93—105.

IN an attempt to find an American substitute for English ball clays, various clays were ground so as to pass through an 18—20-mesh sieve and were made into plain slips containing only clay and water, and body slips containing clay 50%, flint 30%, and felspar 20%, and water. These slips were allowed to stand for 24 hours and were then blunged three or four times for several minutes each time. Some clays, such as Sant's English No. 1, Knowles' No. 12, and the Kentucky Construction Co.'s Special and Black clays slaked readily with much less water than other clays, such as Tennessee No. 3. Slips containing English or very similar American clays left a larger residue on a 150-mesh sieve (Tyler's Standard) than slips made from the same clays on a manufacturing scale. To avoid this discrepancy, the bodies were ground in small ball-mills. The screened slips were placed in plaster moulds lined with cambric and the paste so produced was kept in a damp place for about 3 days to obtain a workable plastic

mass. The water-content of the paste varied greatly on account of the personal factor. The paste was cut into pieces about 5 in. \times 1½ in. \times 1 in. and three pairs of shrinkage marks 5 cm. apart were placed on each. These pieces were allowed to dry for an hour, turned on end, and dried in a commercial dryer, and then the shrinkage marks were re-measured. The shrinkage of different pieces of the same clay, and even of different parts of the same piece, varied up to 4%, especially when some of the test-pieces were thinner than others, but the average variation did not exceed 1%. The variations in the shrinkage of the body mixtures was less than in that of the clays, but even with bodies made on a large scale the handling when in the plastic state and the varying humidity in the dryers caused a variation in shrinkage in different parts of the same surface of a given piece. The shrinkage on burning showed similar variations. In comparing different ball clays or bodies made from them, errors may easily arise through (i.) imperfect sampling, (ii.) insufficient blunging, (iii.) unsuitable consistency or irregular texture, (iv.) uneven packing when making test-briquettes, (v.) variations in the humidity of the dryers, and (vi.) the position of the pieces in the kiln and resulting variations in the burning temperature. —A. B. S.

Fineness of [ceramic] raw materials; Determination of the —. F. W. Walker, jun. Trans. Amer. Ceram. Soc., 1916, 18, 499—507.

100 GRMS. of the material, dried at 100°C., is mixed with water and the finer particles are gently washed through an 8-in. W. S. Tyler standard sieve of 280-mesh, the residue being dried at 75°C. The residue is then placed in the top of the following Tyler standard sieves arranged one above another: No. 115 (0.0049 in. opening), No. 150 (0.0041 in.), No. 170 (0.0035 in.), No. 200 (0.0029 in.), and No. 280 (0.0020 in.). The set of sieves is then rapped in a "Tyler" Ro-tap machine for 69 mins., after which a "one minute" test is made and the amount of material passing through a No. 280 sieve is ascertained. The residue on each sieve is weighed and the results are plotted on a graph with the cumulative percentages of residue as ordinates and the sizes of opening in the sieves as abscissae. —A. B. S.

Felspar-calcite and felspar-magnesite: Fusion study of the mineral systems —. F. A. Kirkpatrick. Trans. Amer. Ceram. Soc., 1916, 18, 575—618.

FROM observations on "cone-mixtures" heated in an electric furnace, the author concludes that with the system orthoclase-calcite there is a well-defined maximum on the deformation point curve with a mixture containing 27½% of calcite and two well-defined eutectics with 3% and 50% of calcite respectively. There appears to be no predominating compound in this poly-component system. The system orthoclase-magnesite shows one eutectic point at 3% of magnesite; beyond this the curve rises rapidly with increasing magnesite. The system albite-calcite shows a long eutectic range at 10—55% of calcite; beyond this the curve rises rapidly. The albite used was very impure. With the system albite-magnesite also, there was a long eutectic range, at 5—20% of magnesite, the effect of magnesia being, however, less than that of lime. The lowest fusion point with mixtures containing calcite occurs at cone 01 (1080°C.) with 25% calcite and 75% albite; the lowest fusion point with mixtures containing magnesite occurs at cone 14 (1105°C.) with 15% magnesite and 85% albite. Orthoclase and albite appear to be decomposed by calcite but not by magnesite. The best types of Bristol glazes lie in eutectic areas of the orthoclase-calcite system. A list of 80 references to the behaviour of analogous mixtures is given. —A. B. S.

Potash-felspar-steatite mixtures; Softening points of —. W. S. Howat. Trans. Amer. Ceram. Soc., 1916, 18, 488—491.

MIXTURES of steatite and Maine felspar or a selected microcline felspar were made into small cones and heated in an electric furnace rapidly to 800°C. and afterwards at the rate of 2½°C. per minute until they deformed. It was found that with either kind of felspar the eutectic contained 17—23% of steatite. —A. B. S.

Fireclay body: Effect of non-plastic materials on the shrinkage and mechanical strength of a No. 3 —. W. C. Millsom, H. S. Robertson, and C. C. Treischel. Trans. Amer. Ceram. Soc., 1916, 18, 524—531.

A No. 3 fireclay from Macomb, Ill., was mixed with broken sewer pipe, local crushed rock, and a calcined clay made by heating the fireclay to 600°C., all the materials being ground separately and passed through a No. 10-mesh sieve. The mixtures were ground in a wet pan for 5 mins., and transferred to a small pug-mill fitted with a 2½ in. pipe-mouthpiece. The pipes produced were cut in 12 in. lengths, allowed to dry for 2 or 3 days, and then set upright in a small rectangular down-draught kiln. Four briquettes were simultaneously made in a small dry-press and were used for measuring the shrinkage. During the burning the temperature rose steadily from cold to cone 4—5 (1170°C.) in 20 hrs. and was then kept constant for 3 hrs., a good, thick bed of fire being maintained. About 10 lb. of salt was then scattered over each fire in turn, this salting being repeated three times at intervals of 1—2 hours, and the temperature raised to cone 4 after each salting. A final dose of salt was given to both the kiln fires simultaneously, after which the fires were closed and the dampers lowered until the kiln was cold. The ware was completely vitrified and but little inferior to commercial salt-glazed ware. Some of the pieces cracked on account of the excess of sand present. The mixtures with the highest modulus of rupture ($M = \frac{0.96Pd}{lt}$, where P is the load required to

crush the tile, d is the mean diameter of the tile, l is the length, and t the thickness of wall) consisted of clay with 20—40% of broken pipe, the addition of sand not increasing the strength. The smallest shrinkage occurred in the mixtures of clay and broken pipe and of raw and calcined clay. The authors conclude that added sand is an undesirable constituent of a clay for drain pipes and that the reduction of shrinkage should be effected by the use of calcined clay rather than sand, when this can be done without spoiling the glaze. —A. B. S.

Fireclay bodies; Mechanical strength of — after repeated heating. F. A. Kirkpatrick. Trans. Amer. Ceram. Soc., 1916, 18, 545—556.

TO study the deterioration of fireclay bodies on repeated heating, mixtures containing equal weights of grog and clay were made, the kind of clay being different in each mixture. All the 1200 test-pieces were burned simultaneously, the rate of heating being about 50°C. per hour. The temperature reached in the first burning was cone 7 (1230°C.), in the second burning cone 10 (1300°C.), and in the remaining burnings cones 13—15 (1380—1435°C.), with a final "soaking" for 4—6 hrs. at the maximum temperature. Except in the first burning, the pieces were set on edge, with a small space between, and were exposed to the open fire, many of them becoming glazed with kiln-dust. The average moduli of rupture and the average deviation from the mean show that the strength of all the mixtures increased during the second burning, but decreased in the third to the tenth burnings, with occasional intervening slight increases in some cases. The apparent sp. gr. and porosity decreased

(though irregularly) on repeated heating. The relation between the modulus of rupture and porosity is generally parallel but not wholly consistent. Neither porosity nor apparent sp. gr. is changed much after the fourth burning at the temperatures mentioned. An open-grained and tough New Jersey fireclay showed the most constant results, and a brittle, close-grained St. Louis mixture showed the widest variations and became useless through cracking after the fifth burning.—A. B. S.

Clays for grog; Methods of calcining — C. B. Harrop. Trans. Amer. Ceram. Soc., 1916, 18, 165—179.

AFTER reviewing the various types of kilns used for the production of grog, the author recommends that the clay be burned in lumps in a continuous kiln with small chambers. He finds that the *Etagenofen* type is excellent except for the amount of labour required in working the material along the horizontal flue from the bottom of the upper to the top of the lower chamber. Shaft kilns choke too readily but might be improved by drawing or blowing air mechanically through the material. Inclined rotary kilns as used for cement are too costly for burning clay.—A. B. S.

Chemical porcelain. E. T. Montgomery and M. G. Babcock. Trans. Amer. Ceram. Soc., 1916, 18, 88—92.

CHEMICAL porcelain does not differ essentially from other hard-paste porcelain except that it may be more aluminous and less silicious. For many laboratory purposes, vessels made of china are quite satisfactory, but true "chemical porcelain" must (A) withstand rapid changes in temperature; (B) be thin, vitreous, and translucent; (C) the glaze must be so hard that when the ware is heated on a pipe-clay triangle with a blast burner, neither the triangle nor the contents of the vessel adhere to the glaze; (D) the glaze must resist alkaline solutions; and (E) the ware must not be deformed below a temperature corresponding to Seger cone 25 (1580° C.). The biscuit ware may be fired at a low temperature, but the glost ware requires cone 16 (1460° C.). Of nine mixtures tried, the best body consisted of clay 80%, felspar 10%, and quartz 10%.—A. B. S.

Pyrometer tubes; Notes on the manufacture of porcelain — W. L. Howat. Trans. Amer. Ceram. Soc., 1916, 18, 268—270.

AN analysis of a Marquardt porcelain tube from which the glaze had been removed showed SiO_2 35.12%, Al_2O_3 63.20%, and K_2O 1.65%. This was matched by a body composed of grog No. 1, 45.7; grog No. 2, 7.3; North Carolina kaolin, 17.0; Florida kaolin, 5.0; Tennessee ball clay, 15.0; and English china clay, 10.0 parts. Grog No. 1 was composed of calcined alumina 70, North Carolina kaolin 22, and potash spar 8%. Grog No. 2 was composed of potash spar 64, and calcined alumina 36%. Each grog was calcined at cone 19 and crushed so as to pass a 120-mesh sieve. The body was wet-ground in a ball-mill and filter-pressed. Tubes made by extrusion warped badly, but those cast in simple plaster moulds were quite satisfactory. The casting slip was made by adding sodium carbonate and silicate to the filter-pressed body and blunging the mixture with water. The slip had a sp. gr. of 1.874 and 200 c.c. of it required 2 mins. to flow through the viscometer (U.S. Bureau of Standards). The tubes, suspended in special saggars, were biscuited at cone 05 (1000° C.), glazed with a mixture corresponding to (0.15 K_2O , 0.20 MgO , 0.65 CaO) 1.0 Al_2O_3 , 10.0 SiO_2 , and burned at cone 17 (1480° C.). The tubes compared favourably with those made at the Marquardt factory, but would be improved by a more refractory glaze.—A. B. S.

Tunnel kiln; A continuously operated — for high-grade clay ware. L. E. Barringer. Trans. Amer. Ceram. Soc., 1916, 18, 106—123.

A DESCRIPTION of the Didier-March kiln at Keasbey, N. J., is given. It consists of a simple tunnel, 197 ft. long, with two furnaces on each side near the middle. The kiln holds 36 cars which carry the goods and are moved forward one car-length every two hours. Each car will carry 87 saggars 12 in. diam. by 6 in. high inside measurement. Three tons of coal is used daily for burning porcelain in saggars at 1400° C.; for burning firebricks at 1400° C. 6 cwt. of coal is required for each 1000 bricks. The labour cost is 10% less than for periodic kilns and the life of the saggars is 16% greater. Repairs cost the same as for periodic kilns with the same output.—A. B. S.

Clay trials; Methods for saturating — for absorption and porosity determinations. M. F. Beecher. Trans. Amer. Ceram. Soc., 1916, 18, 73—79.

AFTER reviewing published methods and making a series of tests, the author concludes that for ordinary laboratory determinations of porosity and absorption, saturation by boiling in water for 45—60 mins. is sufficiently accurate. Where exceptional accuracy is required, the most effective means of saturation consists in immersing the samples in boiling water and subjecting them to a vacuum of 29 in. mercury for 3 hrs. and then immersing them in water at room temperature for 96 hrs. The customary method of immersion in cold water gives low results, even after a week's soaking. Immersion in cold water with subsequent subjection to a vacuum also gives low results.—A. B. S.

Drain tile [pipes]; Comparison between sodium sulphate and freezing tests for — H. F. Staley. Trans. Amer. Ceram. Soc., 1916, 18, 612—683.

THE author found that the following method is quicker, more convenient and more economical than any other freezing or sulphate tests he has tried, one treatment by this process being equal to two treatments by the customary method of freezing the tile whilst partially immersed. Samples were immersed in a 15% solution of sodium sulphate at 21° C. (70° F.) for 48 hrs., then placed in a dryer at 110° C. for 7 hrs. Subsequent treatments consisted in immersing the samples in the solution for 16 hrs. and then placing them in the dryer for 7 hrs., the intervening hour in each 24 hrs. being used for transferring and examining the samples. The method is inapplicable to concrete articles as the sulphate attacks cement.—A. B. S.

Dryer-scum [on clay products]; Dissociation of calcium sulphate and the removal of — A. E. Williams. Trans. Amer. Ceram. Soc., 1916, 18, 271—276.

DRYER scum is customarily removed by finishing the burning of the goods under reducing conditions, but this tends to spoil the colour of red ware. The author's experiments showed that at 800° C. in the presence of a high percentage of carbon monoxide, gypsum mixed with 4 times its weight of clay is completely and rapidly reduced. Bricks scummed during drying were burned in an oxidising atmosphere at 700° C. and then for 6 hrs. in a reducing atmosphere at 700—800° C. The kiln-gases contained 2% of oxygen and in one case 1½%, and in the other 4% of carbon monoxide. The firing was finished under oxidising conditions at 1000° C. No improvement resulted. It was found that the customary use of barium carbonate is effective, and that it can be satisfactorily replaced by barium fluoride, hydrated barium hydroxide, sodium oxalate, and sodium fluoride.—A. B. S.

Slags [from coal ash]; Method of testing the corrosive action of — on firebrick. G. H. Brown. Trans. Amer. Ceram. Soc., 1916, 18, 277—281.

A SLAG may penetrate a firebrick by capillary attraction as well as by dissolving the brick-material. Hence the author objects to the customary method of placing the slag in a depression in a firebrick or in a cell cemented to the brick, and prefers to place the bricks on end in fireclay boxes, each 9 in. \times 8 in. \times 3 in. internally, and burned at cone 12 before use. The bricks are packed on two sides with finely-ground slag and the boxes with their contents are heated in a down-draught kiln at a temperature reaching 1400° C. in 36 hrs., reducing conditions being maintained during the last 12 hrs. In this manner, a considerable portion of the brick is subjected to the action of the slag and structural defects are readily detected. The use of so large an amount of slag reduces errors due to changes in its composition and facilitates a study of the time-effect. The author found that the slag prepared from coal ash and also a synthetic mixture of similar composition vigorously attacked silica and bauxite bricks, penetrating to the centre and producing a honey-comb structure. A magnesite brick showed penetration to the centre and considerable solution at the surface, whilst a carborundum brick showed no penetration but excessive surface solution. Some brands of clay bricks were not attacked at all, but others which were under-burned or contained coarse grog were irregularly penetrated.—A. B. S.

Terra-cotta glazes; Influence of variable silica and alumina on —. R. B. Keeler. Trans. Amer. Ceram. Soc., 1916, 18, 282—311.

IN opposition to Seger, the author considers that no ratio between the silica and alumina can be correct for all the RO combinations in glazes, and that within wide limits any RO will form a glaze if the proper proportions of silica and alumina are present and the glaze is properly heated. For ordinary terra-cotta glazes the following limits are safe:—0.2—0.4KNaO, 0.1—0.6CaO, 0.1—0.4ZnO, 0.02—0.1MgO, 0.02—0.3BaO, 0.0—0.6PbO, 0.2—0.5Al₂O₃, 1.5—4.0SiO₂, and 0.02—0.15SnO₂. Experiments in which the RO, Al₂O₃, and SiO₂ were all varied showed that high alumina and low silica usually produce immature glazes which, when they fuse, tend to flow and to craze. Low alumina and low silica induce crazing, pinholes, and immaturity, and stannic oxide is not dissolved. High silica and alumina produce beading, immaturity, and waviness but no crazing. Low alumina and high silica give fairly bright glazes which show waviness and become rougher if the alumina is increased. Glazes and matts containing 0.1PbO and low felspar, with 0.2 to 0.35 Al₂O₃ and 1.5 to 2.25 SiO₂ are good and cover the body well at cone 2 (1120° C.). Low felspar with high ZnO and MgO produces a good glaze above cone 3 (1140° C.), but the glaze must contain 0.35 Al₂O₃ and 2 SiO₂ for use at cone 3. High K₂O produces good, bright glazes with 0.4—0.5 Al₂O₃ and 2.4—2.9 SiO₂ at cone 4 (1160° C.). High MgO and ZnO and low K₂O limit the Al₂O₃ to 0.4—0.48 and the SiO₂ to 2.06—2.68 at cone 4, but with fairly high K₂O and less MgO and ZnO the fusing point is lowered, the alumina range is slightly increased, and the silica range changed to 2.4—2.9 SiO₂. Other experiments showed that, for good matt glazes, it is desirable to use a rather hard felspar, and a mixture containing at least 0.35 K₂O, less than 0.35 ZnO, and low CaO. For clear glazes, 0.3 K₂O, 0.3 CaO, 0.3 ZnO, 0.05 BaO, and 0.05 MgO is good at cone 4. The materials, duration of burning, and time of cooling influence the results, and glazes made of the same materials but derived from different sources differ widely in their behaviour.—A. B. S.

Bristol glazes compounded on the norm basis; A study of —. A. S. Watts. Trans. Amer. Ceram. Soc., 1916, 18, 424—430.

STALEY (Trans. Amer. Ceram. Soc., 1911, 13, 126; compare Purdy, this J., 1912, 1128) has shown that the classification of glaze compositions into "norms" reduces the study of glazes to that of a three-component system. Ordinary Bristol glazes contain the following oxides:—K₂O and Na₂O introduced as felspar (a mixture of microcline and albite); CaO introduced as whiting, CaCO₃; zinc oxide, ZnO; Al₂O₃ introduced in felspar and kaolin; SiO₂ introduced in felspar, kaolin, and as free silica (flint). The minerals which would normally form in Bristol glazes are microcline (K₂O, Al₂O₃, 6SiO₂), albite (Na₂O, Al₂O₃, 6SiO₂), anorthite (CaO, Al₂O₃, 2SiO₂), wollastonite (CaO, SiO₂), willemite (2ZnO, SiO₂), and sillimanite (Al₂O₃, SiO₂). Two series, each containing 45 mixtures, were prepared to correspond to mixtures of (i.) felspar, willemite, and wollastonite and (ii.) felspar, willemite, and anorthite.

Series I. The temperature of deformation of the various components and eutectics was: felspar, cone 6 (1250° C.); willemite, cone 13 (1390° C.); wollastonite, cone 8 (1290° C.); felspar-willemite eutectic (0.525Na₂O, 0.225K₂O, 0.250ZnO, 0.75Al₂O₃, 4.625SiO₂, cone 2 (1170° C.); willemite-wollastonite eutectic (0.5CaO, 0.5ZnO, 0.75SiO₂), cone 5—6 (1240° C.); and one ternary eutectic (0.175Na₂O, 0.075K₂O, 0.375CaO, 0.375ZnO, 0.25Al₂O₃, 2.06SiO₂), deformed at cone 1 (1150° C.). The glazes of this series do not opacity if 0.5 or more equivalent of felspar is present or unless the willemite exceeds 0.25 equivalent. At cone 4, the mixtures approaching the ternary eutectic have a brilliant gloss and towards the willemite end of the triaxial diagram a satin-like texture is developed; the other mixtures are matt or pinholed.

Series II. The deformation point of anorthite is cone 18 (1500° C.); of the willemite-anorthite eutectic (0.25CaO, 0.75ZnO, 0.25Al₂O₃, 0.875SiO₂) cone 5 (1230° C.). The lowest deformation temperature is that of the felspar-willemite eutectic shown in Series I. Mixtures containing less than 0.25CaO or more than 0.25ZnO tend to be opaque. Crazing only occurs with mixtures containing more than 0.5 felspar or less than 0.25 CaO. All the glazes in this series are matt.

The fusion point of Bristol glazes is lower if the lime is present as wollastonite than if it is introduced as anorthite. The presence of willemite also reduces the maturing temperature of the glaze. A low felspar content is necessary to avoid crazing and more than 0.25 willemite must be present to make the glazes glossy.—A. B. S.

Bristol glazes compounded on the eutectic basis; Study of —. A. S. Watts. Trans. Amer. Ceram. Soc., 1916, 18, 631—641.

THE most fusible mixture of modern Bristol glaze type was found to be produced by mixing Canadian felspar 59.02, whiting 8.03, zinc oxide 6.59, Florida kaolin 13.81, and flint 12.04%, corresponding to (0.4KNaO, 0.3CaO, 0.3ZnO)0.60Al₂O₃, 3.55SiO₂. It deformed at cone 03 (1040° C.). Glazes were made of this and allied mixtures and burned at cone 03—01 (1040°—1080° C.) and cone 4 (1160° C.), and it was found that there is a rapid increase of glossiness with a slight increase of felspar, greater white opacity with more ZnO, and a greater cream opacity with more CaO. Allowance must be made for a slight volatilisation of the ZnO.—A. B. S.

Bristol glazes; Effect of clay on the fusibility of —. E. C. Hill. Trans. Amer. Ceram. Soc., 1916, 18, 508—518.

THE results of experiments by R. C. Purdy (this J., 1903, 1047) on Bristol glazes showed that in glazes composed of felspar, whiting, zinc oxide, clay,

and flint, the amount of clay which gave the most fusible glaze decreased as the felspar increased at the expense of the whiting, so that the most fusible glaze produced by him (1035° C.) contained 0.4 felspar, 0.2CaO, 0.4ZnO, 0.08 clay, and 0.08 flint. Purdy also found (this J., 1911, 1385) that for porcelain glazes made of the same materials and with an $\text{Al}_2\text{O}_3 : \text{SiO}_2$ ratio of 1 : 6, increase of clay decreased the fusibility. As these experiments left some doubt as to the amount of clay required for different proportions of CaO and ZnO to form a fusible glaze, the author planned a series of glazes to cover additions of clay between the ones used in Purdy's two series. He found that with an $\text{Al}_2\text{O}_3 : \text{SiO}_2$ ratio of 1 : 6 and CaO : ZnO = 3 : 1, any addition of clay up to 0.3 equiv. makes the glaze more fusible and confirms Purdy's results, but with CaO : ZnO = 1 : 1, clay increases the fusibility up to 0.02 equiv. and further additions decrease it. The author found that glazes containing 0.30 equiv. of clay are more refractory than any containing less clay or none, though Purdy has stated that this equiv. of clay is present in the most fusible glaze of its type. With CaO : ZnO = 1 : 3, the glaze with 0.05 equiv. clay is only slightly more fusible than those free from clay, and any further addition makes the glaze more refractory. Hence, within the limits studied, the most fusible glazes were those with a CaO : ZnO ratio of 3 : 1 and an increase of either base reduced the fusibility. An increase in the proportion of silica increases the fusibility, but the clay must then be lower to secure a readily fusible glaze. The author points out that if Purdy had added silica instead of clay to his earlier series of glazes the fusibility would have been greatly increased and that the fusing point of these glazes would have been higher if clay alone and not a mixture of clay and flint had been used. He agrees with Purdy that in glazes devoid of ZnO the clay must be present in 0.3 equiv. (irrespective of the silica ratio) in order to have the maximum fusibility, but adds that with the lowest SiO_2 used (2.0 equiv.), increase of clay up to 0.3 did not increase the fusibility. With each increase of SiO_2 , however, up to that giving the most fusible mixture, the effect of clay in increasing the fusibility was greatest with 4.0 SiO_2 .—A. B. S.

Leadless glazes; Fritted — for sanitary ware.
C. W. Parmelee and G. A. Williams. Trans. Amer. Ceram. Soc., 1916, 18, 812—841.

For sanitary ware burned at cone 7 (1230° C.) the best range of RO in the glaze was found to be within the following limits:—0.4—0.6 K_2O , 0—0.3ZnO, and 0.4—0.6CaO, the other oxides being 0.5—0.6 Al_2O_3 , 5 SiO_2 , 0.5 B_2O_3 . The use of soda instead of potash increased the range within which good glazes could be obtained. Glazes within the limits mentioned do not readily craze, but become opalescent with an excess of alkali or boric acid. The best glaze obtained was composed of:—*Frit*: nitre 1212, whiting 400, flaky boric acid 1860, and flint 2520; *mill batch*: frit 1450, whiting 366, felspar 1671, Florida clay 516, and flint 240.
—A. B. S.

Enamels; An attempt to fit — to plastic clay bodies. F. A. Kirkpatrick, H. C. Arnold, and C. F. Geiger. Trans. Amer. Ceram. Soc., 1916, 18, 139—164.

THE authors have endeavoured to apply an enamel coating to a stiff, plastic column of clay extruded through a die, the column being afterwards cut into bricks. To secure a perfect fit between glaze and clay there must be sufficient adhesion between them and they must both shrink to the same extent and at the same rate. The enamels were ground wet in ball-mills for 2 hrs. and were then passed through a 100-mesh sieve. The percentage of water in each was determined and

various electrolytes and water were then added and the mixtures were shaken by hand for 3 mins. The viscosity of each slip was determined in an Ostwald viscometer. The following methods for regulating the shrinkage of the enamel and its adhesion to the clay were used:—*Precipitation of colloidal silicates* in the enamel. Sodium silicate solution and afterwards either magnesium or aluminium chloride solution in the proportion of 65 : 35 were added to the wet enamel. Decrease of viscosity occurred with small amounts of the reagents, but an increase with larger additions, particularly in the mixtures containing aluminium chloride. The enamels so treated had too little shrinkage and adhesion and flaked on drying. *Coagulation by salts*: Divalent ions from MgSO_4 and CaCl_2 gave the least increase in viscosity; the trivalent ion from $\text{Al}_2(\text{SO}_4)_3$, AlCl_3 , or alum gave greater viscosity, and the stannic ion from SnCl_4 gave the greatest viscosity. The effect of zinc chloride resembled that of trivalent and quadrivalent rather than of divalent ions. All these enamels flaked or cracked in use. *Coagulation by acids*: Hydrochloric, oxalic, and boric acids increased the viscosity but caused bad flaking and cracking. *Coagulation by alkalis*: The addition of up to 10% of sodium carbonate or borax increased the viscosity but the enamels lacked adhesion. *Precipitation of colloidal silica in the enamel* by adding a 9% solution of sodium silicate and then a 1.82% solution of hydrochloric acid or a 9% solution of oxalic acid, so that the mixture contained 80% sodium silicate, gave poor results with hydrochloric acid but good with oxalic acid, using 4—6% of the mixed reagents. The enamels then thickened greatly, some setting to a jelly. *Substituting calcium, barium, and zinc oxalates* for the oxides or carbonates of these metals in preparing the enamels doubled the viscosity and produced enamels which gave a large percentage of perfect trials, but the price of the oxalates is prohibitive. *Increase of clay content* to 35%, followed by the addition of 3—5% of sodium silicate and 1—3% of oxalic acid gave perfect-fitting enamels on one clay, and might be used with advantage in some cases. *Addition of organic colloids*. The addition of 1% of starch or of 0.3—0.5% of gum tragacanth proved to be the most readily applicable method of attaining the desired result. Glue was not satisfactory. The influence of time on the viscosity and adhesion of the enamel is important, but less so with mixtures containing sodium silicate and oxalic acid than with others.—A. B. S.

Ground-coats for sheet-iron enamels; Effect of variation in the composition of —. R. R. Danielson. Trans. Amer. Ceram. Soc., 1916, 18, 343—362.

IN an enamel corresponding to 0.25 K_2O , 0.5 Na_2O , 0.25CaO, 0.15 Al_2O_3 , 2.0 SiO_2 , 0.5 B_2O_3 , 0.25 Fe_2O_3 , part of the first three oxides was replaced by 0.01—0.04CoO or by 0.01—0.05NiO, or by 0.02—0.14 MnO_2 , or by equivalent mixtures of these oxides. The mixed materials were fritted in gas-fired crucibles, stirred to eliminate bubbles, and kept at the maximum temperature until free from undissolved matter. After about 3 hrs. the frit was poured into water, dried, mixed with 8% of ball clay and 1% of borax, the latter being added in hot solution, and ground in porcelain ball mills with 40% of water for 20 hrs. Trials were made on iron plates which had previously been scaled, pickled, washed, and dried. Increasing the CoO improved the quality and increased pinholes. Increasing the NiO decreased bubbling, but the enamels were not very smooth. Increasing CoO and decreasing NiO removed bubbling and gave a good texture. Increasing MnO_2 gave a very smooth enamel with some bubbles. Increasing CoO and decreasing MnO_2 reduced the number of fine bubbles.

Increasing SiO_2 or CaO increased pinholing. Decreasing B_2O_3 increased pinholing and blisters. Tests with a 1 lb. weight dropped from varying heights on the ground coats showed that CaO and NiO have similar toughening action, but MnO_2 decreases toughness. The addition of CoO or NiO to MnO_2 increases the toughness. The introduction of part of the flint into the frit increases the toughness, but makes the frit more refractory. Enamels with low B_2O_3 or high CaO are not satisfactory. Variations in SiH_2O_3 do not affect the toughness but alter the opacity. When a white coat is applied to the ground coat, CoO should be present in the latter. The best ground coats were obtained with a mixture containing 0.4% CoO and 0.75% NiO , which was heated on the steel until the enamel turned black. As NiO is cheaper than CoO the use of both oxides instead of cobalt oxide alone is desirable.—A. B. S.

Enamel; Heat-transmission of —. E. P. Poste. Trans. Amer. Ceram. Soc., 1916, 18, 570—574.

THE author endeavoured to ascertain the effect of the enamel itself and the influence of surface-condition on the transmission of heat through it by filling small cylindrical enamelled dishes, each 3 in. deep and 5 in. diameter, with water and noting the time required to evaporate 500 c.c. of water. Copper dishes required 140 mins., plain steel dishes 153 mins., enamelled steel (4 coats) 179 mins., when heated on a water-bath. With steam at atmospheric pressure the times were reduced to 106, 117, and 164 mins. respectively, whilst with steam under a pressure of 10 lb. per sq. in. they were only 16, 19, and 73 mins. The results show that enamelled steel transmits heat more slowly than the plain metal, the retardation being slight with hot water and much greater with steam under pressure.—A. B. S.

Report of the Refractory Materials Committee of the Institution of Gas Engineers. See 11A.

PATENTS.

[Glass] pot; Reversible —. G. A. Shields. Columbus, Ohio. U.S. Pat. 1,226,022, May 15, 1917. Date of appl., Oct. 26, 1914.

AN integral reversible glass pot comprises two receptacles placed base to base and connected by a narrow neck in the centre, this forming an annular groove for an operating tool. A central boss projects from the bottom into each receptacle and an air duct extends through both bosses and the connecting neck.—W. F. F.

Hot-kiln. A. B. Klay, Modesto, Cal. U.S. Pat. 1,226,535, May 15, 1917. Date of appl., May 31, 1916.

THE heating chamber is provided with a series of openings in the bottom and a corresponding series of flues in the top, the openings in the bottom being connected with separate interconnected furnaces below. A number of stacks communicate with opposite sides of the chamber along its length, and means are provided in the top of the chamber, at a distance from the furnaces, for feeding the latter with fuel.—W. F. F.

Dental cement. J. E. Mahan, Swissvale, Pa., Assignor to L. S. Smith and Son Manufacturing Co., Pittsburgh, Pa. U.S. Pat. 1,226,232, May 15, 1917. Date of appl., June 13, 1916.

A DENTAL cement consists of zinc, bismuth, magnesium, and manganese oxides, and about 2.5% of copper silicate.—W. F. F.

Refractory bodies; Manufacture of —. H. F. Chappell, Assignor to Mineral Products Corporation, New York. U.S. Pat. 1,226,750, May 22, 1917. Date of appl., Nov. 15, 1916.

ALUNITE is calcined and then leached, and the

product, with or without an intimate mixture of fireclay, is heated to such a temperature as to cause the material to bind together.—W. F. F.

Abrasive material; Method of making —. H. T. Kalnus, Brookline, Mass., Assignor to The Exelon Co., Cambridge, Mass. U.S. Pat. 1,226,892, May 22, 1917. Date of appl., May 7, 1915.

THE substances from which the material is to be made, e.g., aluminous material, are fused in an electric furnace and poured in a thin stream on to a surface which is moved in such a way that the material solidifies in thin layers.—W. F. F.

Silicon carbide refractory articles. The Carborundum Co., Ltd., Manchester. From F. J. Tone, Niagara Falls, N.Y., U.S.A. Eng. Pat. 106,393, Sept. 11, 1916. (Appl. No. 12,827 of 1916.)

SEE U.S. Pat. 1,204,211 of 1916; this J., 1916, 1261.

Insulator and composition of material for [electrical] insulating and other purposes. U.S. Pat. 1,226,088. See XI.

IX.—BUILDING MATERIALS.

Sands [for mortar]; Colorimetric determination of organic impurities in —. D. A. Abrams and O. E. Harder. Chem. Engineer, 1917, 25, 9—11. Analyst, 1917, 42, 217—218.

TWO hundred grms. of the dry sand is digested, with occasional stirring, for 24 hours, with 100 c.c. of 3% sodium hydroxide solution and the extract filtered. Ten c.c. of the clear filtrate is diluted to 50 c.c. with water and the colour compared in Nessler cylinders with that of a freshly-made solution of sodium tannate, which is prepared by mixing 10 c.c. of a 2% solution of tannic acid in 10% alcohol with 90 c.c. of 3% sodium hydroxide solution, and allowing the liquid to stand for 24 hours. From 1 to 10 c.c. of this solution is diluted to 50 c.c. with water for the comparison, and the colour value in parts of tannic acid per million of the sand, is 100 times the number of c.c. of the sodium tannate solution necessary to match the colour. This test has proved that there is a relationship between the amount of organic impurities and the colour values, and that sands with high colour values give low results in mortar tests. Approximate comparisons between the colour values of sands and the strength of the mortars made from them indicated that a colour value of 250 corresponded to a loss of about 10 to 20% of compressive strength in a 1:3 mortar; a value of 500 to a loss of 15 to 30%; 1000 to a loss of 20 to 40%; 2000, to 25 to 50%; and 3000 to 30 to 60% loss.—C. A. M.

Silica brick mixtures; Volume-changes of —. A. V. Bleiminger and D. W. Ross. Trans. Amer. Ceram. Soc., 1916, 18, 519—523.

THE amount of permanent expansion of silica bricks (9.375 to 9.438 in. per linear ft.) is usually considered the criterion of proper firing. For the complete conversion of quartz to cristobalite, the calculated expansion is 13.4%, but in practice this conversion is never complete and the formation of tridymite causes an additional expansion. The authors fired 2 in. cubes of a prepared silica brick mixture containing quartzite rock from Tyrone, Pa., U.S.A., to temperatures of 1200°—1500° C., with a temperature-rise of 20° C. per hour, the cubes being held at the maximum temperature for 4 hours. The original and subsequent volumes of the cubes were measured in a Seger's volumometer and the linear expansion was measured directly. The results show that expansion occurs at 1200° C., though no appreciable formation of

cristobalite occurs below 1250° C. Between these two temperatures there is a lag in the expansion curve, but beginning at 1300° C. the rate of expansion remains constant and is coincident with, but not proportional to, the formation of cristobalite. The most desirable burning temperature appears to correspond to a break in the expansion curve somewhat beyond 1530° C., (i.e., at about cone 20), but the experiments did not extend far enough to locate it. The amount of cristobalite after burning at 1350° C. was determined by sketching the outlines of the crystals by means of a microscope and camera lucida on thin paper, cutting them out, and comparing the weight of these pieces of paper with that which represented the microscope field. At 1300° C. not more than 5% of cristobalite and no tridymite were found. At 1350° C. the material consisted of 57.13% of cristobalite and a mixture of quartz and calcium silicate. At 1400° C. 72.17%, at 1450° C. 81.26%, and at 1500° C. 90% of cristobalite was present. Only small proportions of tridymite were observed. It seems evident that the volume expansion of the bricks is not proportional to the amount of cristobalite formed and it is somewhat greater than three times the linear expansion, the relation between the two not being quite so regular as is often assumed.—A. B. S.

Slag paving bricks. E. T. Montgomery and P. W. Burdick. Trans. Amer. Ceram. Soc., 1916, **18**, 492—498.

THE best slag bricks, hitherto, have been made from copper smelters' slag containing 47—57% SiO_2 , 5—18% Al_2O_3 , 3—10% Fe_2O_3 , 18—33% CaO , and 1—8% MgO . In a previous investigation (this J., 1914, 81) it was found that slag bricks should not contain less lime and magnesia than that represented by a slag composed of 52% of dolomite and 48% of shale. It was now sought to produce more fusible slags by the addition of fluxes. The most satisfactory slag was made of dolomite 60, shale 40, and 10 parts of a mixture of flourspar 65, cryolite 35 parts. The molten slag at 1258° C. was poured into iron moulds which had been washed inside with a clay-alumina mixture and then heated to 900° C. The bricks in the moulds were kept at this temperature for 2 hrs. and were then allowed to cool. The bricks gave better results in the rattler test than the ones usually adopted for the standard for paving bricks made of clay.—A. B. S.

sistency figure and the time of setting. The tensile strength of the plaster is increased by the addition of less than 4% of lime but is greatly decreased by larger amounts. An increase in the amount of water added to the plaster increases the time of setting and reduces the tensile strength. If the plaster is mixed in a room, the temperature of which is above 24° C., the tensile strength decreases in proportion to the increase of temperature above this figure.—A. B. S.

Note on the determination of dissociation points [of calcium carbonate and hydroxide and gypsum]. Montgomery and Groves. See VII.

PATENTS.

Roofing material. H. Abraham, New York. U.S. Pat. 1,226,738, May 22, 1917. Date of appl., Feb. 27, 1917.

A ROOFING composition comprises a felted mixture of rags, paper, and sea grass fibres, waterproofed with bituminous substances.—W. F. F.

Roofing. R. C. Neptune, St. Louis, Mo. U.S. Pat. 1,226,904, May 22, 1917. Date of appl., May 24, 1916.

A FLEXIBLE sheet material suitable for roofing is made by embedding metallic netting in a plastic mixture of Chinese wood oil, gum or oil residue, and fibre. The surface hardens and becomes waterproof and airproof on exposure to air, and the interior remains plastic.—W. F. F.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Platinum situation in the United States. U.S. Commerce Report, No. 130, 1917.

THE quantity of platinum in the United States is estimated by the U.S. Geological Survey at 1,000,000 troy oz., besides which there is over 400,000 oz. of other metals of the platinum group, principally palladium, iridium, and rhodium. In 1916 the crude platinum mined in Colombia (25,000 oz.) was refined in the United States, and 28,088 oz. of metals of the platinum group was recovered by American refiners from all sources, foreign and domestic, of which 24,518 oz. was platinum.

The following table shows the world's production of crude platinum for the last 8 years in troy ounces:—

Countries.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.
Borneo and Sumatra	500	200	—	—	200	(a)	(a)	(a)
Canada	30	20	30	30	50	30	100	60
Colombia	6,000	10,000	12,000	12,000	15,000	17,500	18,000	25,000
New South Wales and Tasmania ...	440	332	470	778	1,500	1,248	303	222
Russia	264,000	275,000	300,000	300,000	250,000	241,200	124,000	63,900
United States	672	390	628	721	483	570	742	750
Total	271,642	285,952	313,128	313,529	267,233	260,548	143,145	89,932

(a) No basis for estimate

Plaster of Paris; Influence of variations in water, lime, and temperature on the setting of —. C. H. Kerr and R. J. Montgomery. Trans. Amer. Ceram. Soc., 1916, **18**, 180—191.

In testing plaster care must be taken not to disturb the material after setting has commenced as this may cause defective setting. Plaster of "standard consistency" will flow 16 in. down a rectangular copper-lined trough inclined at an angle of 30° from the horizontal. The number of c.e. required by 100 grms. of plaster to produce a mixture of this consistency is termed the "consistency figure." The addition of slaked lime or hydrated lime to the plaster increases the con-

It is estimated that 30,000 oz. of crude platinum containing 85% metal, will be produced in Colombia in 1917, and that the production of Russia and the United States will be considerably increased.

Apparently the normal requirements of platinum in the United States call for 165,000 oz. annually. The dental industry formerly used 25 to 30% of the supply, but a number of alloys are now being employed instead of platinum. The jewelry industry used 40 to 50% of the supply, but has voluntarily agreed to limit the use of platinum in jewelry for the duration of the war. The quantity of platinum in chemical laboratories in the United

States is probably not over 10 to 15% of the supply and is all recoverable.

In 1915 about 44,000 oz., or 4% of the apparent United States stock of platinum, was used in contact-process sulphuric-acid works. The output of contact-process plants has increased nearly 200% since 1915, and these plants, it is understood, are not yet working to their full capacity. Thus there is apparently no pressing need for a large supply of platinum by the sulphuric-acid industry.

Government laboratories seem to be well supplied with platinum utensils and are not in the market for platinum at present. The United States mints refine platinum, and doubtless have stocks sufficient to meet any immediate Government requirements. The United States Geological Survey is taking a census of stocks of unmanufactured platinum in the United States that can be considered as immediately available, from which it appears that there are supplies of platinum sufficient to meet such extensions of contact-process plants as may be required immediately and a surplus left for all ordinary requirements. Should new demands arise, however, expansion in the chemical industries may make necessary the further curtailment of platinum in the manufacture of jewelry.

Steel: Influence of the speed of cooling on the temperature of transformation of —. Portevin and Garvin. Comptes rend., 1917, 164, 885—888.

WITH a given steel and the same initial temperature of quenching, the temperature of transformation is lowered with increasing speed of cooling. With a low rate of cooling, the transformation point is well marked and troostite is formed, while with a high rate no break in the cooling curve is noticeable and martensite is obtained. In this case the transformation is only indicated on the cooling curve by comparison with a metal showing no transformation. The critical rate of cooling above which the sudden transformation does not take place varies for a given critical temperature with the composition of the steel and appears to have a maximum value for a steel of eutectic composition.—J. N. P.

Nickel and cobalt; Rapid method of determining — in ores and alloys. W. R. Schocher and A. R. Powell. Analyst, 1917, 42, 189—199.

NICKEL and cobalt are precipitated from an ammoniacal solution by potassium iodide, as hexammine nickelous iodide, $[\text{Ni}(\text{NH}_3)_6]\text{I}_2$, and hexammine cobaltous iodide, $[\text{Co}(\text{NH}_3)_6]\text{I}_2$, respectively, and in the presence of excess of iodide (0.6 gm. KI per 0.1 gm. of nickel and cobalt) beyond that required for complete precipitation the precipitates are sufficiently insoluble for quantitative work. The volume of strong ammonia solution (sp. gr. 0.88) should be at least two-thirds of the total liquid, which should not be much in excess of 80 c.c., and the required amount of potassium iodide in cold saturated solution should be added immediately after the ammonia to prevent oxidation of the cobalt. Since small amounts of nickel or cobalt (less than 2 mgrms.) do not give a precipitate within 10 to 15 mins. the method is not suitable for the detection of traces of these metals. The crystalline precipitate which can be rapidly filtered off, without the use of a filter-pump, is washed with a solution of potassium iodide (40 grms. per litre) containing 800 c.c. of ammonia solution. The washed precipitate is dissolved in hydrochloric acid, with the addition of sulphurous acid to remove the liberated iodine, the solution filtered, and the cobalt and nickel determined by the authors' alkalimetric method (this J., 1916, 656). Ferrous

salts in ammoniacal solution containing sufficient tartaric acid to prevent precipitation of hydroxide yield a white precipitate of hexammine ferrous iodide $[\text{Fe}(\text{NH}_3)_6]\text{I}_2$, whilst ferric salts are not precipitated under these conditions. Hence, in the presence of excess of tartaric acid (about ten times the amount of iron present) cobalt and nickel may be separated in this way from iron by a single precipitation. Manganous salts yield a white pentammine manganous iodide, $[\text{Mn}(\text{NH}_3)_5]\text{I}_2$, which is more stable than the ferrous salt. Manganese is less readily precipitated than nickel or cobalt, but is liable to be carried down with the iodide precipitates of those metals. It is therefore advisable to dissolve the mixed iodide precipitate in a small excess of dilute acid, add sodium acetate in excess, and re-precipitate the nickel and cobalt with hydrogen sulphide. Copper is not precipitated under the conditions described (i.e., in ammoniacal 4% potassium iodide solution), but with a higher concentration of iodide yields a blue crystalline tetrammine cupric iodide, $[\text{Cu}(\text{NH}_3)_4]\text{I}_2 \cdot 2\text{H}_2\text{O}$. In presence of nickel and cobalt, however, some precipitation of copper takes place simultaneously from weaker solutions. This copper may be separated by dissolving the mixed precipitate in dilute hydrochloric acid, when cuprous iodide is precipitated, with the liberation of iodine. The liquid is boiled, cooled, and filtered, the precipitate of cuprous iodide washed with cold water, and the cobalt and nickel determined in the filtrate. The copper may alternatively be removed as cuprous thiocyanate prior to the precipitation of the cobalt and nickel, and the filtrate oxidised with nitric acid, evaporated nearly to dryness, and treated with tartaric acid, ammonia, and potassium iodide. Cadmium yields a white crystalline precipitate of tetrammine cadmium iodide, $[\text{Cd}(\text{NH}_3)_4]\text{I}_2$, and is co-precipitated with nickel and cobalt. In the rare cases when it is present in nickel and cobalt ores it may be separated by passing a current of hydrogen sulphide through a solution of the mixed iodide precipitate, faintly acidified with sulphuric acid. Zinc is not precipitated under the conditions of the determination. Barium salts are removed from ores as sulphate at the same time as the insoluble gangue. Soluble calcium salts do not interfere with the method, but if present in large quantity they might crystallise as tartrate and interfere with the separation of the cobalt. In such cases it is advisable to evaporate the solution of the ore with 1 c.c. of strong sulphuric acid until fumes appear, then to add water and an equal volume of methylated spirit, and separate the anhydrous calcium sulphate. The precipitate is washed with 50% alcohol, and the filtrate and washings evaporated to about 5 c.c. Magnesium has no influence on the results. Lead iodide is soluble in ammoniacal tartrate solution and its presence is negligible, but if lead is present in large amount it may be separated as sulphate. Mercuric salts yield a complex iodide which crystallises in needles, and is decomposed by water and acids leaving insoluble mercuric iodide. Silver forms a white precipitate which is decomposed by water or dilute acids, yielding the normal iodide, which can be separated by filtration. Aluminium, chromium, antimony, and bismuth do not interfere with the determination provided that sufficient tartaric acid has been added. Arsenic, oxidised by nitric acid into arsenic acid, does not influence the results. Should arsenic and magnesium be present together (e.g., as in dolomite) a preliminary fusion of the ore with soda-sulphur or soda-nitre mixture would be necessary, since otherwise magnesium ammonium arsenate would be precipitated on the addition of tartaric acid and ammonia. Sulphides, unless decomposable by hydrochloric acid, are oxidised by nitric acid to sulphates, although in the separation of copper, as described above, some tetram-

mine cupric sulphate may be precipitated with the mixed iodide precipitate. This compound sulphate is converted into cuprous iodide when the mixed iodide precipitate is treated with hydrochloric acid, provided sufficient nickel or cobalt iodide is present; otherwise sufficient potassium iodide must be added to precipitate the whole of the copper. When an ore is treated with sulphuric acid as little as possible should be used, or most of the excess expelled as described in the case of calcium. Ammonium chloride in quantities exceeding 0.5 gm. has a slight solvent action upon the iodide precipitates, especially that of nickel. Hence if an ore has been decomposed with hydrochloric acid, the excess should be removed by boiling and the chlorides decomposed by evaporating the solution to a small volume with nitric acid, care being taken to avoid the separation of basic salts. The required amount of tartaric acid may then be added in the smallest quantity of hot water necessary to dissolve it, and the liquid cooled and treated with ammonia and potassium iodide.—C. A. M.

Lead ores; Treatment of low-grade —. A. E. Wells. U.S. Bureau of Mines, Salt Lake Expt. Sta. Rept.

LOW-GRADE lead ores which had failed to yield to flotation or leaching processes, were heated with sodium chloride to about 800° C.; high extractions of lead were obtained, irrespective of the type of gangue in the ore. The lead volatilises as chloride, and silver and gold are also volatilised. The chlorides are precipitated from the fume in a Cottrell precipitator. The lead chloride is mixed with lime and a small quantity of reducing agent, and submitted to a red heat; metallic lead and calcium chloride are obtained, and the latter can be used in place of sodium chloride in the first operation; from 50 to 75% of the chlorine is recovered in this manner. It is considered possible that the process will be cheaper than water concentration followed by smelting.

Volumetric determination of sulphur in pyrites. Craig. See VII.

Action of sulphur dioxide on metal oxides. Hamnick. See VII.

Method of testing corrosive action of slags on fire-brick. Brown. See VIII.

Slag paving bricks. Montgomery and Burdick. See IX.

PATENTS.

[*Flotation*.] *Process and apparatus for separating ores* [by —]. E. Primosigh, Also-Szalank, Hungary. Eng. Pat. 10,087 of 1914; date of appl., Dec. 19, 1913.

AN intermittent flotation process for finely-divided ores (—130 mesh) is carried out in an apparatus consisting of a closed mixing vat divided into compartments and containing mixers on horizontal shafts rotating in opposite directions. The material is thus circulated outwardly from the centre of the mixer and upwardly into a concentric inner chamber containing a hollow cone, through which the froth is allowed to rise by retarding the downward motion, with or without the aid of compressed air.—W. R. S.

Ore-flotation process and apparatus. H. C. Colburn, Colorado Springs, and E. A. Colburn, Denver, Colo. U.S. Pats. (A) 1,226,062 and (B) 1,226,063, May 15, 1917. Dates of appl., May 31 and Oct. 31, 1916.

(A) The process consists in mixing the ore pulp

with an oil, agitating and emulsifying the mixture in a receptacle with addition of a gas under reduced pressure, and causing the froth to rise in another receptacle under a higher pressure. (B) The apparatus comprises a mixing-chamber having a feed opening and air outlet, inlets for introducing oil and gas, a mixer for emulsifying the pulp, and means for maintaining a partial vacuum; and a settling chamber under a higher pressure, connected with the outlet of the mixing-chamber.—W. R. S.

Flotation; Process of concentrating and separating minerals by —. H. E. T. Haultain, Toronto, Canada. U.S. Pat. 1,226,330, May 15, 1917. Date of appl., June 15, 1915.

THE ore pulp is first treated by flotation in a series of steps in which the sinking products are successively re-treated to obtain a final sinking product free from the most readily floatable constituent. The floating products are again treated by flotation in a series of steps in which the floating products of each step except the first are returned for re-treatment in a previous step to obtain a clean final product as a float from the first step. The floating products of the first stage are introduced at different steps in the second stage, and those of the later steps are progressively moved up for re-treatment in earlier steps.—W. R. S.

Coating metal plates with tin, terne, or other metal or alloy. P. B. Taylor, Briton Ferry, S. Wales. Eng. Pat. 106,120, May 5, 1916. (Appl. No. 6501 of 1916.)

THE apparatus is provided at the entry end with a hood closed by the feed rolls in combination with a flap, so that the surface of an entering plate is kept in a moist atmosphere and in contact with flux fumes. The upper surface of the plates is kept damp and sprayed with a current of fumes from a jet device above the surface of the flux. In this manner a coating of equal brilliancy and finish is claimed to be obtained on both sides of coated plates.—W. R. S.

Electroplating non-conducting substances with copper; Process of —. H. Ueno, Tokyo, Japan. Eng. Pat. 106,181, July 29, 1916. (Appl. No. 10,228 of 1916.)

ARTICLES of wood, porcelain, cloth, plaster, etc., are impregnated with a mixture of beeswax, paraffin wax, and white wax; the surface is covered with a powder formed from a mixture of graphite (100 parts), mercury (2 parts), auric chloride (1 part), and sulphuric ether (50 parts), and the articles are then subjected to the action of an electric current in a solution of copper sulphate.—B. N.

Pickling-bath and method of making same. A. F. Hoffman, Assignor to W. M. Parkin, Pittsburgh, Pa. U.S. Pat. 1,225,956, May 15, 1915. Date of appl., July 21, 1915.

SULPHURIC acid is added to concentrated brine in the molecular proportion $H_2SO_4 : NaCl$. The precipitate formed in the presence of the material being pickled is removed and heated in order to produce gases which will combine with the residual liquor to produce pickling elements.—E. W. L.

Copper; Process for the extraction and recovery of —. A. Cox, Plainfield, N.J., and A. H. Peter, New York. U.S. Pat. 1,226,190, May 15, 1917. Date of appl., Aug. 20, 1913.

THE copper in the ore is converted into sulphide by treating it with a soluble sulphur-yielding

compound; the copper sulphide is extracted by cyanide solution, and the copper recovered from the liquor.—W. R. S.

Furnace for heating or annealing. *Furnace.* U.S. Pats. 1,226,266 and 1,226,267. See I.

XI.—ELECTRO-CHEMISTRY.

PATENTS.

Electrodes; Electric furnace — V. Stobie and S. Davenport, Dunston-on-Tyne, Durham, Eng. Pat. 106,152, May 22, 1916. (Appl. No. 7244 of 1916.)

STEEL or iron turnings are added to the usual substances used in the manufacture of carbon electrodes and electrode jointings for electric furnaces.—B. N.

Electrodes; Manufacture of ——. Electric furnace and method of producing molten magnetite therein. A. P. Scott, Chicago, Ill., Assignor to Chile Exploration Co., New York. U.S. Pats. (A) 1,226,121, and (B) 1,226,122, May 15, 1917. Date of appl., Nov. 17, 1915.

(A) HOLLOW electrodes are formed by pouring molten magnetite, at about 1590° C., into moulds heated to about 350° C., the moulds being provided with a heated removable top in the form of an extension. The mould is left undisturbed for about one minute, and the magnetite still remaining molten is then poured out, leaving a hollow electrode, which is stripped from the mould at about 1100° or 1200° C. It is annealed by immersion in a finely-divided material, for a sufficient length of time to permit the desired cooling to take place. (B) A single-phase, alternating-current electric furnace of the direct arc type is provided with a lower fixed contact, and an upper movable electrode. The bottom electrode is formed from a protective conducting layer of magnetite overlying the bottom contact, and cast magnetite scrap is incorporated with the magnetite layer.

—B. N.

Electric furnace. F. C. Schmitz, New York. U.S. Pat. 1,226,261, May 15, 1917. Date of appl., Nov. 3, 1913.

IS an electric furnace the melting pot is trough-shaped and is supported by a U-shaped beam at each end, and by longitudinal reinforced concrete beams with their ends on the U-beams and their outer flanges projecting beyond the walls. Removable water-cooled units are placed between the longitudinal beams and are supported by means resting on the exposed flanges of the beams. Similar parallel beams and water-cooled units are provided in the end walls of the pot.

—W. F. F.

Refractory-metal [tungsten electric resistance] tube. W. D. Coolidge, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pat. 1,226,171, May 15, 1917. Date of appl., Feb. 5, 1916.

A RESISTANCE element, for an electric furnace, is formed from a homogeneous, pressed and sintered tungsten tube, with copper terminals autogenously united to it.—B. N.

Insulator and composition of material for [electrical] insulating and other purposes. F. M. Locke, Victor, N.Y. U.S. Pat. 1,226,088, May 15, 1917. Date of appl., June 16, 1914.

AN insulator, for high voltage current, is formed

by fusing silicon and boron compounds with a fluorine compound to form a homogeneous body, and then moulding the mass.—B. N.

Process of eliminating and recovering acids or metallic salts [from vulcanised fibre]. U.S. Pat. 1,226,279. See V.

Process of securing potassium cyanide from water-insoluble potassium-containing minerals. Process of securing water-soluble potassium compounds from water-insoluble potassium-containing minerals. U.S. Pats. 1,226,811 and 1,226,812. See VII.

Process of making [purifying] caustic soda. U.S. Pat. 1,227,153. See VII.

Electroplating non-conducting substances with copper. Eng. Pat. 106,181. See X.

Method of producing smoke for curing meats. U.S. Pat. 1,225,798. See XIXA.

XII.—FATS; OILS; WAXES.

Olive and other oils; Rapid method of obtaining neutral — suitable for the preparation of camphorated oil. G. Cordier and A. Lesure, J. Pharm. Chim., 1917, 15, 369—381.

To remove free fatty acids from olive oil intended for the preparation of camphorated oil for injection, the French Codex prescribes that the oil should be washed with alcohol, but the method is tedious and removes only part of the acidity. A much more rapid and effectual process is to neutralise the free fatty acids with alkali, in the presence of alcohol, which will dissolve nearly the whole of the resulting soap. The oil is freed from the last traces of alcohol by heating, and the soap dissolved in this alcohol is left completely insoluble in the oil, and may be separated by hot filtration.—C. A. M.

Peanut [arachis] oil; Detection of — in olive oil R. Land. Amer. Perfumer, 1917, 12, 89.

THE following modification of a method devised by Franz is recommended for the detection and approximate determination of arachis oil in olive oil:—One c.c. of the oil is saponified with 5 c.c. of 8% alcoholic potassium hydroxide solution (80 grms. of potassium hydroxide in 80 c.c. of water made up to 1 litre with 90% alcohol). The flask is fitted with a condensing tube 80 cm. long and is heated on the water-bath, with continuous shaking, until the oil is saponified (1 min.). The soap solution is cooled to 25° C. and treated with 1.5 c.c. of dilute acetic acid (1:2) and 5 c.c. of 70% alcohol. If the liquid becomes turbid, as is usually the case in the presence of much arachis oil, the flask is heated on the water-bath, until clear solution is obtained. It is then slowly cooled, and the temperature at which a flocculent deposit begins to form is noted. The crystallisation temperature for the alcoholic fatty mixture from pure olive oil usually falls between 13° and 11° C., but in exceptional cases may be somewhat lower. In the case of arachis oil the crystallisation temperature is about 40° to 41° C. Should the temperature fall to 15° C. without crystallisation taking place the quantity of arachis oil, if present at all, must be less than 5%. Franz gives the following crystallisation temperatures for mixtures of olive oil and arachis oil:—Pure olive oil, 13-5

with 5% arachis oil, 16.9°; with 10%, 19.8°; with 20%, 25.7°; with 30%, 29.2°; with 40%, 31.5°; with 50%, 33.8°; with 60%, 35.3°; with 70%, 36.6°; with 80%, 38.0°; with 90%, 39.3°; and pure arachis oil, 40.3° C. The formation of a deposit at 16° C. may be due to the presence of insufficient acetic acid, for, in exceptional cases, the potassium salts precipitate the myristic acid. Should such a precipitate be obtained an additional three drops of acetic acid is added, and the flask heated on the water-bath until a clear solution is obtained, which is then cooled as before.—C. A. M.

Perilla oil and pawlownia [tung or wood] oil in Japan. U.S. Cons. Rep. No. 105 of 1917.

THE average annual crop of perilla seed in Japan is approximately 1,000,000 kin (1,230,000 lb.); 1,283,662 U.S. gallons of perilla oil, worth \$691,742, and 930,436 gallons, valued at \$186,894, were produced in Japan in 1912 and 1913, respectively. An oil used in Japan in the manufacture of oil-paper and paints, and for illuminating purposes, is obtained from the fruit of a tree, *Aleurites cordata* ("oil pawlownia"). This tree had been growing wild in Japan until four years ago, when it was for the first time, on a very small scale, cultivated for commercial purposes. The use of the "oil pawlownia" product has been known in Japan for a long time, but has not yet acquired any commercial importance. The oil is extracted by the most primitive methods (drying, pounding, steaming, and crushing) by producers on their farms. Japan's output is about 1,500,000 bushels of nuts annually, from which 238,309 gallons of oil, worth \$110,000, is obtained. None of this oil is exported. Shells and kernels crushed together give 36.1% of oil, while 48.85% of oil is obtained from the kernel.

Unsaponifiable matter in oils, fats, and waxes; Determination of —. J. M. Wilkie. Analyst, 1917, 42, 200—202.

FIVE grms. of the oil, etc., is heated with 12.5 c.c. of 2N-alcoholic potassium hydroxide solution for $\frac{1}{2}$ to 1 hour in a flask beneath a reflux condenser, and is then transferred to a separating funnel with 50 c.c. of water and extracted with successive portions of 40, 30, and 30 c.c. of ether. The ethereal extracts are united in a separating funnel containing about 20 c.c. of water. The latter is run off without shaking, and the ethereal solution is washed with 2, 5, and 30 c.c. of water, and evaporated, and the residue weighed. In the case of sperm and similar oils a fourth extraction with 30 c.c. of ether is required. The difficulty of treating saponified beeswax with ether may be overcome by introducing the soaps of the fatty acids of ordinary oils, and especially those of linseed and castor oils, which have a solvent action upon hydrocarbons:—A mixture of 0.5 gm. of the beeswax with 4.5 grms. of castor oil is saponified with 12.5 c.c. of 2N-alcoholic potassium hydroxide solution for 1 hour, and the soap solution transferred to the separator with 40 c.c. of water at 30° C., and extracted with 50, 40, 40, and 30 c.c. of ether. The ethereal extracts are washed with 2, 5, and 30 c.c. of water and evaporated, and a deduction made from the residue for the known unsaponifiable matter in the castor oil. The results thus obtained agree well with those normally given by oils, fats, and waxes. In the case of medicinal cod liver oil the unsaponifiable matter is often distinctly crystalline.—C. A. M.

Oils; Rapid method of determining the suitability of — for soap-making. R. Lecoq. Bull. Soc. Chim., 1917, 21, 101—103.

A SMALL quantity of the oil may be converted

into a neutral soap by the action of the exact quantity of alkali indicated by the saponification value, provided that the following conditions are observed. A good emulsification, which is essential, can only be obtained with weak lyes (8° to 10° B., sp. gr. 1.059—1.074), but complete saponification cannot be effected by lyes weaker than this. To obtain good emulsification it is advisable to add the lye to the oil rather than the oil to the lye. The quantity of sodium chloride required for "salting out" a neutral soap varies with the nature of the soap, and the soaps will contain variable amounts of water. The addition of a special soap (10 grms. in 56 c.c. of water) to 100 grms. of the oil promotes rapid emulsification. The mixture is heated on the water-bath in a 750 c.c. conical flask the mouth of which is covered with a perforated watch-glass through which passes an agitator. The amount of alkali solution (in about 60 c.c.), calculated from the saponification value, is added at the rate of about 12 c.c. every 30 mins., and after boiling the mixture for $\frac{1}{2}$ hours saponification is complete. Potassium (soft) soaps thus prepared require dilution to bring them to the conventional standard of 50% of water. In the case of soda soaps the product is dissolved in 400 c.c. of water, and the soap precipitated by the addition of 125 grms. of salt, the liquid decanted, and the soap dried with the aid of a pump. Fatty acids are best saponified by adding them after melting, in two fractions (3 parts and 1 part), at an interval of 30 mins., to the whole of the hot alkali lye. Saponification is complete after boiling for 1 hour.—C. A. M.

PATENTS.

Oil; Removing catalyst from —. C. Ellis, Montclair, N.J. U.S. Pat. 1,221,291, May 1, 1917. Date of appl., Feb. 5, 1916.

OILY material containing a finely-divided catalyst is passed through a filtering material consisting of silicic acid precipitated on fullers' earth or other solid material in a fine state of division.—C. A. M.

Product of hydrogenation [nickel catalyst]. C. Ellis, Montclair, N.J. U.S. Pat. 1,226,620, May 15, 1917. Date of appl., Feb. 7, 1917.

A CATALYST suitable for hydrogenation processes consists of a "non-noble metal" in colloidal form, such as colloidal nickel, suspended in hydrogenated fatty or other organic material.—C. A. M.

Fats and oils; Apparatus for the decomposition of —. B. E. Reuter, Assignor to Reuter Process Co., Chicago, Ill. U.S. Pat. 1,227,198, May 22, 1917. Date of appl., Nov. 7, 1913.

FATS or oils are heated in an open tank in which is a steam jet coil, and are then transferred to a closed tank where they are mechanically agitated and heated by means of a steam jet coil. The glycerin water from the decomposition is received in a third tank, whilst the fatty acids are transferred to a closed bleaching tank provided with a closed steam coil and with a mechanical agitator. Access of air to the contents of the second tank is prevented by the introduction of steam at practically atmospheric pressure into the upper part of the tank.—C. A. M.

Soap or the like. W. P. Thompson, Liverpool. From F. C. Simpson, Pretoria, S. Africa. Eng. Pat. 106,197, Aug. 5, 1916. (Appl. No. 11,072 of 1916.)

THE soap consists of a mixture of soft soap (1 part), petrol (1 to 3 parts), and water (1 to 8 parts), to

which may be added 90% alcohol in a proportion not exceeding $\frac{1}{2}$ fl. oz. in 5 fl. oz. One or more of the following substances may also be introduced:—Stearic acid, borax, hydrogen peroxide, *liquor cresolis saponatis*, kaolin, kieselguhr, carbon tetrachloride, Castile soap, and tribasic sodium phosphate, preferably in specified proportions. An ingredient which will prevent the mixture from being readily inflammable (e.g., carbon tetrachloride) may take the place of part of the petrol in the soap.—C. A. M.

Soap-like detergents and the manufacture thereof. W. Feldenheimer, London. Eng. Pat. 106,423, May 19, 1916 (Appl. No. 16,628 of 1916)

LYES or mixtures of lyes and curds (particles of soap contained in the lyes), which have been separated from soap during the boiling process, are treated with ground "maize-cones" (about 15%) while at a temperature of 80° to 90° C., and the mixture is heated to boiling point and allowed to cool. China-clay (about 15%) may also be added with the ground maize-cones.—C. A. M.

Process of making a nickel catalyst. U.S. Pat. 1,226,915. See I.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Oleoresin of Douglas fir. A. W. Schorger, J. Amer. Chem. Soc., 1917, 39, 1010—1044.

THE author examined two authentic samples of oleoresin from the heartwood of Douglas fir, possessing the following constants:—Sp. gr. at 20° C., 0.993 and 0.989; $[\alpha]_D^{25} = +2.84$ (second sample only); acid value, 115.6 and 114.2; saponif. value, 121.7 and 120.5; volatile oil, 30.4 and 28.64%; colophony, 68.82 and 69.77%. The volatile oil was found to consist mainly of *l*- α -pinene (b. pt. 156°—157° C.; sp. gr. at 20° C., 0.859; refr. ind., $n_D^{20} = 1.4670$; $[\alpha]_D^{25} = -47.52$) together with smaller quantities of *l*-limonene and *l*-terpineol. The *l*- α -pinene yielded pinonic acid on oxidation, but, as was anticipated from its high rotatory power, it formed no nitroschloride. It is doubtless identical with the "terpene" of Frankforter and Frary (this J., 1906, 1107). A sample of oleoresin from the sapwood of Douglas fir yielded 22% of volatile oil containing *l*- α -pinene (b. pt. 156°—158° C.; sp. gr. at 15° C., 0.8629; $[\alpha]_D^{25} = -18.96$; nitroschloride, m. pt. 103° C.) besides *l*- β -pinene and probably *l*-limonene.—J. H. L.

Theory of colour-lakes. Baudisch. See IV.

PATENTS.

Ink [; Printing —] and process of making the same. A. Rogers, Brooklyn, N.Y. U.S. Pat. 1,224,668, May 1, 1917. Date of appl., Feb. 1, 1917.

A NEWSPAPER ink is prepared by mixing 39% of a thickened odourless, asphalt-base petroleum residue, with about 47% of oil of 43° B. (sp. gr. 0.824) known as "300" oil," about 4% of rosin, 0.25% of chip soap, and 10% of carbon black; or the petroleum residue may be heated until it is odourless and has a density of about 14.5° B. (0.909), and is then mixed with about two-thirds of its vol. of "300" oil," about 5% of rosin, 12% of carbon black, and 0.25% of soap.—C. A. M.

Condensation product, and process of making same. Synthetic gum. Artificial gum and process of making same. (A) W. A. Beatty, Assignor to G. W. Beadle; (B) and (C) W. A. Beatty, New York. U.S. Pats. (A) 1,225,748, (B) 1,225,749, and (C) 1,225,750, May 15, 1917. Dates of appl., (A) June 6, 1912; (B) and (C) June 30, 1915.

(A) A CONDENSATION product, consisting of a brittle, odourless gum which is soluble in alkalis, acetone, alcohol, amyl alcohol, amyl acetate, glacial acetic acid, and tetrachloroethane; insoluble in linseed oil, turpentine, and mineral oils; converted into a substance insoluble in alkalis by the action of an acid; and by heat into a substance insoluble in the above-named solvents, is obtained by condensing a substance having the formula $R_2C(C_6H_4OH)_2$ —where R is an alkyl group—with a substance containing at least one methylene group. (B) The condensation product obtained by heating $R_2C(C_6H_4OH)_2$ —where R is an alkyl group—with a substance containing at least one active methylene group, in presence of alkali at 100°—150° C., is further heated, when a hard, inodorous, transparent, non-brittle and not easily inflammable substance, insoluble, and unacted upon by acids, alkalis, acetone, alcohol, amyl alcohol, amyl acetate, glacial acetic acid, tetrachloroethane, or mixtures of these, is produced. (C) A gum, soluble in alcohol and alkali, and convertible into an insoluble mass, is obtained by condensing a ketone, such as acetone, or an impure ketone, with a cresol, or mixture of cresols, or an impure phenol containing cresol, and condensing the resulting product with an aldehyde, such as formaldehyde. (See also Fr. Pat. 447,647 of 1912; this J., 1913, 244.)—E. W. L.

Floor covering. D. F. Haverstick, Trenton, N.J. U.S. Pat. 1,225,954, May 15, 1917. Date of appl., May 17, 1916.

THE floor covering consists of a backing of suitable fibrous sheet material saturated with a water-proofing substance, covered by an impervious layer of Manila copal, or a mixture of the latte and acaroid resin; and a top or surface layer of flexible material.—E. W. L.

Paint and process of making same. J. Jacob, Maastricht, Netherlands. U.S. Pat. 1,226,888, May 22, 1917. Date of appl., Mar. 7, 1916.

SEE Eng. Pat. 16,448 of 1915; this J., 1916, 933.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Caoutchouc or its homologues: Polymerisation isoprene, divinyl, and dimethylerythrene to — I. Ostromyslenski. J. Russ. Phys.-Chem. So. 1916, 48, 1071—1114.

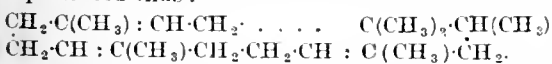
THE author has investigated the different caoutchoucs obtained by polymerisation from (1) mixtures of isoprene with amylenes, (2) isoprene, (3) mixtures of erythrene with butylenes, (4) erythrene, and (5) $\beta\gamma$ -dimethylethyrene. The determination of the physical properties of different caoutchoucs and that of the two new constants (this J., 1916, 58) renders it necessary to modify the views formerly held with respect to their constitution and the author now considers that higher and lower caoutchouc-like polymerides of one and the same diolefin do not exist, but that the various isomeric caoutchoucs are polymerides of one and the same magnitude. Thus, the isomerism of "individual" caoutchoucs is determined.

mined solely by the positions of the ethylene linkages of the nucleus or by the positions of the methyl groups in the side chains.

The four isoprene-caoutchoucs described below are obtained under conditions of catalytic thermopolymerisation which when applied to erythrene yield always one and the same caoutchouc. In erythrene-caoutchouc, as in erythrene, there are no methyl groups but the number of double linkages present is the same as in isoprene-caoutchouc. Consequently, the isomerism of α -, β -, γ - and δ -isoprene-caoutchoucs is conditioned by differences in the positions of the methyl groups, i.e., of the side chains.

The same conclusion may be drawn from the existence of only one form of $\beta\gamma$ -dimethylethyrene-caoutchouc. The two methyl groups of $\beta\gamma$ -dimethylethyrene are arranged symmetrically in the molecule and thus, unlike the single methyl group of isoprene, cannot give rise to isomerides. The isomerism of normal γ -isoprene-caoutchouc with normal ϵ -caoutchouc is, however, probably conditioned by the different positions occupied by their ethylene linkages, since the conditions in which isomerides are formed are those in which the corresponding isomerides of erythrene-caoutchouc are obtained.

Two abnormal isoprene-amylene-caoutchoucs are described: (1) the α -form, obtained first by Matthews and Strange, and later, under the name of sodium-isoprene-caoutchouc, by Haries; (2) the β -isomeride, here described for the first time and prepared in quantitative yield by the catalytic action of barium peroxide or benzoyl peroxide on the α -form in toluene solution. α -Isoprene-amylene-caoutchouc forms a viscous sticky mass which adheres firmly to wood, metal, glass, etc., and is easily drawn out into long threads; when exposed to the air it becomes covered with an oxidised layer which is non-adhesive. When vulcanised it yields a product which is not sticky or plastic but is also devoid of the elastic properties of natural caoutchouc and may be easily torn like a rotten rag; its elastic point evidently lies above its temperature of decomposition. This caoutchouc has no industrial application and when added to natural caoutchouc, even to the extent of 1%, appreciably lowers the value. The molecule of α -isoprene-amylene-caoutchouc probably contains the amylene as a saturated radicle, $-\text{C}(\text{CH}_3)_2\text{CH}(\text{CH}_3)-$ the proportion of bromine combined diminishing as that of the amylene mixed with the isoprene increases. The structure may be represented thus:—



That amylene is present in the molecule is supported by the gradual and direct alteration of the physical properties as the proportion of amylene used increases; for example, the liquid state is more and more nearly approached. Elementary analysis is insufficient to detect the presence of even considerable proportions of amylene. If, in the preparation of α -isoprene-amylene-caoutchouc, the amylene is replaced by isobutylene, caoutchoucs with similar properties are obtained.

β -Isoprene-amylene-caoutchouc forms a compact mass quite free from pastiness and at about 100° C. acquires all the elastic properties of natural caoutchouc, its elasticity point being thus lower than that of the α -isomeride. In the air β -isoprene-amylene-caoutchouc is oxidised moderately rapidly to a very compact, solid, amorphous, oxygenated mass, which can be readily pounded to a fine powder; as the oxidation proceeds the elasticity point and the "fatal temperature" gradually rise. Vulcanisation converts it into a product which at 80°–90° C. exhibits all the properties of vulcanised natural caoutchouc.

α -Isoprene-caoutchouc, prepared by the action

of sodium on chemically pure isoprene at 60°–75° C. for 10–11 hours, differs considerably from α -isoprene-amylene-caoutchouc, which is obtained from isoprene containing amylene, in particular from the isoprene prepared by the catalytic removal of two molecules of hydrogen chloride from dichloro-isopentane at a low pressure: α -isoprene-caoutchouc forms a colourless, glass-transparent non-glutinous, non-fluid, insoluble mass, which can be rolled hot or easily broken, but not drawn into threads; it swells up slowly and slightly in various media but does not dissolve even in traces. Its elasticity is low and the noise of its impact resembles that of a solid body. It is an abnormal caoutchouc, its elasticity point lying above 110° C. and its "fatal temperature" somewhat below 0° C.; at about 110° C. it acquires all the elastic properties of natural caoutchouc. It is vulcanised by sulphur or nitro-compounds, although more slowly than caoutchoucs of the normal series, and it is applicable in practice only for certain special purposes. β -Isoprene-caoutchouc, obtained in quantitative yield by the action of a mixture of sodium with barium (or benzoyl) peroxide on pure isoprene at 60°–70° C., has usually a pale cinnamon colour and is transparent in thin layers; it flakes but has no stickiness or fluidity and may be rolled comparatively easily even at 60° C. It is an abnormal caoutchouc, its elasticity point being about 80°–90° C., which is somewhat lower than that of the α -isomeride, and its "fatal temperature" about –10° C.

γ -Isoprene-caoutchouc, prepared in small yield (40%) by the action of barium or benzoyl peroxide or an alkali sulphide or polysulphide on chemically pure isoprene at 45°–50° C. for 2–4 months, is an almost colourless, glass-transparent, brittle, amorphous substance, which cannot be drawn into threads but is possessed of considerable elasticity and spring; after deformation it resumes its original form and dimensions almost instantaneously. It is a normal caoutchouc, its elasticity point and "fatal temperature" being about the same as those of natural caoutchouc.

α -Isoprene-caoutchouc, prepared from β -myrcene, is of the normal series.

ϵ -Isoprene-caoutchouc is the name proposed by the author for the caoutchouc obtained in quantitative yield by gently heating isoprene with sodium in an atmosphere of carbon dioxide. It is formed also by the action of ultra-violet light on isoprene in presence of sodium and carbon dioxide. It is a normal isoprene-caoutchouc and quite insoluble. This form appears to be a physical isomeride of the normal γ -isoprene-caoutchouc, the elasticity points and the "fatal temperatures" being apparently the same for the two. Towards a mixture of sodium and carbon bisulphide isoprene is quite passive, both at the ordinary temperature and on heating.

Recovered caoutchouc is always abnormal, its "fatal temperature" and elasticity point being relatively high; only above 120° C. does it regain the elastic properties of ordinary caoutchouc. The process of recovery is evidently accompanied by rearrangement in the nucleus.

α -Erythrene-caoutchouc is obtained by heating erythrene alone or with sodium (0.3–0.5%), barium peroxide, sodium and barium peroxide, or first with one of these and then with the other. When, however, the erythrene is heated in presence of sodium and in an atmosphere of carbon dioxide, it is converted into an insoluble ϵ -caoutchouc analogous to the normal insoluble ϵ -isoprene-caoutchouc. The isomerism appears to be of a chemical character and conditioned only by the different positions of the ethylene linkages in the molecule. A third isomeride (α') is often formed in small proportion, together with the α -variety, when erythrene is heated with sodium in absence

of carbon dioxide. This differs from α -erythrene-caoutchouc only in its insolubility and is a highly elastic, colourless, glass-transparent substance, which swells in light petroleum, turpentine, etc., and is readily vulcanised under the ordinary conditions given for the vulcanisation of synthetic caoutchoucs.

α -Erythrene-caoutchouc is a colourless, transparent, elastic, highly resilient, non-adhesive substance, which is readily rolled in the hot, but if rolled in the cold requires slight admixture of a liquid of high boiling point, since otherwise it crumbles between the rolls like factis; after deformation, if not too prolonged, it recovers its form and dimensions almost instantly. This caoutchouc belongs to the normal series, its elasticity point and "fatal temperature" being somewhat lower than those of Para caoutchouc; thus, at normal temperatures it is more elastic than natural caoutchouc, and it remains elastic when Para rubber reaches its elasticity point. It is vulcanised more rapidly and easily than the natural rubber under ordinary conditions or by means of benzoyl peroxide, nitro-compounds, chlorine, etc. The vulcanised product is highly elastic and resilient and its residual elongation negligible; it is more resistant to deformation than vulcanised natural caoutchouc, but its resistance to shearing is slight. If, before vulcanisation, the caoutchouc is caused to swell by means of albumin or some other substance with colloidal properties, the resulting product corresponds in properties with vulcanised natural caoutchouc.

α -Erythrene-butylene-caoutchouc, prepared by the action of sodium on erythrene containing butylene, closely resembles α -isoprene-amylene-caoutchouc.

β -Erythrene-butylene-caoutchouc, prepared by heating a toluene solution of the α -isomeride with barium peroxide (0.5—5%) at 60°—75° C. for 1—7 days, is not sticky, very compact, somewhat resistant to shearing, cannot be drawn into threads, and is moderately easily rolled in the cold. It belongs to the normal series and is readily vulcanised to a product showing all the properties of vulcanised natural caoutchouc; it dissolves in benzene, light petroleum, turpentine, etc. The isomerisation of the α - to the β -isomeride occurs only if the former contains comparatively little butylene, erythrene containing 10—15% of the latter being utilisable.

All the caoutchoucs which have been obtained from $\beta\gamma$ -dimethylethythrene (Concunier, Ann. Chim. Phys., 1892, [vi.], 26, 489; Kondakoff, J. prakt. Chem., 1901, [ii.], 64, 109; Harries, this J., 1911, 1973) have been investigated and are found to be identical; they usually contain varying proportions of the dimeride and of foreign liquids, which lower the elasticity point and the "fatal temperature." The form obtained by the action of sunlight on the monomeride (α') does, indeed, differ from that resulting from the thermo-polymerisation of $\beta\gamma$ -dimethylethythrene (α) by its solubility in various media, but this difference is doubtless conditioned by differences in the physical state, the two being merely colloidal modifications of one and the same hydrocarbon. A number of different catalysts were employed, but in all cases the α -form was obtained in the hot and mostly the α' -form at temperatures up to 20°—30° C. Further, polymerisation of $\beta\gamma$ -dimethylethythrene in presence of foreign olefins yields always the ordinary α - or α' -modification, mixed or "combined" forms not being obtained in this case. The α -form of $\beta\gamma$ -dimethylethythrene-caoutchouc, obtained at any temperature from 40° to 170° C. and especially rapidly in presence of a small proportion (1%) of piperidine piperidylthiocarbamate, belongs to the abnormal series, its elasticity point being 125°—130° C. and its

"fatal temperature" -5° C. When vulcanised it acquires all the elastic properties of natural caoutchouc at 109° C.—T. H. P.

Erythrene-caoutchouc: Synthesis of the symmetrical and higher chlorides of—. New chlorides of natural, isoprene- and erythrene-caoutchoucs. I. Ostromyslenski. J. Russ. Phys.-Chem. Soc., 1916, 48, 1132—1151.

It has been already shown that polymerised vinyl bromide represents the symmetrical bromide of erythrene-caoutchouc and the natural supposition that caouprene chloride is the corresponding symmetrical chloride is now justified experimentally. Baumann (Annalen, 1872, 163, 317) described caouprene chloride as a viscous, plastic, insoluble mass, but these properties are caused by admixture of extraneous liquids such as the higher chloro-derivatives of ethane, esters of the fatty acids, etc., the chemically pure chloride being a snow-white, amorphous mass readily reducible to a fine powder. Caouprene chloride is rapidly formed by the action of the light from a quartz mercury lamp on liquid vinyl chloride and exists in a soluble α -modification, which swells in various media to a more or less mobile layer, and in a more stable, insoluble γ -form; the former is completely converted into the latter by prolonged heating at 30°—40° C. or by the action of the light from a mercury lamp. The relation between the α - and γ -caouprene chlorides is undoubtedly analogous to that between the α - and α' -forms of $\beta\gamma$ -dimethylethythrene-caoutchouc (see preceding abstract). The asymmetric chlorides of erythrene-caoutchouc and natural caoutchouc also exist in a soluble α - and an insoluble γ -modification. The molecular weight of α -caouprene chloride, measured cryoscopically in ethylene bromide solution, is 1021, which corresponds with the molecule $(\text{CH}_2\text{CHCl})_{16} = 999$; this result is in agreement with that obtained for caouprene bromide. When heated with one of a number of different compounds, α - and γ -caouprene chlorides give ebonite-like substances which are identical with those obtained under analogous conditions from the asymmetric chloride of erythrene-caoutchouc (see following abstract) and in their physical and mechanical properties closely resemble the ebonites obtained from the chloride of natural Para caoutchouc.

Like the bromide, caouprene chloride is a unicyclic halogenide, the ring containing sixteen CHCl-CH_2 groups. The absence of double linkages is shown by its behaviour towards various reagents, such as permanganate, tetranitromethane, etc., and especially by its stability towards oxidising agents like chromic acid and concentrated nitric acid (sp. gr. 1.35), by its passivity towards halogen hydracids, including boiling hydrochloric acid, and towards concentrated sulphuric acid, and by the ability of the halogen present to take part in reactions of double decomposition.

Unlike all natural and synthetic caoutchoucs and all their known halogenated derivatives, which are insoluble in acetone, α -caouprene chloride dissolves readily in this solvent. Gradual addition of a solution of the calculated amount of chlorine in carbon tetrachloride to a solution of erythrene-caoutchouc in the same solvent yields an asymmetric chloride of erythrene-caoutchouc, $\text{C}_{32}\text{H}_{48}\text{Cl}_{16}$, isomeric with caouprene chloride, from which it differs only in the positions of the halogen atoms; this chloride also dissolves readily in acetone. Under the same conditions, natural caoutchouc gives a chloride of normal composition, $\text{C}_{32}\text{H}_{40}(\text{CH}_3)_8\text{Cl}_{18}$, also readily soluble in acetone. Like caouprene chloride, each of these chlorides exists in α - and γ -modifications. Owing to the solubility of the chlorides in acetone, they may be freed from admixtures of free caoutchouc

and of colloidal higher chloride and thus obtained in a chemically pure condition.

The polymeride of dichloroethylene yields a peculiar ebonite and is termed, by analogy, chlorocauprene chloride. It is isomeric with the higher chlorides of erythrene-caoutchouc, obtained by the action of chlorine on a solution of the free caoutchouc, the isomerism depending on the position of the halogen. Under the influence of the light of a quartz mercury lamp, asymmetric dichloroethylene polymerises almost instantly.

Cauprene chloride has been prepared from alcohol and chlorine by the following reactions: (1) $C_2H_5OH = C_2H_4 + H_2O$, (2) $C_2H_4 + Cl_2 = C_2H_4Cl_2$, (3) $C_2H_4Cl_2 + NaOH = NaCl + H_2O + CH_2 : CHCl$ and (4) $16(CH_2 : CHCl)_{16}$. Owing to the "poisoning" of the alumina used as catalyst in the dehydration of the alcohol, the yield of ethylene obtained gradually falls. It is found that this alumina may be regenerated by cautious ignition in a current of air and subsequent treatment with superheated steam. The yield of ebonite obtained amounts to at least 60–75 parts per 100 parts of absolute alcohol and this is probably capable of considerable increase by varying the experimental conditions employed. Pure vinyl chloride has b.pt. $-12^\circ C.$ and not $-18^\circ C.$ as stated in the literature.

The asymmetric chloride of erythrene-caoutchouc, $C_{32}H_{48}Cl_{16}$ (see above), is a snow-white, amorphous mass, which is readily powdered and becomes electrified when sifted through silk; it cannot be distinguished from cauprene chloride. It behaves towards permanganate like a saturated compound, remains colourless when treated with tetranitromethane, reacts with phenol losing hydrogen chloride, and is passive towards nitric acid (sp. gr. 1.35), concentrated sulphuric acid, boiling fuming hydrochloric acid (sp. gr. 1.19), and boiling chromic acid. Under similar conditions this chloride and cauprene chloride yield one and the same ebonite or one and the same plastic mass resembling celluloid or guttapercha (see following abstract); the two substances behave similarly towards camphor, naphthalene, copper oleate, etc., and are soluble in the same solvents.

The chloride of natural Para caoutchouc cannot be distinguished from that of synthetic normal γ -isoprene-caoutchouc, although they undoubtedly differ in the positions of the methyl groups in the nucleus. They are almost white, amorphous substances, which become electrified when rubbed and, when pure, are easily powdered. Chemically and physically they behave like homologues of the chlorides of erythrene-caoutchouc.

When treated in light petroleum (b.pt. up to $80^\circ C.$) solution with a current of anhydrous chlorine at $0^\circ C.$, α -erythrene-caoutchouc yields a higher chloride, $C_{32}H_{32}Cl_{32}$, which is white, amorphous, and opaque and may be readily crushed.—T. H. P.

Ebonite, celluloid, or guttapercha; Preparation of substances equivalent to—. *Synthesis of vulcanised caoutchouc.* I. Ostromyslenski. J. Russ. Phys.-Chem. Soc., 1916, 48, 1114–1131.

WHEN treated with free chlorine, either natural or synthetic caoutchouc is converted into a substance which exhibits the properties of ebonite, in some cases to an enhanced degree. In its stability towards alkali or high temperatures it is the equal of ebonite and, unlike the latter, it is very stable towards acids. Thus, the product obtained by the action of chlorine on synthetic normal erythrene-caoutchouc is not changed by the prolonged action of nitric acid (sp. gr. 1.35), by boiling fuming hydrochloric acid (sp. gr. 1.19), by boiling chromic acid, or concentrated sulphuric acid. It may be worked and polished like the

best ebonite obtained from caoutchouc and sulphur and is equally plastic. Its specific gravity is almost equal to that of ebonite, and it is a better electrical insulator, its conductivity approximating to that of the best types of glass and bakelite. Ordinarily it is black but if prepared under certain special conditions it may be obtained almost white or even colourless and transparent and it is easily coloured. An ebonite-like substance may also be obtained by heating caoutchouc chloride or bromide (this J., 1916, 370) in an iron mould out of contact with air at the ordinary temperature employed in vulcanising caoutchouc, but the product yielded in this way is always more or less porous.

Cauprene chloride, readily obtainable either from ordinary alcohol and salt through mono- or di-chloroethane, or from carbon, lime, and hydrochloric acid through the carbide, may be easily converted into a plastic mass equivalent in its properties to celluloid, guttapercha, or the best ebonite. When treated with a very small proportion of naphthalene or copper oleate, the chloride yields a highly coherent ebonite; with camphor, paraffin wax, or hexachloroethane, a product corresponding with celluloid is obtained, whilst with oils such as paraffin oil, esters, tri-, tetra- or penta-chloroethane, or with a large excess of naphthalene, etc., a substance with all the properties of natural guttapercha is formed. This synthetic ebonite exhibits all the mechanical properties of ordinary ebonite and is furthermore non-inflammable and of high stability towards acids or an atmosphere of moist chlorine. Analogous products are obtainable in a similar manner from the higher chloride of caoutchouc, $C_{40}H_{48}Cl_{32}$, or the homologous chlorocauprene chloride.

—T. H. P.

Rubber plant, rich in rubber, indigenous to Germany. J. Schiller. Gummi-Zeit., 1916, 30, 499–510. Chem.-Zeit., 1917, 41, Rep., 156.

Lactuca viminea (N. O. *Compositae*) occurs in the western districts of the Danube valley and in the Elbe valley to beyond Dresden. It contains pure caoutchouc amounting to 0.49% of the dried plant, 19.06% of the total extractable substances, and 73.21% of the crude rubber. "Wolf's milk" (spurge) contains only 0.27%, "sow thistle" (*Sonchus oleraceus*) 0.16%, *Hevea Braziliensis* and *Kickxia elastica* 0.3%, and guayule (*Parthenium argentatum*) 10% of pure caoutchouc, calculated on the dry weight of the plant.—E. W. L.

XV.—LEATHER; BONE; HORN; GLUE.

Hide; Solubility of— in salt solutions. L. Balderston. J. Amer. Leather Chem. Assoc., 1917, 12, 193–198.

WET-SALTED hide, which has been soaked to remove salt and loose nitrogenous matter, appears to be no more soluble in dilute salt solutions than in water. A 20% salt solution exerts a marked preservative effect.—F. C. T.

PATENTS.

Leather, imitation; Methods and apparatus for making—. A. E. Alexander, London. From The Duratex Co., Newark, N.J., U.S.A. Eng. Pat. 106,336, May 22, 1916. (Appl. No. 7261 of 1916.)

SEE U.S. Pat. 1,190,806 of 1916; this J., 1916, 935. After being coated with the mixture containing nitrated cotton and oil, the fabric is subjected to

a calendering operation before the japanning composition is applied. An apparatus for carrying out the process is also claimed.

Glue joints: Method of waterproofing ——. F. H. Stevens, Horley, Surrey. Eng. Pat. 106,139. Jan. 9, 1917. (Appl. No. 132 of 1917.)

THE surfaces to be joined are moistened with a formaldehyde solution, preferably one containing 25% of a 10% aqueous solution, and are then covered with glue in the usual way. Formaldehyde may be added to the glue itself if the latter be used immediately after the addition.

—C. A. M.

Plastic material [from gelatin]; Process for the manufacture of a non-inflammable and odourless —, and the product thereof. R. Pioget; Paris. Eng. Pat. 106,118. Feb. 10, 1917. (Appl. No. 2047 of 1917.)

MELTED gelatin is treated with a solution containing a decoction of hops and dilute oxalic acid or other dicarboxylic acid of the general formula $C_nH_{2n-2}O_4$, whereby impurities are precipitated and the gelatin is rendered more supple. The liquid gelatin is formed into sticks or sheets, which are dried and coloured, and immersed in a bath containing formaldehyde (25 to 35%), water (25 to 35%), and alcohol (25 to 35%), together with oxalic acid or other dicarboxylic acid, as above, tannin, and glycerin. After impregnation, the sheets, etc., are dried, preferably in hot air, and form a plastic, malleable material, imitating ivory, horn, tortoiseshell, amber, etc., according to the colouring.—C. A. M.

XVI.—SOILS; FERTILISERS.

Soils: Fixation of ammonia in ——. I. G. McBeth. J. Agric. Res., 1917, 9, 141—155.

FIFTY mgrms. of nitrogen as ammonia or ammonium sulphate, chloride, or nitrate, was added to 100-grm. portions of a soil from Riverside, California, and after standing for 30 minutes, the portions were extracted with water, and with hydrochloric acid of concentrations varying from 1 to 10%. The amounts of ammonia in the extracts were then determined by distillation with sodium hydroxide. Determinations of ammonia were also made by direct distillation of the soil with magnesia. The amounts of ammonia found were practically the same for all the compounds used, water extracting about 25% and 10% acid about 52% of the added nitrogen. The nitrogen recovered by the same acid from a Lordsburg soil after similar treatment was also found to be independent of the nature of the anion of the ammonium salt, but the quantity was much less than from the Riverside soil (20% as against 52%). In both cases the magnesia method gave approximately the same figures as the 10% acid extraction method. Boiling the treated soils with sodium or potassium hydroxide solutions resulted in a much greater nitrogen recovery, 2.5 c.c. of the alkali giving the maximum amount (about 65%); and these results seem to hold for semi-arid soils and sub-soils generally. When 100-grm. samples of the two soils containing 50 mgrms. of ammonium sulphate were leached with water until 2400 c.c. of percolate was obtained, it was found that 33% of the added element was removed from the Riverside soil and 14.2% from the Lordsburg soil; 10% hydrochloric acid removed 81.2% from the former soil. The sub-soil of six out of seven semi-arid soils investigated showed an increased

nitrogen fixation with depth, and the fixation was greater the higher the concentration of the applied ammonium salt solution. Increase of temperature diminished the fixation, the amount of nitrogen recovered at 100° C. being only 53.6% of that recovered at 5° C. Fixation was most rapid during the first few minutes, but it continued for several days. When the soils were heated to temperatures not above 200° C. for six hours prior to the addition of the ammonium salt, the percentage recovery was unaffected, but at 250°—300° C. the recovery was much increased. The percentage of nitrogen fixed was nearly constant for small amounts of added ammonium sulphate, but beyond a certain point the percentage decreased, although the absolute amount continued to increase. The ammonia-fixing powers of the two semi-arid soils were reduced by the presence of salts of aluminium, iron, and potassium, but salts of calcium, magnesium, and sodium had practically no effect. The nature of the anion of the added salt was without influence. The amount of calcium brought into solution by ammonium chloride increased with the depth of the soil, but when the chlorides of aluminium, sodium, and magnesium were used as extracting media, the amount of calcium dissolved did not increase with the depth.—E. H. T.

Phosphoric acid in soils: Influence of the presence of calcium carbonate on the determination of available — by Dyer's method. J. N. Sen. Agr. J. India, 1917, 12, 258—265.

THE highly calcareous soils of Bihar, India, when examined by Dyer's method (extraction with 1% citric acid solution), are found to be poor in "available" phosphoric acid. The low results obtained are probably due to the interfering action of calcium carbonate, since the addition of 10% of calcium carbonate to a soil decreased the amount of "available" phosphoric acid from 0.312 to 0.009%. The action of calcium carbonate seems to reach a limit when the quantity added is increased to 20%, larger quantities causing no further diminution of the solvent action. The influence of calcium carbonate is, therefore, not due solely to neutralisation of the citric acid.

—W. P. S.

Lemna minor: Some effects of organic growth promoting substances (auxinones) on the growth of — in mineral culture solutions. W. I. Bottomley. Roy. Soc. Proc., 1917, 89 B, 481—507.

Lemna minor plants were cultivated in dishes of similar size, some of which contained only Detmer's solution, whilst others contained the same quantities of the mineral solution, with the addition of the decomposed phosphotungstic acid fraction or of the silver-baryta fraction, or other fractions of bacterised peat (this J., 1917, 975). It was found that the plants could not grow for any length of time in the solutions containing only mineral substances, and that the presence of soluble organic matter was essential. In addition to the culture solution 368 parts per million of organic matter from the aqueous extract of bacterised peat, the growth of the plants as compared with the control plants was increased 20 times in number and 62 times in weight. The aqueous extract freed from humic acid (corresponding to an addition of 97 parts of organic matter per million) caused the plants to increase 9½ times in number and 29 times in weight; the alcoholic extract (32 parts of organic matter per million) increased the growth by 3½ times the number and 7½ times the weight; and the phosphotungstic acid fraction (13 parts per million) gave 1½ times

the number and $2\frac{1}{2}$ times the weight. The progressive improvement in the appearance of the plants supplied with increasing amounts of auximones was also pronounced. The fact that comparable results were obtained in experiments in which "conductivity" or glass-distilled water was used proved that the beneficial effects of the auximones was not attributable to their neutralising toxic substances in the ordinary metal-distilled water. It is suggested that some of these growth-promoting substances may act directly as nutrients, whilst others act as accessory food materials. (See also this J., 1913, 878, 919, 920; 1914, 366; 1915, 881; 1916, 871).

—C. A. M.

Soil organisms concerned in the nitrogen cycle; Some effects of organic growth-promoting substances (auximones) on —. F. A. Mockeridge. Roy. Soc. Proc., 1917, 89 B, 508—533.

PURE cultures of *Azotobacter chroococcum* from the soil, and of *B. radicola*, the nitrogen-fixing organism of the nodules of leguminous plants, were cultivated in nutrient solutions to which were added small amounts of the different fractions of bacterised peat prepared as described by Bottomley (this J., 1914, 975). It was found that certain organic substances of unknown nature which could be separated from the prepared peat had an appreciable effect upon the rate of nitrogen fixation by these organisms. Similar experiments with nitrifying organisms in soil and in culture solutions showed that the addition of bacterised peat to a fertile soil caused a rapid increase in the proportion of nitrate up to a maximum, above which the growth of the organisms was inhibited by the concentration of the nitrate, and nitrification ceased. The rate of nitrification was greater in soil containing bacterised peat than in that containing an equivalent quantity of soluble ammonia in a form suitable for nitrification. The stimulation of the soil organisms does not depend upon the amount of nitrogen in the bacterised peat, judging by the effect of the phosphotungstic fraction upon the nitrification. It is probable, however, that the methods so far employed do not extract the whole of the auximones from the material. Although the auximone fractions accelerate the rate of nitrification both in soil and in culture solutions they have no influence upon the rate of ammonia formation. On the other hand, they reduce the rate of denitrification whether added to a pure culture of denitrifying organisms or to the soil itself. For example, whilst the amount of gas liberated in 48 hours by the soil alone was 63.0 c.c., that liberated by the same amount of soil to which the phosphotungstic fraction of bacterised peat had been added was only 8.1 c.c. The addition of an aqueous extract of the bacterised peat, however, has practically no effect upon denitrification, and it is suggested that this may be due to the depressing effect of the auximones being counterbalanced by the readily-oxidisable organic matter contained in the soil.

—C. A. M.

Plant growth; Accessory factors for —. O. Rosenheim. Biochem. J., 1917, 11, 7—10.

ACCORDING to Bottomley's experiments, peat rotted by aerobic soil organisms, then sterilised, and inoculated with nitrogen-fixing bacteria, was found to produce striking results in the development of pot-grown plants; later it was established that the presence of nitrogen-fixing bacteria was not an essential factor. The author has investigated the chemical composition of the soluble portion of the treated peat:—15 grms. of the substance was

steeped for 18 hours in 2 litres of water; 500 c.c. of the clear brown solution was decanted off and diluted to 1250 c.c. This extract contained 0.045% of total solids, 0.031 of organic substances, 0.011% of inorganic substances, and 0.005% of nitrogen. Plants of *Primula* grown in pots and treated with 60 c.c. of this extract showed a remarkable development of growth as compared with control plants, and it was found that treatment with a further 60 c.c. had no additional influence. It is to be noted that the quantity of plant food contained in 60 c.c. of the dilute extract is so infinitesimal that the results cannot be attributed to a direct nutrient action; an analogy is therefore suggested to the effects produced on animal growth by small quantities of accessory food substances termed "vitamines." Some of these latter are soluble in alcohol and are precipitated by phosphotungstic acid. Extracts were made under comparative conditions from garden soil, natural peat, and treated peat, using 15 grms. of material in 100 c.c. of water. To 20 c.c. of each filtrate was added 2.5 c.c. of concentrated sulphuric acid in 10 c.c. of water; the volume was made up to 50 c.c. and each extract treated with 30% phosphotungstic acid solution. The extract from the treated peat gave an immediate copious precipitate, that from natural peat only a faint opalescence, and that from garden soil remained clear. Extracts of treated peat made with alcohol or acetone, evaporated, and redissolved in water, also gave a heavy precipitate with phosphotungstic acid; a considerable part of the phosphotungstic acid precipitate was insoluble in acetone. The chemical examination of the treated peat extract lends strong support to the "vitamine" analogy deduced from the experiments on plant growth which should serve as a working hypothesis for future investigations.

—J. F. B.

Soil nitrogen; Relation of the transformation and distribution of — to the nutrition of citrus plants. I. G. McBeth. J. Agric. Res., 1917, 9, 183—251.

REPRESENTATIVE samples of soils to which nitrogenous materials were to be added were taken from each plot by means of borings to a depth of 12 in., and these were mixed, sifted, and kept in closed vessels. The desired quantity of the substance was then added to 1 kilo. of the dry soil, the moisture content brought up to the optimum, and incubation carried out in Mason jars at 28° C. Subsequently the ammonia was determined by extracting the soil with 10% hydrochloric acid, and distilling an aliquot part of the extract with excess of sodium hydroxide. The nitrates were determined by the aluminium reduction method, 24 hours being allowed for the reduction. The conclusions drawn from the experiments were as follows:—Semi-arid soils frequently fail to nitrify dried blood when added in the proportion of 1%, but nitrification always takes place when the addition of blood is not greater than is usual under field conditions. The addition of 1% of dried blood to such soil frequently caused a large accumulation of ammonia in the soil, although the addition of dried blood or other nitrogenous substances in the form of fertilisers caused no accumulation of ammonia. Hence conclusions drawn from studies of nitrification or the formation of ammonia in semi-arid soils to which 1% of dried blood has been added are of questionable value. Green manures, especially those of leguminous character, undergo very rapid nitrification, and as much as 50% of the nitrogen in the green plant tissues may be converted into nitrates in 30 days. Green manures, therefore, are suitable for the supply of energy for non-symbiotic nitrogen-fixing organisms. An unsatisfactory distribution of soil

nitrate is often caused by the furrow system of irrigation. Thus, in many citrus groves the surface 6 in. of soil contains more than two-thirds of the nitric nitrogen present in the upper 4 ft. This system of irrigation is also responsible for the production of "nitre spots," the surface scrapings of which may contain as much as 1% of nitric nitrogen. The brown colour of these spots is probably due to several factors, and notably to the deliquescent nature of calcium nitrate. Where the furrow system of irrigation is employed it is advisable to apply the fertilisers at a depth below that to which the land is cultivated. The roots will thus be able to assimilate the available food substances, whereas fertilisers applied nearer to the surface are liable to be carried away by the irrigation. Leaching is also responsible for the loss of nitric nitrogen, and this loss may be best prevented by a winter covering crop. The basin or overhead system of irrigation gives a more satisfactory distribution of soil nitrates than the furrow system, and when combined with a mulching system in which the mulch is not too frequently employed, appears to be the most promising system of irrigation. The occurrence of mottled orange-leaves in citrus plants is accompanied by a higher proportion of moisture, and generally also of nitrogen, than is found in healthy leaves. Extreme mottling is often accompanied by a high proportion of nitrates in the leaves, but the relationship is not invariable.—C. A. M.

Nitrates and nitrites: Assimilation of—[by plants]. [*Separation of nitrates from nitrites.*] O. Baudisch. Ber., 1917, 50, 625—660. (See also this J., 1916, 736, 749.)

THE action of iron and of magnesium compounds on plant life may be due to their power of forming complex compounds with certain proteins. A complex compound of iron and dextrose can be obtained by boiling an excess of a solution of dextrose with an iron salt (FeSO_4 , FeCl_3), and adding a large excess of sodium hydroxide to the yellowish liquid. A green precipitate is formed, which on further heating gives a deep, dark brownish-red solution containing iron in a "masked" form. This solution does not react with potassium nitrate, and is very stable towards heat; but it readily reduces nitrites to ammonia or amines. In this way nitrates may be separated from nitrites. Inasmuch as mannose, lactose, and levulose give similar solutions, but mannitol and sucrose do not, it seems probable that the ability to form such compounds is dependent upon the presence of a hydroxyl group closely connected to one of the groups $\cdot\text{CH}:\text{O}$ or CO . The power of reducing nitrites may depend upon the direct coupling of the nitrate molecule to the iron atom, the liberation of oxygen which oxidises the sugar, and the setting free of hydrogen to effect the nitrite reduction. The liberation of oxygen from nitrates, the reduction of nitrites to ammonia, and the oxidation of the latter to nitrite and nitrate are processes of plant metabolism which can be best studied from the chemical standpoint.—E. H. T.

PATENT.

Fertiliser [from sulphite-cellulose waste liquor], and process for making same. E. C. L. Kressel. Camden, N.J. U.S. Pat. 1,225,825, May 15, 1917. Date of appl., July 21, 1914.

SULPHITE waste liquor is mixed with "biological agents," calcium oxide, and sodium chloride or other alkali chloride. The product is a granular, hygroscopic, and non-putrescible mass, and forms a culture-medium for bacterial development and growth in the soil.—J. B. C. K.

XVII.—SUGARS; STARCHES; GUMS.

Sucrose, inulin, and dextrin: Comparative adsorption of— M. A. Rakuzin. J. Russ. Phys.-Chem. Soc., 1916, 48, 1319—1324.

THE author's previous work indicates that the necessary conditions for adsorption include the colloidal state of the adsorbed substance and adsorbent, the only case observed in which a crystalline substance is irreversibly adsorbed by a colloidal adsorbent being that of the solid paraffins of petroleum by aluminium hydroxide, floridin, etc. In order to test the accuracy of Freundlich's rule, that adsorption is prevented by a tendency to dissociation and by an accumulation of hydroxyl groups, the author has now carried out experiments on the adsorption of sucrose, inulin, and dextrin. The results show that this rule holds only for crystalline carbohydrates, such as sucrose, and inulin; colloidal carbohydrates, on the other hand, are well adsorbed by both aluminium hydroxide and animal charcoal, and in the case of dextrin (commercial "*dextrinum purissimum*"), both these adsorptions are irreversible with respect to boiling water. Further, both adsorptions are quantitative; animal charcoal adsorbs 8.04% of β -achrodextrin and aluminium hydroxide 16.02% of products intermediate to β - and γ -achrodextrins. The above commercial dextrin is found to be a mixture of maltodextrin with β -achrodextrin and products intermediate to β - and γ -achrodextrins.—T. H. P.

β -Glucose [β -dextrose]: Preparation of— A. W. Mangum and S. F. Acree. J. Amer. Chem. Soc., 1917, 39, 965—968. (See also Hudson and Dale, this J., 1917, 349.)

THE preparation of β -dextrose by crystallisation from hot aqueous solutions of the sugar does not always yield a pure product, and the following modification of Behrend's method (Annalen, 353, 106; 377, 220) is recommended. α -Dextrose is dissolved completely in boiling pyridine (e.g., 25 grms. in 25 c.c.) and the solution is allowed to crystallise for 24 hours, preferably in an ice-box. β -Dextrose separates with 1 mol. of pyridine, which it loses readily in the air, *in vacuo* over sulphuric acid, or in an oven at 120° C. If the pyridine is completely removed, the product shows an initial specific rotatory power of 20°—25°. The yield is 70—85%.—J. H. L.

Jute plant; Occurrence of raffinose in the seed of the— H. E. Annett. Biochem. J., 1917, 11, 1—6.

JUTE seed, finely ground, was exhausted with ether and with petroleum spirit; the residue was exhausted with alcohol, and a copious white precipitate was obtained on the addition of ether to the alcoholic extract. The crude substance was dissolved in hot 80% alcohol, the solution filtered, and left for several days; a deposit of rosettes of white needles was obtained and was recrystallised from 80% alcohol. The sugar thus prepared did not reduce Fehling's solution and did not yield an osazone; it was identified as raffinose. The quantity of raffinose present in jute seed was determined in an aqueous extract of the seed, after clarification with lead acetate, by determining the fall in rotation produced by the action of invertase and melibiase; in the sample of seed examined the raffinose amounted to about 2.25%.—J. F. B.

Xylose; Preparation of— C. S. Hudson and T. S. Harding. J. Amer. Chem. Soc., 1917, 39, 1038—1040.

COTTONSEED hulls form a convenient material for

the preparation of xylose, and yield 8—12% of the crystalline sugar by a process described, which includes a preliminary steeping in dilute ammonia, boiling with dilute sulphuric acid to hydrolyse the xylan, neutralising with lime, removal of calcium sulphate, acidification with phosphoric acid, decolorisation, concentration, and crystallisation with the aid of alcohol.—J. H. L.

Sedoheptose, a new sugar from Sedum spectabile.
I. F. B. La Forge and C. S. Hudson. J. Biol. Chem., 1917, 30, 61—77.

AN aqueous solution of the leaves and stems of one of the stone-crops, *Sedum spectabile*, was found to contain a non-fermentable heptose, designated sedoheptose. The sugar itself was not isolated, but crystalline phenyl- and bromophenyl-osazones, m.pt. 197° and 227°—228°C. respectively, were prepared and analysed, and a compound of the osone with *o*-phenylenediamine was also obtained. Reduction of the concentrated plant extract with sodium amalgam, yielded two heptitols, α - and β -sedoheptitols, m.pt. 151°—152° and 127°—128°C. respectively. These and their tribenzal derivatives were analysed. The plant extract, which was practically optically inactive, lost about 80% of its cupric-reducing power, and acquired strong levo-rotatory power, on heating with dilute hydrochloric acid, owing to the conversion of about 80% of the sugar into a non-reducing anhydride, $C_7H_{12}O_6$, termed anhydrosedoheptose, m.pt. 155°C., $[\alpha]_D^{20} = -146.3^\circ$, of which a dibenzal derivative was prepared. In aqueous solution this anhydride is reconverted, to the extent of 20%, into the heptose on heating with dilute acid. The heptose is not oxidised by bromine, and as it yields two heptitols on reduction it is regarded as a ketose.—J. H. L.

XVIII.—FERMENTATION INDUSTRIES.

Zymin; The conditions of activation of washed — and the specific function of certain cations in alcoholic fermentation. A. Harden. Biochem. J., 1917, 11, 64—69.

ZYMIN (acetone-yeast) and dried yeast which have been rendered inactive by thorough washing, owing to the removal of the co-enzyme, may be readily restored to an active condition by the addition of potassium pyruvate in presence of a suitable concentration of a phosphate. The carboxylase of the zymase has been shown to be unaffected by washing, and since acetaldehyde is the immediate product of the decomposition of pyruvates by yeast-carboxylase, it was to be expected that acetaldehyde might have a similar influence in restoring activity. The first experiments with acetaldehyde were carried out in presence of sodium phosphate with negative results, but when this salt was replaced by potassium or ammonium phosphate the action of the acetaldehyde was the same as that of the pyruvate. Hence it would appear that potassium and ammonium ions possess a specific function which does not belong to the sodium ion, although the latter is not positively inhibitory; this is in accord with the fact that sodium phosphate cannot replace potassium phosphate in the composition of a synthetic culture medium for yeast. The observation recorded with regard to acetaldehyde would be consistent with the theory that acetaldehyde is an intermediate product in alcoholic fermentation and is reduced to alcohol by hydrogen formed at another stage. It might also be held to favour the suggestion that acetaldehyde may be regarded as constituting the co-enzyme of yeast juice, since

it certainly acts as a co-enzyme with washed zymin provided the phosphates of certain cations are present.—J. F. B.

Bacteria; A new type of chemical change produced by —. Conversion of histidine into urocanic acid by bacteria of the coli-typhosus group. II. Raistrick. Biochem. J., 1917, 11, 71—77.

THE most common chemical change induced in amino-acids by bacterial action is the formation of bases, often toxic, by a process of simple decarboxylation with loss of carbon dioxide. Thus, for instance, histamine and tyramine are formed from histidine and tyrosine by putrefactive bacteria. Another change brought about by bacterial action is "deamination," i.e., the splitting off of ammonia, which however is usually accompanied by hydrogenation, with formation of a saturated acid, under the anaërobic conditions of the experiments. In the present experiments it was considered advisable to carry out the reaction without the presence of other organic substances than the amino-acid under observation. In this way secondary reactions were avoided, although the bacteria did not grow well; this was compensated by copious sowing of vigorous growths (agar slope cultures) and prolonged incubation. For the purposes of the experiment, pure histidine hydrochloride was dissolved in Ringer's solution, with an indicator and sufficient alkali to give a hydrogen-ion concentration, after boiling, of $p_H = 7.35$. The solution was inoculated with 24-hour old cultures of various bacteria of the coli-typhosus group. All these bacteria yielded a substance giving a crystalline picrate, which was identified as the picrate of urocanic (3-iminazolylacrylic) acid. This is an unsaturated acid produced from histidine by the simple splitting off of ammonia without subsequent hydrogenation. Some of the liquids in the culture flasks developed an alkaline reaction, but the production of urocanic acid from histidine is not confined to those bacteria of the group which develop alkalinity; in fact the largest yield was obtained with *B. paratyphosus*. In the cultures of which showed no alkalinity. This type of reaction consisting of deamination to an unsaturated acid has not previously been recorded.—J. F. B.

Decomposition of protein substances by the action of bacteria. Robinson and Tartar. See XIXa.

Optimum reaction of tryptic digestion. Long and Hull. See XIXa.

Optical activity of proteins, enzymes, toxins, and serums. Rakuzin. See XIXa.

PATENTS.

Hops; Method of drying —. G. H. Benjamin, New York. U.S. Pat. 1,226,052, May 15, 1917. Date of appl., Sept. 23, 1914.

THE moisture-content of hops is sufficiently reduced to prevent development of mould, without rendering the cells incapable of subsequent endosmosis, by subjecting the hops to the action of large volumes of air, first at 120° F. (50° C.) for 1—2 hours and then at successively higher temperatures, e.g., 140°—165° F. (60°—74° C.) for 2—5 hours, and 170° F. (77° C.) for 30 mins. to 1 hour, and finally to sulphur dioxide for 15—30 mins.—J. H. L.

Yeast substitute. J. O. Lumsden, Seattle, Wash. U.S. Pat. 1,226,347, May 15, 1917. Date of appl., Dec. 4, 1916.

A MIXTURE of water, rice flour, white-corn (maize)

flour, white-wheat flour, granulated sugar, and malted grain (barley), in specified proportions, is fermented and the resulting liquid used as a substitute for yeast.—F. Sp.

Beverage and process of making same. J. Ashus. Roxbury, Mass. U.S. Pat. 1,226,639, May 15, 1917. Date of appl., Feb. 5, 1917.

RYE flour is mixed with water to form a dough, which is baked, dried, and crumbled. The crumbs are placed, together with hops, in hot water, the mixture is strained, mixed with sugar and yeast, with or without lemon juice, and allowed to ferment.

Amylaceous substances: Process for treating [liquefying and saccharifying] —. A. Boidin, Seclin, France, and J. Effront, Brussels. U.S. Pat. 1,227,371, May 22, 1917. Date of appl., Nov. 6, 1913.

SEE Fr. Pat. 461,853 of 1912; this J., 1911, 213.

Diastrases and toxins: Process of manufacturing — by oxidising ferments. A. Boidin, Seclin, France, and J. Effront, Brussels. U.S. Pat. 1,227,525, May 22, 1917. Date of appl., July 6, 1914.

SEE Fr. Pat. 471,546 of 1913; this J., 1915, 444.

Apparatus for decarbonating water, especially for brewing. Ger. Pat. 297,178. See XIXB.

XIXA.—FOODS.

Foods: Effect of high temperatures on the nutritive value of —. A. G. Hogan. J. Biol. Chem., 1917, 30, 115—123.

THE nutritive value of proteins (albumin, casein, maize proteins, etc.) is not materially lowered when the proteins are heated in an autoclave for 6 hours under 30 lb. pressure.—W. P. S.

Proteins of the peanut, Arachis hypogaea. Distribution of the basic nitrogen in the globulins, arachin and conarachin. C. O. Johns and D. B. Jones. J. Biol. Chem., 1917, 30, 33—38.

THE two globulins, arachin and conarachin (see this J., 1917, 158), yield arginine, histidine, lysine, and cystine when examined by the Van Slyke method. The relatively high percentage of lysine in the proteins of the peanut (earthnut), namely, 4.98% in arachin and 6.04% in conarachin, indicates that this nut might be used to supplement diets deficient in lysine.—W. P. S.

Protein substances: Decomposition of — by the action of bacteria. R. H. Robinson and H. V. Tartar. J. Biol. Chem., 1917, 30, 135—144.

ALL proteins are changed to a greater or less extent by the action of bacteria (*B. subtilis*, *B. mycoides*, and *B. vulgaris*), ammonia being the final product of the decomposition, but in no case is any one form of nitrogen destroyed completely. The rapidity of the action varies with different proteins; casein undergoes no further change after a few days, whilst gliadin continues to yield ammonia for more than 30 days. One and the same organism does not have the same action on

different proteins, and the relative proteolytic activity depends on the protein used. The mono-amino-acid nitrogen and the diamino-acid nitrogen of the protein are the chief sources of the ammonia formed, and the similarity of the changes brought about by acid hydrolysis and bacterial action indicates that the latter is largely hydrolysis to the point of formation of various amino-acids. There is no formation of a toxic substance which would inhibit complete ammonification of a protein.—W. P. S.

Tryptic digestion: Optimum reaction of —. I. J. H. Long and M. Hull. J. Amer. Chem. Soc., 1917, 39, 1051—1059.

THE results of the experiments described indicate that the optimum reaction for tryptic action depends on the nature of the protein substrate. With fibrin the optimum range of hydrogen ion concentration was found to be from 10^{-8} to 5×10^{-9} , and with casein 3×10^{-6} to 5×10^{-7} . The enzyme exhibited considerable hydrolytic activity towards casein at hydrogen ion concentrations sufficiently high to arrest all action on fibrin. In carrying out the experiments, solutions of phosphates (as buffer salts), with hydrochloric acid or sodium hydroxide where necessary, were prepared, with values of p_H ranging from 2.36 to 11.86. Fifty c.c. portions of each were treated with 1 gm. of powdered fibrin or casein. It was found that in general the protein affected the reaction of the solutions, lowering the hydrogen ion concentration in the more acid ones, and raising it in the more alkaline ones. Fibrin appeared to be in equilibrium with a p_H of 6.5 and casein with a p_H of 4.9. After addition of 0.1 gm. of trypsin to each solution, digestion was carried out for 3 hours at 40° C. The concentration of hydrogen ions was again determined, and the amount of hydrolysis which had occurred was estimated by Sørensen's method of formaldehyde titration.—J. H. L.

Proteins, enzymes, toxins and serums: Optical activity of —. M. A. Rakuzin. J. Russ. Phys.-Chem. Soc., 1916, 48, 1251—1291.

THE author has collected from all sources numerical data which have been obtained relative to the optical activity of animal and vegetable proteins and their derivatives, enzymes, toxins, and anti-serums.—T. H. P.

New type of chemical change produced by bacteria. Conversion of histidine into urocanic acid by bacteria of the coli-typhosus group. Raistrick. See XVIII.

PATENTS.

Foods: Process for preservation of — and product thereof. N. C. Fowler, jun., Boston, Mass., U.S.A. Eng. Pat. 106,302, May 12, 1916. (Appl. No. 6811 of 1916.)

EQUAL weights of cereals and fruit are ground together and the mixture is dried. For example, a mixture of maize, wheat-bran, and water is heated at 100° C. for 12 hours, washed prunes are then added, the mixture is pressed and ground, and dried at 225° F. (107° C.). Flavouring substances and about 0.5% of salt may be added, if desired. (Reference is directed, in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pats. 3250 of 1868; 7013 of 1892; 13,600 of 1893; 3108 of 1899; 13,245 of 1905; and 2607 of 1915; this J., 1891, 752; 1906, 774; 1916, 321.)—W. P. S.

Food adapted to promote digestion ; Composite —. N. C. Fowler, jun., Boston, Mass., U.S.A. Eng. Pat. 106,324, May 17, 1916. (Appl. No. 7052 of 1916.)

FINELY-DIVIDED grain, including bran, is ground with fruit, the mixture is dried (see preceding abstract), and a dry culture of bacteria capable of producing lactic acid is added. The proteins of milk, separated from the cream and water, may also be added. The product is mixed with milk or cream for use.—W. P. S.

Curing meats ; Method of producing smoke for —. R. J. Gaudy, Detroit, Mich. U.S. Pat. 1,225,798, May 15, 1917. Date of appl., Nov. 16, 1916.

HEAT is generated by electrical means in a resistance placed on the top of a pile of some smoke-producing material, which becomes carbonised but is not heated sufficiently to ignite. The resistance is allowed to descend by gravity through the pile.—J. H. J.

Dough or flour for bread and bakers' wares ; Method of preparing (A) tubers. (B) legumes for manufacture of —. E. Simons, Cassel, Germany. U.S. Pats. (A) 1,225,877 and (B) 1,225,878, May 15, 1917. Date of appl., Sep. 22, 1915.

(A) TUBERS are subjected to the action of steam below 100° C., and are then dried and crushed. The steam may be replaced by hot gas below 100° C., the effect of which is to produce steam within the tubers and thus disintegrate them. (B) Legumes are submitted to the action of steam as above.—J. H. J.

Protein in any form ; Process of digesting and concentrating — by dissolving it in grape juice. E. Monti, Turin, Italy. U.S. Pat. 1,226,983, May 22, 1917. Date of appl., May 26, 1915.

PROTEIN from eggs, milk, blood, meat, etc., is dissolved in grape juice at 35°–40° C., and the mixture is evaporated at a low temperature until its water content is reduced to 33%.—W. P. S.

Eggs ; Process for desiccating —. T. C. Primavera, Corona, N.Y. U.S. Pat. 1,226,999, May 22, 1917. Date of appl., Mar. 12, 1917.

EGGS are mixed with lemon juice and the mixture is dried at 75°–80° F. (24°–27° C.).—W. P. S.

Malt syrup ; Process of making —. H. T. Neidlinger, Oswego, N.Y. U.S. Pat. 1,227,184, May 22, 1917. Date of appl., Sept. 6, 1912.

MALTED grain is digested with water at 149° F. (65° C.), the temperature is then raised to 171° F. (78° C.), and the liquid portion is separated and evaporated to a syrup of about 36° B. This syrup is cooled rapidly and any precipitate of albuminous matter, etc., is removed.—W. P. S.

Potato peelings ; Preparation of — for the purpose of their industrial utilisation. E. Borrás, Barcelona, Spain. U.S. Pat. 1,226,852, May 22, 1917. Date of appl., June 17, 1916.

SEE Eng. Pat. 100,675 of 1916 ; this J., 1916, 860.

XIXB.—WATER PURIFICATION ; SANITATION.

Water ; Disinfection of — by means of bleaching powder. H. Langer. Z. Hyg., 1916, 84, 296. Chem.-Zeit., 1917, 41, Rep., 166.

A DISTINCTION is drawn between disinfection, i.e.,

rendering bacteria harmless, and the killing of bacteria. In the case of bleaching powder, disinfection is dependent only upon the concentration of the available chlorine, not upon the duration of the exposure. The action is a rapid one, and does not consist in oxidation but in absorption of chlorine. The time required to kill the bacteria depends only upon their power of resistance to the injury effected by the chlorine. Disinfection, therefore, is independent of the time elapsing before neutralisation of the chlorine ; whether this follows at a longer or shorter interval, the killing of the bacteria is not influenced. The presence of organic matter reduces the concentration of the available chlorine, though the amount of this reduction can only be determined by a bacteriological test. The disinfecting action is rendered greater by adding the bleaching powder in fractions, a cumulative effect replacing that of concentration.—J. H. J.

Cholera culture media ; The chemistry of —. G. Seiffert and H. Bamberger. Arch. Hyg., 1916, 85, 265. Chem.-Zeit., 1917, 41, Rep., 165.

THE improved growth of cholera cultures on alkaline blood media is brought about by the hæmoglobin, which can be replaced by other pyrrole derivatives, such as bile pigment and chlorophyll, and by pyrrole itself. This property is possessed also by transformation products of the hæmoglobin, as hæmin and hæmatoporphyrin. In practice, a chlorophyll medium has proved useful, and on this, after addition of fuchsin and sugar, cholera cultures gave a growth of light red colonies. The medium is made shortly before the plates are required, as repeated heating spoils its selective action.—J. H. J.

"Mercurophen," a new antiseptic. J. F. Schamberger, J. A. Kolmer, and G. W. Raizin. J. Amer. Med. Assoc., 1917, 1458. Pharm. J., 1917, 98, 469.

SODIUM oxymercuri-*o*-nitrophenoxide (mercurophen) contains about 53% of mercury, and is an odourless, brick-red powder, freely soluble in water. Against *Staphylococcus aureus*, in the "antiseptic test," it has proved to be fifty times more active than mercuric chloride, destroying the bacteria on prolonged exposure in bouillon in a dilution of 1 : 10,000,000. In a menstruum of ascites fluid, it is 200 times more germicidal against *S. aureus* than mercuric chloride. By the Rideal-Walker method, it exhibits 10,000 times greater germicidal power against *B. typhosus* than phenol, and over thirty times greater activity than mercuric chloride. Mercurophen disinfects the hands in dilutions of 1 : 10,000 to 1 : 40,000 in one minute, whereas mercuric chloride in a dilution of 1 : 5000 requires over five minutes, and in a dilution of 1 : 10,000 requires over fifteen minutes. It sterilises ordinary rubber tubing in thirty minutes in a dilution of 1 : 100,000. Mercuric chloride accomplishes this result in a dilution of 1 : 16,000. The precipitating effect of mercuric chloride on human serum proteins is four to five times greater than that exhibited by mercurophen ; this is an obvious advantage in favour of the latter. It has a lower toxicity than mercuric chloride.

New type of chemical change produced by bacteria. Conversion of histidine into urocanic acid by bacteria of the coli-typhosus group. Raistrick. See XVIII.

PATENTS.

Water ; Apparatus for decarbonating — especially for brewing. E. Werle, Oberglogau. Ger. Pat. 297,178, Feb. 11, 1914.

THE water passes through a series of vessels placed

at different levels, proceeding from the top of one into the bottom of the next higher in the train. In each it is agitated and heated with steam, the gases liberated passing up a stand-pipe rising from the top of each vessel.—H. J. H.

Insecticides, sheep dip, and the like. G. J. Lemmens, Wateringbury, and P. J. Fryer, Tonbridge, Kent. Eng. Pat. 106,133, Dec. 1, 1916. (Appl. No. 17,383 of 1916.)

Finely powdered leaves, seeds, and other portions of the plants known as tephrosia, particularly *Tephrosia vogelii*, constitute the product claimed; soap, sulphur, copper sulphate, etc., may be added according to the purpose for which the product is to be used. (See also Eng. Pat. 17,381 of 1916; this J., 1917, 611.)—W. P. S.

Bacteria and fungi exterminator. W. R. Kleckner, Cowell, Cal. U.S. Pat. 1,227,451, May 22, 1917. Date of appl., Sept. 6, 1916.

THE composition consists of a mixture of equal parts by weight of potassium ferrocyanide, potassium ferricyanide, and potassium thiocyanate; a mixture of hexamethylenetetramine and ammonium cyanide; a mixture of equal quantities of Methylene Blue, Methyl Violet, Malachite Green, and potassium xanthate; and a mixture of flavouring extracts, oxalic acid, and gelatin.—W. P. S.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Atropine: Exact quantitative determination of —. H. Baggesgaard Rasmussen. Ber. Deuts. Pharm. Ges., 1917, 27, 193—201.

In a study of the silicotungstate method of determining atropine (see Javillier, this J., 1910, 1176; 1911, 238), the author found that a moderate excess of the precipitant, e.g., 10%, does not affect the results. The precipitate, after standing for 8 or 12 hours, is collected in a Gooch crucible, washed three times with 1.5% hydrochloric acid, and, in incinerating, is ignited over a Techn burner for 5 mins. after all carbon has been burnt. The residue cannot be ignited to constant weight, owing to the slight volatility of tungstic oxide at high temperatures. The factor for calculating the weight of atropine from that of the ignited residue is 0.4067, and the correction for solubility is 0.0054 grm. of atropine per 100 c.c. of liquid (cf. *loc. cit.*). Where necessary the results may be checked by carrying out a duplicate precipitation and determining the nitrogen in the precipitate, to confirm that the substance precipitated is really atropine or an isomer. A description is given of the application of the method to the analysis of belladonna extracts.—J. H. L.

Digitalis seeds and leaf: The relative proportions of the active constituents in —. W. Straub. Arch. Exp. Pathol. u. Pharmacol., 1916, 80, 52. Chem.-Zeit., 1917, 41, Rep., 158.

THE methods used for the isolation and purification of the active principles of digitalis involve large losses. The estimation has been made physiologically by determining the minimum fatal dose of the total extract and of the single fractions. In the case of the seeds, a cold water extract contained 1.3% of active principles on the dry material, the greater part consisting of substances (*digitalinum rerum* and *digitalein*) not shaken out by chloroform.

The small portion soluble in chloroform apparently contained only traces of these substances. Practically no further quantity of active principles was obtained from the residue by extraction with 96% alcohol. From the leaves, cold water extracted about two-thirds of the active constituents and 50% alcohol about one-third. From the cold water extract chloroform dissolved 61% (*gitalin*), 42% remaining insoluble; the loss of about 12% is probably due to the transformation of the lactone, *digitalein*, into the inactive acid. The treatment of an infusion prepared in the official manner confirmed the observation of Kraft that owing to the high temperature an appreciable loss of water-soluble active glucosides takes place. It is confined to the *digitalein* fraction; the *gitalin* fraction is indeed increased, but apparently through the formation of *digitoxin*, since the real *gitalin* is decreased. Similarly the titration value of the *gitalin* fraction is considerably diminished by heating a cold-water extract and to the same extent that of a chloroform extract of this infusion, as well as of pure *gitalin*. The treatment of the extract with alcohol in the cold also lowers the titration value, confirming the observations of Kraft with *gitalin*.—J. F. B.

Sera: The reaction of — as a factor in the successful concentration of antitoxic sera by the methods at present in use. A. Homer. Biochem. J., 1917, 11, 21—39.

IN the Banzhaf method (Collected Studies Research Dept. Health, New York, 1913, 4, 230) for the concentration of antitoxic sera, uncertainties in the filtration arise from two causes: (A) That no cognisance has been taken of the reaction (hydrogen ion concentration) of the serum. (B) That as the precipitating power of 30% of ammonium sulphate is not appreciably increased during the heating process, a certain amount of euglobulin escapes precipitation with the first fraction precipitate and appears in colloidal suspension in the final product. The uncertainties in the filtration of the hot serum-ammonium sulphate mixtures can be obviated and the complete elimination of the euglobulin can be assured by an adjustment of the hydrogen ion concentration to the point at which the desired increased precipitation is assured, also by brine extraction of the second fraction precipitate containing the pseudo-globulin-antitoxin combination together with the small amount of euglobulin which has escaped precipitation with the first reaction, and, thirdly, by subjecting the serum to a preliminary prolonged heating at 57°—58° C. whereby the precipitation of the serum proteins is considerably enhanced. Assistance is also derived from the addition of organic substances such as phenol and its homologues, ether, or chloroform, which increase the precipitation of the serum proteins, presumably by virtue of their effect on the surface tension of the protein aggregates in colloidal solution, but these additions must be made with caution. The extent of the heat denaturation of the serum proteins during the heating of serum at 57° C. for several hours is also influenced by the hydrogen ion concentration of the serum and can be controlled by the adjustment of the latter. The denaturation induced by heat in alkaline sera apparently does not involve the same type of change as that induced in acid sera.—J. F. B.

Tuberculin: Selective adsorption of Denys' — by aluminium hydroxide. M. A. Rakuzin and G. D. Flier. J. Russ. Phys.-Chem. Soc., 1916, 48, 1316—1319.

TWO samples of tuberculin, prepared by (1) Vermet, Moscow, and (2) L'Institut de Bactériologie de Louvain, have been examined. Both preparations were straw-yellow and neutral, and

the other physical properties were: (1) sp. gr. 1.0223 at 15° C., c (dry matter, per cent.) 6.3134, $[\alpha]_D = -9.81^\circ$ and (2) sp. gr. 1.01944 at 15° C., $c = 2.285$, $[\alpha]_D = -21.22^\circ$. Both contained free ammonia and showed Adamkiewicz's, Molisch's, Pettenkofer's, Ostromyslenski's, Liebermann's, and the xanthoprotein reactions (compare this J., 1916, 433), but the limits of sensitiveness differed widely in the two cases; only the Louvain preparation gave Millon's reaction and neither gave the biuret reaction. Aluminium hydroxide adsorbed 7.62% and 23.08% of the respective preparations and both adsorptions were irreversible as regards boiling water. With reference to the colour reactions of the proteins and to the rotatory power, the products of adsorption behaved similarly to the original tuberculin.—T. H. P.

Antidiphtheritic serum: Selective adsorption of — by aluminium hydroxide. M. A. Rakuzin and G. D. Flier. J. Russ. Phys.-Chem. Soc., 1916, 48, 1324—1330.

It has been shown previously that the adsorption of enzymes and toxins, especially by aluminium hydroxide, is in most cases selective, and the investigations have now been extended to antidiphtheritic serum. The serum employed, sp. gr. 1.0340 at 15° C., $[\alpha]_D = -28.876^\circ$, was straw-yellow and of neutral reaction. It gave the following protein colour reactions with the degrees of sensitiveness indicated in brackets (compare this J., 1916, 433): biuret (1:660), Millon's (1:330), Liebermann's (1:2500), Adamkiewicz's (1:9000), xanthoprotein (1:660), Molisch's (1:330), Pettenkofer's (1:1250) and Ostromyslenski's (1:1250). The adsorption by aluminium hydroxide proceeds irreversibly and with quantitative separation of the toxin, the proportion of the latter adsorbed being 43.47%. The liquid remaining after the adsorption is colourless and neutral and gives all the above colour reactions of the proteins.—T. H. P.

Desoxycholic acid; Preparation of —. W. Mair. Biochem. J., 1917, 11, 11—13.

In investigating the solvent action of bile salts on pneumococci it was found that sodium desoxycholate was ten times more active than sodium cholate or commercial sodium taurocholate. A method for the separation of desoxycholic acid from the crude mixture of bile acids has been worked out. To 4 litres of ox bile is added 240 grms. of caustic soda; when the soda is dissolved, the liquid is boiled gently in an iron digester for 20 hours; the volume should then be between 2 and 3 litres. While still hot the liquid is made neutral to phenolphthalein by adding gradually about 350 c.c. of strong hydrochloric acid. A flocculent precipitate of silica is formed but none of the bile acid is thrown out if the liquid is sufficiently warm. After cooling, the bile is filtered; the filtrate is made acid to litmus by adding about 50 c.c. of glacial acetic acid. The bile acids separate out as a fluid crystalline mass, white at first but rapidly absorbing pigment; the acids are caused to adhere in a single mass by rotating the flask, and the mother liquor is decanted. The mass is squeezed, transferred to a flask, and dissolved in rather more than an equal volume (about 600 c.c.) of glacial acetic acid by warming on the water-bath. The solution is allowed to crystallise by standing for 2—3 days, the mixed crystals containing practically all the desoxycholic acid, a nearly equal amount of cholic acid, and some fatty acid. The crystals are filtered off, washed free from pigment with 60% acetic acid, drained as dry as possible, and redissolved by heating with 300 c.c. of glacial acetic acid. The next crop of crystals is pressed between porous tiles and redissolved

by boiling with 750 c.c. of 60% acetic acid; the solution is filtered, any fatty matter is skimmed off after cooling, and the crystals which separate are washed first with 60% acetic acid, then with water, and are finally pressed and dried at 100° C. The product is practically pure desoxycholic acid, m.pt. 172°—173° C.; the yield from 4 litres of bile is 32—42 grms.; the yield from 1000 grms. of commercial taurocholate is 50 grms. The method is only recommended where a maximum yield of desoxycholic acid is required and the cholic acid may be neglected; the latter may, however, be recovered after distilling off the acetic acid from the mother liquors. In general it is better to follow Schryver's method (J. Physiol., 1912, 44, 265) for the preparation of cholic acid.—J. F. B.

Biochemical reactions for distinguishing catechol, quinol, and resorcinol. Wolff. See III.

Oleoresin of Douglas fir. Schorger. See XIII.

Rapid method of obtaining neutral olive and other oils suitable for the preparation of camphorated oil. Cordier and Lesure. See XII.

Optical activity of proteins, enzymes, toxins, and serums. Rakuzin. See XIXA.

"Mercuraphen," a new antiseptic. Schamberg and others. See XIXB.

PATENTS.

Compound for internal administration; Metallic —. W. B. McLaughlin, New York, U. S. Pat. 1,226,229, May 15, 1917. Date of appl., Aug. 5, 1916.

THE compound consists of an iron or a calcium soap dissolved in stearic acid.—J. H. J.

Iodine compound and method of preparing same. H. P. Slater, Cedar Rapids, Iowa, U.S. Pat. 1,226,394, May 15, 1917. Date of appl., Nov. 15, 1915.

SOLUTIONS of hexamethylenetetramine and iodine are mixed at room temperature, when a precipitate of hexamethylenetetramine periodide is produced; this is filtered off, washed, and treated with ammonia, when a finely-divided, red powder is produced, which is dried at room temperature. Instead of filtering off the addition product, it may be treated, while suspended in its mother liquor, with ammonia.—J. H. J.

XXII.—EXPLOSIVES; MATCHES.

PATENTS.

Moulding of gunpowder and similar mixtures; Process for —. J. Lersch, Niederdielfen. Ger. Pat. 296,245, Nov. 3, 1912.

SULPHITE-CELLULOSE waste liquor, concentrated to 35° B. (sp. gr. 1.32), is proposed as binder for components of moulded explosive mixtures, such as nitrates, carbon, sulphur, wood meal, aluminium powder, etc. The moulded product is hard, convenient to handle, impenetrable to moisture, and the products of combustion are less disagreeable than when other materials are used.—H. J. H.

Match boxes and the like; [Cellulose ester] composition for waterproofing the striking or abrasive surfaces of — A. V. St. Armande, Nitschill, Renfrewshire, Eng. Pat. 106,375, Aug. 16, 1916. (Appl. No. 11,593 of 1916.)

The striking surface for ordinary and safety matches is rendered waterproof by the application of a varnish consisting of a solution of cellulose nitrate, acetate, formate, propionate, or the like, or a derivative of cellulose such as celluloid. Other substances such as resins, camphor, acetanilide, oils, pigments, dyes, etc., may be added. —W. F. F.

Blasting cartridge. W. Weber, Hayingen, Germany. U.S. Pat. 1,226,833, May 22, 1917. Date of appl., Oct. 1, 1915.

SEE Eng. Pat. 12,163 of 1915; this J., 1917, 101.

XXIII.—ANALYSIS.

Filter paper; Reducing matter extractable from — R. S. McBride and J. A. Scherrer, J. Amer. Chem. Soc., 1917, 39, 928—933.

THE authors conclude that there is undoubtedly some substance in most filter papers which is readily extracted and which reduces permanganate. The quantity is sufficient to cause error if a permanganate titration is to be made after filtration, particularly if the permanganate is dilute (N/50 or N/100) and the titration is made in hot solution. Apparently most of the reducing material is removed in the first washings and therefore a preparatory washing with about 25 c.c. of reagent is sufficient to avoid subsequent error, even if titration takes place in the presence of the paper, or even if the paper is very old. —W. H. P.

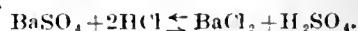
Dialysis; Technique of preparing membranes for — W. Brown, Biochem. J., 1917, 11, 40—57.

THE principle adopted in a previous investigation (this J., 1915, 1118) for preparing collodion membranes of graded permeability is capable of general application to a large variety of membranes and liquids. Given a membrane substance, a restraining liquid, *A*, of which the membrane substance imbibes only a negligible amount, and a swelling liquid, *B*, strongly imbibed by the membrane substance, then if *A* and *B* are miscible in all proportions, membranes of graded permeability may be obtained by steeping films of the membrane substance in mixtures of *A* and *B*, and subsequently washing in *A*; the higher the percentage of *B* in the mixture the greater is the permeability of the membrane. The great majority of membranes prepared in this way are of a type suitable for use in the restraining liquid. Of this type the author has prepared graded membranes of collodion in water, benzene, chloroform, etc.; of agar and gelatin in alcohol, acetone, benzene, etc.; of cellulose acetate in water, alcohol, benzene, etc. It is obvious that when the membrane is required for use in a liquid which is not imbibed by it but which, owing to its immiscibility with the swelling liquid *B*, cannot be used directly as the restraining liquid, the latter can be displaced by the third liquid after the membrane has been graded. For instance, membranes of gelatin or agar, graded by alcohol and water, may be prepared for use with benzene by subsequent displacement of the alcohol by

means of the latter. The type of membrane graded for use in the swelling liquid, *B*, can only be prepared when a method exists for suppressing the capacity of the membrane substance to imbibe *B*, this suppression to be brought about at the stage where the membrane is still immersed in the mixture of *A* and *B*. Up to the present only one representative of this type has been prepared, *viz.*, gelatin membranes graded with alcohol and water, prepared for use in water by the prolonged action of formaldehyde. The degree of permeability of graded membranes may be expressed by the ratio of dry weight to wet weight of the film. —J. F. B.

Barium sulphate; Properties of — Z. Karaglanow, Z. anal. Chem., 1917, 56, 225—246.

BARIUM sulphate was prepared free from occluded chloride by dissolving in concentrated sulphuric acid and re-precipitating by dilution with water. By heating to varying temperatures in a platinum or porcelain crucible, no appreciable change was observed at the temperature given by a Teclu burner, but with a blow-pipe flame a loss of weight occurred through decomposition into sulphide, which was greater with the platinum than with the porcelain crucible. On igniting the precipitate in contact with filter paper over a gas flame, no change of weight occurred when a platinum crucible was used, but with a porcelain crucible, a diminution from 0.1622 to 0.0618 gm., through reduction to sulphide was observed. The solubility of barium sulphate in water and in different electrolytes was measured by agitating the precipitate for 24 hours in contact with the liquid and determining the loss in weight. In pure water the solubility was found to be 0.0013 gm. per litre, or 1 part of barium sulphate in 232,588 parts of water. The greater solubility over that previously estimated is in part due to the fine state of division of the precipitate used in the present measurements. In the presence of barium chloride or sulphuric acid, the solubility of the sulphate was found to be lowered in accordance with the law of constant solubility product of anion and cation. With potassium chloride and nitrate an increased solubility was obtained which was greater in the latter case and which is attributable to double decomposition giving potassium sulphate and barium chloride or nitrate, an action which is favoured by the low degree of dissociation of the two last compounds. The solubility increased in presence of potassium chloride in proportion to its concentration. With calcium chloride, at a concentration of 0.36N and below, no influence was exerted on the solubility, but at higher concentrations the solubility was diminished, which is due to the calcium sulphate giving, through primary dissociation, more sulphate ions than potassium sulphate. With strontium chloride the solubility of the barium sulphate was increased to a greater degree than with potassium chloride, owing to the lower solubility of strontium sulphate as compared with calcium sulphate and consequent formation of fewer sulphate ions. With lead nitrate at a concentration of 0.118N, the solubility was diminished, but at lower concentrations was increased, a maximum value being obtained with 0.03N, below which the solubility again diminished. In ferrous sulphate solution containing free sulphuric acid, no loss of weight was obtained, but in some cases a slight increase through adsorption. With ferric chloride the solubility was found to be considerable, and to vary with the concentration of the chloride; it was increased by the presence of hydrochloric acid, and arrested if barium chloride was also present. With hydrochloric acid alone, the solubility was greater than with the alkali chlorides and depended on the concentration of dissociated hydrogen chloride, indicating the reaction,



With nitric acid solution, the solubility was still higher, varying with the concentration and amounting to 0.142 gm. in 200 c.c. of a 2.8*N* solution, though the sulphate is practically insoluble in nitric acid if the solution also contains either barium chloride or sulphuric acid.—J. N. P.

Potassium and sodium in the form of sulphates: Determination of — by platinum chloride. B. Turkus. Ann. Chim. Analyt., 1917, 22, 101—102.

The determination of potassium by platinum chloride is generally carried out after conversion of the sulphates into chlorides, but in certain cases, particularly in the case of silicates decomposed by hydrofluoric and sulphuric acids, the removal of sulphates is tedious and it is far more convenient to treat the solution of mixed alkali sulphates direct. The theoretical quantity of platinum chloride, plus 50% excess, calculated on the supposition that the whole of the sulphate is sodium sulphate, is added to the solution in small portions, then a few drops of strong hydrochloric acid, and before each addition the solution is evaporated to dryness to eliminate as far as possible the free acids. The residue is treated with 85% alcohol with the addition of one drop of ether; the sodium platinichloride is dissolved and the potassium compound remains insoluble. The residue is washed several times before being brought on the filter and the washing is continued until the filtrate becomes colourless. The potassium platinichloride is collected on the filter while it is still moist; the filter is incinerated at first with gentle heat and afterwards at dull redness until white fumes of potassium chloride cease to be evolved. The contents of the crucible are washed with hot water and the platinum digested on a water-bath with a little dilute hydrochloric acid, washed, and incinerated, finally over the blowpipe, until the weight is constant. The results are satisfactorily accurate and the method is recommended for the determination of alkalis in silicates.—J. F. B.

Tin and antimony: Separation of — by hydrogen sulphide in hydrochloric acid solution. A. Prim. Chem.-Zeit., 1917, 41, 414—415.

THE separation is effected by precipitation of the antimony from the mixed solution by hydrogen sulphide in a hydrochloric acid solution of definite concentration, which must be rigidly adhered to. The mixed solution is placed in an Erlenmeyer flask (300—350 c.c.), 60 c.c. of hydrochloric acid (sp. gr. 1.19) is added and the volume made up to 200 c.c. The solution, raised to boiling point, is treated with a rapid current of hydrogen sulphide for 10 mins., after which a slow current is employed while the solution cools down to air temperature. The antimony sulphide is filtered off and washed with a hydrogen sulphide solution containing 60 c.c. of hydrochloric acid (sp. gr. 1.19) in 200 c.c., a final wash with water being given. The filtrate is collected in a 250 c.c. graduated flask, made up to the mark and shaken up at once. The antimony sulphide is returned to the precipitation flask and brought into solution by boiling with 20—25 c.c. of hydrochloric acid (sp. gr. 1.19) and an equal volume of water, a funnel being placed in the neck of the flask. 30—40 c.c. of water is added and boiling is continued for 10 mins. After cooling, 2 drops of phenolphthalein solution, 2—3 grms. of Rochelle salt, and then a slight excess of sodium hydroxide are added. The solution is slightly acidified with hydrochloric acid, and 20—25 c.c. of saturated sodium bicarbonate solution is added. The solution is titrated with an iodine solution standardised against pure tartar emetic. The tin is determined in 100 c.c. of the filtrate from the antimony sulphide.

50 c.c. of water and 2—3 grms of iron powder or wire are added. The flask used is closed by a stopper carrying a tube dipping into caustic soda. By boiling, the hydrogen sulphide is driven off and the tin is reduced. The vessel of soda is replaced by one of sodium bicarbonate and the tin solution allowed to cool, so that air is excluded. 100 c.c. of air-free water and starch solution are added and the solution is titrated with iodine solution standardised against a similarly prepared solution of tin.—H. J. H.

Determination of naphthalene [in coal gas] by picric acid. Knublauch. See IIa.

Biochemical reactions for distinguishing catechol, quinol, and res-oreinol. Wolff. See III.

The elasticum reaction of wool. Naumann. See V.

Determination of the degree of bleaching of cellulose by means of the copper value. Freiburger. See V.

Ticaddelling of electrolytic bleaching liquors. Hepburn. See VI.

Estimation of sodium sulphide in sulphide dyebaths. Swann. See VI.

Volumetric determination of sulphur in pyrites. Craig. See VII.

Conductivity measurements upon oxidation-reduction reactions [ferrous salts and potassium bichromate]. Edgar. See VII.

Determination of boric acid in special glasses. Nicolardot and Boudet. See VIII.

Determination of the fineness of [ceramic] raw materials. Walker. See VIII.

Methods for saturating clay trials for absorption and porosity determinations. Beecher. See VIII.

Method of testing the corrosive action of slags on firebrick. Brown. See VIII.

Colorimetric determination of organic impurities in sand [for mortar]. Abrams and Harder. See IX.

Rapid method of determining nickel and cobalt in ores and alloys. Schoeller and Powell. See X.

Detection of peanut [arachis] oil in olive oil. Lund. See XII.

Determination of unsaponifiable matter in oils, fats, and waxes. Wilkie. See XII.

Rapid method of determining the suitability of oils for soap-making. Lecocq. See XII.

Influence of the presence of calcium carbonate on the determination of available phosphoric acid in soils by Dyer's method. Sen. See XVI.

Assimilation of nitrates and nitrites [by plants]. [Separation of nitrates from nitrites.] Baudisch. See XVI.

Chemistry of cholera culture media. Seiffert and Bamberger. See XIXb.

Exact quantitative determination of atropine. Baggesgaard Rasmussen. See XX.

PATENTS.

Combustible gases; Apparatus for detecting the presence of— A. Philip and L. J. Steele. Portsmouth, Eng. Pat. 106,127, Nov. 22, 1916. (Appl. No. 16,750 of 1916.)

Is apparatus of the type described in Eng. Pats. 27,281 of 1911 and 5167 of 1913 (this J., 1913, 455; 1914, 378) in which two wires of catalytically active material are exposed to the atmosphere to be tested and two similar wires are protected from exposure to the atmosphere, the two pairs of wires being connected in opposite arms of a Wheatstone bridge, the inactive wires are enclosed in a chamber at the same pressure as the surrounding atmosphere. The chamber may be closed except for a connection to the surrounding atmosphere by a tube of great length and fine bore, so that it is sensitive to pressure changes but not to changes in the composition of the atmosphere. Alternatively, the chamber may be entirely closed, one surface containing an adjustable flexible diaphragm.—W. F. F.

Temperature-measuring instrument. T. Spooner, Wilksburg, Pa., Assignor to Westinghouse Electric and Manufacturing Co. U.S. Pat. 1,227,337, May 22, 1917. Date of appl., May 28, 1913.

Two thermocouples are used, a main thermocouple the hot junction of which is at the temperature to be measured, and an auxiliary thermocouple the cold junction of which is at the temperature of the room. The cold junction of the main thermocouple and the hot junction of the auxiliary thermocouple are kept at the same temperature in a single receptacle. A potentiometer and the necessary auxiliary apparatus and connections are provided, whereby the temperature difference between the hot and cold junctions of the main thermocouple is measured, and the indication increased by an amount proportional to the temperature difference between the hot and cold junctions of the auxiliary thermocouple.—W. F. F.

Books Received.

Forty-first Annual Report of His Majesty's Inspectors of Explosives. 1916. [Cd. 8609.] Price 1d. (See page 694.)

EXPLOSIVES. By ARTHUR MARSHALL. Second Edition. Vol. I. History and Manufacture. Vol. II. Properties and Tests. 795 pages. J. and A. Churchill, 7, Great Marlborough Street, London. Price £3 3s. for the two volumes.

Less than two years has elapsed since the publication of the first edition of this work (see this J., 1915, 583); its value may therefore be taken as established. The book has been much enlarged and new illustrations provided. The manufacture of picric acid, trinitrotoluene, and other nitro compounds receives much fuller treatment in this edition, and French explosives and methods are also described in greater detail, advantage being

taken of the publication of "*Les Poudres et Explosifs*," by L. Vennin and G. Chesneau. It may be mentioned that the present edition is dedicated to the Prime Minister, whose portrait is given as frontispiece to Vol. I. Photographs of Berthelot, Sobrero, Nobel, Abel and Mendeléeff from the frontispiece of Vol. II.

TRATTATO DI CHIMICA ANALITICA APPLICATA. Metodi e norme per l'esame chimico dei principali prodotti industriali ed alimentari. Vol. II. Di V. VILLAVECCHIA, Direttore dei Laboratori Chimici delle Gabelle, con la collaborazione dei G. FABRIS, A. BIANCHI, G. ARMANI, G. ROSSI, G. SILVESTRI, G. BOSCO, R. BELASIO, F. BARBONI, ed A. CAPPELLI. U. Hoepli, Milan. XV. + 719 pages, 9½ by 6½ ins., with 105 illustrations. Price L. 18.50.

This is the second volume of Prof. Villavecchia's treatise on applied analytical chemistry, the first volume of which has been previously noticed (see this J., 1916, 1181). The present volume contains sections on: meat and its preparations (29 pages); milk and dairy products (36 pages); flour and starch, and products derived from them (51 pages); sugars and products containing sugar (109 pages); beer (16 pages); wine (74 pages); spirits and liqueurs (70 pages); essential oils (34 pages); turpentine and its products (20 pages); varnishes (10 pages); rubber and gutta-percha (12 pages); tanning materials (22 pages); inks (10 pages); leather (14 pages); colouring matters (91 pages); textile fibres, yarns, and fabrics (107 pages). There is also an alphabetical index covering both volumes.

COMBINAZIONI CHIMICHE FRA METALLI. Di M. GIUA e C. GIUA-SOLLINI. U. Hoepli, Milan. XVI. + 446 pages, 9½ by 6½ ins., with 207 illustrations. Price L. 12.50.

THE present work is that which gained the prize offered in 1915 by the *Reale Istituto Lombardo di Scienze e Lettere* for the best monograph on "Intermetallic compounds." The book comprises chapters on equilibrium diagrams; thermal analysis; nature of intermetallic compounds, including some hitherto unpublished results of experimental work on the degree of dissociation of such compounds; influence of intermetallic compounds on the physical properties of alloys; homopolar intermetallic compounds, i.e., compounds of true metals; heteropolar intermetallic compounds, i.e., compounds of metals with metalloids; ternary intermetallic compounds. The work is completed by a bibliography, an index of authors' names, and an index of the known intermetallic compounds.

TRADING WITH THE ENEMY. Consolidating statutory list of persons and firms in countries, other than enemy countries, with whom persons and firms in the United Kingdom are prohibited from trading. (With notes to British merchants engaged in foreign trade.) Complete to June 22, 1917. No. 29a. H.M. Stationery Office, London. Price 6d. net.

TRADE PRODUCTS OF THE BRITISH EMPIRE. Special Supplement to Chamber of Commerce Journal. July, 1917. Oxford Court and 97, Cannon Street, London. E.C.4. Price 1s.

A STATISTICAL account of the resources of the British Empire in regard to supplies of foodstuffs and of raw materials for British industries.

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J. R. M. Klotz.	H. S. Miner.	H. Wigglesworth.

Hon. Treasurer: Frank C. R. Hemlingway, Bound Brook, N.J., U.S.A.

Hon. Local Secretary:

Allen Rogers, Pratt Institute, Brooklyn, N.Y., U.S.A.

Nottingham Section.

Chairman: R. M. Caven.

Vice-Chairmen: S. R. Trotman and John White.

Committee:

T. H. Adams.	B. Collett.	C. E. B. Merriman.
L. Archbutt.	R. Duncalle.	A. Smith.
M. Barrowcliff.	J. H. Dufoird.	J. T. Wood.
F. H. Carr.	F. Stanley Kipping.	

Hon. Treasurer:

S. J. Pentecost, Lenton Works, Nottingham.

Hon. Local Secretary:

J. M. Wilkie, 5, Balmoral Avenue, West Bridgford, Nottingham.

Sydney, N.S.W., Section.

Chairman: H. G. Smith.

Vice-Chairman: C. E. Fawsitt.

Committee:

R. W. Challinor.	R. Greig-Smith.	Loxley Meggitt.
F. A. Coombs.	G. Barker.	B. J. Smart.
J. D. Granger.	A. B. Hector.	

Hon. Local Secretary and Treasurer:

S. E. Sibley, c/o Messrs. Mauri Bros. & Thomson, Castlereagh Street, Sydney, N.S.W.

Yorkshire Section.

Chairman: J. W. Cobb.

Vice-Chairman: W. Med. Mackey.

Committee:

James E. Bedford.	W. M. Gardner.	L. G. Paul.
B. A. Burrell.	A. G. Green.	F. W. Richardson.
S. H. Davies.	C. H. Hardy.	J. T. Thompson.
C. P. Finn.	H. Ingle.	F. Wood.

Hon. Local Secretary and Treasurer:

T. Fairley, 17, East Parade, Leeds.

Official Notices.

At the Annual General Meeting of the Society of Chemical Industry held at Birmingham on 18th July, 1917, the following Resolution was submitted by the President, Dr. Charles C. Carpenter, seconded by Mr. J. H. Hoseason, and unanimously agreed to:—

"The Council of the Society of Chemical Industry, having considered the matter, recommend, and it is hereby resolved, that—

"(1) The yearly subscription for Members of the Society shall, from 1st January, 1918, be 30s. in place of 25s. as at present;

"(2) The amounts payable for Life Composition under By-law 11 shall each be increased by £5; and

"(3) It is therefore also resolved that By-laws 10 and 11 be altered accordingly."

In terms of Paragraph 38 of the Society's Charter, a General Meeting of the Society is hereby called to be held at Broadway Chambers, Westminster, London, S.W., on Wednesday, 15th August, at 4 p.m., for the purpose of confirming the above Resolution.

J. P. LONGSTAFF,

General Secretary.

30 July, 1917.

LIBRARY CATALOGUE OF CHEMICAL JOURNALS.

Owing to the great activity in chemical industries which has arisen during the last few years, the Council felt that a Catalogue of current Journals dealing with chemistry and chemical industries and the Libraries in which they could be found would be of considerable value, and a Committee was appointed last year to take this matter in hand. The work is not yet completed, but as a great deal has been done it may interest members to know the scope and present state of the Catalogue.

The list of Chemical Journals, about 5000 in number, comprises all those abstracted by the Society of Chemical Industry, Chemical Society, American Chemical Society, Science Abstracts (Chemistry), and contained in the Patent Office Library, Royal Society Library, International Catalogue of Scientific Journals (Chemistry), Smithsonian Collection of Chemical Periodicals, and the *Chemisches Centralblatt*. In addition some thousands of Journals dealing with textile, engineering, and other industries have been added, as these often contain articles of value to chemists, or are industries in which chemistry plays an important part. This list is now practically complete.

About 800 Libraries have been communicated with, and asked to send lists of the Journals taken by them or to mark on copies of our list those contained in their Libraries. This part of the work is steadily progressing, and the Journals from our list which are to be found in over 200 Libraries have been already catalogued.

Patent specifications are also listed.

Though the whole Catalogue is not yet complete, members of the Society wishing to avail themselves of the list and library data already collected, in order to find out the whereabouts of any particular Journal which may not be taken in the Library of their own town, will be given all available information on applying to Dr. A. Holt, Chemical Dept., The University, Liverpool.

FUEL RESEARCH BOARD.

The Fuel Research Board, with the sanction of the Committee of the Privy Council for Scientific and Industrial Research, has appointed a Committee of enquiry into the utilisation of Irish peat deposits.

The terms of reference to the Committee are as follows:—"To enquire into and to consider the experience already gained in Ireland in respect of the winning, preparation, and use of peat for fuel and for other purposes, and to suggest what means shall be taken to ascertain the conditions under which, in the most favourably situated localities, it can be profitably won, prepared, and used, having regard to the economic conditions of Ireland; and to report to the Fuel Research Board."

Though the enquiries of the Committee will ultimately lead up to the consideration of peat as a source of energy in central power stations, there are sound reasons why this aspect of the problem should be postponed to a later stage. On the one hand, the Fuel Research Board is already organising an extensive enquiry into the problems of fuel economy in connection with power production, and the results of this enquiry will supply the fundamental data and information which will be required when the time comes for the consideration of any wide scheme of development in Ireland. On the other hand, any schemes of development must be based on a more exact knowledge than is at present available regarding the selection of the more favourably situated bogs and the possibilities of winning and transporting partially dried peat to centres at which it may be converted into marketable products. It is obvious, therefore, that the enquiries of the Committee are likely to be most fruitful if they are concentrated on the fundamental problems, for until these are settled no satisfactory progress can be made.

The following appointments have been made to the Committee:—Sir John Purser Griffith (Chairman), Professor Hugh Ryan, Professor Sydney Young, F.R.S., Mr. George Fletcher, and Professor Pierce Purcell (Secretary). All communications should be addressed to: The Secretary, The Peat Enquiry Committee, University College, Dublin.

Note: The Offices of the Department of Scientific and Industrial Research (including the Fuel Research Board) have been removed to 15, Great George Street, Westminster, S.W.1.

PROCEEDINGS

OF THE

THIRTY-SIXTH ANNUAL GENERAL MEETING, BIRMINGHAM,

WEDNESDAY, JULY 18TH, 1917.

The Thirty-sixth Annual General Meeting of the Society was held on July 18, 1917, at the University of Birmingham. Dr. Charles Carpenter, the President, in the chair. About 200 members were present.

The Lord Mayor of Birmingham (Ald. A. D. BROOKS) extended a hearty welcome to the members of the Society on the occasion of their visit to Birmingham, and recalled the occasion of their previous visit in 1907. It was the duty of all men, whatever their attainments, to place their services at the disposal of the

State during the present crisis. One of their great objects was to see how far they could assist, in the first place in the prosecution of the war; and, secondly, how they might best be able to help the country after the war. The present struggle differed from the wars of the past in that it was carried on primarily by scientific methods; those who had followed the progress of hostilities had been impressed by the extraordinary development that had taken place with regard to the application of science to warfare. They, as chemists, were now concerned in producing means by which human life could be destroyed; and many gases that it had been desired to eliminate as dangerous to human life were now being produced for the purpose of destroying human life. The experience thus gained would be of enormous advantage after the war if proper use were made of the lessons which were now being learned. Before the war this country had shown a lack of initiative and enterprise. We had allowed many important industries to slip away from us and to pass into the hands of other countries which were now our enemies, to their advantage and our disadvantage. Such things must not be allowed to happen again. In order to succeed in the future it would be necessary to conserve and apply all the resources at our command and to conduct our national and commercial affairs on a sound and economical basis; and the surest way to do that was to make use of all the scientific and technical methods at our disposal. It was for that reason he had so much pleasure in welcoming the Society to Birmingham. Many of its industries depended largely for their success on the recovery of what, in the past, had been termed waste products. A great deal had been done in the direction of their recovery; still more remained to be done. There were certain kinds of coal which it was not profitable to use in the ordinary sense but which might be profitably utilised by the application of chemical methods. There was a large amount of heat being lost up the chimneys, which might be recovered and made use of for other purposes. The war had revealed our deficiencies; it had also revealed our powers of adaptability. It was for us to profit by experience. He hoped that their visit to Birmingham might be enjoyable, interesting, and profitable.

PRESIDENT'S ADDRESS.

The CHAIRMAN then delivered his Presidential address, as follows:—

It was my privilege a year ago to address you amid surroundings which have long been a fruitful source of inspiration in belles-lettres. We meet to-day in a city renowned as being essentially material and practical in its character. If the connection with it of one of the greatest chemists of the eighteenth century is not so close as that of the greatest of mechanical engineers, we may remember that it was here he suffered martyrdom for his opinions. It would not, indeed, require a great stretch of the imagination to look upon this gathering as a pilgrimage to the shrine which will ever be associated with the memory of two famous men, the discoverer of oxygen and the inventor of the modern steam engine. And in this double circumstance may be found a theme whose many phases might in themselves constitute full justification for this assembly. If we seek the basis upon which the structure of modern industry has been erected, I think we shall find it largely in the sciences of mechanics and of chemistry; they may indeed be regarded as the first parents of technical industry as it exists to-day. The mechanical engineer will not be likely to dispute the influence of Watt

nor will the analytical chemist be likely to deny indebtedness to Priestley. It is true our present-day vision of the future is not quite the same as that which illuminated the minds of these two great men. But the steam engine the one designed is just as essential an adjunct of the modern power plant as is the chemistry practised by the other to the modern synthesiser of new substances. With the future of our Empire is closely bound up progress in applied science, and, of a certainty, chemical science, and this progress is impossible of achievement without the complete and sympathetic collaboration of both chemist and engineer. It is my belief that with one or two notable exceptions this was not recognised to the full by many manufacturers in this country, certainly until recently. Let me give as an example of what I mean a supposititious case. Suppose the average chemical practitioner were faced with the task of translating a process from the laboratory to the works scale, involving, say, an organic fusion. His conception of carrying this out has not in many instances extended beyond a metal fusion pot with perhaps a run-off cock, having an external furnace and an internal stirrer. This would be as near as he would be likely to visualise on the large scale a familiar process of the laboratory, and, of course, failure to obtain yields would ensue. Such a piece of apparatus might have been useful to a road authority for heating tar by the roadside, but it would be clearly useless for the purpose under consideration. The progress of the chemical industry requires the inspiration of the chemist in all and every direction; that, of course, goes without saying, but what I do urge is that the greatest possible advantage be taken of the engineer's particular gifts to bring about its achievement, once he is made to understand the conditions to be aimed at. The task may not be an easy one, for the temperaments of the chemist and the engineer are dissimilar, and the best examples of both are rarely met with in the same individual. The sorting-out process should begin at school. It should not be left to chance for the lad whose natural bent is along either of the paths which I am now discussing to make his choice of one. If the teaching authority has properly guided and taken pains it should be an easy task to sift the pupil's leanings and direct his course in accordance with them.

But as a preliminary step towards this, the first principles of experimental science should be compulsorily taught in all primary schools, as for instance, is drawing. The ignorance of even the language of science among not only what are called the working classes, but the governing ones also, is appalling, and the only remedy is its universal teaching. I remember hearing on the occasion of a State official being introduced to a highly technical department of which he was to assume control the apologetic utterance, "Gentlemen, in the matters with which you are concerned I am more of a layman than the ordinary layman." While one could not but admire the British pluck underlying such a confession, one could not but be shocked at the system which gave the opportunity for it.

Fortunately, the task of those who are endeavouring to push forward science into the forefront of our educational system is made simpler to-day by the fact that we have no longer to argue the necessity. I might almost say the paramount necessity, of the chemical industries to the nation. But how are we to take full advantage of the latent capacity of our youth unless we teach one and all that the pursuit of chemical knowledge is a calling as honourable and praiseworthy as that of any other of the professions? We have all, I expect, come across men with a strong, natural interest and ability for chemical pursuits which they followed by the merest chance and not as a

matter of course. Their rising to important positions in the chemical industry should have been by design rather than accident. Now here is one of the cases where the community requires and is entitled to have the help of the State. Our educational system needs alteration at its foundations. In my opinion a boy is old enough to learn science when he is old enough to learn history and geography. When he reaches the age of sixteen he should commence work either at the desk or in the factory with compulsory attendance at Continuation Schools. After two or three years he will, if showing himself to possess the necessary ability, be fit for entrance to the University to follow a further course of study along paths adapted to his temperament and qualities. In the past the nation's youth has been developed as unscientifically as its fuel resources. We have seen enough during these last three years to realise that our future depends upon the highest development of our industries, in which the whole populace must be trained to take its share as a pleasure no less than as a necessity. The taunt that we were a nation of shop-keepers was fast becoming a fact when our rude awakening came a century later; if we ever deserve another such rousing our sleep will prove eternal. There were doubtless many contributory causes, but the plight of chemical industry in this country was principally due to the fact that so small a part of the nation was taught its language. The nation cannot be expected to appreciate science at its true value unless that appreciation is inculcated as thoroughly as patriotism, for instance. The next point to be remembered is that the industrial chemistry of to-day is not largely a matter of pots and pans, but a highly complex combination in which temperatures and pressures of fine gradations and extended limits play important parts. The more one sees of this position the more imperative does it appear that the chemist and the engineer should get into double harness as quickly as possible; the very faults of each make him indispensable to the other. In man's war upon nature to wrest her secrets and use them to his advantage, chemist and engineer may be looked upon as playing parts like those of Army and Navy respectively, the one planning his moves upon the contour of an immobile land, the other upon ever-changing waters. Chemical industry teems with examples where the collaboration of both has been successful in extending its fields of usefulness. Take, for example, what is perhaps almost the oldest, that of glass-making; it is the engineer who has made possible the large scale manufacture of jars and bottles to an extent that was quite out of the question as long as the metal required human lungs and hands to blow and fashion it.

The importance of the chemical industries in the scheme of national defence and national progress is at last becoming understood, and must be taken into account in the re-fashioning of our educational system. Another essential change is in our knowledge of the raw material resources of the Empire. Possession of the better maps contributed to the successes of the victors of 1870. And it must be a State matter to map out all our mineral resources that they may be placed at the disposal of industry by, and, I have come to the conclusion, under the control of, the State. I cannot picture a future in which it is possible to work our mines, for instance, with regard only to the present, or in which anything but a surplus output goes abroad before home requirements are satisfied. It should be an offence to supply coking coals for ships' bunkers even though the price paid is a good one. The State must consider whether it is better to export coal for steel-making by our competitors, or to send them the finished article. And if we send our raw materials abroad their sale should be made a matter of inter-State exchange and barter. It ought to be possible to make a

beginning by exporting coke instead of coal and thus increase our control of by-products, the need for which is rapidly increasing. We should thus work up the nitrogen content of our own coal and export this instead of the mineral which should be recognised as the property, as it is the heritage, of the nation.

It has been a matter of deep regret to me that my recent year's holding of an office which I highly value has been an even more troublous and anxious time than its predecessor. The country will never know, still less repay, its debt to this Society. It has pursued its way for the most part unheeded and unrecognised save by the few here and beyond the seas who know its worth. To-day its star, as is that of the industries it represents, is in the ascendant. In local Sections, as well as in membership, it continues to expand, and with this growth your Council are ever on the watch that its usefulness shall keep pace. Much depends upon the energy and enthusiasm with which the Sections perform their decentralised tasks of organising and stimulating progress. Much can only be done centrally, of which the conduct of the Journal is perhaps the most important example. I think you will agree with me, too, that the commencing volume of Reports upon the Progress of Applied Chemistry, which it is proposed to issue annually, is worthy of its subjects, despite the difficulties inseparable from production in the middle of the storm and stress of War. The industry owes much to those who originated and carried through the idea, and it is confidently hoped that the same note of progress which that volume of Reports expresses will be before long extended in the Journal, which it is intended shall not only provide a mirror of the progress of industrial chemistry, but a source of inspiration of new ideals.

It is not so long ago that the suggestion was seriously put forward that the successful investigation and utilisation of what one may call the higher branches of chemical knowledge were pursuits for which the Briton was not temperamentally fitted, and that they might in the world's interests be best left in the hands of a nation which has certainly carried them to a high degree of perfection. One cannot be surprised at the suggestion. To take the case of another industry—that of mechanical engineering—who, familiar with the Continental practices of thirty or forty years ago, could have imagined that to-day those standards compare favourably with our own? Another example of the truism that knowledge knows no frontiers.

So, too, one may imagine the scorn that may but three years ago have been expressed for a contemptible little Army of British technical chemists. As their brothers in France and Flanders, they have belied the criticism and have shown that our race is not incompetent to play its part without limitation or qualification in the tasks which confront mankind, and in which the science of applied chemistry must have an important share.

Professor H. LOUIS moved a vote of thanks to Dr. Carpenter for his address. Their President had shown by his career that a scientific man could be trusted to take charge of the economic and administrative work of a big organisation, a lesson which, he hoped, would not be lost sight of throughout the country.

It was fortunate that Dr. Carpenter had been guiding them through a period when the Society had been undergoing great developments both in its internal and external policy. Many changes had taken place during his presidency. The entire nation had at last awakened to the realisation of the value of the chemical industry, and it would be their task to see that the nation

did not in the future sink into its former apathy with regard to science.

He was entirely in agreement with Dr. Carpenter in his views in regard to education. It had been his own practice to advise every boy who came to him not only to secure the Matriculation qualification, but also to obtain practical knowledge by spending from six to twelve months in an engineering workshop. Whatever a lad was going to be in after life, the best practical education he could get was a few months spent in contact with the materials which he had to use and in association with the working men upon whom the future of the country so largely depended.

He believed that employers were glad to see the rise in wages, because they realised that they were most prosperous when wages were high.

He was in agreement with Dr. Carpenter, moreover, in his desire to see the resources of the Empire in regard to raw materials properly surveyed and recorded, and it was with great satisfaction that he hailed the decision of the Government to appoint an Imperial Bureau of Mineral resources.

The vote of thanks to the President was passed with acclamation.

REPORT OF COUNCIL.

The Report of Council was then presented as follows:—

During the year the Council has held 9 meetings, Accounts Committee 10, Publication Committee 24, Journal Extension Committee 2, Emergency Committee 5, Annual Reports Committee 4, Standardisation Committee 1, Catalogue Committee 2, International Catalogue Committee 2.

The number of Members now on the Register is 4429, as compared with 4059 last year. Since the last Annual Meeting, 521 Members have been elected, and the losses have been 151.

The losses by death amount to 53, viz.:—Hugh W. Aird, John Alden, John L. S. Allan, Rt. Hon. Lord Alerton, F.R.S., P. Carter Bell, Lyman M. Bourne, Henry Bowen, Dr. Harold de Haven Boyd, J. C. Butterfield, George S. Cooper, Dr. J. K. Crow, H. W. Davis, H. T. Deakin, Louis C. Deverell, Wm. Diestel, John V. Dupré, Prof. J. Ferguson, J. K. Forrest, E. G. Francis, Wm. Gemmell, R. Glegg, Harold E. Gresham, Allan T. Hall, C. E. Hanna, Major A. F. Hess, A. H. Hewitt, David Howard, Dr. J. H. Kastle, Edward Kay, Arthur G. Levy, Cuthbert P. Lewis, Ernest A. Lewis, John Lewis, Cyril D. McCourt, Ralph W. E. MacIvor, John Mackenzie, George Nightscales, Prof. John Oehler, S. Ollerenshaw, Harry Parker, Samuel Pope, Dr. Thos. Purdie, Sir Wm. Ramsay, K.C.B., Capt. Hubert W. Rawson, Sir Samuel W. Royse, Dr. J. H. Smith, Thomas W. Steven, R. M. Sutherland, C. Umney, Thos. U. Walton, Jas. W. Westmoreland, Lt.-Col. Thos. Wilton, Dr. Francis Wyatt.

David Howard, D.L., J.P., was President of the Society from 1886 to 1887, and Sir Wm. Ramsay, K.C.B., was President from 1903 to 1904.

The following members of the Society gave their lives to their country:—John L. S. Allan, Major Arthur F. Hess, 2nd Lt. Cuthbert P. Lewis, 2nd Lt. Cyril D. McCourt, Harry Parker, and Capt. Hubert W. H. Rawson.

Dr. Charles Carpenter's second year of office as President of the Society expires after the Annual General Meeting, and the Council has nominated Professor Henry Louis, of Newcastle-on-Tyne, as his successor in office.

Dr. Carpenter has been nominated a Vice-President, and to the vacancies caused by the retirement of four Vice-Presidents, Mr. John Gray,

Mr. A. R. Ling, Prof. R. F. Ruttan, and Mr. J. T. Wood have been nominated.

Four Ordinary Members retire from Council, and to fill the vacancies thus created, Messrs. A. G. Bloxam, W. J. Rees, Edwin Thompson, and Professor James Walker, F.R.S., have been nominated. The nominations being equal in number to the vacancies, there will be no ballot.

The following Chairmen of Local Sections retire:—W. J. Rees (Birmingham), Professor James Walker (Edinburgh), John Gray (Liverpool), A. R. Ling (London), J. H. Hoseason (Manchester), S. W. Wilder (New England). The following have been elected to succeed them:—Dr. R. S. Morrell, David B. Dott, A. T. Smith, Dr. Charles A. Keane, W. Thompson, and R. W. Neff.

The following changes have taken place among the Honorary Local Secretaries:—Dr. J. P. Longstaff (Edinburgh), appointed General Secretary of the Society, Dr. P. C. Mellhiney (New York) resigned after 6½ years' service, Mr. T. U. Walton (Sydney) deceased, were succeeded by Dr. A. Lauder, Dr. Allen Rogers, and Mr. S. E. Sibley respectively. The Council desires to express its thanks to the retiring officers for their services to the Society, and has conveyed to the relatives of the late Mr. Walton an expression of its sympathy and of its high appreciation of the work done by him in Sydney.

The Balance Sheet and Annual Statement of Accounts, which have already appeared in the Journal for 30th June, will be laid before the Meeting.

The Journal for 1916 contained 1274 pages of text, as compared with 1276 pages in 1915.

The Council has resolved to recommend that (1) the Annual Subscription for Membership of the Society should be raised from 25s. to 30s., commencing on 1st January, 1918, and (2) the life composition fees should be increased by £5 each. This recommendation will be submitted to the Meeting, and, if approved, to a Special General Meeting for confirmation.

The Meeting of Council in October was held at the Rooms of the Royal Society of Medicine in Wimpole Street, by the kind permission of the Council of that Society, in order that the Members might inspect the building and its general arrangements. The Meeting in November was held in the Board Room of the University of Leeds, by invitation of the authorities of the University, who also most hospitably entertained the Members present.

The Council has authorised the holding, two or three times a year, of Conferences of the Chairmen and Secretaries of the various Sections for the purposes of mutual assistance, and for helping forward the work of the Society. The first was held in Edinburgh during the last Annual Meeting, and subsequent meetings have been held in Leeds and London.

At the last Annual General Meeting, the Medal of the Society was presented to Mr. C. F. Cross, F.R.S. The Council has also formally conveyed to Mr. E. J. Bevan its high appreciation of the exceedingly valuable work he has done in collaboration with Mr. Cross.

Messrs. Cross and Bevan have placed at the disposal of the Society the sum of £20 as a prize for an essay on "The Interconnection of Economic Botany and Chemical Industry," and a further sum of £300 has been presented by their friend, Mr. T. P. Latham of Weybridge, as a grant towards research undertaken by such one of the competing essayists as may be judged to be of conspicuous ability. Essays are to be submitted to the Council of the Society not later than the close of the year 1917. Full particulars have already been published in the Journal.

The Council has forwarded to the Board of Trade the following resolution:—

"In view of the impossibility of deriving benefits from Patents during the War, the Council of the Society of Chemical Industry is of opinion that the payment of the annual fees upon Patents should be suspended during the War, and that the duration of British Patents should be extended for the same period."

The Publication Committee being aware that many matters of interest connected with Chemical Industry, such as Addresses or Papers given before other Societies, descriptions of new Plant, accounts of the establishment of new Industries, and so forth, are reported in local newspapers or are known to local members, have suggested to the Committee of each Section of the Society that it should appoint as "Corresponding Representative" a Member who would undertake the duty of looking out for such matters within the limits of the Section, and who would send in a Report which could be utilised for the purposes of the Journal. It is hoped that effect will be given to this arrangement.

The Council and Publication Committee have always had in view how best to improve the Journal so as to make it as interesting and as useful as possible to the Members of the Society, and they are glad to have received from time to time expressions of the high appreciation of the value it possesses in the estimation both of Chemists outside the Society and of those who are Members. They are anxious to take advantage of the marked increase of interest which, during the past two or three years, has been manifested in the Journal, to make it as efficient and up-to-date as is possible, and with this in view it has been decided to publish a separate part of the Journal to which the name "Review" is to be given, which shall deal with articles of general and industrial interest.

The appointment of an additional Editor to give the whole of his time to the work of the "Review" has been decided upon, and the Council have unanimously elected Dr. E. H. Tripp.

Dr. E. F. Armstrong and Prof. E. C. C. Baly, F.R.S., have been elected Members of the Publication Committee.

The Committee engaged in the preparation of a catalogue of chemical periodicals and patent literature, has prepared a list of over 5000 Journals, and is now engaged in consulting the various libraries in the United Kingdom with a view to ascertaining which Journals are to be found therein.

Dr. Rudolph Messel, F.R.S., has been re-appointed by the Council to serve on the governing body of the Imperial College of Science and Technology, for a further term of 4 years from 1st June last.

Mr. Tyrer continues to be the representative of the Society on the Executive of the National Physical Laboratory, and Mr. W. F. Reid is its representative on the General Board.

Steps are being taken for the formation of a Bristol and South Wales Section of the Society. A meeting was held at the University of Bristol some little time ago, which was attended by heads and representatives of local firms and others interested in the subject. Mr. Hedley occupied the chair, and the meeting was addressed by Mr. R. F. Easton, to whom is due the initiative in the matter, Prof. Francis, Mr. C. J. Waterfall, Dr. Rixon, and the Chairman, and it was resolved to form a Section of the Society in the district. Since then the Council has received a numerous signed petition in support of this resolution, and has given its approval.

The Council has pleasure in observing a considerably increased interest in the Society in Western Canada. Through the enthusiasm and energy of Mr. J. A. M. Dawson and Mr. J. H.

Hamilton, the question of the formation of a Canadian-Pacific Section of the Society has been brought forward. These gentlemen, after consultation with the officers of the Society in Canada, formed last autumn an Organising Committee consisting of Members of the Society resident in Alberta and British Columbia along with other prominent chemists. A circular letter was drawn up and sent to a number of chemists, technologists, and manufacturers. The result has been a considerable accession of new Members. The Council congratulates the promoters of this movement, and hopes to receive from them soon an application for the formation of a Canadian-Pacific Section.

Consideration is at present being given to a proposal for the formation of a Section of the Society in India.

In last year's Report it was stated that the Council had addressed to the Advisory Council for Scientific and Industrial Research a request for a grant in aid of a research on Cellulose to be carried out under the direction of Mr. Julius Huebner at the Municipal School of Technology, Manchester. This grant has since been received, the sum of £66 13s. 4d. being handed over for the period 1st August, 1916, to 31st March, 1917. The Council being satisfied with the usefulness of the work done, applied for a further grant of £100 for a period of 12 months from 1st April, 1917. This has also been received. The work being carried on is of a preliminary character to that which will be undertaken when more men and opportunities are available, and consists of a series of investigations as to (1) the methods of drying Cellulose in order to obtain exact weights, (2) the effect of drying at different temperatures and over different periods, and (3) the effect of moisture on the properties of raw, scoured, and bleached cotton yarn.

The Council has appointed four representatives of the Society, along with the Editor of the Journal, to confer with representatives of the Chemical Society on the subject of the abstracting of scientific papers with a view to seeing if some scheme could be devised to prevent overlapping. The matter is at present under consideration.

The Sub-Committee of the Board of Scientific Societies on the International Catalogue of Scientific literature submitted a series of questions to the Council regarding the extent of the use of the Catalogue made by scientific men, and asking for recommendations for possible improvement. The matter was remitted to a special Committee who have reported to the Board on the subject.

The Council has appointed two representatives to the Refractory Research and Standards Committee recently formed in order to consider the co-ordination of research work on refractory substances and to endeavour to secure joint action in carrying further the work of standardisation. An account of the first meeting of this Committee will be found in the Journal for 16th April last.

The Council issued last Autumn a series of questions to its Members on the subject of Industrial Alcohol. Since then, a Joint Committee of the Society of Chemical Industry, the Association of British Chemical Manufacturers, and the London Chamber of Commerce, has been formed to deal with the subject.

The approval of the Council has been given to the formation, in connection with the London Section of the Society, of a Committee of Experts in Industries connected with Sugar throughout the Empire to enquire into the question of providing a supply of sugar which should render the Empire independent of foreign sources of supply. Further particulars will be found in the Journal for 30th April, 1917.

The Council acknowledges with thanks several books presented to the Society's Library by Mr.

Tyrer, the Hon. Treasurer, and also valuable sets of the Journal of the Society from Mrs. Dickinson, of Brockley, and Mrs. Warden-White, of Laxham Gardens. It also records with pleasure the generous gift of Mr. Thos. Fairley, Hon. Secretary of the Yorkshire Section, of a complete set of the Society's Journal presented to the Edinburgh and East of Scotland Section to be coupled with the names of his former teachers in Edinburgh, Lord Playfair and Prof. Alex. Crum Brown.

Professor THOMAS TURNER, in moving the adoption of the report, said that the Council was to be congratulated on their work during the past year. The Society had done a considerable amount of useful work despite the difficulties arising from the war. The Journal had been maintained at a high, possibly a higher, standard of quality and usefulness, and the membership had substantially increased. The Report showed that the Council must have done a great deal of work for the benefit of the Society, and the meeting could, he thought, confidently adopt the report, which showed so much progress, and which was so full of encouragement.

Mr. E. ARDERN seconded the adoption. He thought the report was one upon which they could as a Society congratulate themselves. The Council had put in an abnormal amount of work which the members thoroughly appreciated.

The report was unanimously adopted.

TREASURER'S STATEMENT.

The PRESIDENT, in presenting the statement of accounts and balance sheet (see this Journal, 1917, pp. 617—618), expressed regret that Mr. Tyrer, their energetic Honorary Treasurer, was unable to present his financial statement in person, owing to the fact that he had to undergo an operation in respect of his eyes. He suggested that a message should be sent to Mr. Tyrer expressing the hope for his speedy and permanent recovery.

This was cordially agreed to.

Dr. ALFRED REE moved the adoption of the statement of the accounts. They had an excess of revenue over expenditure of nearly £900, which was partly due to the fact that their advertisements had yielded a larger amount and that the sales of the Journal had increased.

Mr. JOHN GRAY seconded the motion, which was unanimously approved.

INCREASE OF SUBSCRIPTION.

The CHAIRMAN said that for some time past proposals for increasing and extending the usefulness of the Journal and for developing its possibilities had been seriously considered by the Council and committees appointed for the purpose. He was glad to state, as the Report of Council had already done, that they were now in a position to announce a definite policy. They intended to maintain the present Journal in its entirety. Its form had been settled many years ago, and through times had changed the Journal remained unaltered. They desired to make the Journal in every way worthy of the Society: to make it eventually a standing weekly book of reference for all interested in chemical technology. They were not quite prepared for that later development; and what was being done now must be regarded as only a step towards that end. They proposed to publish a Journal which would deal with chemical industry in all its phases, recording not only the doings of the Society, but also reflecting what was happening throughout the world in the domain of applied chemistry. For that it would be necessary to build up a set of machinery parallel to that which was already running. They could not disturb the

present organisation; they wanted to add to it another one which would have its own Committee, and its own Editor; and that Editor would be assisted by a staff in the same manner that the present Editor was assisted by his staff of abstractors. The Council felt, too, that the Society's offices were inadequate, and that administration needed centralising. The Council had thought well to proceed with the experiment without waiting for the authority of the general meeting—which he hoped would be forthcoming—to increase the membership subscription. He hoped they would accept the views of the Council and agree with their proposal to increase the subscription. He moved: "The Council of the Society of Chemical Industry having considered the matter recommend and it is hereby resolved that:—

"(1) The yearly subscription for members of the Society shall from 1st January, 1918, be 30s. in place of 25s. as at present; and (2) that the amounts payable for life composition under By-law 11 shall each be increased by £5; and it is further also resolved that By-laws 10 and 11 be altered accordingly."

Mr. J. H. HOSEASON, in seconding the resolution, said that the need for the alteration was proved. Moreover, the purchasing power of the sovereign was not what it had formerly been; and it was not likely to return to its former level for a considerable time.

Professor TURNER suggested that the subscription should be raised to two guineas.

The PRESIDENT pointed out that the Council had considered that matter, but had come to the conclusion, having regard to the financial position of some of the members, that it was advisable not to ask for an amount that would give a surplus, but only sufficient for their needs.

Professor W. A. BONE suggested that the subscription should be made sufficient to cover the cost of the issue to the members of all the publications of the Society, including the Annual Reports, rather than that extra payments should be necessary.

Mr. E. HILL said that in his opinion the advertising side of the Journal was sadly neglected. The British manufacturer did not know how to advertise.

The PRESIDENT pointed out that the present arrangement with regard to the printing of the Journal, which also included the advertising, had been under consideration, but it was felt that for the present the better course would be to leave the matter undisturbed. As to the payment of an inclusive subscription covering all the publications of the Society, including the Reports, it had been finally decided by the Council to issue them at a separate fee, as they were not required by all members.

Mr. W. McD. MACKAY pointed out that the decennial index had been published in 1905, and since the war one had not been issued. Was there any intention to abandon the index?

The PRESIDENT said he was not aware that any announcement had been made that it was intended to discontinue this index. No decision of the kind had been come to. The question of the next issue would be considered.

Mr. L. P. WILSON drew attention to the arrangement whereby members with an income of not more than £150 were entitled to admittance without payment of the entrance fee.

The PRESIDENT stated that a fair number of members had taken advantage of that provision. The names of such members were not published and the whole matter was treated confidentially.

Dr. R. H. PICKARD said that it always seemed to him deplorable that there existed in London no central building at which the whole of the chemical societies might meet. Such a hall

existed in other countries. He hoped it would not be long before similar provision was made in the metropolis. He understood that the Chemical Society favoured such a scheme. Such a hall should in his opinion be common to all engaged in chemical science.

The PRESIDENT said that, without binding the Society, he thought there would be a readiness to consider with the Chemical Society any scheme for the provision of such a hall. The need was great. He was glad to hear that the Chemical Society was considering the matter.

The resolution was then put to the meeting and unanimously adopted.

APPOINTMENT OF AUDITORS.

On the motion of Mr. VLIES, seconded by Dr. CAIN, the auditors, Messrs. Feasey and Co., were reappointed.

VOTE OF THANKS.

On the motion of the PRESIDENT, seconded by Dr. A. HOLT, a vote of thanks was then passed to the authorities of the University for their generosity in allowing the Society the use of the lecture theatres, etc.

The meeting then adjourned, the members lunching at the Grand Hotel, by invitation of the Birmingham and Midland Section.

WEDNESDAY AFTERNOON.

The following papers were read :—

SOME OBSERVATIONS ON THE TEXTURE OF FIRECLAYS.

BY WALTER C. HANCOCK, B.A.(CANTAB.), F.I.C., AND W. E. KING, A.R.C.S.

The influence exerted by texture, or "grain-size," on the properties of refractory materials has now become generally recognised. It is obvious that the texture of raw or unburnt clay is quite different from that of the same material after firing and the methods of examining it in the one state are not applicable to it in the other. The determination of texture in the raw material is of course the simpler, since most clays can be thoroughly disintegrated by boiling with water, and separated into classes of grains the sizes of which lie within selected limits. In the case of the fired material there is no analogous method of procedure, and indeed it is not improbable that in that condition the individuality of the finer grains has disappeared owing to intimate coalescence or initial fusion. At present there seems to be no other possible method of determining the texture of fired clays except the microscopical examination of thin sections or at least of plane polished surfaces.

The experiments recorded below were made on a typical Stourbridge fireclay, and it seemed that a comparison of the properties of the raw and of the fired material might afford some link between the two states or indicate something of the mechanism of the physical changes that occur on firing.

Successive portions, amounting in all to about 1300 grams, or nearly 3lb., were subjected to elutriation in a Schoene apparatus and separated into the four usual grades designated as "clay substance," "silt," "fine sand," and "sand." By increasing the rate of water flowing through the apparatus this last fraction was subdivided into two grades the mean diameters of the particles in which were 0.04–0.10, and 0.1–0.2 mm. respectively. Incidentally the finest fraction was also subdivided in consequence of a comparison which was carried out between the Schoene

elutriation and a sedimentation process, which may be briefly outlined here.

The sedimentation process adopted was that suggested by Prof. T. B. Wood* for the mechanical analysis of soils. Ten grams of the disintegrated clay is thoroughly stirred with water in a beaker on which heights from the bottom are marked in centimetres. The liquid is brought up to the 8.5 cm. mark and allowed to stand 24 hours; at the end of that time the supernatant liquid, containing the finest particles in suspension, is drawn off, the residue at the bottom again worked up with water and brought to the 8.5 cm. mark and allowed to stand a further 24 hours. This procedure is continued till the supernatant liquid at the end of the specified time is clear. The finest particles drawn off in suspension may be allowed to settle and then be dried and weighed, or the various portions of liquid may be mixed, made up to a known volume and an aliquot part evaporated and weighed. The material left in the beaker is stirred with water, made up to the 10 cm. mark, and allowed to stand 100 seconds. The process is repeated till the liquid is free from suspended matter, the residue in the beaker being the coarsest fraction or "sand." All the material in suspension separated from the "sand" is allowed to settle and then stirred with water, made up to the 7.5 cm. mark and left to stand 12½ minutes: the material in suspension is designated "fine silt," and the residue which settles out at this stage, "silt." A comparison of the results obtained by the Schoene and the above sedimentation process are shown below; in each case 10 grams of dry clay was taken.

Size of particles. Diameters in mm.	Elutriation.	Sedimentation. (mean of 3 expts.)
0—0.002	4.6724 1.2511 } 2.1536 0.9025 } 3.1086	{ 0.5204 } 3.2484 { 2.7280 } 1.8314
0.002—0.010		
0.010—0.025		
0.025—0.040		4.8324
0.040—0.200		
	9.9346	9.9122

As mentioned above, the finest fraction obtained by elutriation was subdivided by the sedimentation process, five days being required to effect complete separation. Some of the liquid containing the finest particles in suspension was evaporated to dryness and the residue weighed, and in another portion the particles were allowed to settle, collected, dried, and weighed. The former procedure gave a product very seriously contaminated by the dissolved mineral matter in the tap-water used, as is clearly shown by the analyses in Table I., in which column No. 1 A represents the composition of the material allowed to settle out, and No. 1 B that obtained by evaporation. Even in the former case some contamination is indicated by the rather higher proportions of Fe₂O₃, CaO, and MgO, and by the fact that carbonates, chlorides, and sulphates accounted for the 7% deficiency shown in the analysis.

The extreme diameters of the particles in each group, confirmed also by microscopic measurements, were :—

Fraction No. 1	0—0.002 mm.
" No. 2	0.002—0.010 mm.
" No. 3	0.010—0.025 mm.
" No. 4	0.025—0.040 mm.
" No. 5	0.040—0.100 mm.
" No. 6	0.100—0.200 mm.

Table I. (p. 748) gives the chemical composition of the original clay and of the various fractions.

* J. Agric. Sci., I, Pt. 4, March, 1906.

TABLE I.

	No. 1 A.	No. 1 B.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Original clay.
SiO ₂	45.97	42.82	54.60	63.87	62.54	60.97	61.00	63.80
Al ₂ O ₃	25.65	7.46	28.76	23.79	24.45	25.30	24.10	23.16
Fe ₂ O ₃	2.44	1.39	2.57	2.20	2.28	1.79	2.38	0.67
CaO	5.64	27.82	1.11	1.28	1.05	1.02	1.18	0.85
MgO	1.26	1.70	0.39	0.35	0.28	0.32	0.22	0.11
K ₂ O	1.83	5.99	1.43	1.49	1.48	2.48	2.58	1.53
Loss on ignition ..	10.57	23.16	11.13	7.15	8.74	9.06	9.24	10.00

Rational analyses of the clay and of the various fractions were also made according to the process given in Lunge and Keane's "Technical Methods of Chemical Analysis," Vol. I., Pt. II., p. 587.

	Clay substance.	Quartz.	Felspar.
Fraction No. 1	90.0	7.4	2.6
" No. 2	79.2	26.6	4.2
" No. 3	66.4	30.1	1.5
" No. 4	65.3	32.3	2.4
" No. 5	66.1	31.2	2.7
" No. 6	65.9	30.5	3.6
Original clay	68.8	28.5	2.7

These tables show that the "clay substance," or material approximating to that represented by the "kaolinite formula," $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$, as might be expected, composes the bulk of the finest grained fraction and the quartz tends to accumulate in the coarser fractions.

Physical properties. Measurements of some of the physical properties of the various fractions were also made.

Plasticity.—A quantity of each fraction was pugged up by hand with water and submitted to a "plasticity test" by means of a Vicat needle. It was found necessary to modify the time, and in place of the usual five minutes a period of a quarter of a minute was substituted; hence the results are only relative with regard to the series in question. From the mean results of a number of experiments, the following "plasticity numbers" were obtained:—

Original clay	100
Fraction No. 1	123
" No. 2	139
" No. 3	113
" No. 4	98
" No. 5	94
" No. 6	100

The amounts of water in the various test-pieces were adjusted so that the 300-grm. needle penetrated a depth of 5 cm. in 15 seconds; the test-pieces were then dried at 105° C. and the water present calculated on 100 parts of dry clay. The figures in the above table show the ratios of these amounts of water, taking that in the original clay as 100.

Air- and fire-shrinkage.—A number of test-pieces, 10 cm. by 1 cm. by 1 cm., were moulded and allowed to dry. Some test-pieces from each fraction were allowed to dry very slowly in a covered vessel in order to decrease the tendency to warp, which was very noticeable in those of the fine-grained material. When all the bricks had become constant in weight, they were dried in an air-oven at 105° C. for 2½ hours to drive off all the hygroscopic water and were afterwards fired to 1200° C.

The following table shows the shrinkage and loss of weight of the test-pieces under these conditions:—

TABLE III.

	Water at time of moulding.	Loss of weight.		% Shrinkage.
		Air.	105° C.	
Original clay	24.0	17.0	19.4	5.7
Fraction No. 1 ..	22.4	16.9	18.3	—
" No. 2 ..	27.0	20.0	21.2	5.8
" No. 3 ..	19.5	15.9	16.6	4.0
" No. 4 ..	18.2	14.3	15.4	4.2
" No. 5 ..	19.2	15.2	16.1	4.3
" No. 6 ..	20.7	16.1	17.7	4.7

It was not possible to obtain readings for the shrinkage of the bricks of fraction No. 1, owing to excessive warping. It is interesting to note that the air-shrinkage appears to have a minimum value in test-pieces made from fraction No. 3.

The following table shows the results obtained on firing to 1200° C.

TABLE IV.

	% Loss of weight at		Diff.	% Shrinkage at		Diff.
	105° C.	1200° C.		105° C.	1200° C.	
Original clay ..	19.4	27.3	7.9	5.7	8.8	3.1
Fraction No. 2 ..	21.2	29.5	8.3	5.9	12.4	6.5
" No. 3 ..	16.6	24.7	8.0	4.0	7.2	3.2
" No. 4 ..	15.4	23.7	8.3	4.2	8.6	4.4
" No. 5 ..	16.1	24.3	8.2	4.3	9.0	4.7
" No. 6 ..	17.7	25.8	8.2	4.8	9.6	4.8

These figures also show that the minimum shrinkage is obtained with test-pieces composed of grains from fraction No. 3.

Conclusion.—Of course from a set of observations on a single clay, general conclusions cannot be drawn, but we think that the results obtained may not be without interest. The experiments have involved a very much larger amount of work than might at first sight appear. They seem to confirm the distribution of the "clay substance" and quartz which one would expect to find among the various fractions. Fraction No. 2 (0.002–0.010 mm.) differs markedly from the others; it takes the highest amount of water for moulding, and gives the largest air and fire-shrinkage, which have minimum values in the fraction with the next larger grains (0.010–0.025 mm.). If points such as these are substantiated by later observations, they should be of some practical value as a guide to the size of grain which should be selected in materials in order to ensure certain physical properties. Further work on these lines is in hand.

The experimental work recorded has been carried out in the refractory materials laboratory in the Department of Chemical Technology of the

Imperial College of Science and Technology, South Kensington, and our thanks are due to Professor W. A. Bone, D.Sc., F.R.S., for the facilities he has afforded us.

DISCUSSION.

The CHAIRMAN said that scientific methods were being adopted by most of the British manufacturers of refractories. The old method was simply to take the clay, and after a due amount of weathering it was mixed with a certain amount of "grog" and that was the end of it. That had been the English manufacturer's idea of building up refractory material for general use. The German method was to find what the ultimate composition of their clay should be, and if it were deficient in the qualities required they fortified it in the light of experiment and experience. In that way they were able to compete with goods in this country, although they did not possess all the materials necessary to produce them. The final article they produced was better for practical work than anything the British manufacturer had been able, for a long time, to produce. We were now altering our methods, and producing something that was better than before, though not yet equal to that made by the Germans.

Mr. A. G. ROBERTS asked for further information in relation to the percentages as stated in cols. No. 1 A and No. 1 B.

Dr. J. T. DUNN drew attention to the variations in the analyses in the two columns mentioned, particularly in relation to silica and alumina, and pointed out that the samples commencing with No. 3 up to 6 differed little from the original clay with regard to original constituents; but the amount of iron was considerably greater than that in the original clay. The figures appeared difficult to explain. It would have been interesting if Mr. Hancock had ascertained the relative refractory characters of those portions of the clay as compared with the original.

Mr. ROBERTS said that adsorption led to difficulties in separating certain clays; by the use of distilled water it might be possible to overcome many difficulties.

Mr. J. W. HINCULEY expressed the hope that the author would later on devote his attention to the elucidation of the problem of plasticity. It was important to define what was meant by "working condition." There was a great tendency to work the clay with too much water, and in a too plastic state.

Mr. HANCOCK, in reply, said he used the term "working condition" in the sense that there was a kind of "feel" about well-tempered clays which was difficult to define. It was that feeling, or sensitiveness, which afforded guidance to the worker. Regarding the two columns to which reference had been made by Mr. Roberts, the one was the analyses of the fine material separated; the second column gave the partial analyses when evaporated down. The use of distilled water would get over many difficulties, but it was not easy to arrange for the necessary large supplies. Regarding Dr. Dunn's observations, he was aware that the composition of the first fraction did not exactly represent the composition of china clay; but the ratio between silica and alumina in that fraction was nearer to that found in china clay than it was in the original clay itself. The presence of iron showed the disturbing effect arising from the use of tap water. The iron content was high, owing to the fact that a certain amount of iron was collected from the iron vessel used. His own experience confirmed that statement. He hoped, later on, to be able to extend the work to other physical determinations and particularly with regard to the refractoriness of the samples mentioned by Dr. Dunn.

Mr. BUTTERFIELD asked if the author held that the finer parts which were separated existed in that degree of fineness in the original firebrick, or did he think they were produced from the more fragile constituents of the firebrick. It seemed to him that this method of disintegration amounted merely to measuring the brittleness of certain parts of the firebrick as burnt and it might not have much bearing on their refractory character.

Mr. HANCOCK said that if the original clay, as mined, were treated with water, it could be disintegrated satisfactorily. Using ordinary care he did not think the state of subdivision of the constituent parts of the clay was materially different from that in the particles produced in the segregation of the rock. His contention was that they had no means of disintegrating firebrick in the same way.

CHEMICAL LABORATORY PORCELAIN.

BY HENRY WATKIN.

Introduction.

The first attempts to make porcelain in Europe were undoubtedly in imitation of the Chinese porcelain imported into Europe by the Dutch, English, and French East India Companies about 1673.

Its beautiful whiteness, its thinness, its translucency, its close vitreous fracture, apart from and also in conjunction with its decoration, at once appealed to and obtained the admiration and emulation of the Europeans.

The story of the struggle in the attempt to reproduce it is not within the scope of this paper, but suffice it to say, that it was accomplished in Germany by Bottcher about 1706—1718, and in England by Cookworthy of Plymouth about 1767.

The one factory continued for the reason that not only were the products excellent, but the financial success was not the main object, while the other had to bear its own losses and though there was considerable promise of success, the financial aspect of the undertaking was a complete failure. It is well, then, at the outset to note that we do not owe the origin of the porcelain to the continental potters but to the Chinese.

Chinese porcelain being at that time the only translucent pottery in existence, there can be no wonder about the admiration it called forth.

It cannot be surprising, then, that the English potters were very anxious to produce such a body, and if that object could be obtained, the means by which it was attained were secondary matters, and we find that instead of continuing the manufacture of hard paste porcelain, they produced, about the end of the 18th century, (1) a beautiful white earthenware which for generations secured the market of the world, and made it possible to replace almost all other pottery for domestic purposes. (2) A translucent white porcelain similar to the Chinese, by the use of other materials and methods, equally beautiful, which for over a century has held its own amongst all other porcelain productions, and which is generally known as Bone China.

The ceramic productions of the world as regards their bodies or paste, apart altogether from decorative effects, vary from goods made from the coarsest to the finest clays, through almost every variety of texture by admixture of the natural clay with other materials, such as sand, flint, barytes, feldspathic rock, etc. From these materials were produced at one end of the scale the cinerary urns of our great ancestors, and at the other end, the excellent hard paste porcelain which we are considering to-day.

The marvellous difference in the productions of the various peoples of the world may probably be explained by the general assertion that the potters

have from the very earliest times worked with the materials they had at hand. The cinerary urns of the Ancient Britons were made from natural clays.

The Staffordshire potters used, at first, natural clays, found cropping up simultaneously with the coal, and subsequently improved the colour and texture of the product by the addition of, first, fire clay, then Devon and Cornish clay, and calcined flint. Messrs. Eler Bros. used the red marl of the Burslem district for their fine red ware. Bottcher of Germany at first made red ware from local clays, etc., and afterwards porcelain from the white clays or kaolin, and pegmatite.

The Chinese for centuries had been working with their natural materials, kaolin and petuntze, and from these produced their fine porcelain. Some of these various clays naturally required a much greater heat than others to produce hard vitreous bodies.

These varying conditions with regard to materials to the hand of the potter, when means of communication were so restricted, necessarily involved very varied methods of manufacture. The materials differing so essentially from each other naturally required very varying degrees of heat necessary to bring to maturity.

The kaolin and petuntze used by the Chinese would require a much higher temperature to mature than the clays, etc., used in other countries at the time. The exact temperature would not be found at once, and in working out the same an observant potter could not fail to notice the changes taking place in the fired material in regard to vitrification, translucency, and finally distortion at the various temperatures. Thus in all probability without any more scientific knowledge whatever than careful observation, the fine product of that time would be produced which even now (centuries later) is the object of our research.

While the Chinese were for centuries making the most suitable material in the world for chemical laboratory ware, they had no use for such, and consequently did not make it. It was only with the advance of scientific chemical knowledge in Europe, that the need was felt for the various porcelain accessories that were then called into use.

It is not surprising, therefore, that Germany and France having continued making the Chinese type of porcelain, should have applied themselves to this particular demand, and while the English porcelain manufacturers were busy on their own particular class of porcelains they should have almost entirely secured the trade of the world in this branch.

With the cessation of the importation of Continental porcelain into this country, came the call to the English potter, and, as might have been expected, it was not every manufacturer that would listen to the call, neither was it needful that they should.

There was no very tempting offer of any lucrative opening in the new business, and a potter must be more tempted by patriotism to his country, and a desire to meet its needs, than by immediate prospective financial success.

Definition of porcelain.

It is almost impossible to give a definition of chemical porcelain which could generally be regarded as entirely satisfactory. When first porcelain was introduced into Europe, its translucency was sufficient to differentiate it from all other ceramic productions of that period.

We have seen in the attempts to produce a similar porcelain in Great Britain and the Continent other kinds of translucent pottery were discovered, which are known under other names, such as bone china, soft paste porcelain, etc., the former of

which for over a century has held its own amongst the finest productions of the world.

It is quite clear then, that what was once the predominant and characteristic definition of Chinese and Continental hard paste porcelain is so no longer, and translucency alone could never be regarded as the guarantee of chemical porcelain. Translucency is only one of the properties of porcelain and that rather of beauty than utility, as evidenced by the fact that so much of the beautiful translucent porcelain of England has been found useless for the purposes we have in our minds at the moment. To understand the nature of the porcelain required for this purpose needs a clear conception of the uses to which it is to be applied and consequently the qualities required of it.

Properties of porcelain.

In order to decide on the possibilities of the manufacture and the manner of procedure, it was desirable to consider the relative importance of the qualities demanded.

These vary very considerably in their degree of importance, and I am inclined to place them in the following order.

1st. The first and foremost quality, I submit, is that of *resistance to very sudden changes of temperature* of as wide a range of heat as possible without cracking during the operation or at its close on cooling. The greater the range of difference in the temperature the porcelain will allow itself to be subjected to in the quickest time without cracking or breaking, the better and more suitable the porcelain.

2nd. *The resistance of the glaze to the action of chemical reagents* so that the solution may not take up additional weight by dissolving portions of the glaze and thus leading to false estimations in chemical analysis.

3rd. *The colour of the porcelain* should be white or cream, although for special purposes green, blue, or black is sometimes used.

4th. *Fusing point.* The glaze should resist fusion at temperatures well above that at which the articles are generally used.

5th. *The weight of the material.* This is not a very important matter, but it is inadvisable to put excessive weights upon delicate balances, and secondly, liability to cracking increases considerably with the thickness of the material.

6th. *Composition.* The materials which enter into the composition of a porcelain for chemical laboratory purposes appears to matter very little, providing the qualities required for the purpose are complied with; e.g., we are all quite well aware of the fact that one of the materials entering into all porcelains, namely, silica, can without any other additions be made by fusion to fulfil perfectly all the conditions required, unless the material being tested reacts with the silica itself at the temperature.

7th. *Translucency.* This appears to be a quality which is not absolutely necessary for the purpose and may be dispensed with entirely without detriment to the article, provided the other qualities are correct. A piece of very translucent pottery may, for the purposes we are considering, be much worse than a piece of very feeble translucency.

The question now becomes, is it necessary or compulsory to confine ourselves to the methods of either the Chinese or Continental manufacturers? Are these the only ones open to us?

We have seen that it was possible to use materials in such proportions that the firing temperature became a necessity on account of the proportions of fusible to infusible materials present, which needed the high temperature in order to give to it one of its qualities which is not a necessity.

Hence with similar or other materials, it was quite feasible to suppose that the same end could be attained by regulating the length of time the glaze is allowed to remain in a fusing condition on the ware.

Materials.

The materials generally used in hard paste porcelain bodies are ball clay, china clay or kaolin, quartz or flint, felspar, Cornish stone, pegmatite, sometimes a very small proportion of lime, and sometimes ground broken porcelain.

Manufacture.

The materials are weighed out in their proportions, and by the usual blunging operations are intimately mixed by using a large excess of water. The mixture is passed over sieves to abstract any coarsely ground materials, and passed through a trough containing magnets to eliminate any particles of iron either present in the clay as pyrites or other magnetic forms, also from the wearing of the bearings of the machinery. It is then passed through the filter presses from which, when the excess of water has been removed, it is taken as oblong sheets of plastic clay approximately 6 ft. long \times 2 ft. wide \times $\frac{3}{4}$ in. thick. These sheets are then rolled up for convenience of removal and passed through a pug mill where the clay is made homogeneous, the air driven out, and extruded as a continuous mass of plastic clay of a square section about 6 in. and cut off in convenient lengths. It is now ready for use for most purposes, but sometimes is still further improved by wedging or by rolling on machines by the French method.

Castings.

This consists of pouring the slip or body mixture into moulds made of plaster of Paris, and allowing it to remain there for a definite period, when the surplus is emptied out and the article is dried and removed from the mould. The thickness depends upon the length of time the slip is left in the mould. There is always a liability to get differences in weight and thickness which may account for cracking for the following reasons.

First.—The articles may be made so thin that although they are on that account able to conduct or disperse the heat quickly when suddenly heated or cooled there is not sufficient mechanical strength to withstand the strain.

Second.—In making the article thick enough to withstand the mechanical strain, there is a great danger of making it so thick that the porcelain is cracked owing to unequal expansion or contraction.

When the articles are made they are placed in fire-clay receptacles called saggars, which are arranged one upon another in the ovens for firing. The matter of placing is of very great importance and requires great experience and care. When the oven is filled it is either fired according to the method adopted by the hard paste manufacturer whose work we are considering, or by the English method.

The Chinese and Continental manufacturers invariably give their clay ware an easy or low temperature treatment in the first firing, which not only facilitates the subsequent dipping process, but also gives the glaze when fusing upon the surface of the biscuit during the second fire, a better chance of assimilating itself to the body. This can be clearly seen by the absence of a sharp dividing line between the glaze and the body, which is often seen in earthenware and china. The English manufacturer, on the contrary, invariably gives the highest degree of temperature during the first fire.

In some instances where the article is sufficiently strong to be dipped into the glaze without collapsing

and losing its form, it is fired both for body and glaze at the first and only fire, but this procedure is rather restricted in its extent by the nature of the articles, and generally it is preferable to submit the goods to the easy fire first, *e.g.*, it would not be found an easy process to dip evaporating basins in the clay state without collapsing. The first firing, except in the case last mentioned, viz., the clay dipped goods, produces what is known as the biscuit or once-fired goods, the surface of which is rough and without glaze.

This ware is then emptied from the saggars, carefully inspected, faulty goods eliminated, brushed to remove any particles of sand, and passed on to be dipped, which means the glazing process, which consists of dipping the articles in a mixture of compound silicates of alumina, potash, calcium, etc., etc., ground to a fine powder and held in suspension in water, or in ground felspar and lime as practised by the Chinese.

The glaze when dry is then removed from such parts as needful to prevent the pieces sticking to each other during the fusion of the glaze in the next or second firing operation. Another method of separation is by the use of stilts and spurs of various designs. To keep the goods true in form in the second firing is one of the most difficult problems of the manufacturer of chemical porcelain.

The firing of the oven is usually taken to a higher temperature than that of the first or biscuit firing, and takes about 50/60 hours or more to complete.

The judgment of the temperature reached during the operation is effected by various pyrometers, including electrical pyrometers, radiator pyrometers, Wedgwood pyrometers, pyro cones, recorders, etc., etc.

When fired there is still another operation, namely, that of removing any stray bits of sand, sagger dirt, etc., etc., adhering to the glaze, which is accomplished very much on the principle of the glass cutters' operation, who no doubt introduced it to the potters' industry.

The last and final operation is selection and packing.

Testing.

The method of testing the suitability of a porcelain for chemical purposes does not appear to be standardised. Samples sent to one analyst may be treated in quite a different manner to those sent to another.

The three essential qualities that need to be tested for are as follows:—

(1) The resistance to sudden changes of temperature without cracking.

(2) The resistance of the glaze to the action of chemical reagents.

(3) The fusing point of the glaze.

The first of these (the resistance to sudden changes of temperature without cracking) appears to be the most important, judged from the number of tests applied to this particular quality by the German chemists.

Out of 9 tests applied to the Haldenwanger porcelain, 7 were those applied to this quality, while 2 only were applied to the resistance of the glaze to the action of chemical reagents.

German. Seven methods of testing.

(1) Heated repeatedly for 2 days on a Bunsen burner and allowed to cool.

(2) Exposed to great heat and then suddenly placed on a cold metal plate.

(3) Immersed in water for 6 days and then heated until glowing.

(4) Made red hot on a burning gas flame and suddenly placed on a cold metal plate.

(5) Made red hot, gas turned off, and immediately exposed to a blast of cold air.

(6) Heated up to melting point to Seger cone 610-950° C. in a muffle furnace, sustained at that for 10 mins., then quickly taken out and placed on a cold stone.

(7) Same experiment as last, taken up to melting point to Seger cone 1-1150° C.

English. Four methods of testing.

(1) Crucible filled with wax and heated until the temperature rose to 130° C., then allowed to cool to 125°, to insure that the outer layers of the porcelain did not exceed this temperature.

(2) Crucible plunged into cold water at 15° C., and the same experiment repeated at 175°, 200°, 225°, and 250° C.

(3) Crucible placed in a muffle heated to about 900° C. and when thoroughly heated, removed and allowed to cool in the air.

(4) Crucible plunged into a furnace at dull red heat, approx. 550° C., and allowed to cool in the air.

The resistance of glaze to the action of chemical reagents.

The action of water on the vessels is determined in the manner usually employed for glass ware, viz.:—Very carefully prepared distilled water is placed in the vessels, which are then heated to 80° C. for 3 hours. The action of the water is determined with iodococin, equal volumes of water being used for each dish, and the same volumes equally distributed between 3 crucibles. The contents after treatment with iodococin are placed in the series of comparison cylinders to observe the difference in alkalinity. The volume of iodococin solution required to restore the colour determines the amount of acid or alkali dissolved from the porcelain.

A second test is made as before but the action is continued for 6 hours at 100° C.

Action of alkali.

The dishes are heated in a steam oven, cooled in a desiccator and weighed. Fifty cubic centimetres of caustic soda solution (40 grms. per litre) is placed into each of the dishes, and another 16 c.c. divided equally between the 3 crucibles. After heating in a perfectly closed oven so that no liquid is evaporated, for 3 hours at 80°, the dishes are removed and cleaned, then heated in a steam oven, cooled in a desiccator and weighed, the difference in weight giving the amount of silica or other materials dissolved.

The same method as the foregoing is adopted but with caustic potash for 5 hours at 100° C. instead of 3 hours at 80°.

Action of sulphuric acid.

In this test 5 c.c. of normal sulphuric acid (49 grms. per litre) is placed in each crucible, and carefully evaporated, finally volatilising the sulphuric acid by heating over a Bunsen burner. The crucible is then weighed and any difference in the weight gives the amount of loss sustained by the crucible.

Action of nitric acid.

The action of nitric acid on the crucibles is tested for 5 hours at 100° C.

Recent output.

More than 150 years' experience of the manufacture of hard paste porcelain at the State supported Royal Factory of Berlin, the experience of which was placed at the disposal of the porcelain trade of Germany, gave it a tremendous advantage over the English manufacturer. It was therefore no light task for an English manufacturer, minus

that experience, under entirely different conditions, with all the models and moulds to prepare, to attempt the task. Some three or four English manufacturers, however, have attempted the same with very considerable success.

While I cannot speak with any degree of confidence in relation to the manufacture or supply of other factories than our own, I think I may safely say that there is now no very serious occasion to go abroad for any of the chemical porcelain accessories needed in this country.

In spite of all the difficulties surrounding the problem, English samples were in the hands of the dealers for testing purposes in November, 1914. On and by the 20th January, 1915, deliveries were commenced. The permanent success of the venture for all the firms concerned will depend upon the behaviour in use.

Doubtless demands will be made upon our manufacturers, from time to time, for very special articles, such as the condensing worms as shown in the Royal Berlin Catalogue, page 107, but if our Government will behave towards her potters as Continental countries have done to theirs, such articles will be made by special assistance.

We cannot refrain from expressing a sense of satisfaction that something has already been done by making a grant of £10,000 to the North Staffs. Technical School, Stoke-on-Trent, for experimental work in connection with hard paste porcelain, and extensive scientific research work in that direction is being carried out under the superintendence of Dr. Mellor.

Future prospects.

With regard to the future of the trade, it may be well to repeat, that the English potters for two years now have supplied Great Britain with nearly all that has been needed for scientific work, as also for chemical processes in connection with the war. The cry, therefore, that it cannot be done, is no longer admissible.

We may not at present have succeeded in making anything superior to the German production, but I venture to say that in much less time than chemical hard paste porcelain has been manufactured, our country will be making something superior.

Much will depend on conditions prevailing after the war as to the permanent success of the undertaking. That there will be a keen fight for the trade goes without saying.

The Germans will not very willingly relinquish their hold upon a trade they have held so long. Other countries also will compete. France, Denmark, Japan, and Russia have already commenced to supply and the "Engineer" says:—"Like this country, America, prior to the war, depended upon Germany for porcelain articles used in chemical work, and especially for laboratory work. Since the war the German supply has ceased and much inconvenience was caused to chemists across the Atlantic. To-day, however, we learn that American pottery manufacturers are producing porcelain equal to any produced in Germany."

The aim of the English potter in relation to this matter should be not slavishly to copy the hard paste porcelain, but rather to follow the method pursued in the past, viz., to produce his own particular type of porcelain; but in this case it should be a porcelain suited to the particular requirements. The occasion is ripe for the introduction of something better than anything yet produced, and whatever the slight difference as to the colour and the degree of translucency, the main endeavour should be to produce a porcelain that will fulfil the requirements demanded of it. At present unfortunately there are no definite requirements laid down, and this association could render the potters very valuable service in

arranging in some definite form the tests that should be laid down, *e.g.*, what temperature should the porcelain be expected to stand without cracking, and at what speed should the heat be applied? To what degree of temperature may the glaze be expected to be raised without softening? What limitations should be made to the chemical operations that should be allowed in porcelain crucibles? Unfortunately students are instructed how to use a platinum crucible, but seldom so with a porcelain crucible. Of course the porcelain crucible to be sold for a few pence ought to be expected to stand all sorts of usage. Unfortunately that previously in use will not do this.

Inquiries show that there has always been a considerable percentage of loss on the Continental porcelain, and from tests made by the writer on a number of Continental crucibles and evaporating dishes, the following data has been supplied:—

The Continental porcelain varies in quality amongst the various makers and even from the same maker; of two crucibles tested immediately one after another, under exactly the same conditions, one cracked whilst the other remained perfect. On increasing the severity of the test, every piece of five different Continental porcelains broke down under conditions which might very readily obtain in any chemical laboratory.

DISCUSSION.

Professor T. TURNER said that if the crucibles now being produced were not so good as German crucibles, they were of a reasonably good quality and sold at a reasonable price. They hoped that the present success would not be limited to the time of restricted competition, but that the trade would increase in volume when peace came.

Mr. R. H. PICKARD said he thought Mr. Watkin would be well advised to pay special attention to the action of alkalis on chemical porcelain. It should be recognised that there were two kinds of such porcelain in use—one a cheap kind for students; the other, of a higher quality, for important analytical work, which would resist the action of chemical reagents.

Mr. G. N. HUNTLY pointed out that chemical porcelain was used for a variety of purposes; small articles such as crucibles had to resist sudden changes of temperature, to which dishes used for evaporation, etc., were not subjected; in the latter case the essential property to be secured was effective resistance to reagents.

Mr. WATKIN, in replying on the discussion, said there was no doubt that in many respects silica would be better than porcelain. As to alkalis acting upon the English products and in some cases penetrating the glaze, he pointed out that no tests were really satisfactory unless they were comparative. Though some pieces of English chemical porcelain had been rejected as defective, he felt sure that many German samples, if subjected to the same tests, would also have failed.

SANDS USED IN METALLURGICAL PRACTICE WITH COMPARATIVE NOTES ON THOSE USED IN GLASS-MANUFACTURE.

BY PROF. P. G. H. BOSWELL, D.SC., A.R.C.SC., D.I.C., F.G.S.

Prefatory.

The increase in the output of glass of all kinds and the augmented production of metals and alloys—particularly of the ferrous group—resulting from the demands for munitions of war, has necessitated the investigation and utilisation of British resources of sands to a much greater extent than heretofore. Moreover, before the

outbreak of war, unnecessarily large supplies of foreign sands were imported into this country, particularly for lining the hearths of furnaces, for steel-castings, and for the making of the best qualities of glass. The reduction of the available labour and shipping compelled steel-founders and glass-manufacturers to look to home supplies, and the geologist was naturally called upon to assist in satisfying the urgent national needs. Except in the case of one or two foreign supplies of sand, which so far as investigation has gone up to the present have not yet been equalled in the British Isles, it has always been clear that the country could be self-supporting in this connection. When peace conditions once more reign, economic considerations will be the determining factor which will say whether we shall use our native supplies, or unnecessarily jeopardize the safety of a key-industry by still being dependent upon sea-borne material.

It is appropriate that these questions should be raised at a meeting in a city which has long been notable for its sand deposits. If ever there was "matter in the right place," it is the excellent red moulding-sand for which the Birmingham district is famous and from which it has been sent, incredible as it may seem, to many distant parts of the world.

In this paper the requirements of the glass-industry, so far as sands are concerned, can be no more than mentioned incidentally. British resources of glass-sands have been already treated in practically exhaustive detail by the writer.*

The same sand is often very valuable for both glass-making and refractory work. In metallurgical practice the sands required may be classified into those used (A) in moulding, (B) in lining hearths and furnace-bottoms, and (C) in silica brickmaking. Moulding-sands may be subdivided into those used (i) with a natural bond, and (ii) with an artificial one. Sands used in good glass-making are in most cases precisely the same as those used in classes A(ii), B, and in part C, above. The resources may in this respect be treated together.

We are not yet in a position to discuss refractory sands exhaustively; the requirements differ according to the kind of metal made, the ores used, the type of furnaces, and the craft and prejudices of the user.

If ever there was a case made out for the accumulation of a large number of facts, it is in the matter of refractory materials. The generalisations will follow later; at present the work must run on two lines: (A) Analyses must be made of successful and likely supplies; (B) We must have the carefully recorded results of their trial in the works on a commercial scale. In the latter direction, as in many others, where it is knowledge we are seeking, the next best thing to success is failure.

Information which analyses may supply.

This Society is one which concerns itself more particularly with chemical questions, but it is manifestly impossible, in the case of natural deposits used in such industries as glass-manufacture and metal-production, to divorce the considerations of chemical composition from those of texture, constituent minerals, etc. We need therefore three types of analyses of sediments like sands, clays, and crushed rock-materials used in commerce: chemical, mechanical, and mineralogical. For example, the value of a natural moulding-sand depends upon the texture, that is, the mechanical composition, as well as the chemical constitution. Probably, it is the chemical composition of each

* "British Resources of Sands Suitable for Glass-Making, with Notes on Certain Crushed Rocks and Refractory Materials"; published at the instruction of the Ministry of Munitions of War; Longmans, Green & Co., London, 18. 6d.

And Supplementary Memoir in course of publication.

separate "grade" (see below) which counts. Again, the fritting of high silica sands used for glass-making, furnace-lining, etc., depends on the grade-size and angularity of the sand, as well as upon the silica-content. It is axiomatic to say that fine-grained sands melt more readily than coarse ones.

Actual figures being accessible elsewhere, it appears undesirable to load with them a paper which, from its title, must necessarily be general where the field is so vast. They are therefore only used illustratively. Notes on new methods of work, precautions to be observed, indications of directions where further information is required, and a general statement as to how far the country can be self-supporting, will be of most value.

Chemical analyses of sands.

Chemical analysis should be carried out in the usual manner, but by a chemist familiar with the methods and precautions to be adopted in making analyses of silicate rocks.* Care should be taken by repeated precipitation that too high a result is not obtained for the silica. It is not sufficient to estimate it by difference. Alumina should be estimated (as Al_2O_3). In the case of glass-sands alumina is frequently of value for special glasses (certain optical glasses, thermometer and resistant glasses, etc.) or for its toughening and strengthening properties (bottle-glass). In high-silica sands for refractory purposes it tends to cause fritting at a lower temperature; its presence in small quantity is thus desirable in sands used for furnace-hearthths.

The total iron may, for glass-making purposes, be recorded as Fe_2O_3 , and since in the case of good glass-sands there is a very low percentage (0.02 or less, to 0.06), it is estimated on large and separate samples by colorimetric methods. Many excellent high-silica sands contain up to 0.2% of iron oxide, an amount too great for the making of better-class glass, but quite low enough for the highest refractory demands. Most of the laboratory determinations of iron, like those of silica, appear to be too high. In any case, iron oxide should not rise over 3% and if the sands are to be used under reducing conditions, it should be much less, or the result will be the production of the easily fusible ferrous silicate from combination with some of the quartz present.

In glass-sands which contain more than 0.5% of alumina, it is desirable to look for and estimate titanium. In the form of the mineral rutile (TiO_2) or, less commonly, its isomers anatase and brookite, it is frequently plentiful in sands and quartzose rocks. Exactly what rôle it plays we do not know, but it is clear that in quantity it is decidedly inimical in glass-making. The precise part played by small quantities of so-called impurities in sands, whether in glass-manufacture or in industries using refractory materials, is not yet known, and indicates the need for experimental work and exact analyses. These "impurities" may behave as catalytic agents in facilitating conversions. It is a remarkable fact that titanium is always high in fireclays, most of which are exceedingly refractory, whether they are found in this country, on the Continent, or in America.† A search does not yield rutile or its isomers, and we are therefore led to think that the substance is scattered throughout the clay, possibly in a colloidal or clay-like form.

For glass-sands, other impurities such as lime, magnesia, alkalis, etc., are best absent, or if present should be as "a trace" only. When

required they may be added quantitatively to the "batch," or mixture of raw materials. The alkalis and alkaline earths form, of course, essential constituents of glass, so that their presence in a glass-sand is not inimical. The very reason which requires their presence to make a glass, renders them forbidden constituents in any sand which is to be of value for resisting high temperatures. It is a well-known phenomenon that a particular mixture of substances mutually soluble in one another has a lower melting point (the "eutectic" point) than that of any of the individual substances, and for each pair, triplet, or quadruplet, etc., of substances a definite percentage mixture (the "eutectic composition") always possesses the lowest melting-point. As a common example from everyday life, we may quote that of a mixture of salt and ice. The freezing-point of the mixture in the most suitable proportions for the attainment of low temperatures (23.8 of salt to 76.2 of water) is $-22^\circ C$. Such well-known alloys as those of copper and silver, of the various steels, and even solder itself, provide similar instances. Solder is used on account of the readiness with which it melts. Timman's solder consists of about 60% of lead (melting point $327^\circ C$) and 40% of tin (melting point $232^\circ C$), and possesses a melting point itself of about $180^\circ C$. The mineral constitution and texture of rocks which have been formed by cooling from the molten state are found to be controlled to a large extent by these considerations of eutectics. The compounds and minerals occurring in rocks are those which are also constituents of glass and refractory materials. The rock known as obsidian has the appearance, properties, and composition of a common "black" bottle-glass. Most refractory materials are natural rock-substances. Silica has a melting point about $1600^\circ C$, alumina (for example, as the artificial refractory material, alundum) about $2020^\circ C$, magnesia about $2000^\circ C$, and lime about $1990^\circ C$. Each of these is highly refractory. Aluminium silicate ($Al_2O_3 \cdot SiO_2$), however, as the mineral sillimanite (which is the isomeric form with the highest melting point), crystallises at $1300^\circ C$. Calcium silicate ($CaO \cdot SiO_2$) as the mineral wollastonite, or rather pseudo-wollastonite, to which it inverts, melts at $1512^\circ C$. Numerous other examples might be adduced, but in illustration of the principle, there may be quoted in conclusion only the "Seger" and other types of cones used for temperature determination in furnaces. The cones are mixtures of these substances and the alkalis, and possess a range of melting points according to the composition of the mixture of which they are made.

The addition of potash and soda, or even of lime to a sand therefore, so far reduces the melting-point of the mixture as to enable a glass to be formed. More refractory glasses which are required to possess a higher melting-point and to withstand subsequently a greater heat without softening or devitrifying, are produced by the use of alumina, magnesia, boron, etc. For example, the Thuringian sand used so successfully for thermometer-glass contained 3.66% of Al_2O_3 , the remainder being silica.

It is clear, on the other hand, that sands to be used for refractory purposes should be as highly silicious as possible, or failing that, should contain silica and alumina only. Most sands are quartzose, that is, are wholly or almost wholly composed of quartz (SiO_2). As examples of the best of these, we may quote:—

British.	% SiO_2 .
Aylesbury	99.80
Lynn	99.23
Leighton Buzzard	99.59
French.	
Fontainebleau	99.50
Belgian	99.58
Dutch	99.63

* Washington, H. S., Chem. Analyses of Rocks, 1906, New York.
Hillebrand, W. F., Bull. United States Geol. Survey, No. 176, 1900.
† E.g., see Ries: "Clays, their Occurrence, Properties, and Uses," 1908, 2nd Ed., New York.

U.S.A.	% SiO ₂ .
Wedron, Illinois	99.58
Ottawa, Illinois	99.43
Berkeley Springs, W. Va.	99.65
Germany.	
Lippe	99.88

The next most commonly occurring mineral in sands is felspar. The felspar group of minerals con-

analysis. For glass-making purposes, inimical elements, such as iron, titanium, and zirconium, can be determined at once.

The following table includes analyses of sands which have proved very suitable for lining Siemens furnace-hearths, for the beds of reheating furnaces, etc.

	SiO ₂ .	Al ₂ O ₃ .	Fe ₂ O ₃ .	CaO.	MgO.	Alkalis.	Loss on ign.	Total.
Leighton Buzzard.....	99.59	0.25	0.21	n. d.	n. d.	n. d.	0.27	100.32
Lynn*	98.90	0.58	0.18	nil	nil	nil	0.35	100.01
Lynn (Harwood)	97.34	1.34	0.19	0.09	trace	0.37	0.76	100.09
Belgian*	99.10	0.36	0.24	nil	0.07	nil	0.24	100.01
Belgian (Jesseps Foundry).....	98.79	0.49	0.16	0.16	0.09	0.28	0.21	100.18

* Quoted from Cosmo Johns; Trans. Faraday Soc. Vol. XII. (1917).

sists of ortho-silicates of potash and soda, and polysilicates of soda and lime, in combination with

In the making of silica-bricks sands of the following composition have been successfully utilised :—

	SiO ₂ .	Al ₂ O ₃ .	Fe ₂ O ₃ .	CaO.	MgO.	Alkalis.	Loss on ign.	Total.
Derbyshire 1	74.54	18.04	0.05	0.19	none	n. d.	7.21	100.06
Derbyshire 2	90.40	6.56	0.18	0.16	tr.	n. d.	2.48	99.78
Derbyshire 3	98.17	0.71	0.025	0.11	0.07	0.41	—	{ TiO ₂ 0.42 100.02
East Anglia	94.57	1.09	1.40	nil	0.22	0.72	0.91	{ SO ₃ 0.19 100.00

alumina. The presence of the alkalis, even in small quantity, has the effect which would be expected, namely, that of lowering the refractoriness. Muscovite mica is a related hydrous compound of potash and alumina and has a similar effect. Generally speaking, therefore, felspathic and micaceous sands and rocks must be avoided in refractory work. Felspar, however, is not a stable mineral: it decomposes to micas and then to clayey aggregates (china-clay) by the leaching out of its alkalis as a result of the atmospheric agencies or chemically active gases and solutions. In this way are produced the refractory china-clay of Devon and Cornwall, and the highly aluminous, but lime- and alkali-free sands of Derbyshire, so valuable for the manufacture of silica-bricks. For such purposes as fettling Siemens furnace-hearths, lining reheating-furnaces, etc., it is not desirable to use the exceedingly refractory quartzose sands mentioned above. Better results are obtained when advantage is taken of a sand containing a small quantity of alumina, iron, or even alkalis sufficient to make the sand-grains frit and bind together at their angle of rest on the banks of the hearth. Mr. Cosmo Johns considers that the melting point of quartz, as distinct from that of another form of silica—cristobalite—may be achieved in the presence of small amounts of impurities in the sand. He would suggest the following permissible range of impurities*: Al₂O₃ up to 2% or more; Fe₂O₃ up to 0.5%; CaO, 0.5%; MgO, 0.5%; Na₂O, 0.15%; K₂O, 0.15%; if only one impurity were present. If more than one were present, the amounts would be reduced proportionately.

For the detection of small quantities of "impurities" in sands spectroscopic analysis has already proved of great value qualitatively. It is to be hoped that the method will soon be made quantitative. The procedure adopted is to introduce a small quantity of the sand into an electric arc flame, take a photographic record, and afterwards determine the elements present and their relative amount by measurement of the lines, using comparative spectra. The presence and relative abundance of the constituents can be estimated in a much shorter time than it takes to make a chemical

Connection between chemical and mechanical constitution.

In the above two tables, the chemical composition yields definite information as to the properties of the sands and their likely behaviour when used in furnaces. Similarly, in the case of high silica sands used with an artificial "bond" for steel-casting, we can determine their probable value from their chemical composition. When, however, we endeavour to interpret the chemical analyses of such moulding-sands as those with a natural bond, particularly the sands of value to the steel industry, we obtain little information which is of practical utility. It is true we learn that lime, magnesia, potash, and soda, if present at all, should be in small quantity, but we gain little information as to what compounds in the sands are responsible for their success.

Steel-founders have long said that bulk-analyses of such sands are practically useless. As an example, we may quote the analysis of a valuable sand for steel-casting :—

SiO ₂	% 84.7
Al ₂ O ₃	6.85
Fe ₂ O ₃	7.2
CaO	0.1
MgO	0.2
Loss on ignition	3.9
Total	102.95

If, however, a chemical analysis be made of each grade in a sand, we obtain much valuable information. In high-class moulding-sands (with natural bonds), certain grades such as coarse sand and clay are strongly in evidence, others like fine sand and silt are subordinate. Usually the coarse sand is one of the highly refractory silica sands like those discussed earlier in the paper. It is almost entirely composed of quartz-grains, sometimes bearing thin pellicles of ferric oxide. Felspar grains are occasionally seen, but are usually uncommon. Other minerals are so rare as to be practically absent.

Except for certain iron-casting work and for brass-moulding, where smooth surfaces are required, fine sand and silt are practically absent. The clay grade is, however, of the utmost importance. Coarse high silica sand has no bond in it and would not stand up as a face. The clay yields, with the

* Trans. Faraday Soc., Vol. XII., 1917, "Silica as a Refractory Material."

water it adsorbs, the "glue" which holds the coarse quartz-grains together even at high temperatures. A chemical analysis of the clay-grade is therefore very desirable. The clay must be as refractory as possible. Ideally it would be merely silicate of alumina (kaolin), but unfortunately kaolin has no great binding properties. Fireclay itself is occasionally added to silica-sands as a binder.

As indicating the importance of grading in the matter of size and proportion of grains, the following tables are of interest. The most useful classification into grades is as follows:—

Greater than 2 mm. diam.	Gravel.	} Sand-grade.
Greater than 1 mm. diam. and less than 2 mm.	Very coarse sand.	
Greater than 0.5 mm. diam. and less than 1 mm.	Coarse sand.	
Greater than 0.25 mm. diam. and less than 0.5 mm.	Medium sand.	
Greater than 0.1 mm. diam. and less than 0.25 mm.	Fine sand.	} Silt grade.
Greater than 0.05 mm. diam. and less than 0.1 mm.	Superfine sand or coarse silt.	
Greater than 0.01 mm. diam. and less than 0.05 mm.	Silt.	
Less than 0.01 mm.	Clay or mud grade.	

TABLE I.

Some natural moulding-sands for steel-casting.

Mechanical analyses obtained by elutriation: Percentage weights.

	>1 mm.	> 0.5 and <1 mm.	>0.25 and <0.5.	>0.1 and <0.25.	>0.05 and <0.1.	>0.01 and <0.05.	<0.01.	Total sand-grade >0.1 mm.
Belgian sand	—	7.5	64.9	12.0	3.3		12.3	84.4
French sand	—	0.6	18.0	62.7	3.1		15.6	81.3
Cornish Red sand	—	0.6	37.3	42.7	5.7		13.7	80.6
Huttons Ambo sand	—	4.5	57.7	16.0	1.8		20.0	78.2
South African sand	—	0.5	3.4	70.5	1.0	6.3	18.3	74.4

TABLE II.

Mechanical analyses of "mixtures" used for steel-casting.

	>1 mm.	>0.5 and <1 mm.	>0.25 and <0.5.	>0.1 and <0.25.	>0.05 and <0.1.	>0.01 and <0.05.	<0.01.	Total sand-grade >0.1 mm.
Core-sand	6.5	2.5	10.4	57.8	0.3	4.8	17.7	77.2
"Strong" sand	0.4	0.8	15.8	64.7	0.1	2.4	15.8	81.7
Small green-sand work	2.7	2.2	16.8	61.9	0.1	2.2	14.1	83.6
For very large work	36.2*	8.5*	7.7	23.5	1.1	9.3	13.7	75.9

* Contains much clincker.

In each of these it will be observed that the coarse and medium sand-grade is high, and the clay-grade comparatively high, but that the percentage of fine sand and silt is very low. This is an important characteristic of all good moulding-sands. The predominant coarse sand ensures that the mould shall be open, containing adequate pore-space for the free passage of air, vapours, and gases. The clay-grade provides the refractory bond, which, with water, unites the large grains together, but the quantity of clay is of course not sufficient to fill the interstices between the grains (the pore-space is probably about 40% of the whole). Fine sand and silt, which would tend to pack up and fill all the pore-space, are practically missing. Good sands for greensand-moulding are therefore non-graded materials, *i.e.*, they are made up of a mixture of grades and of such different materials as clay and sand. Glass-sands on the other hand should be exceedingly well-graded, as the following analysis of Lynn sand indicates:—

>0.5mm., nil; >0.25 & <0.5, 94.8; <0.1 & <0.25, 4.9; >0.01 & <0.1, 0.2; <0.01, 0.1; total sand-grade >0.1 mm., 99.7%.

	Aylesbury.	Aylesford.
SiO ₂	99.80	99.06
Al ₂ O ₃	0.32	0.56
Fe ₂ O ₃	0.03	0.04
CaO	tr.	0.17
K ₂ O	0.04	0.26
Na ₂ O	none	0.11
Loss on ignition	0.22	0.22

100.41 100.42

Leighton and Lynn sands which, though less pure, are coarser, prove to be much more suitable. Sands with an aluminous bond (kaolin), like that from Huttons Ambo, of value for fettling purposes, are obviously not well-graded. The chemical and mechanical analyses of such a sand are as follows:—

	%
SiO ₂	98.36
Al ₂ O ₃	3.63
Fe ₂ O ₃	1.28
CaO	0.52

98.84

>0.5 & <1 mm., 1.4%; >0.25 & <0.5, 84.9; >0.1 & <0.25, 7.5; >0.01 & <0.1, 4.1; <0.01, 2.1: total sand grade >0.1, 93.8%.

In the case of the red sands of Triassic (Bunter) age, of which Birmingham sand is a well-known example, the clay or mud-grade which serves as a bond is not hydrated aluminium silicate, but ferric oxide. The same character is observed no matter where the sands are found—Birmingham, Stourbridge, Kidderminster, Wolverhampton, Runcorn, Ormskirk, Worksop, Hensall, Heck, Doncaster, Mansfield, Belfast, etc. In all cases there is a thin pellicle of iron oxide around each of the grains of quartz. This iron oxide possesses, to a remarkable degree, the power of holding a film of water by surface tension, and so making a strong bond between the grains. A characteristic property of all good moulding-sands is their water-carrying capacity. Many will hold as much as 10 or 12% of water without being really wet. Some mechanical analyses of these Bunter sands are as follows:—

	>0.5 and <1 mm.	>0.25 and <0.5.	>0.1 and <0.25.	>0.05 and <0.1.	>0.01 and <0.05.	<0.01.	Total sand-grade >0.1 mm.
Mansfield	4.0	30.0	43.75	16.25		6.0	77.75
Birmingham (close)	1.8	40.6	46.0	6.5		5.1	88.4
Compton, near Wolverhampton	0.2	6.5	77.9	7.1	1.3	6.0	84.2
Kidderminster	tr.	33.5	51.8	7.8	4.0	2.9	85.3
Ormskirk	tr.	4.3	77.8	12.6		5.3	82.1
Belfast	0.4	3.0	30.9	50.2		15.5	34.2

and a bulk chemical analysis of that from Belfast is:—

	%
SiO ₂	81.47
Al ₂ O ₃	8.84
TiO ₂	0.35
Fe ₂ O ₃	1.84
CaO	0.86
MgO	0.81
K ₂ O	2.78
Na ₂ O	1.50
Loss on ignition	2.24
Total	100.69

Such sands are used very largely for the casting of iron and brass, and for steel where the conditions are not very exacting, nor the temperature attained very high. There is no danger either of the setting in of reducing conditions which would yield the easily fluxed ferrous silicate if the temperature were sufficiently high.

Mineral composition.

Little need be said at this stage as to the bearing of the mineral composition of sands used in glass-making or metallurgical practice. It has been evident throughout the foregoing remarks that not merely are the chemical elements present of significance, but that their state of combination, i.e., the minerals present, is also important. Zircon (ZrSiO₄), rutile (TiO₂), ilmenite (2Fe₂O₃·3H₂O), and ilmenite (FeTiO₃), among others, are, for example, very harmful in glass-making. The presence of felspar may be a distinct advantage. On the other hand, in sands to be used as refractory bodies, felspar is inimical. Similarly, dolomitic and calcareous sands (containing dolomite [Mg.Ca]CO₃ and calcite CaCO₃) are known to be very objectionable. Chemical analysis is a long and tedious process. The geologist, making a mineral analysis by separating the various minerals of different densities by means of a heavy liquid, such as bromoform, and examining them under the microscope,* can determine at once the suitable or harmful minerals present, and obtain an idea of the qualitative and relative quantitative

chemical composition of the sand. Further, if he should know the mineral composition of British sands and the chief of foreign supplies, he will be able to identify any sample referred to him, or to say whether successive consignments of sand come from the same quarry or bed.

Silica itself exists in sands in several different mineral forms, as quartz, opal, chalcedony, etc., and after the sand has been subjected to high temperatures for considerable time, as tridymite and cristobalite. It is a fact which is the outcome of experience that crushed silicious rocks such as vein-quartz, quartzites, and certain sandstones, do not make as satisfactory glass as ordinary pure sands. The batch containing crushed rocks requires greater heat to bring it into the molten state. Whether this is because of the presence of two allotropic low temperature forms of quartz differing crystallographically and physically, one possibly as a cement, of the different hydration of the silica acting as matrix, or of the presence of certain inclusions in the quartz, is not known.

Apart from the "allogenic" minerals in sands derived from the breaking-down of older rocks, there are also "authigenic" minerals, formed when the sand was laid down or at some subsequent time. Of particular significance in this connection may be the colloidal minerals such as gelatinous silica, glauconite (iron potassium aluminium silicate), etc. Much of the ferric oxide in sands has been derived from the decomposition of ferruginous minerals, and it is noteworthy that some of the most successful steel-moulding sands—with the strongest bond and velvety grip—such as the "Belgian Red" and "Yellow" (Diastian) and "Cornish Red" (Pliocene deposits, St. Erth), owe their colour to iron oxide and are associated with glauconite-bearing deposits. Other important high-silica sands used in casting work, such as those from Leighton Buzzard and Lynn (Lower Greensand), contain seams in which glauconite occurs. Colloidal silica may be in itself an important bond. As we have seen, china-clay or kaolin is also a decomposition product, usually being formed from felspar. The question is one upon which we have very little information, and which will repay the investigator who follows it up. The presence of small quantities of certain minerals may influence to a marked extent physical changes and mineral conversions in sands.

In speaking of sands required for metallurgical practice and glass-manufacture, those used as abrasives should not fail to receive attention. Usually, fairly coarse sands are employed; the rougher the work the coarser the sand used. The sand should be made of a tough mineral, such as quartz, with a very poor cleavage, and while the grains need not be angular, they should not be highly rounded. The sand should be dry and well-graded, so as to slip freely through the feeding-funnel and jet. Aylesbury, Lynn, Leighton, and river sands, besides those from Belgium and Fontainebleau, have been successfully used. Road-grit from roads made of flint is a valuable and effective abrasive, a fact fully recognised by the motorist and cyclist! Almost any "sharp" sand (i.e., well-graded and containing no silt or clayey matter) used in the works for any other purpose is

* Memoir, p. 18.

likely to be of value as an abrasive. In the U.S.A. garnet-sands have been similarly used. The mineral garnet is hard, tough, and possesses a poor cleavage. Artificial products such as carborundum, have in certain directions largely replaced natural products like emery (corundum) and quartz. Natural minerals, such as quartz, which are not too hard, have, however, advantages, as in the grinding of plate-glass.

General observations.

In the above notes an attempt has been made to show quite as clearly what we do not know and in what directions research would be profitable, as to indicate the present extent of our knowledge. The glass-sands of the United Kingdom—their properties, composition, and location, have now, under the auspices of the Ministry of Munitions, been dealt with fairly thoroughly. It is clear that the country can be entirely self-supporting, even in the matter of optical glass. The importance of the inquiry into the resources of such sands, and of the publication of the results, has been testified to by those interested in the industry all over the country. The question of British supplies of refractory sands, especially those used in the steel industry, is, if anything, even more urgent.* Much preliminary research work into the properties of such sands is, however, required before all the suitable supplies can be located. The requirements must first be well-known and an idea obtained of the reasons for the suitability of the good materials.

British resources of high-silica sands for steel-moulding, furnace-fettling, crucible-making, etc., may be dealt with without much further work—most of the best have already been described as glass-sands. The supplies suitable for making silica and sand-lime bricks need investigation. Recent developments have shown that large supplies of sands exist suitable for the former purpose, the successful standard of composition being lower than was expected previously. A complete statement of British resources of moulding-sands with natural bonds is very desirable, especially those of value in such a key-industry as steel-founding. It is only in this direction, if any at all, that the importation of foreign supplies is justifiable.

The production of steel by the Bessemer, or its modification, the Tropenas process, is doubtless declining, and that by the open-hearth process increasing. The demands of the steel upon the sand in the former process, in which very high temperatures are reached, are much greater, whereas few difficulties are experienced in finding sands suitable for casting steel made by the latter process. Natural bonds, too, appear to be passing in favour of such artificial ones as dextrin, flour, treacle, sugar, etc. High-silica sands, of which in Britain we have an abundance, will then come into their own.

Above all, the economic considerations dominate the questions of production. Foreign glass-sands were imported into this country before the war, not merely on account of their supposed superiority of quality, but because they were frequently transported as ballast, and could be delivered at British works at a price much lower than our native sands. The same remarks apply to certain refractory sands. At the present moment, it is not so much the cost as the difficulty of transport which has to be considered: what is the nearest suitable supply of sand to every works? When peace conditions return, the governing factor will again be one of cost, and only by the working of British supplies on an extensive scale, by co-operative action, by careful and up-to-date treat-

ment of the materials, by increasing inland water-transport, and by reduction of railway freights, shall we be able to remain self-supporting as an island Kingdom.

THURSDAY MORNING.

INDUSTRIAL FUEL FROM GAS WORKS.

BY E. W. SMITH, M.S.C., F.I.C.

(Chief Chemist, Gas Department, Birmingham).

The industrial world seems to be at last awakening to a proper appreciation not only of the magnitude and importance of the gas industry, but of its value as a relatively untapped source of fuel of the most useful and nationally efficient kind.

It is generally agreed that the use of raw coal for most purposes is wasteful of one of the most important assets. It is to be hoped that the day will soon come when no coal will be used for any heating processes—whether it be in boiler firing or in the domestic grate. In this country the latter has become a national institution which it is difficult, largely from convention and sentimental reasons, to abandon. The war has still further encouraged the use of other forms of heating and the advantages have been so great that I believe the old prejudice in favour of the coal fire has at last been broken down.

During the year ending March 31st, 1917, the quantity of town's gas made in Birmingham was over eleven thousand million cubic feet, of which nearly ten thousand millions was obtained from the carbonisation of over 800,000 tons of coal. The remainder was carburetted water gas, produced from nearly 5,000,000 gallons of petroleum oil and over 37,000 tons of coke.

Of the gas sold, nearly 80% was used for heating and power purposes, domestic and industrial. Of this over 20% was used in industrial heating processes and nearly 14.0% for motive power. So far this year the gas output amounts to over 11.0% more than in the corresponding period last year, an increase due almost entirely to heating processes.

Gas is not the only type of fuel produced on the works. The 800,000 tons of coal yielded nearly 570,000 tons of coke, of which 16.55% was used for fuel on the works and 83.45% was available for sale, or about 487,000 tons. Over 24,000,000 gallons of tar was also produced, and from it would be obtained benzol suitable for motor spirit and 8 million gallons of creosote suitable for boiler firing, such as is used in the Navy.

The national aim should be so to use the coal supplies that the maximum national value may be obtained. Even if coal distillation were to cost so much that the net value obtained were less than the net value obtained by the direct combustion of coal, the indirect value to the country for home-produced residuals would justify an increased cost, but as a matter of fact it pays to carbonise coal rather than burn it.

The gas industry distils coal for the gas, and the value of the by-products goes to the reduction of the price of gas. The coking industry exists mainly for the production of a special coke, and the by-products reduce the price of coke. There is no necessity for this distinction and there is no satisfactory reason why the gas industry should not produce more blast-furnace coke or more coke-oven gas made available and suitable for town's use. At our Saltley works we have 60 ovens of the Koppers type in which quite excellent blast-furnace coke is produced. The whole of the coke is available for sale, unlike other methods of carbonisation, because the ovens are heated by means of external producers in which inferior

* Since this was written, the systematic investigation of British resources of such sands has been undertaken by the writer at the request of the Ministry of Munitions of War.

cheap fuel is used. The whole of the coke dust produced on these works, for which there is little sale, is being converted after mixture with 70% slack into producer gas for heating the ovens, and about 45 lb. of sulphate of ammonia per ton is recovered as a by-product per ton of dust.

Many gas works find a ready sale for unscreened coke and consequently in those works little "sized" coke is available. In most of the larger works there is a considerable demand for special grades. In Birmingham we have very extensive screening plants. The quenched coke is separated into the following sizes:—

Large coke, 9 in. to 2 in., used for metal melting, boilers, drop-forgings, etc.

Small coke, 1½ in. to 2 in., used for household purposes, drop-forgings, etc.

1 in. breeze—chain-making, blacksmiths' hearths.

Bean breeze—blacksmiths' hearths.

Pea breeze—concrete and blacksmiths' hearth.

Dust—boilers and concrete slabs.

The proportions of each material made depend on the coal carbonised and the particular type of carbonising plant and on the screening plant.

The coke from continuous verticals is smaller, more porous, and dryer than other coke. That from intermittent verticals is denser, harder, and larger. That from stamped charges in the coke ovens is large, lustrous, dense, and hard.

All works make coke dust. There is no consensus of opinion, however, as to what constitutes coke dust. In Birmingham this amounts to about 5.0% of coke made. When sized it has the following composition:—

20%	over screen	9 holes to 1 sq. in.
22.7%	over screen	16 holes to 1 sq. in.
14.6%	over screen	36 holes to 1 sq. in.
7.7%	over screen	64 holes to 1 sq. in.
33.1%	through screen	64 holes to 1 sq. in.

In works where such elaborate screening is not employed the quantity of dust made may in some cases be less than this.

Practically all our boilers are run on coke, and some of them on coke dust. Wherever there is ample boiler capacity and a suitable boiler is available coke dust may be used, but the water evaporated per hour will be reduced. The efficiency of the fuel, however, need not be reduced. The Meldrum type of furnace has been proved quite satisfactory for the purpose. Here there is a deep fuel bed and low forced draught.

I have known the results from the Stirling underfeed boilers working on an inferior slack, to be much improved by the addition of 30% of coke dust. Coke dust alone is of no use where the boilers are being pressed.

Briquettes are comparatively little used in this country, largely because they are too dense to burn without a large amount of induced draught and because of their cost. Results are being obtained now, however, which would seem to indicate that these troubles have been overcome. Briquettes are now being produced which are as hard, but porous, and require little induced draught. In fact they burn readily—without the objectionable dripping of pitch—in an open domestic grate, and give an almost flameless incandescent body of fuel. More should be heard of this fuel in the not far distant future.

Coke contains sulphur, fixed and combustible. That containing less than 0.3% of combustible sulphur is suitable for braziers, and may be used in the "dug-outs" of the firing line in place of charcoal.

About ten gallons of tar is obtained from each ton of coal. The composition of the tar varies with the type of carbonising installation and the condition of temperature to which the distillation

products are subjected. The average quantity of creosote present in the tar may be taken as 30%. It gives on distillation 5% to 200° C., 85% to 300° C., and 15% above 300° C. Its viscosity at 60° F., taking rape oil as 100, varies between 10 and 16. Its specific gravity is 1.04, and when used under boilers one pound of creosote will evaporate 11.24 lb. of water, a result which is nearly twice as good as when coal is used.

Creosote has been used for some time as a fuel oil. There are special oil burners for the purpose which require air pressures from 0.5 lb. to 3.0 lb. per square inch. The temperatures attainable are extremely high and the cost of heating compares favourably with many other fuels. Oil is not, however, so convenient as gas; it is more variable in the results obtained, and the burners are liable to give trouble. Creosote oil makes an excellent fuel for boiler firing and metal-melting furnaces.

Gas, however, is the most important type of fuel produced on the gas works. There is a tendency at the present time to standardise gas quality for all works. Until quite recent years, gas has been made and sold on the illuminating power basis. Now that well over 90% of the gas is used for heating purposes, including the incandescent mantle, the standard is being rapidly changed to that of calorific value.

The standard minimum quality of gas, which most undertakings are adopting by permission of the Government Departments concerned, is 500 B.Th.U. gross. There is nothing to prevent undertakings from providing a much higher value than this; indeed they would have to do so, to ensure never falling below the minimum.

One cannot find from published records what determined this standard of 500 gross—what were the economic and scientific reasons for its adoption. So far it has not been possible to produce such a quality of gas from an average coal alone by the usual methods of carbonisation and purification, and the average works does not possess a blue water gas plant. It is significant that the railway companies are now taking a keen technical interest in the conditions of gas supply. They are large consumers and it has been reported in the technical press that they suggest that there should be a limit to the amount of inert gases allowable in the gas. This may be another effort on their part to ensure a higher standard of gas for calorific value. There is no doubt they would not be satisfied with a good quality blue water gas having a gross calorific value of 300 B.Th.U., even though the inerts amounted to less than those in a good coal gas.

If 500 gross is the standard agreed upon, then unless blue water gas of good quality be used for dilution the inerts are bound to be high. Flame temperatures in this case suffer, and consequently low inerts are necessary to the highest temperature operations, and to incandescent lighting. I have seen cupro-nickel furnaces, taking 250 lb. of metal per heat, worked with blue water gas having a calorific value of 300 gross. The temperature necessary is almost 1700° C. and the B.Th.U. required per pound of metal compared favourably with the B.Th.U. expended when coal gas is used. In normal times the cost of this heat (as B.Th.U.) is about the same in either case. The Heating, Lighting and Ventilating Committee of the University of Leeds and the Institution of Gas Engineers, is now making a study of this question. They are making a very practical effort to evaluate gases of varying quality and composition for various purposes. The range of quality will be a wide one, and the results of their work when co-ordinated with the economic production side, should make it very much easier for the gas engineer in deciding what gas he should make, to give the greatest service to the consumer.

I am of the opinion that gas engineers should carbonise their coals so as to obtain the highest calorific value multiple (make per ton \times cal. value). The dilution of the gas with inerts, whether from the furnaces or by another means, will not affect the multiple appreciably because as the volume of gas made is increased the quality is proportionately reduced. The poorer the quality of gas, however, the lower is the efficiency of extraction of by-products and the costs all round the works and distribution costs will be increased per ton of coal. There is no sense whatever in distributing nitrogen and other inerts. The consumer has a limitless supply of these gases in a more convenient form mixed with oxygen.

So far as possible the gas consumer would naturally like to buy his gas with the precision obtainable when buying electricity. To the consumer extreme accuracy in volume measurement is rather wasted energy when the figures presented do not necessarily have any relation to B.Th.U. supplied. The conditions prevailing during the war on many works, are anything but normal however. There are many factors that militate against the delivery of as good a service of gas as is desirable. Most of the difficulties have been insuperable. After the war, when it is possible for statutory standards to be again observed, then the consumer should have little of which to complain.

I take it as an extremely healthy sign that combinations of railway companies, chambers of commerce, and ratepayers' associations are giving more attention to gas matters, and so far as their interest and criticism is intelligent and well-informed, it cannot but be of enormous value to the industry, although it is to be expected that for various reasons "gratuitous interference" may easily be resented.

Internal versus external producers for retort setting.

It is the usual practice for retort settings to be heated by means of internal producers—that is producers built into the retort setting. For horizontal and inclined retorts this has the following advantages:—(1) The fuel is fed hot from the retort into the producer (this does not hold for vertical retorts). (2) The producer gas passes immediately from the producer into the retort setting, so conserving the sensible heat of the gas for heating the retorts. (3) The radiation losses from the producers may be largely ignored as it is surrounded by the setting to be heated. (4) The capital cost is less than for external producers.

Some of the drawbacks may be stated as:—(1) A large amount of labour is expended in giving the necessary attention to the fires. (2) If poor coal is being carbonised and poor coke being produced, heats suffer and still worse results are obtained than if good heats had been maintained. (3) Heats fluctuate while firing and clinkering, and this is likely to reduce the life of the setting.

The composition of gas produced from coke in an internal producer is:—CO₂, 6.3%; O₂, 0.5; CO, 22.5; H₂, 9.9; CH₄, 1.6; N₂, 59.2%. Calorific value 112 net. Make of gas per ton of coke, 100,000 cub. ft. Tonnage of coke used per ton of coal carbonised, 5.10. Producer gas used per ton of coal carbonised, 10,000 cub. ft. Temperature of producer gases, 850° C. Sensible heat in 1 cub. ft. of producer gas, 29.0 B.Th.U. Therefore total heat in entering setting per ton of coal carbonised is 1,410,000.

If external producers were used making a gas of 130 B.Th.U. net, then 10,850 cub. ft. of this gas would be required per ton of coal carbonised. At 1½d. per 1000 cub. ft., the cost of heating would be 1s. 5d. per ton of coal carbonised.

The cost of internal producer gas would include not only the cost of the coke, but labour, and maintenance, interest and depreciation, supervisory and standing charges, dissectable to the internal producer.

Labour	2.4d.	per ton of coal carbonised.
Coke	24.0d.	" " "
Maintenance	2.5d.	" " "
Int. and dep. 15%	1.0d.	" " "
Total	30.9d. (2s. 6d.)	

This rough computation at least indicates that further trials of external producer gas are justified.

The following should be noted in connection with the external producer:—(1) The capital cost is high. (2) Regulation of heats is simple. (3) There is ample latitude in the type of fuel to be used. (4) If cheap coal slack with over 1% nitrogen is obtainable then sulphate and tar recovery is possible. (5) Once producer gas is available it may be used for electrical generation and excess gas for boiler heating. (6) It releases coke for sale. In some districts this is an advantage.

On our horizontal and continuous working vertical test plants in Birmingham tests have been arranged for external producer heating. Very shortly information will be available on this subject.

Low temperature carbonisation.

This subject has been the topic of many papers and discussions during recent years. There seems to be no general agreement, however, as to the object of commercially developing low temperature carbonisation.

The experimental work of the experienced research chemists indicates the great differences in results obtainable between low and high temperature conditions. Those who have attempted to extend the processes from the laboratory stage to a practical working scale have varied in their aims. Some in the early days have hoped for high benzol yields. Others have expected the high tar yields to justify the process, while still others have had as their main object the production of a solid fuel that would burn easily in the domestic grate without producing smoke.

I think that those who are in closest touch with many of the processes that have been and are being tried agree that so far no really satisfactory results have yet been obtained. This does not mean that there is nothing in low temperature carbonisation. I do not believe there has been sufficient competent research work carried out to enable one to pass an opinion either way. If one judged by the average published results no more would be heard of the process.

The saving in freight brought about by the introduction of a centralised low temperature power scheme at the pit mouth is now recognised to be a delusion. The solid fuel produced will occupy a much greater bulk than the original coal, will stand less handling—unless briquettes are made of it, and this is not yet a practical scheme—and the fuel will have to be distributed to many small domestic consumers. If this fuel were completely gasified at the pit it would be better, but it is doubtful whether there would be a sufficient outlet for the power produced except from a uselessly small plant.

In any case the energy in the coal gas is very much less than that from high temperature carbonisation, and it is doubtful whether the financial return from the washed tar oils will be a sufficient justification for the process.

The Government should initiate a scheme for putting the best brains and experience into the subject. Chemists and engineers with wide carbonising experience should be given the subject to work out to a conclusion.

The experience gained in the past by others should be pooled and dissected. It is extremely doubtful whether any of the present suggested retort installations are likely to be satisfactory.

DISCUSSION.

The PRESIDENT said it was with satisfaction that he was able to say that one of the activities of the new Department of Research would be in the direction of investigations similar to those which Mr. Smith had suggested. The Fuel Board of that Department had decided that it was a matter of national importance that experiments should be made which were absolutely unimpeachable in their accuracy. Under the present conditions it had become the duty of the State to see that the fullest possible information with regard to the utilisation of the fuel resources was made available for the nation at large. To-day negotiations were in a fairly forward state with regard to the appropriation of the land for the purpose and for the erection of the necessary works.

Professor HENRY LOUIS asked the author if, instead of giving the screening sizes in so many holes to the inch he could give the diameter of the mesh. The most important point which had been raised was the need for so dealing with fuel as to get the maximum value out of it, but they must be very clear what was meant by that value. It could be taken from a great many points of view. It was conceivably possible to treat coal so as to get the maximum pecuniary value from it and yet not treat it in such a way as to get the maximum benefit for the nation at large. It was also possible to treat coal so as to get the maximum power value but not to secure the maximum value possible. It was an enormously difficult question for there were so many different factors which were not fixed factors but necessarily varied from time to time. He was pleased to hear that the briquetting of coal slack was receiving serious attention. He had been urging on the authorities the fact that this was the time for pushing forward with it. Patent fuel had not found favour in this country to the same extent that it had on the Continent, probably because there was good coal at a cheap rate in England. There were a number of works making patent fuel, but probably three-quarters of this was exported, very little being used in the country. It was probable that coal depôts would be established at the large centres of consumption, and the large quantities of dust which would accumulate at these depôts should be utilised by setting up patent fuel factories. Pitch was not dear, and the wastage of coal and coke dust which was now going on could easily be prevented if energetic steps were taken in that direction.

Mr. W. J. A. BUTTERFIELD agreed with the author that one of the most important points to be considered was the question of the quantity of inert gases in a public gas supply. It was a sign of the healthy condition of the gas industry that there was now an inquiry from within as to that question, and he thought they might anticipate that before long the gas industry would recommend gas undertakings on their own initiative to keep the quantity of inert gas within reasonable bounds. One of the most prominent gas engineers in the country had for years past made it a practice in his own works to keep the inert gases within a limit—he believed it was of 10%. That perhaps was rather a lower limit than many gas undertakings which used water gas were prepared to accept, but some such limit, perhaps 2% or even 5% higher, should surely be recognised as the maximum permissible. Where water gas was used in public supplies, it should be used in approximately uniform

proportions. It was an intolerable nuisance to consumers to have one day 5% or 10% of water gas in the mixture and another day 50%, yet there were some districts in the country where that state of things prevailed. Many consumers would rather pay considerably increased prices for the gas provided they could secure uniformity. He was pleased to hear that coke briquettes were a greater success than formerly. That arose particularly in connection with low temperature carbonisation, because the coke produced was so extremely bulky that the transport cost was much higher for the same fuel value than for coal. It might be possible to deal with this by pulverising and briquetting it so as to get fuel which would have some of the compactness and density of coal. In considering the question of low temperature carbonisation it must be borne in mind that the value of the products was chiefly their fuel value. Very few of them having a value for any other purpose could have much effect upon the ultimate results. That being so, it was a question whether raw coal could be burnt to the same advantage as the gas, coke, and tar resulting from carbonisation. Any saving in the fuel value obtained in the briquettes must be more than the fuel expended in the plant used.

Mr. J. DRUMMOND PATON pointed out that it was not possible to treat every coal on the same basis. There were millions of tons of coal in this country which would never be used until low temperature carbonisation came into operation. It was impossible to coke a resinous coal or burn it in a furnace, but it could be utilised by a low temperature process. He submitted that the question to be settled was the relative value of low temperature and high temperature work with various coals. They were moving in the direction of a higher recovery of products, and coal oil was one of the most valuable assets of this country. Enormous quantities of this oil could be obtained by low temperature distillation from coal left in the mines to-day. He called attention to the valuable investigations of Mr. Thomas Lomax, of Bolton. It was not possible to briquette coal having a high ash content for domestic purposes. Coal containing 20 to 30% of ash could not be briquetted, but it might be gasified. Regarding Commissions, he suggested that when such bodies were appointed they should consist of men who were conversant with the subject under consideration.

Mr. SMITH, in reply, said that a Government department was taking up this question of utilisation of coal from the point of view of complete gasification. The briquetting system he had referred to was not being developed in Birmingham. Briquettes were being tried in the city, but the system was being developed in Lancashire. He had no intention of casting any reflection on the bonâ fides of those who were experimenting with low temperature carbonisation, but he regretted that more work by properly qualified people was not available. In briquetting low temperature fuel for domestic purposes a cost of 5s. 6d. per ton for briquetting had to be overcome, so the fuel must be fairly low priced.

Mr. F. R. O'SHAUGHNESSY said that they were being embarrassed at the Birmingham sewage works by the enormous amount of waste which was sent there, particularly in the shape of tar. This had increased very largely since the outbreak of war, owing to the great growth of small plants.

Mr. SMITH replied that he supposed producer plants were in question and it was to be hoped that the by-products were being satisfactorily recovered.

THE CALORIFIC VALUE OF INDUSTRIAL GASEOUS FUEL.

BY W. J. PICKERING

(Central Laboratory, City Gas Department,
Nechells, Birmingham).

[ABSTRACT.]

The chief object of this paper is to indicate briefly the results of several years' experience in testing gas for calorific value at Birmingham, and to describe the apparatus and methods at present adopted for this purpose.

It has been rightly pointed out by several authorities that the "gross" calorific value given by many calorimeters is not the real "total heating value," owing to the effect of certain atmospheric conditions, as low humidity, etc.

For industrial purposes it will be sufficiently precise to define the "Total heating value" of a gas as "the number of British thermal units produced by the combustion, at constant pressure, of the amount of the gas which would occupy a volume of one cubic foot at a temperature of 60° F., if saturated with water vapour, and under a pressure equivalent to that of 30 in. of mercury at 32° F. and under standard gravity, with air of the same temperature and pressure as the gas, when the products of combustion are cooled to the initial temperature of gas and air, and when the water formed by combustion is condensed to the liquid state." [See Circular No. 48 of the United States Bureau of Standards—"Standard Methods of Gas Testing."]

Apparatus employed in testing.—The method of testing must be neither too long nor the apparatus too complicated, so that a junior assistant can readily carry out a test at any required time in, say, ten minutes, with a margin of error of 1%.

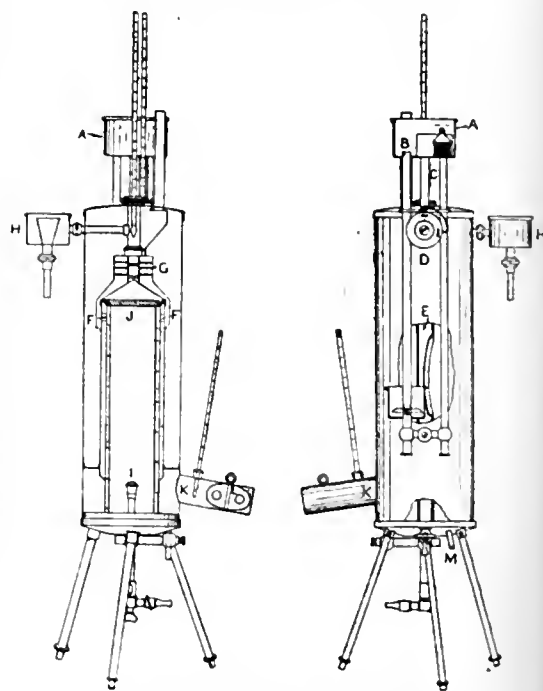
The "flow" type of calorimeter is generally used. "Flow" calorimeters are of two classes: (1) those in which the paths of travel of products of combustion, and water, are relatively short and parallel; and (2) those in which the stream of water flows in a long tube, arranged as a spiral, round which the products of combustion pass slowly.

The calorimeter in general use at Birmingham is of type (1), and the Boys instrument, as prescribed by the Metropolitan Gas Referees, is the best known in class (2).

Up to the commencement of the present war, the Junkers calorimeter had been adopted for many years, at Birmingham, as the best instrument for technical work; but after 1914, as the supply from the Continent had necessarily ceased, a calorimeter of similar pattern but with alteration of several points in the design, tending both to greater accuracy of result and longer life of the instrument, was constructed. Under the supervision of Mr. J. Turnbull, Superintendent of the meter shops at the Windsor Street Works of the Birmingham Gas Department. The cost of construction, even in war conditions, has proved considerably less than the price of the German-made calorimeter. Fig. 1 illustrates the Birmingham instrument, which is made chiefly of 20 B.W.G. tinned copper. Improvements have been effected, as compared with the German design, in the life of the instrument, by using slightly heavier gauge metal in the internal parts exposed to the action of the products of combustion, and in the accuracy of the results obtained, by improving the device for mixing the water before it reaches the bulb of the outlet thermometer.

The water supply is led first to the overflow reservoir, A, or "constant head," and is adjusted so that when the proper flow through the calorimeter has been arranged the overflow pipe B is working slightly. The water travels down the pipe C to the quadrant regulating cock, D, whence it passes

over the bulb of the inlet thermometer. It then travels down a flattened pipe, E, to the base of the calorimeter body and ascends the annular space immediately adjacent to the chimney, in spiral fashion, the motion being determined by means of a continuous strip of metal arranged as a spiral with 2 inches "pitch." On arriving at the top the water passes outwards, via four short horizontal tubes, F, into the space above the conical top of chimney, where it receives the full heating effect of the products of combustion. It then passes upwards through a specially constructed series of baffle plates, G, which ensure thorough mixing of the heated water before reaching the bulb of the outlet thermometer. After the latter has been passed, the water enters a special overflow outlet, H, from which it flows to the "change-over" funnel and so into the collecting vessel or to waste.



Birmingham Junkers calorimeter.

FIG. 1.

The gas is burnt centrally within the chimney in a special Bunsen burner, I, fitted with air regulator, stop tap, and cone injector with needle valve capable of adjustment so as to pass up to 15 cubic feet of gas per hour at 7- to 8-10ths inch pressure (water gauge). The products of combustion pass up to the conical dome of the chimney and are then diverted downwards through an annular waste gas flue, J, having division walls arranged vertically and radially $\frac{1}{4}$ inch apart. On reaching the base of the instrument they enter a common collecting flue, K, which carries a waste gas thermometer and special baffle plate, L. The condensed water from the waste gases falls into the bottom casting of the instrument and drains through the drip outlet, M, into the collecting tube or to waste. The thermometers for measuring the temperature of inlet and outlet water are specially calibrated, by comparison with a standard thermometer specially checked by the National Physical Laboratory, and a correction card made out for each giving corrections to be applied for every 2° rise in temperature from about 6° to 46° C. These thermometers are read, by means of

small telescopes attached to the stem of each, to the nearest 0.01° C.

Between the body of the calorimeter and the outer case, there is an annular air jacket, about in. in width, which prevents loss of heat from the calorimeter to the atmosphere. The instrument is readily adapted to the testing of low grade gas, or producer gas, by adjustment of the cone valve injector on the burner in such a manner that the rise in temperature of the water flowing through the instrument is kept at about the same figure.

The calorimeter prescribed by the Metropolitan Gas Referees has been designed by Professor Boys, and its latest pattern is illustrated and described in the Notification of the Gas Referees for the year 1916. The description is reproduced in the Gas World Year Book.

The Boys calorimeter may quite easily be adapted for testing producer or low-grade gas, such as Mond gas, by fitting special flat flame burners to pass gas at a greater rate, such that the normal temperature rise of the water flowing through the calorimeter may be maintained.

In addition to the calorimeter itself, whether of class (1) or (2) type, the following equipment is essential for the proper carrying out of the test :—

1. *A proper supply of water of uniform temperature*, the latter being, if possible, only slightly below that of the atmosphere of the laboratory. An overhead tank, of about 30—50 gallons capacity with ball-cock feed from town supply, and overflow pipe, is very useful in this connection.

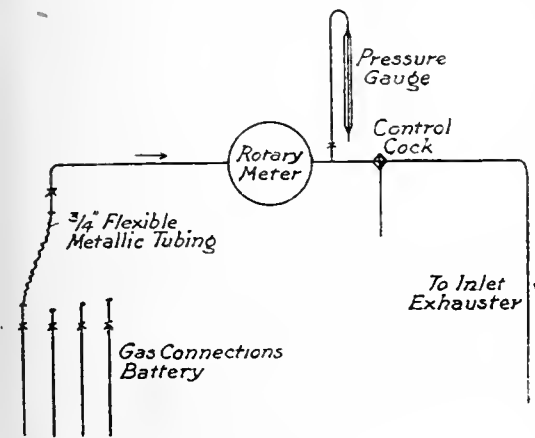


FIG. 2.

2. *A divided funnel for quickly diverting water* flow from calorimeter to collecting vessel or waste. This, which is sometimes attached to the calorimeter itself, tends to reduce the personal error in reading.

3. *A collecting vessel, for receiving water from calorimeter*. This should be accurately graduated, on the neck, in divisions representing 10 c.c. The vessel used for this purpose at Birmingham is a 6 to 5½-litre flask, strongly made, with long neck or graduations. All flasks used are calibrated in the laboratory.

4. *A graduated cylinder for measuring the condensed water from calorimeter*. This should be of narrow bore, a convenient arrangement for this purpose being the "Eggertz" carbon tube, cut off to suitable lengths, and mounted in a simple foot for quickly adjusting its position below the calorimeter.

5. *A primary governor on the gas supply*. Where gases at various pressures have to be tested on one set of apparatus, it is essential to have a primary governor to reduce the pressure to proper limits.

A mercury governor of the "Stott" type is satisfactory for such work.

6. *A secondary governor on the gas supply* is essential to keep the pressure of the gas at inlet to test meter uniform. The Gas Referees' type of balance governor answers best.

7. *A test meter, fitted with Fahr. thermometer*, making 1 revolution per 10 cubic foot of gas passed, with dial divided into 100 parts and each 0.01 position marked.

8. *A small diaphragm governor*, on the outlet of the meter, takes up any slight oscillations in pressure due to wave motion of the water in the meter.

9. *Pet-cocks*, for attaching pressure gauges, at inlets of the primary governor, secondary governor, meter and calorimeter.

10. *A hygrometer*, of the Gas Referees' pattern, for taking the humidity of the air of the room.

At the right-hand end of the calorimeter bench at Birmingham, below the water tank, is arranged a battery of gas services, each of which may be connected to either or both of two calorimeter sets by means of flexible metallic tubing with winged-nut ends. In order to ensure that the actual gas from a collected sample or stream of gas goes through to the calorimeter, a special battery of gas connections has been installed, and each gas, before testing, is connected to the inlet of a rotary meter the outlet of which, fitted with pressure gauge and regulating cock, is connected by 1½-in. pipe to the main going to the inlet of the works exhauster.

By this arrangement, as shown in Fig. 2, a "pull" of 15 to 30 tenths of an inch is utilised to draw the gas quickly from the sample holder or works main to the inlet of the testing apparatus, the regulating cock (Fig. 2) being adjusted in the case of each gas so that 1 inch pressure is maintained on the adjacent gauge. After the proper volume of gas has been "pulled-over," a few minutes will suffice to burn through to the calorimeter before proceeding to test.

Given satisfactory conditions of apparatus the test may be carried out and the result arrived at in 8 to 10 minutes from the commencement of the test.

Errors in testing. The results obtained in Birmingham by the method just described, are sufficiently accurate for modern industrial purposes.

Data from actual tests suggest that it is unnecessary to apply corrections for atmospheric humidity and other disturbing factors.

In the technical press in February last* were published the instructions for "Determining the Heating Value of Gas," as elaborated by the Paris Municipal Lighting Laboratory and approved by the Prefect of the Seine. The calorimeter used is apparently an old type Junkers, with inlet and outlet water thermometers at different levels, and is not so convenient in use, for this reason, as the Birmingham pattern.

No mention is made of a correction for humidity conditions, but among the corrections is one for the pressure of gas at the meter, which is not usually made in this country. The pressures obtaining in the sets of apparatus at Birmingham are, on an average, as follows :—

Inlet test meter : 20/10°, water gauge.
Outlet " " : 16/10°, " "
Inlet calorimeter : 8/10°, " "

Assuming 18/10° pressure of gas at the meter, this amounts, if neglected, to —0.4% error in the corrected gas volume, or a result which is 2 B.Th.U. high for a 500 B.Th.U. gas. This correction is hardly worth the extra labour involved in making it.

Our aim in Birmingham has been to reduce both

* "Gas Journal," 137., p. 202.

apparatus and method of calculation to the simplest or most easily understood conditions, so that the large number of tests of this kind carried out at various periods of the 24 hours can be satisfactorily made by a junior chemist. We do not claim that our method is either perfect or "fool proof," but it is sufficiently accurate for modern industrial requirements.

The heat efficiency of the calorimeter used is admittedly as high as in any of this class, and in the absence of any really reliable method for easily standardising gas calorimeters, we have adopted the plan of frequent comparison tests, which should agree to within 3 B.Th.U., when a collected sample of "straight" coal gas is well "burnt through" on both calorimeter sets.

If the results differ by more than 5 B.Th.U., when the rest of the apparatus (meter, etc.) has been carefully verified, the calorimeter giving the lower result is carefully overhauled, it being contended that the higher figure must be the more correct one.

It is worthy of note that a new calorimeter requires to be run for about 24 hours before the results obtained reach a maximum figure. This would appear to be due to the time necessary for the surface of the waste gas vertical flues to assume a certain physical condition which ensures the necessary time contact for proper cooling to take place.

Recording calorimeters. The perfect recording calorimeter has yet to be placed on the market, but the instruments at present available are extremely useful as a guide to fluctuations in quality of the gas on a works "stream." The readings cannot be taken as absolutely correct, but require to be regularly and frequently checked by actual tests in order to maintain a fair degree of accuracy. Special precautions must be taken to screen the instruments from draughts and from exposure to direct sunlight, otherwise the record may develop serious error.

Of the type which indicate the "net" value of the gas, the most satisfactory appears to be the Beasley Recorder, as made by Messrs. Parkinson and W. and B. Cowan, Ltd., of Birmingham. This instrument is in fairly extensive use in the Birmingham Works. It is constructed in two types, one being used for coal and town's gas, with a chart range of 300 to 700 B.Th.U., and the other for Mond or producer gas, with a chart range from 50 to 250 B.Th.U. The gas is burned within a well-radiating chimney, and the working of the calorimeter depends upon the fact that the average rise in temperature of this chimney is proportional to the heat developed by the flame.

A recording calorimeter which would give a continuous record of the "Total heating value" of the gas would undoubtedly be a valuable instrument, especially in large works. Such an instrument will very probably be placed on the market in the near future in this country. Its cost would necessarily be higher than that of the "net" value recorder, but its accuracy and sphere of usefulness should more than outweigh this. Before the war, practically the only type of "gross" value instrument had to be obtained from Germany. Let us hope that this will not be so in the future.

In conclusion, the author wishes to thank the Birmingham Gas Committee for kindly granting permission for this paper to be given, and also his chief, Mr. E. W. Smith, for helpful facilities afforded him during its preparation.

SOME SOURCES OF BENZENE AND TOLUENE FOR HIGH EXPLOSIVES.

BY T. F. E. RHEAD, M.Sc. (CENTRAL LABORATORY, BIRMINGHAM GAS DEPARTMENT).

Although a large amount of the information obtained during the war concerning the production

of benzene and toluene has not been published, for obvious national reasons, it is hoped that a review of such work that has been described in the technical press will be found both useful and opportune.

By way of introduction it will be recalled that Michael Faraday is usually credited with the discovery of benzene in 1825 while investigating the liquids condensed from the thermal decomposition products of fish and vegetable oils for gas making and called by him "bi-carburet of hydrogen." The Germans, however, claim to have discovered it forty years before Faraday.

Toluene was discovered in 1838 by Pelletier and Walter in the condensation products from the manufacture of rosin gas and called "resinaphtha." Deville obtained it later by the distillation of "tolu balsam" and Berzelius named it toluene.

The preparation of synthetic phenol, and its subsequent nitration to picric acid, which has been successfully worked out on a commercial scale during the war, caused the great demand for benzene as the starting point of this process. The phenol used previously was obtained from coal tar, but synthetic phenol, being much purer, is far more satisfactory.

The trinitro derivative of toluene, T.N.T., was little known in this country three years ago, but the comparative safety with which it can be manufactured and handled and its excellent explosive properties caused an urgent demand for it, and consequently for the toluene from which to make it. The history of the Allies' success in producing this German explosive will, when written, be one of the most interesting romances of chemical industry.

The value of benzene and toluene for producing high explosives depends on their purity. Benzene is fairly easy to purify because it freezes at 4° C., but such is not the case with toluene, which only freezes when cooled to -90° C. Particularly troublesome impurities in some brands of toluene are those paraffin hydrocarbons which are neither removed by sulphuric acid washing nor by fractional distillation; such impurities complicate the nitration process and make it more expensive. However, when the supply of toluene was unequal to the demand, both the pure and paraffinic varieties were used for making T.N.T., but since the sources of the pure substance have themselves become sufficiently developed, the paraffinic product and likewise the processes producing it have apparently been less profitable.

The various sources of benzene and its homologue toluene can be classified as follows:—

- (1) Synthetic, catalytic, and electrical processes.
- (2) Certain crude petroleum products containing them in the uncombined state.
- (3) The destructive distillation of coal.
- (4) The thermal decomposition or "cracking" of petroleum oils.

The methods under group (1) do not appear to have advanced much beyond the experimental stage.

In 1899 T. B. Jacobs prepared benzene along with other hydrocarbons by heating a mixture of finely divided metallic carbide and a fusible metallic hydroxide in equivalent molecular weights up to the melting point of the hydroxide.

Fischer and Niggeman (Ber., 1916) describe some work wherein they boiled xylene with 2 to 4% of aluminium chloride for two hours beneath a reflux condenser and obtained 12% of toluene with a certain proportion of benzene and of higher homologues of xylene. The method gave negative results when solvent naphtha (distilling 2% at 140° C.) was used.

Scholiren in 1901 prepared benzene and its homologues by electrolysis. According to him, when coal, tar-oils, or other carbon compounds are exposed to a direct electric current in a porous

cell or to an alternating current in any sort of vessel in the presence of water and soluble or insoluble acids, bases, or salts (inorganic or organic) first benzene and its homologues and subsequently their hydroxyl compounds are formed. Only very weak currents are required for the reaction and the temperature has but little influence on the process.

Just prior to the war a Swedish engineer patented an electrical process for extracting benzene from coal at a lower cost than by other methods and giving a pure product.

Uncombined benzene and toluene in crude petroleum. Some years ago the idea was prevalent that benzene and other aromatic compounds could only be obtained in quantity from coal distillation products, but it is now well known that crude petroleum from certain districts contain considerable amounts of these substances and this source proved of very great value when the shortage of benzene and toluene was serious. The submarine peril has presumably endangered the reliability of this supply and it is gradually giving way to that obtained from coal. Moreover, the toluene obtained from crude petroleum has a high paraffin content, which is another drawback.

At present by far the most important source of these two hydrocarbons is that of the carbonisation of bituminous coals, and under suitable conditions, very pure products are obtained.

The mode of formation of benzene and its homologues during the thermal decomposition of coal is very incompletely known, and possibly a brief résumé of the present state of our knowledge on this problem will be useful at this juncture.

Evidence seems to show that benzene and its homologues are not primary thermal decomposition products of coal but owe their formation to polymerisation and secondary reactions among the primary products while the latter are exposed to the requisite conditions.

Benzene hydrocarbons produced during coal distillation seem to be formed by three main groups of reactions: (1) Condensation of olefines; (2) dehydrogenation of corresponding naphthenes, and (3) the polymerisation of acetylene.

Olefines, naphthenes, and acetylene appear in the low temperature or primary decomposition products of coal.

Burgess and Wheeler (Chem. Soc. Trans., 1914, 105, 131), distilling coal in a vacuum up to 450° C., were unable to detect any benzene hydrocarbons in either the liquid or gaseous products.

Jones (this J., 1917, 36, 3) has analysed the tar obtained in the above investigation and found it to consist of (1) unsaturated hydrocarbons, (2) naphthenes, (3) liquid paraffins, (4) phenols and xylenols, (5) aromatic compounds (homologues of naphthalene), (6) pyridine, (7) traces of a solid paraffin, but benzene and its homologues were absent. From the results of the thermal decomposition of this tar at different temperatures, Jones concluded, among other things, that benzene and its homologues are chiefly formed as the result of olefinic condensation at temperatures of 700° C. and upwards. To some extent they are products formed by the thermal dehydrogenation of the corresponding naphthenes. Jones (Chem. Soc. Trans., 1915, 107, 1582) had previously found that the cyclo-hexanes decomposed at 490°—510° C. over hot porcelain and formed the gaseous products hydrogen, methane, ethane, ethylene, and traces of acetylene and considerable quantities of benzene.

If the necessary naphthenes predominated in the primary products of coal distillation, a temperature of 500° C. upwards would give the maximum yield of benzene hydrocarbons, but apparently the olefines predominate because the maximum benzene yield is obtained at 700° C. upwards.

The once prevalent view that acetylene was the basis of aromatic formation during coal distillation is now discredited, but it seems quite probable that an appreciable quantity of benzene is produced by the polymerisation of this hydrocarbon, which appears among the primary products of the thermal decomposition of coal.

According to Burgess and Wheeler (Chem. Soc. Trans., 1910, 97, 1917) gas obtained from bituminous coal distilled at different temperatures over a range 450°—1000° C., contained 0.5% acetylene. In another of their papers (Chem. Soc. Trans., 1914, 105, 131) they record having obtained acetylene from coal, at a temperature as low as 300° C., equal to 0.55% by vol. of the gases, while at 340° C. the gas contained 0.75% and at 400° C. 0.6%.

Bone and Coward (Chem. Soc. Trans., 1908, 84, 1201) in their work on the thermal decomposition products of hydrocarbons, state that acetylene at comparatively low temperatures exhibits a strong tendency to polymerise forming benzene, etc., so that whenever acetylene is a primary product in the decomposition of another hydrocarbon (for example, in the case of ethylene) there is always a marked secondary formation of aromatic hydrocarbons, including benzene, at low temperatures. This tendency to polymerise reaches a maximum probably somewhere between 600° and 700° C., after which it diminishes rapidly as the temperature rises and is but little in evidence above 1000° C.

It is interesting to note that Bone and Coward found that acetylene partially polymerises and partially decomposes at 480°—500° C. Ethylene decomposes fairly rapidly at 570°—580° C., and gives principally acetylene, together with methane, hydrogen, and aromatic hydrocarbons, including benzene. Ethane decomposes fairly rapidly at 675° C., and gives hydrogen, methane, acetylene, naphthalene, but no benzene.

There is as yet no evidence to show which part of the coal substance provides the benzene-forming compounds, but while it seems likely that the resinous constituents of bituminous coals provide most of them, there is reason to believe that the humic constituents may also aid in the process, though to a much less degree.

Jones and Wheeler (Chem. Soc. Trans., 1915, 107, 1318) resolved a bituminous coal into three portions: (a) insoluble in pyridine, (b) soluble in pyridine but insoluble in chloroform, and (c) soluble in chloroform. These separate portions were thermally decomposed *in vacuo*, the temperature being taken to 450° C. They apparently did not detect any benzene, but the gases from (a) and (b) gave very similar analyses, showing about 60% by volume of paraffin hydrocarbons and 5% of ethylene, whereas the gases from (c) contained 88% of paraffins and 2% of ethylene. The authors conclude from these results and previous work that the portions (a) and (b) consist mainly of the "humous substances" in coal and that (c) represents the "resinous substances."

The high paraffin content of the above gases from (a), (b), and (c) points to the possibility of benzene being formed if these gases were "cracked" at higher temperatures, because, according to Egloff (Met. and Chem., Eng., 1917), and others from their work on oil cracking, all paraffin hydrocarbons except methane will give benzene and toluene under suitable thermal treatment. Moreover, the phenolic bodies which were produced from (a) and (b), but not from (c), would yield benzene when passed over hot carbon (*vide* Watson Smith; Chem. Ind., 1891, 77).

The foregoing résumé points to the conclusion that the temperature 700°—750° C. is the most satisfactory for coal carbonisation when a maximum yield of benzene and its homologues is desired. However, the period of heating of the primary

products, or in other words the "time of contact," plays an important role. If the rate of a particular reaction is slow at a certain temperature a long time of contact will be necessary to complete it, whereas at a higher temperature a much shorter time would be necessary.

It is common in the gas industry to state that high-temperature carbonisation favours benzene production, but it is because the charges in the retorts take up heat so slowly and the retort material conducts heat so badly that it is necessary to have a high temperature (1250° C.) on the outside of the retort to force the heat through the contents in a reasonable time. Cobb and Hollings (J. Inst. Gas Eng., 1914) showed that 5% of benzene mixed with 47.5% of methane and 47.5% of hydrogen when passed over red-hot coke at 800° C., was unaffected, but the benzene was rapidly and totally destroyed at a temperature of 1100° C. It is very probable, therefore, that much of the benzene produced in coal carbonisation is destroyed by contact with the hot sides of the retort.

The products formed during the industrial carbonisation of coal depend on the following factors:—

- (1) The temperature of carbonisation.
- (2) The thermal conductivity of the carbonising mass.
- (3) The chemical and physical composition of the carbonising mass and also its quantity and physical condition.
- (4) The degree of cracking to which the primary low temperature products are submitted before leaving the retort.
- (5) The influence of foreign bodies like iron and lime on the chemical reactions.

The products formed in any carbonising system have been subjected to a greater or lesser degree of cracking according to the position in the retort where they originated. For the same reason the products from different systems vary even with the same coal. For example, in the case of horizontal settings, the primary gaseous decomposition products which are produced, as the charge gradually heats up, are modified according to the time they have to spend in the retort in contact with the hot walls and coke. Products formed near the ascension pipes are subjected to very

from the existing sources, and then of investigating and encouraging possible new sources.

The gas and tar from coke-oven recovery plants and a small proportion of gas works tar supplied us with all the benzene and toluene we required prior to the war and much was sent to Germany in part payment for the German recovery plants set up in this country. A large and little-known field of supply was town's gas, which often contains 30 to 40 times the amount found in the tar.

In the years immediately preceding the war the high price of petrol had focused attention on benzol as a possible substitute, and several people had advocated washing this body out of town's gas.

Doherty, an American engineer, had urged the possibility in this country of recovering 2½ gallons per ton of coal carbonised for gas manufacture. However the antiquated illuminating power standard prevented this procedure. The war demand put a new aspect on the problem, and a large and increasing proportion of town's gas is now being washed for these valuable products.

It became a matter of much import to know which system of carbonisation gave the best yield, and although it is impossible to lay one's hands on reliable comparative data, the order of importance is, roughly: Horizontals, inclined, coke ovens, intermittent verticals, and continuous verticals.

One great difficulty in solving this and allied problems has been the lack of a rapid, simple, and reliable test for the benzol content of a gas, and there is still much room for improvement in this test. It was early discovered that the benzol content of gas from continuous verticals was poor and high in paraffin content and consequently not profitable to wash.

Many experimenters, encouraged by the Ministry of Munitions, worked on processes which were intended to increase the benzol content of coal gas. Experiments were carried out at the Birmingham Gas Works by Mr. E. W. Smith (J. Gas Lighting, 1916.) on the effect of carbonising along with the coal such substances as coal-tar pitch, Mond gas pitch, petroleum residue, and bitumen in horizontal gas retorts. The results with respect to the production of benzol and toluol are contained in the following table:—

	Coal.	Coal + coal tar pitch.	Coal + Mond gas pitch.	Coal + petroleum residue.	Coal + bitumen.
Medium quality gas making coal.					
Nature of coal					
Percentage of pitch, etc., in mixture ..	100.0	4.23	4.25	3.84	4.03
Gallons Benzene per ton mixture	1.659	1.669	0.947	0.905	0.716
do. Toluene per ton mixture	0.4	0.460	0.387	0.538	0.550
do. Benzene per ton pitch	—	0.89	8.64	8.94	4.78
do. Toluene per ton pitch	—	0.35	—	3.70	4.19
Rich South Yorkshire coal.					
Nature of coal					
Percentage of pitch, etc., in mixture ..	100.0	1.20	3.52	5.05	5.57
Gallons Benzene per ton mixture	1.438	0.09	0.514	0.239	2.040
do. Toluene per ton mixture	0.596	0.518	0.70	0.524	0.646
do. Benzene per ton pitch	—	—	0.40	—	2.77
do. Toluene per ton pitch	—	—	1.87	—	1.38

little cracking and pass away very slightly altered—they are really low-temperature products and their proportion to the total products depends on the size of the coal charge. In the case of continuous vertical retorts, where the primary products are subject to comparatively little heat treatment, they pass away without much modification and the chance of benzene formation is less than in the case of horizontals.

Meeting the demand for toluene and benzene. When the urgent demand for toluene and then benzene had to be met, the Ministry of Munitions took the logical course of increasing the supply

As indicated in his paper the coal gas pitch—a high temperature product—does not give much increase in benzene and toluene, being already severely cracked, but the other three do materially increase the benzene and toluene content. However, as only a small percentage can be carbonised at a time it is not profitable to work the process for benzene hydrocarbon production.

Rollason, Stevenson, and others (J. Gas Lighting, 1916) have tried the effect of carbonising the coal along with lime or limestone, and claim that the latter acts catalytically and increases the yield of benzene, but further data are required to sub-

stantiate this claim. Experiments have also been carried out in passing inert gases and steam through gas retorts during carbonising, in the hope of increasing the benzene yield by preventing its being thermally destroyed after formation, but little information is to hand as to the value of this method.

The various low temperature systems of carbonisation, introduced by the Coalite Co.—using a temperature of 400°—500° C.—produce no benzene, etc., but in the new coalite process employing a temperature of 650° C., a yield 1.5 to 2.0 gallons of benzol per ton of coal carbonised is claimed (J. Gas Lighting, 1912).

Cracking of petroleum oils. It has long been known that various oils, especially those in crude petroleum, when subjected to the right conditions of temperature and pressure, break down or polymerise and yield a certain proportion of benzene and its homologues, the amount of which varies with the composition of the oil.

The mode of formation of benzene, etc., during the cracking of petroleum oils is parallel to that of its formation from the cracking of the primary decomposition products of coal. These latter contain many compounds found in petroleum, such as naphthenes, paraffin hydrocarbons, olefines, etc., and since it is far easier to separate petroleum into simple groups of compounds than is the case with coal, a systematic study of the thermal decomposition products of petroleum oil fractions should throw much valuable light on the mechanism of coal carbonisation.

In Russia it has long been the practice to crack petroleum oils to obtain benzene and other aromatic compounds for the dye and explosives industries, the shortage of coalfields made such an industry of vital economic importance. Moreover, Russian petroleum, being rich in naphthenes, lend themselves admirably to benzene formation. There is little doubt that that this industry, founded by the Russian chemists, led by Nikiforoff, has received a great impetus from the needs of the war.

The first systematic work in the modern era, on producing aromatic hydrocarbons from petroleum, was carried out by Rittman (Met. and Chem. Eng., 1915), but the large-scale installation put down at Pittsburgh as a result of his experiments has been unable to compete with other sources of benzene and toluene owing to the small yield and poor quality of the products.

American chemists are working out the mechanism of oil cracking in a very careful manner, and much valuable work has already been done on the effect of temperature, time contact, pressure, nature of the original oil, etc., by Rittman, Egloff, Moore, Twomey, and others. Egloff (Met. and Chem. Eng., 1917), from his own researches and others', draws the following conclusions as to the production of benzene, toluene, and xylene from petroleum:—

(1) All groups of paraffin hydrocarbons have formed benzene and toluene on the thermal treatment, with the one exception, methane.

(2) We can control the yields of aromatic hydrocarbons so as to form benzene, toluene, xylene, naphthalene, or anthracene in maximum quantity.

(3) The group of paraffin hydrocarbons present in petroleum distillates is of great importance in forming aromatics in large yields.

(4) All paraffin hydrocarbons form aromatics but with varying percentage yields, on the basis of the oil used.

(5) The temperature at which the petroleum is cracked is of primary importance in giving maximum yields of benzene, toluene, xylene, naphthalene, and anthracene. The effect of pressure and the time factor are of less importance within limits than temperature, but the three factors, temperature, pressure, and time, are

intimately related, and a nice balance must be held to yield maximum percentages of aromatic hydrocarbons.

(6) A cracked oil is not so well adapted to aromatic or gasoline production as is a petroleum oil.

(7) Whatever cracking takes place to the lower boiling point hydrocarbons from a cracked oil may be attributed to a large extent to unchanged petroleum in the cracked oil and not to its aromatic constituents.

(8) There is a limit to the number of times which an oil can be re-cracked, because of the tendency to form aromatic compounds which decompose neither into gasoline nor members of the benzene series appreciably, but toward the ultimate products, hydrogen and carbon.

(9) The course of aromatic hydrocarbon formation from paraffin base petroleum distillates in all likelihood is as follows:—

High and low boiling point paraffin hydrocarbons.

↓
Low boiling point paraffin and unsaturated hydrocarbons.

↓
Naphthenes (alicyclic hydrocarbons, polymethylene).

↓
Aromatic hydrocarbons as

benzene ←————→ toluene ⇌ xylene

diphenyl naphthalene.

↓
diphenylbenzenes.

↓
triphenylene.

↓
carbon and hydrogen.

The manufacture of carburetted water gas is essentially an oil-cracking process, and the evidence so far available goes to show that a good quality benzene and toluene can be obtained by washing the gas from this process. In the early days of the war, this source was unjustly ignored, owing to the lack of a good test for the benzol content of a gas. The shortage of gas oil supplies has considerably handicapped this source in England, but it affords vast possibilities in America, the home of carburetted water gas plants.

Some tests made at the Birmingham Gas Works showed that, of the oil cracked in this process, 3.27% appeared as benzene and about 2% as toluene, and the products were not seriously contaminated with paraffin hydrocarbons.

Egloff (Met. and Chem. Eng., 1917), experiment, ing with a Lowe carburetted water gas plant, obtained per 1000 cub. ft. of gas, 0.07 gall. of benzene, 0.06 gall. of toluene, and 0.01 gall. of xylene. On this basis he estimates that the carburetted water gas manufactured in America, if washed, would yield annually 8,689,000 galls. of benzene, 7,448,000 galls. of toluene, and 1,241,300 galls. of xylene.

In conclusion, the author desires to thank the Birmingham Gas Committee for permission to submit this paper.

APPENDIX.

A device which the author has found very successful for testing the benzene and toluene, etc. contents of a gas is shown in the diagram (which is drawn to scale).

It is designed to scrub 100 cub. ft. of gas in 4 to 5 hours, as that is the minimum volume of gas which gives a reasonable quantity of crude benzol for analysis.

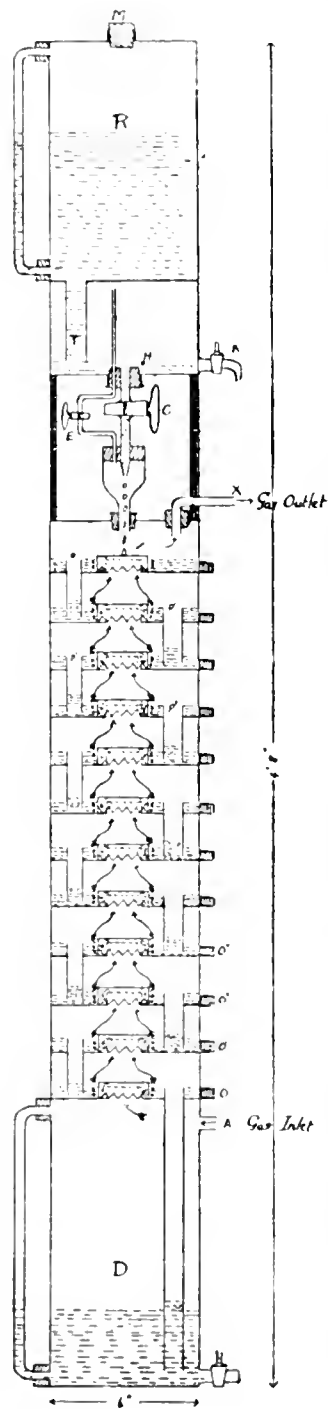
The washer works on the continuous counter-current principle and is very similar in action to a fractionating column. It is constructed from sheet tin.

Gas passes in at the bottom, A, and travels up through the washer, bubbling through the circular serrated lutes in each compartment, and finally passes out at X. Prepared oil flows from the constant head, H, through the control cock, C, into the top of the washer and gravitates from tray to tray, down the sealed pipes, P, P', etc., to the bottom of the washer, where it collects in the chamber, D, until the end of the test.

In the present form, the gas bubbles through a $\frac{1}{2}$ -inch seal in each compartment, and with an initial pressure of 5 to 6 inches of water, the washer will scrub 20 cub. ft. of gas per hour, leaving no appreciable quantity of washable products in the gas. After once starting, if the oil has been carefully filtered free from grit, the washer requires little or no attention until the end of the washing period, i.e., 4 to 5 hours for 100 cub. ft. of gas.

The manner of carrying out a test is as follows:—

The reservoir, R, which is to feed the constant head, H, is filled *via* M with prepared oil, after closing C, E, and K. A rubber bung is then tightly inserted in M. Taps, C and E, are then opened and oil allowed to flow into the washer. Each time the tube, T, becomes unsealed, a little gas displaces oil in R, and T is re-sealed; in this manner the control tap, C, remains under a constant head as long as any oil remains in R. Consequently a uniform flow of oil is secured. As soon as the compartments have each received their quota of oil, indicated by oil commencing to flow from the bottom one, at the "run off," O (left open for the purpose and afterwards closed), the control tap, C, is adjusted, to give the necessary oil feed—depending on the gas rate,



etc. The metered gas is then passed through the washer. At the end of a test, the main bulk of the oil having collected in D is run off and also that from each compartment by the drain holes, O, O', etc. (being uncorked for this purpose).

The crude benzol is then steam-distilled out of the oil in the usual manner and analysed by Colman's method.

About 4 litres of oil is required to scrub 100 cub. ft. of gas, and this, or more, is easily carried in the washer. The reservoirs, R and D, have capacities of 1 and $1\frac{1}{4}$ galls, respectively.

A test can be started and the figures for the pure benzene and toluene contents of the gas determined within 8 hours, i.e., 5 hours for washing and 3 hours for analysis. Chemists who have had to determine the benzol content of a gas will appreciate the advantage of the speed of the above method. A smaller initial gas pressure than 5–6 inches water can be used by employing a smaller number of compartments but the gas rate must then be lowered accordingly.

DISCUSSION.

Dr. J. C. CAIN said he had not been able to ascertain that the German claim to the discovery of benzene before Faraday had been substantiated. There was practically no difference between synthetic phenol and natural phenol. Mr. Rhead had suggested that benzene was fairly easy to purify and that it could be done by freezing. He should like to know how such a process was used. The reference to Rollason, Stevenson, and others was interesting, but he believed that the process had not proved successful.

Mr. W. J. A. BUTTERFIELD said that he had published figures 20 to 25 years ago showing that it was possible to obtain carburetted water gas so that the vapours in the gas consisted entirely of aromatic hydrocarbons.

Dr. R. LESSING asked what was the percentage of oil extracted from the gas, and what was the percentage of recovery by distillation.

Mr. F. H. ALCOCK recalled having heard it stated in a lecture many years ago that the discovery of benzene was made in this country, where it was found in the liquid which separated in the cylinders containing compressed gas which were in those days utilised for conveying the gas to the point of consumption.

Professor BONE suggested that the gas referred to by Mr. Alcock was oil gas and not coal gas.

Mr. RHEAD, in reply, said that the statement as to the German claim concerning the discovery of benzol was contained in Lunge's "Coal Tar and Ammonia" (Vol. 1, p. 224). Lunge (Vol. 2, p. 940) also stated that chemically pure benzene was made by a freezing process. As regarded synthetic phenol, he had been under the apparently wrong impression that it was easier to purify than coal-tar phenol owing to the cresol contents of the latter. He did not know to what extent recrystallisation was necessary for the T.N.T. prepared from paraffinic toluene.

In the early days of the war, there had been a doubt in some quarters concerning the paraffin content of the toluene obtained from the washing of carburetted water gas.

He had been unable to wash out any more crude benzol from the gas after the latter had passed through the washer described. By fairly prolonged steam distillation he had been able to recover all but a negligible quantity of the crude benzol from the oil. The amount of steam distillation necessary had been determined by steam distilling known mixtures of benzene, toluene, and wash oil.

RECENT DEVELOPMENTS IN THE INDUSTRIAL APPLICATION OF TOWN'S GAS.

BY C. M. WALTER, B.S.C.

The developments which have taken place during the past few years in the application of town's gas for industrial, heating, and manufacturing purposes have been such as to signify that the future of this form of fuel is largely dependent on its employment in this connection, and further to predict the possibility of very great developments in this application as a substitute for solid fuel.

The degree to which town's gas will ultimately replace solid fuel will naturally depend to a great extent on the increased heating efficiency to be obtained by its use, and when it is remembered that at the present time, in many instances, town's gas has been able to compete favourably with solid fuel, with but slight increase in heating efficiency, owing to the economies obtained by its use in other directions, it will easily be realised to what extent its field of application will be extended when the efficiency of the town's gas-heated furnace is still further increased as to reduce the cost of the B.Th.U. required to perform a given operation to a figure comparable with that obtained with solid fuel.

That the heating efficiency of the gas furnace will be considerably increased there is little doubt, as up to the present little has been done in the way of conserving the heat carried away in the waste gases by the employment of regenerative systems, in furnaces designed for operating with this fuel, and it seems possible that the heating efficiency might in some instances be so increased by this means, as to enable town's gas to compete with solid fuel on a fuel cost basis alone. To quote an example where this has actually been the case, the author can refer to an installation of gas-heated lehrs, which were installed some few years ago for the annealing of glass. The installation referred to consists of two annealing furnaces, each approximately 74 ft. in length and 5 ft. 6 in. in width by about 2 ft. 6 in. in height to centre of arch, the combustion chambers extending for a length of 20 ft., being arranged beneath the bed with suitable regenerative settings for the pre-heating of the air. Gas was supplied at ordinary town pressure through ordinary atmospheric burners, the secondary air being pre-heated prior to its entrance to the combustion chambers. The results of tests carried out on the furnaces referred to showed that to maintain a temperature of about 550° C. when under load, a gas consumption of approximately 750 cub. ft. per hour was required, corresponding with an efficiency of just over 30 %, whereas in the case of a similar furnace direct fired by coal, the fuel consumption approximated to 1 cwt. of coal per hour, corresponding with an efficiency of approximately 8.5 %; the fuel costs amounted to 11.25 pence per hour in the case of the gas-heated furnace, as compared with 10.8 pence per hour in the case of the coal-fired furnace, the cost of handling the fuel not being included in the latter case; thus owing to the increased efficiency with the former system of heating, the fuel cost alone was only slightly in excess of that obtaining in the case of solid fuel-fired furnace. This is referred to merely as an example of the increased efficiencies which can be obtained by the judicious application of town's gas, and although it may be said that the solid fuel-fired furnace has yet to be considerably improved, nevertheless, making due allowance for such improvements, the advantages obtained by the use of town's gas due to cleanliness, convenience, simplicity, and ease of temperature control

must weigh greatly in its favour, in the case of many manufacturing processes.

It is the intention of the author, in this paper, to refer to the more recent applications of town's gas as an industrial fuel in connection with metal melting, annealing, hardening, etc., rather than to deal at length with figures of fuel cost which obtain in its many applications, as compared with other forms of fuel.

Metal melting.

The developments which have taken place during the last twelve months in connection with the application of town's gas for metal melting, have been in some respects phenomenal, and at the present time many thousands of brass, gun-metal, and aluminium castings are being produced daily in melting furnaces heated by this fuel. At the same time large quantities of metal are being melted for the production of strip, billet, and ingot in gas-heated furnaces, with considerably increased economy in melting costs as compared with other forms of fuel. For the production and melting of aluminium alloys, gas-heated furnaces having pots of capacity up to 600 lb. (copper) are being employed, with the result that not only has the speed of melting been considerably increased, but the fuel cost has been reduced, and in many cases superior quality alloys have been produced owing to the cleanliness and ease of temperature control which obtain when melting under such conditions. In the case of the melting of brass, bronze, and gun-metal in gas-heated furnaces, the output has, in many instances, been considerably increased and at the same time the metal loss during melting reduced.

With regard to the relative efficiencies of direct-fired melting furnaces heated by coke and gas, figures obtained from a series of experiments carried out some time ago in connection with the melting of common yellow brass showed these to be in the ratio of approximately 3 to 15 respectively, again showing the large increase in heating efficiency which has been obtained with coal gas as a fuel.

Perhaps a more recent application of town gas in this connection is its use for the melting of cast iron. At the present time, in many parts of the country, cast iron is being melted in pots of 60 to 120 lb. capacity with town's gas, for the production of high grade castings, and although the fuel costs are considerably higher than when melting by coke, it is found that owing to the superior quality of work which can be obtained, this extra fuel cost is easily justified. The results of tests carried out in connection with this work show that about 700 cub. ft. of town's gas of calorific value 600 B.Th.U. gross is required for each cwt. of metal melted, and that from 7 to 9 heats of metal are obtainable for each pot.

Annealing.

For the annealing of iron, steel, and brass stampings, forging, etc., gas is rapidly replacing solid fuel, especially in cases where it is found advisable to split up the annealing plant into small units. In this connection the replacing of solid fuel-fired furnaces by modern gas-fired furnaces fitted up with suitable temperature indicating apparatus, has placed manufacturers in a position in which they are able to deal with work of a repetitive nature, in a very different manner to what they were accustomed to when working by rule-of-thumb methods.

Taking, e.g., the annealing of brass and steel stampings, an enormous industry of this city, one no longer sees in this connection the cumbersome coal-fired furnace: in its place we now have a number of small furnaces heated by gas at ordinary pressure, each constituting a complete

unit fitted with its temperature indicating apparatus and capable of dealing with work at a speed at least double that of its predecessor.

The advantages brought about by this change result in the work being done more expeditiously, with greater uniformity, and at a lower manufacturing cost, for temperatures can be quickly and easily controlled with absolute precision; the number of units in use can be adjusted in accordance with the amount of work to be dealt with, and the working of such a plant becomes, to a great extent, automatic.

The extent to which gas is replacing solid fuel in this particular application may be gathered from the fact that in this city alone, during a period of nine months, upwards of £12,000 worth of gas-heated furnaces have been installed on the premises of various manufacturers engaged on Government work, this representing an increased gas consumption amounting to upwards of 250 million cub. ft. per annum.

Carburising, hardening, and tempering and general heat treatment of metals.

What has been said with regard to annealing applies equally to such processes as carburising, hardening, and tempering and the general heat treatment of metals, in which processes town's gas is now being employed to a very considerable extent. Special furnaces for particular processes of heat treatment are being designed almost daily, with the result that working efficiencies are being considerably increased.

During the last six months, a considerable amount of investigational work has been carried out in the Industrial Research Laboratories of the City of Birmingham Gas Department, in connection with the carburising of mild steel in an atmosphere of coal gas, and already this process is being used with considerable success for the carburising of small parts of machine tools, gauges, etc.

New methods are also being employed for the heating of delicate tools for purposes of hardening, by radiation in an atmosphere of coal gas to avoid oxidation, and by combining this process with a special arrangement for heating by radiation, it has been found possible to reduce the amount of distortion which takes place on quenching to a minimum.

The applications of town's gas for industrial heating purposes have been so varied and numerous as to require a large amount of scientific investigation and experimental work to be carried out to ensure that the most economical methods for the carrying out of any particular process are employed, and with this object in view the Industrial Research Laboratories of the Birmingham Gas Department are working, hand in hand, with the various manufacturers, as only by this means does it appear possible to combine science with practice to bring about the results required.

When dealing with the question of industrial heating, no paper would be complete which did not make reference to the subject of pyrometry, a subject which is, at the present time, receiving considerably more attention than it has in the past. The employment of pyrometers in all heat treatment operations of a repetitive nature must receive still more attention by the manufacturers in the future, and every facility should be offered to ensure that the correct type of instrument is used for any particular process under consideration.

The many advantages obtained by the use of town's gas in the particular manufacturing processes referred to above also apply to a more or less degree to other manufacturing processes such as glass manufacture, porcelain firing, japanning, lacquering, etc., in consequence of which the gas-heated furnace is gradually becoming a

sine qua non in the industries referred to, and speaking generally it may be said that application of gas as an industrial fuel has gone far to augment the output of munitions and war stores of the large manufacturing centres of our country.

In conclusion, the author wishes to offer his thanks to the Birmingham Gas Committee for their permission to contribute this paper.

DISCUSSION.

The PRESIDENT said that Mr. Walter's statement as regarded the work done by the Birmingham Gas Department was most interesting. To achieve success they had spent a considerable sum of money and installed important plant.

Mr. DRUMMOND PATON asked as to the pressure at which air was introduced into the furnace.

Mr. TAUDEVIN agreed with the author that the development and the design of gas furnaces was in a crude stage. He did not think he had seen a really well-designed annealing gas furnace yet, though he had seen gas furnaces which gave promise of good results.

Mr. E. W. SMITH stated that in the south of England Sir Alex. Duckham had 16 muffles working successfully. They were 15 feet by 5 feet 6 inches, all raised above the ground and heated with producer gas, and they were so arranged that the bottom of the furnace could be dropped out. The strip for annealing was placed edgewise on the bottom and the furnace was rarely opened for more than forty seconds, and in two hours it was possible to treat 3 tons, corresponding to 30 or 35 tons of metal through-put per day. It was not possible to determine with the pyrometer a difference of more than 5 to 10 degrees of temperature in any part of the muffle. The heating was uniform and very easily controlled. He thought the gas companies would have to face the competition of producer gas in muffles. Water gas was not nearly so suitable for many methods of heating. The dilution of producer gas enabled one to get more effective flame over moderate temperatures and over big areas.

Mr. A. E. TUCKER submitted that the pressure should be exercised on the gas and not on the air. It was invariably the case in the furnaces with which he was connected and that detail was of great importance, because by that means alone the action on the pots could be much reduced, and pots at the present time cost £1 or £5 each. Secondly, the control of the heat was much more easily effected. The limits of copper in brass were specified by the Ministry of Munitions as between 57 and 62%, and it was a wide margin, but labourers did not always appreciate the significance of using excessive heat, and the result was that in some gas-fired furnaces, he had known a loss of 10% of zinc; a considerable amount of brass had thus been wasted.

Mr. H. L. HEATHCOTE said that one Coventry firm paid over £3000 a year for gas for industrial purposes. He was glad that Mr. Walter had emphasised the need for pyrometric control in connection with furnace work. To a very large extent the value of the furnace was determined by the accuracy with which its working could be controlled.

The PRESIDENT said he thought a mistake often made was in depending upon the average workman to use a pyrometer having a scale which was not sufficiently open. He had reason to know that where a pyrometer with an open scale had been used, not much difficulty was experienced in getting working men to work within close limits.

Mr. WALTER, in reply, said that in their furnaces air was used at a pressure of about 2 lb., with gas at the ordinary town pressure. In many cases it was found to be more satisfactory to use both gas and air under pressure. The main advantage

to be derived from using the combined arrangement was that the variations which were bound to take place were eliminated when one was dealing with gas at some positive controlled pressure. In Birmingham they had upwards of 17 miles of high-pressure mains, which transmitted gas at a working pressure of 12 lb. per square inch, and in cases where manufacturers were on the route of these mains the Corporation were in the position to supply them with melting furnaces in which the gas was supplied under pressure and the air taken in by injection in the ordinary way. A considerable number of these furnaces had been in operation for some 5 or 6 years. Where there was a difficulty of obtaining high-pressure gas it had been found to be a commercial proposition to instal compressing plant. He agreed as to the ease of control and efficiency of the high pressure gas-heated furnace. When high-pressure gas was employed direct, the amount of gas it was possible to introduce into the furnace was decided by the size of the jet and the working pressure. To some extent that prevented the possibility of the metal being over-heated by using an excess of gas just prior to pouring.

THURSDAY AFTERNOON.

GROUP I.

The PRESIDENT in the Chair.

MANUFACTURE OF SYNTHETIC NITRATES BY ELECTRIC POWER.

BY E. KILBURN SCOTT, A.M.INST.C.E., M.INST.E.E.

PART I.

In the process of fixing atmospheric nitrogen in an electric furnace, the reaction mainly depends on the contact of air with the electric arc. Clearly therefore that design is best which provides for most air to come under the action of the arc.

Many furnaces are faulty because a large proportion of the air passing through cannot come into contact with the arc, and on the reason being investigated it is found to be due to their being of the single-phase type.

For example in the Birkeland-Eyde furnace (see this Journal, 1915, 114) the arc alternately fills the top and bottom half, but never both simultaneously, and as air flows into the reaction chamber through all the holes, it follows that only half of it can be on the side where the arc is, at any moment. There is thus a leakage of air and it is especially pronounced through the holes nearest the periphery.

In the Schönherr furnace (this J., 1915, 115) a rod-like arc is formed up the centre, and a whirling current of air keeps the arc in the centre. As the section of the arc is only a fraction of an inch, whereas the cross sectional area of the tube is over 30 square inches, much of the air passes without contact. This is helped by the whirling action which tends to keep air away from the arc.

The Pauling furnace (this J., 1915, 116) consists of horn-shaped electrodes between which a fan-shaped flame is formed by the single-phase current which shuttles backwards and forwards between them. The nozzle of the air pipe is provided with a narrow slit, but as air cannot travel in a flat stream, it spreads in all directions. Therefore a large portion of the air must necessarily pass through the furnace without coming in contact with the arc.

Further particulars of the above furnaces are given in my paper on "Production of Nitrates from Air" in Journal for February 15th, 1915, No. 3, Vol. XXXIV.

Another single-phase furnace not described therein, is that of Mosciicki which is used in Switzerland. This type (see Fig. 1) has a reaction chamber, A, and air chamber, B, surrounded by

water. An annular space is provided between the high-tension electrode, C, and the lower edge of the reaction chamber, which latter is at earth potential. The arc strikes across this annular space and it is caused to rotate by the magnetic field set up by coil, D.

Naturally the single-phase arc can only be at one point of the annular ring at any one moment, whereas the air passes through all the ring space, all the time. Therefore this design, which otherwise has several good features, presents the disadvantage common to all single-phase furnaces of allowing air to pass through without contact with the arc.

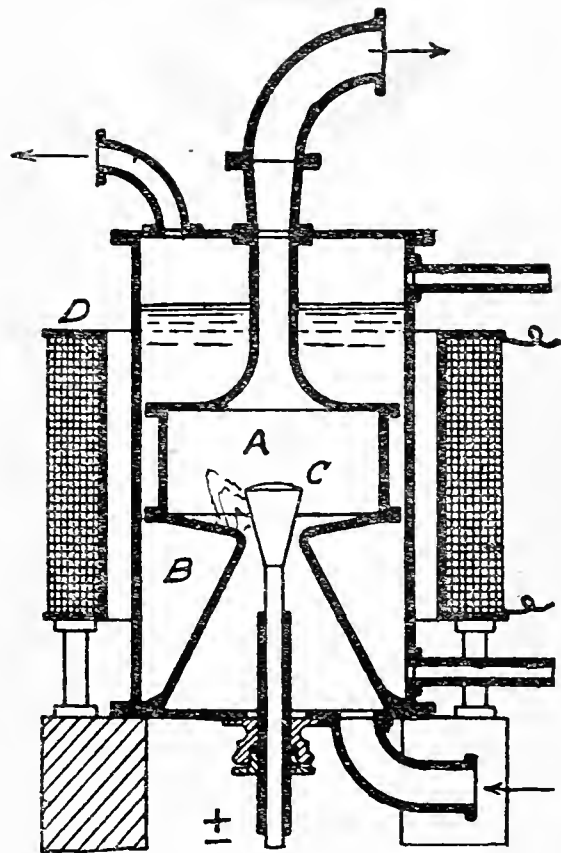


FIG. 1.
Mosciicki single-phase furnace.

Three-phase furnace. Now consider what happens in the three-phase furnace shown diagrammatically in Fig. 2. The three electrodes, A, A', A'', are arranged with intervening firebricks, B, B', B'', so that together they entirely enclose a six-sided conical space. Air entering the bottom from the pipe, C, expands and fills the cone before passing away at the top, the only exit.

The electrodes receive the three-phase currents, a, a', a'', and these currents interact in such way as to produce an arc flame which rotates rapidly in accordance with the periodicity of the supply, viz., 50 times a second.

Since the air takes longer than 1/50th of a second to pass up through the reaction chamber, every particle must come into contact with the rapidly revolving triple arc flame.

It is rather surprising that those who are interested in nitrogen fixation abroad should have only worked on single-phase lines. Having started

in that way they still keep to it owing no doubt to patent considerations, and the absence of competitive conditions.

When alternators first came into use all alternating current plant was single-phase, but directly three-phase motors came into vogue then single-phase began to go out. For a certain period two-phase apparatus was employed because it was easy to change over to it from single phase. Three-phase generators are now universally used, and yet for fixation of nitrogen, the Kilburn Scott type is the only one designed as a self-contained three-phase unit.

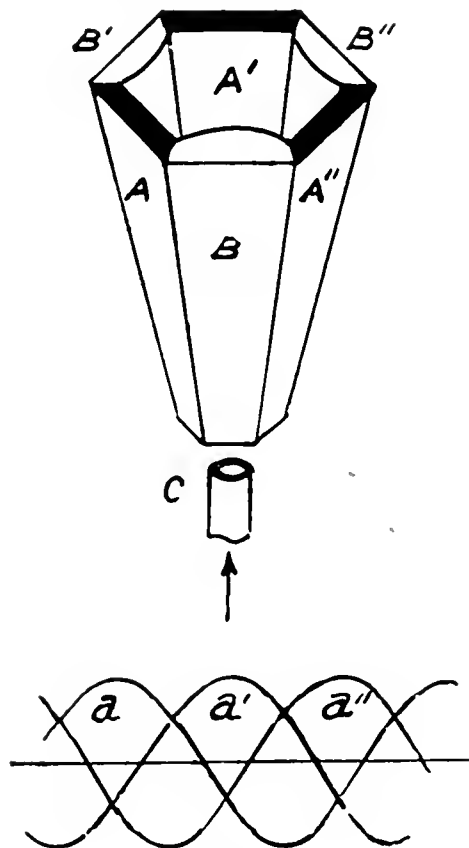


Fig. 2.

Diagram of Kilburn Scott furnace, showing entirely enclosed and conical reaction chamber, in which the combined three-phase arc flame rapidly rotates.

By employing three currents in one reaction chamber, the electrical energy is converted into heat at an even rate, because power varies between 0.86 and unity, taking the maximum as unity. This is indicated by the three alternating curves shown in Fig. 2, the crossing points of which are only a little below the maximum values. On the other hand the single-phase curve clearly indicates that in a single-phase furnace the power varies between zero and a maximum twice every cycle or period.

Blown arc flames. For the proper working of nitrogen fixation furnaces, it is essential to blow the arcs into flames, and this can be done by a magnetic field as in the Birkeland-Eyde furnace, which causes the arc flame alternately to expand into two half discs. Mosicki's furnace has a magnetic field which causes the arc to rotate round an annular opening, but the arc is extended

into a flame by the air which blows through the opening.

On the other hand furnaces can work merely by the air flowing through as in the Schönherr, Pauling, and Kilburn Scott types.

One objection to the magnetic blow is that in addition to alternating current for the arc, direct current is also required to excite the magnets. To obtain the direct current, special transforming plant is necessary, and it must be of the rotating type because of commutation. The first cost and upkeep are therefore high.

Seeing that, in any event, air must pass through the furnace, it may just as well be used for creating the flames, and thus do away with extra direct current plant. The arc flames obtained by air are just as effective as when obtained by magnetism.

In the Schönherr furnace the air is given a whirling motion to keep the arc in the centre of the tubular reaction chamber, but in the Pauling and Kilburn Scott furnaces this is not necessary.

Electrodes. For a given power or output the trouble of operating electric furnaces may be said to vary with the number of electrodes. Also the energy lost in electrodes will vary with their number. The least that can be used for any furnace are two and, therefore, three furnaces of single-phase require six electrodes, as shown in Figs. 3, 4, and 5. On the other hand, a three-phase furnace requires only three electrodes as shown in Fig. 6.

The Birkeland-Eyde furnaces, Fig. 3, are shown in "delta" connection, this being the preferred method, but some of those in Norway are also connected in "star." Schönherr furnaces, Fig. 4, are always connected in star, and as the top electrode of each furnace is earthed, there are only three electrodes at high tension.

Pauling furnaces are worked two in series, and they have a special transforming device, as shown in Fig. 5, which raises the voltage temporarily, in case one furnace of the series goes out. This assists towards continuity of working.

The material of which electrodes are made has an important bearing on the yield. For example the electrodes of the Birkeland-Eyde furnace are a special alloy of copper which has been found from experience to be beneficial.

The modified Pauling furnaces which Dr. Rossi has at work in Legnano have electrodes made of an aluminium alloy, and he claims that the metal has a catalytic action which is favourable to the yield. (See Brit. Pat. 23,959 of 1913.)

Schönherr and Mosicki furnaces, which have one of the electrodes at earth potential, must of necessity use iron or steel for one if not both electrodes. The iron oxide carried over with the gases is detrimental.

In my three-phase furnace a special alloy is used, particulars of which it is not desirable to disclose.

Starting furnace. Single-phase furnaces are started by moving the electrodes towards each other until the air gap is sufficiently narrow for the voltage to jump across. These adjustments have to be carefully made, as the electrodes are at high tension, and there is also liability of current rushes.

In the three-phase furnace, I dispense with adjustments because the arcs are started by pilot or trigger sparks. A wire placed about midway between the points of the three electrodes, just above the air pipe, is connected to a high-frequency apparatus. When this apparatus is started sparks pass from the wire to the electrodes, and thus break down the air dielectric. The operation of starting the furnace is first to turn on the air, then close the main three-phase switch, and finally switch on the pilot sparks.

By employing high frequency, many pilot sparks pass during each cycle of the main supply, which latter is 50 cycles per second. A continuous path is therefore provided for the main current. The

apparatus for attaining this and the method of connecting up are special and have only been arrived at after considerable experimenting. It will be seen, however, that two currents at different frequencies can work through the same conductor or it is practically the condition which enables telephone and telegraphic messages to pass together.

This method of starting is a great advantage because the electrodes can be set at the best distance apart for the air supply, and a low pressure can be used to operate the furnace. Without the pilot sparks the voltage has to rise to a certain point before current begins to flow and this affects the power factor.

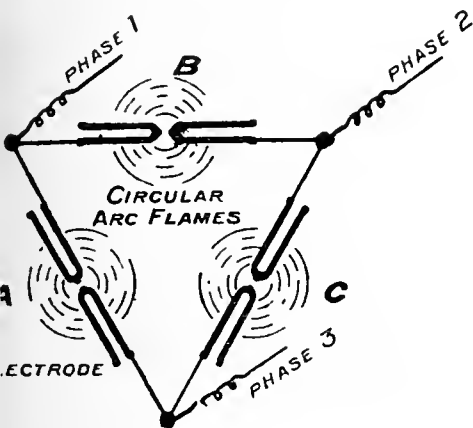


FIG. 3.

Three Birkeland-Eyde single-phase furnaces, connected in delta with 6 electrodes, all adjustable and at high pressure. A separate disc arc flame in each furnace.

It is convenient to keep the pilot sparks working all the time because it improves the yield and helps maintain continuity of working. In all electric furnaces it is most important to ensure continuity, because if the furnaces keep stopping and starting, surges may be set up. A three-phase furnace has a special advantage in this respect because currents are always flowing in the phases and the arcs assist in maintaining each other. The energy is practically always at a maximum, whereas in a single-phase furnace it varies from zero to a maximum twice in each period or alternation of the current.

Preheating. In order to get easy operation of the furnace the air must be preheated, and so long as such preheat is not detrimental in other ways, the higher it is, the better. Ionisation is helped by preheat and this condition is necessary for good electrical working. I have found it advantageous to preheat to 250° C.

It is convenient to get the preheat from the heat of gases leaving the furnace and one large heat exchanger can serve several furnaces.

The Birkeland-Eyde design embodies a preheater because the cold air blown into the furnace goes first into two chambers behind the perforated walls, and in passing through the numerous small holes to the reaction chamber it receives preheat.

In the Schönherr design the preheater is more apparent because it takes the form of several concentric steel tubes outside the reaction tube. It is an effective preheater, but the combination of a preheater with each furnace is costly. In one furnace room at Saaheim factory in Norway, there are 96 preheaters, whereas several separate heat

exchangers could preheat all the air required in a more effectual way.

Preheating the air not only economises heat, and raises the temperature of the furnace but it also enables the air to enter the furnace dry, which is an advantage. Prof. Guye found a slight increase in yield when the air was dry, enough to warrant the removal of moisture in a commercial plant.

I think it may be taken as an established fact that if air is used without any previous treatment, the yield of a furnace will differ with varying atmospheric conditions. Air charged with moisture or with dust or with acid vapours as found in some industrial centres will not act in the same way as the clean dry air of, say, an inland

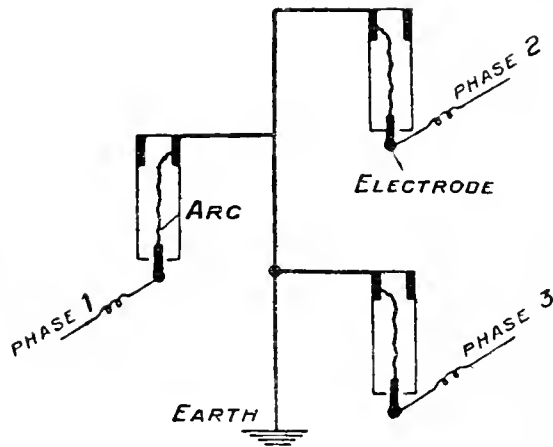


FIG. 4.

Three Schönherr-Hessberger single-phase furnaces, connected in star with 6 electrodes, 3 of which are adjustable and at high pressure. A separate rod-like arc in each furnace.

mountainous region. Natural electrical phenomena are much manifested in a pure dry atmosphere.

Cooling. As the chemical reaction is reversible, it is important to chill the nitric oxide quickly. With single-phase furnaces, it can only be effected by blowing excess air through the furnace, whereas in the Kilburn Scott furnace a cooling device in the form of a boiler acts as the roof. Boilers would no doubt have been applied directly to the single-phase furnaces in Norway, if the designs had been suitable.

It will be noted from Fig. 1 that a boiler is an essential part of the Moscicki furnace, and in that respect I consider it is an advance on the other single-phase furnaces. But considered as a boiler it is faulty, and the reason is simply that it has had to be made to suit the special requirements of the reaction chamber, etc. By employing a boiler simply as the roof of the three-phase furnace it becomes a straightforward job and there is no compromising of either the reaction chamber or the boiler.

Cooling by means of a boiler is effective by reason of the latent heat of steam and there is also considerable economy because the steam can be used for generating electric power. There is a regenerative gain of over 10% by passing the steam into a mixed pressure steam turbine. If not wanted for that purpose the boiler can produce distilled water for the absorption plant.

A blown arc flame acts on the boiler in much the same way as any ordinary flame burning to carbon dioxide. The centre of the arc flame

is the neutral point, and as I connect the boiler to earth, there is no danger and no electrical leakage.

The boiler is not affected, because nitric oxide does not attack metal. Nitrogen peroxide may do so if the temperature is below 600° C., but even it acts slowly and moisture must be present.

In Norway the furnace gases are passed through an ordinary Babcock-Wilcox boiler when the temperature has been lowered to about 200° C., so the gases are at a temperature which is dangerous. From the point of view of action on metal it is much safer to use the boiler *directly* on the furnace where the gas is still in the nitric oxide stage.

Results. The yield which it is generally assumed can be obtained from single-phase furnaces is 50 to 60 grms. of pure nitric acid per kilowatt-hour, or, say, half a ton of pure acid per kilowatt-year. Tests carried out on my three-phase furnace show greater yields, and I consider 50% higher than the above is commercially feasible.

The yields are much improved by having a boiler immediately over the arc flames, and there is no appreciable difference in yield when steam

Those specially interested are referred to Fig. 9 of my paper on "Production of Nitrates from Air" in Journal for February 15th, 1915, No. 3, Vol. XXXIV. This shows a lay-out of absorption towers, etc., and also my proposal to supply the furnace with oxygenated air and work in a closed cycle by bringing air from the last tower back to the furnace.

Dilute nitric acid is collected at the bottom of each tower and forced up to the top of the next. The liquor passes from tower to tower in one direction whilst gas passes from tower to tower in the other direction. Such a system gives an acid concentration of about 25%, which is high enough for making ammonium nitrate and calcium nitrate.

It happens that during the absorption process nitrous acid is formed, and this, being unstable in presence of water vapour, splits up into nitric oxide and nitrogen peroxide. The nitric oxide then takes up more oxygen from the excess air present, and for this it is well to make provision by allowing the gas to move sluggishly between the towers.

It will be of interest to consider what are the conditions for good absorption. A first condition is that the gases move very slowly, and the next

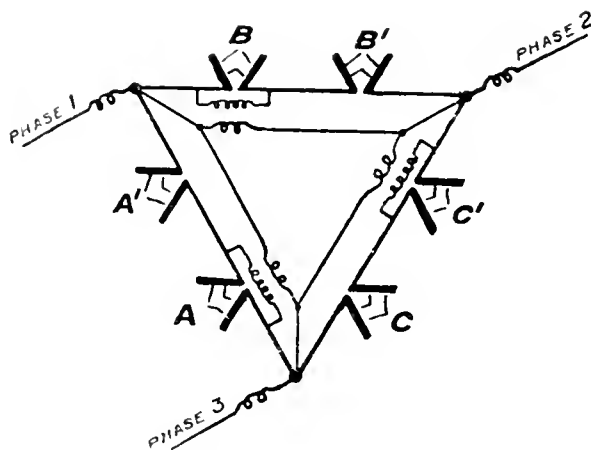


FIG. 5.

Pauling single-phase furnaces, connected in two series and in "delta," with 12 electrodes, all adjustable and at high pressure. A separate fan-shaped arc flame in each furnace.

is being raised as there is before the water boils. Tests have shown that of the total energy put into the furnace, the low pressure steam raised represents about 10%.

If the air is preheated to 250° C. then the yield rises to its full value in about $\frac{1}{4}$ hour from the time of starting the furnace, which is important from the point of view of switching off the furnace during off-peak hours.

The pressure at which the furnace will work is considerably lower than the voltages used in single-phase furnaces. Power factors of over 0.85 have been obtained.

Absorption towers. The most commonly used absorption system consists of a range of high towers made of acid-proof brickwork, the towers being filled with quartz pieces or one of the many patented forms of acid-proof filling. Gas enters the bottom of each tower and leaves at the top after finding its way through the interstices of the filling. At the same time the absorbing liquid covers the filling with a thin layer of liquid, which absorbs the ascending gas. The bulk of the absorption takes place in the first tower which receives the strongest gas.

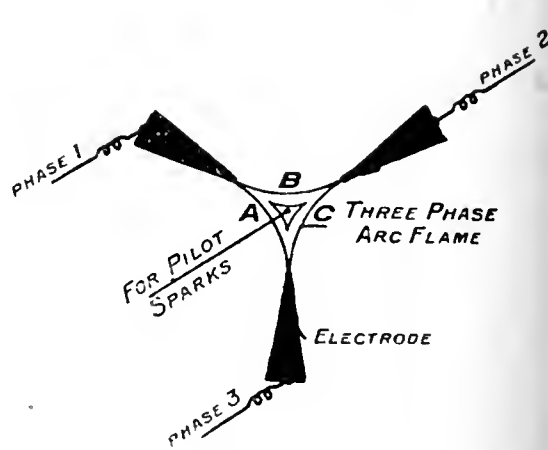


FIG. 6.

Kilburn-Scoll three-phase furnace, connected della-star with 3 electrodes, at high tension. A rapidly rotating arc flame is produced by the three phases in the conical reaction chamber.

is that the contact surface should be as large as possible; also, as mentioned above, there should be opportunity for the further oxidation of the nitric oxide which is formed during absorption.

Prof. Moscicki has also found that it is desirable for the liquor to pass down the towers intermittently so that the filling is periodically wetted. His system is shown in Fig. 7, taken from Brit. Pat. 17,355 of 1911.

The absorption chambers are rectangular in plan, and built together in one block of acid-proof bricks, the party walls, A, pierced with small holes, B. Every second chamber, C, C, is filled with quartz pebbles to offer a large absorption surface. The other chambers act as oxidising chambers, and have an open kind of packing or else are empty. The width of each chamber is about the same as the height and it is only 15 to 30 cm. in the direction of travel of the gas. The space occupied by the whole apparatus is small as compared with the old system of separate towers.

The gas is caused to flow at the very slow speed of about 4 cm. per second, and it travels in a horizontal direction, through the holes in the party walls from chamber to chamber. The absorbing

liquid. D, is poured quickly and periodically over the layers of filling material so as to form each time a column of water which as it sinks downwards places all parts of the filling successively under water and thus thoroughly washes them.

Viewed from the gas inlet pipe the receiving vessels are arranged in stages rising towards the rear end of the chamber and each vessel is connected with the adjacent lower vessel by means of overflow pipes as shown. As distilled water is admitted at the rear end where gas is weakest it causes overflow towards the end where the gas enters and where acid is drawn off. The operation is automatic.

The holes through which the gas passes slope down towards the filling so to as prevent liquid getting through the holes into the oxidation chambers. The outer walls of the chambers are made tight to liquid and gas by a coating of acid-proof asphalt.

After the liquid has fallen to the bottom of each tower it is transferred to the top of the next by a *montejus*, the liquid moving in the opposite direction to the gas as in the other systems. By the Moscicki method the absorption of the nitric

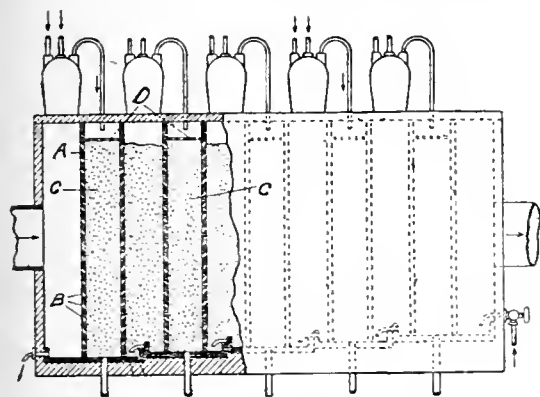


FIG. 7.

Moscicki plant for absorption of nitric acid.

peroxide gas is nearly complete, being about 97%, whilst the nitric acid may be drawn off at a concentration of 40 to 50%.

PART II.

COMPARISON OF METHODS.

During recent years a great deal has been heard of the indirect method of making nitric acid; that is so say, by the manufacture of calcium carbide and calcium cyanamide, and the oxidation of ammonia. Those interested in this method have made comparisons between it and the direct electric arc process, with the object of showing that the indirect is the best. It will therefore be of interest to make out a complete statement of all the various items of the two methods, for obviously, that is the only way by which a fair comparison can be made.

INDIRECT METHOD.

Number of factories. Three, viz., one for calcium carbide, one for calcium cyanamide, and one for the acid.

Number of processes. Ten. (A) Burning limestone; (B) making calcium carbide; (C) grinding carbide; (D) making pure nitrogen; (E) making calcium cyanamide; (F) grinding cyanamide; (G) raising superheated steam; (H) making ammonia; (I) oxidation of ammonia by catalyst; (J) absorption of gas to nitric acid.

Materials. Seven. (A) Limestone; (B) coke or anthracite; (C) carbon electrodes; (D) pure

nitrogen; (E) superheated steam; (F) air; (G) water.

Purity of materials. It is very important (A) to have pure nitrogen for the cyanamide, (B) to free the cyanamide from all traces of carbide; (C) to have pure ammonia and pure air, because the catalyst is easily poisoned.

Electric energy. Electricity is required: (A) For calcium carbide furnace; (B) for calcium cyanamide retorts; (C) for heating catalyst; (D) for powerful motors for grinding the carbide and the cyanamide and for moving these materials.

Grinding machinery. Special machinery is required for grinding the calcium carbide very finely in an atmosphere of nitrogen, so as to prevent formation of acetylene, also for grinding calcium cyanamide.

Steam. Superheated steam is required for making ammonia from the cyanamide in autoclaves. The steam is raised by burning fuel.

Catalyst. Platinum is used as a catalyst, and as it is consumed it has to be renewed.

Electrodes. Amorphous carbon electrodes are required for the carbide furnaces, and the cyanamide retorts. They burn away quickly, and are expensive.

Method of working. A calcium carbide furnace must work continuously, because if the fused material solidifies, it may spoil the furnace lining. The calcium cyanamide retorts must be worked intermittently.

Situation of factory. The site must not only be where electric power is available, but also where limestone, coke or anthracite, and carbon electrodes can be conveniently and cheaply delivered.

Labour. A great deal of labour, much of it skilled, is required to attend to the ten processes, and the large amount of special plant required. The intermittent method of making cyanamide in numerous small retorts requires much hand labour.

DIRECT METHOD.

Number of factories. One.

Number of processes. Two. Nitric oxide gas, made by passing air through an electric arc flame. The gas is then combined with water to form nitric acid.

Materials. Two. Air and water.

Purity. Nitrogen and oxygen are used exactly as they exist in the atmosphere. No precautions necessary.

Electric energy. Energy is only required for the furnaces and sundry small motors.

Grinding. None required.

Steam. Raised by the waste heat of furnace gases.

Catalyst. None.

Electrodes. Water-cooled metal, which wear away very slowly.

Method of working. It is best to work continuously, but the process lends itself perfectly for intermittent working, so as to take advantage of low off-peak or off-season rates.

Situation of factory. The site may be anywhere where suitable electric energy is available. It is not affected by carriage of raw material.

Labour. Very little required, as there is only one process, and that is practically automatic.

It has often been stated that the amount of electric energy required for a given amount of nitric acid made by the *indirect* process, is less than that required by the *direct* process. I have yet to see reliable figures proving this, but even if it were true, it is only one item. The only way to compare two methods is to take into account all the factors, and appraise them at their proper value.

To show how absurd is the argument, one may as well say that the electric energy (represented

by a few motors and lights), required for a plant making acid from sodium nitrate, is much less than by all other processes. That does not prove anything, and yet it is no more absurd than the other argument.

On the question of first cost of plant, the *indirect* method is not in the running at all. For assume for the sake of argument that the cost of a carbide furnace and its accessories is about the same as that of an air nitrate furnace and its accessories, and that the absorption plant required by the two processes is also about the same.

Then, in addition, the *indirect* process requires:—

- (A) A complete plant for making cyanamide.
- (B) Liquid air plant for making pure nitrogen.
- (C) Powerful machinery for grinding the carbide and the cyanamide.
- (D) Steam boiler, and autoclaves for making ammonia.
- (E) A complete catalytic plant for oxidising the ammonia to nitric acid.

Plant is also required for purifying the materials and gases, etc. At the cyanamide works at Odda in Norway they have actually had to carry a pipe up the mountain side so as to get pure air, that about the factory having given trouble with the liquid air plant.

As regards the cost of materials the *direct* method is at a tremendous advantage because the cost of one material is zero and will always remain so, and the other—water—is cheap and not likely to increase. On the other hand, the materials required for the *indirect* method are very expensive and especially difficult to obtain at the present time.

Over three-fourths of the cost of working the *indirect* method is represented by cost of materials which are liable to fluctuate in price, and are now much higher than before the war and will remain up. On the other hand in the cost of working the *direct* method, less than one-fifth represents cost of materials which depend on market rates. The principal item of cost, namely, electric power, will most certainly tend downwards.

The *direct* method is automatic in its working, whilst the *indirect* method requires much skilled and unskilled labour, and some of the operations are dangerous to health. The more that labour demands increase, the more is the *indirect* method handicapped.

Power. It is often said that there is not enough electric power for electro-chemical processes, and we cannot generate power cheaply enough. As a matter of fact, for some years before the war electric energy had been sold in this country at lower rates than those at Niagara.

In the future the problem of cheap electric power is going to be solved for this country by the establishment of super-power houses, and some of 120,000 kilowatts each are already projected. Generation of energy by coke-oven gas will also give a large amount of power, and as time goes on, the manufacture of coke will be carried on on a much larger scale and all bee-hive coke ovens be replaced by up-to-date ovens, recovering the products, and giving large amounts of gas. It is estimated that the gas from a battery of 100 modern coke ovens will generate 3000 or 4000 horse power.

Electric power generated by super-power houses, and by utilisation of waste gas, will be used for electro-chemical and metallurgical processes, and I am confident that the manufacture of nitrates from air by the *direct* method will be one of the principal of these.

The *direct* process lends itself particularly well because it is so suitable for off-peak or off-season loads. The furnaces differ from most others in that there is no fused material to solidify, and very little brickwork to deteriorate in case of a stoppage. The furnace can be switched on

and off like an arc lamp without detriment to the furnace or to the process of manufacture.

As a basis load for a power house the *direct* process also presents the advantage that it can be established anywhere. The only raw materials are air and water, and therefore considerations of carriage do not weigh, as is the case with many other electrical products. The factory can be built alongside the power house.

In the case of power from coke ovens the *direct* process presents the advantage that the electric power can be used to make nitric acid, which is then combined with ammonia in the gases to produce nitrate of ammonia. This is better than purchasing sulphuric acid, and the nitrate of ammonia has the advantage over sulphate of ammonia in entering a better market and commanding a higher price per unit of combined nitrogen.

One very important fact regarding the manufacture of chemical products is that they are sold on analysis, and so long as prices are right the products will command a market.

The market of nitrogen compounds does not depend on goodwill, advertising, and so on, like that of manufactured articles.

Conclusion. I would like to point out that before the war the Central Powers were the largest purchasers of Chili nitrate, Germany taking twice as much as the next consumer, the United States, and over six times as much as this country. Now they do not require any, because they have established immense plants to make nitrates from air, and by keeping money in the country they are at an economic advantage.

The manufacture of nitric acid from Chili nitrate, which is universal in this country, is not only wasteful and expensive, but the raw material has to be transported 5000 miles in expensive tonnage at considerable national risk. Hitherto the powerful financial and other interests concerned with Chili nitrate have had their own way. It is now of national importance that reactionary influences should be stopped and steps taken to bring this country into line with other countries in the adoption of modern scientific methods of making nitrates from air.

DISCUSSION.

Mr. BOWER said that he had been much impressed with the description of the absorption process of Mosicki, which seemed a very good method, because in the treatment of these gases it was necessary to carry out a double function, to oxidise and to absorb. The cycle of operations was so speedy that it was almost simultaneous, although in practice the time for oxidation might or might not be longer than the time for absorption.

The PRESIDENT pointed out that the matter had not been neglected by the authorities, and that a good deal of work was being done at the present time with regard to this all-important matter. The outstanding difficulty, when entering on the erection of plant of this magnitude, was to decide whether to adopt a process which required the minimum amount of power or a process such as Mr. Scott had described in which it was suggested that the power requirements were considerably larger. Though the *indirect* process might require very much less electrical energy, in the long run it might be found that the *direct* process was better than the *indirect* one, although more had to be paid for electrical energy.

Dr. M. E. FYLEMAN asked whether there was any possibility of electrolytic corrosion in the boiler; any sort of electric current in and around a boiler used for steam raising was apt to be inconvenient and sometimes dangerous. From what one gathered in a general way it was almost if not entirely impossible, under practical conditions, to convert completely the nitric oxide

obtained in these processes into nitrous or nitric acid, the loss of nitrogen amounting to some 3 or 5% according to the literature. He would like to have some figures indicating roughly the cost of plant necessary to produce a certain quantity of nitric acid and to hear something about the cost of labour and supervision. This information would make it very much easier to form an idea of the possibility of using the process described.

Mr. F. SPROXTON said that it was somewhat puzzling to hear that the yield with Mr. Scott's new furnace was only 50% better than with the old furnace. It seemed that the advantages Mr. Scott claimed should have led to a far greater yield than that. Would there be any advantage in modifying the composition of the air by admixture of oxygen so as to get nearer to the theoretical composition which would give the most favourable results?

Mr. WEBB said that as Mr. Scott had pointed out, the time factor in the whole process was the oxidation of the NO to NO₂, and this seemed to depend on the actual time of the traverse of the NO through the absorption towers. Previously the absorption had been spoiled to a very large extent by the use of very fine packing, such as broken quartz. It became obvious that there must be a packing in the towers which would give a sufficient surface and also ample free space. He was rather at a loss to see how Mosiecki's patent would improve matters to any large extent. Broken quartz packing gave approximately 40% free space. He did not see why there should be the two separate chambers. Why not have one chamber and, for example, ring packing? This gave approximately 75 or 80% free space, and at the same time a considerably greater surface than would be obtained with broken quartz packing, unless the broken quartz was of the order of a quarter of an inch or less, in which case he imagined the draught difficulties would be fairly considerable. Assuming that there was the correct amount of free space and surface, and that the NO was given time to oxidise, there were other factors such as the dilution of the NO with air when entering the towers, and this dilution depended to a very large extent on the factor of packing. He rather understood that the packing question had actually been solved by the Norwegian and Swedish workers.

Dr. R. H. PICKARD said he should like to hear an incisive discussion on the relative values of the two catalytic processes on the same lines as Mr. Scott had given the relative values of the cyanamide and the arc processes.

Mr. MASON mentioned the Rankin process, of which Prof. Norton had spoken most favourably.

Mr. SCOTT, in reply, said that Mr. Bower had made some useful experiments with reference to the absorption question, and therefore what he had said on the subject carried considerable weight. Dr. Carpenter had mentioned that the Government were doing something at last, but we were three years late. The late Minister of Munitions, Dr. Addison, had stated in a recent speech, that at last we were going to do something in the fixation of atmospheric nitrogen. With regard to the point raised by Dr. Fyfe, it should be noted that the boiler was carefully earthed; it was known that corrosion occurred under certain conditions when alternating currents passed through earth, but this was only due to the presence of certain salts in the earth. He did not think there was any danger, but the point was worth looking into. There was some escape of nitric oxide into the atmosphere with the systems used abroad. He had mentioned in a paper some years ago an idea he had of making a complete cycle, taking the air as it left the apparatus and bringing it back, adding oxygen to it on the way, so that instead of passing the air

alone, air plus oxygen would be used: he had found the yield increased very considerably by oxygenating the air. With reference to Mr. Webb's remarks about packing, he could only say that the Mosiecki method had undoubtedly given 50%. Quartz pebbles, quite small, were used; the small spaces were completely flooded with water, which sank gradually, and this was followed up again with another lot of water, completely flooding all the spaces. He did not believe a great deal in ring filling. It appeared that the Norwegians always used quartz. Time must be given for the oxidation of NO to NO₂ to take place in between the layers in the towers. He did not know the cost of the cyanamide process. The cost of the plant for the arc process was roughly about £8 per kilowatt. According to quotations given about two years ago a German firm was prepared to build a factory in this country for £6 10s. per kilowatt, but he thought £8 was a safe figure, although, perhaps, it would be a little higher now.

THE SYNTHESIS OF AMMONIA AND THE OXIDATION OF AMMONIA TO NITRIC ACID.

BY EDWARD B. MAXTED, PH.D., B.SC.

The direct production of ammonia from its elements is at the present time a subject of peculiar interest, not only by reason of the conditions under which the reaction is carried out in practice, but also because it constitutes the most economical method available, if the initial difficulties are once overcome, of fixing atmospheric nitrogen.

It has long been known that on leading a mixture of nitrogen and hydrogen over certain catalysts, such for instance as iron or manganese, small traces of ammonia are produced even at atmospheric pressure, while in conformity with the well-known principle of Le Chatelier, the equilibrium ammonia content for a given temperature is increased by carrying out the reaction at an elevated pressure, the use of a pressure furnace for the synthesis of ammonia having been described for instance by Jost early in 1908.

We are, however, almost exclusively indebted to the pioneer work of Haber for the discovery of catalysts which become active at comparatively low temperatures and therefore under conditions such that the ammonia content of the reaction mixture is raised to values sufficiently high to render possible the commercial utilisation of the synthesis, while the subsequent development of his methods by the Badische Anilin und Soda Fabrik constitutes a most remarkable example of the introduction of modern physico-chemical methods into commercial life.

Despite the fact that no less than about one million tons of synthetic ammonium sulphate per annum is being manufactured by the Badische Anilin und Soda Fabrik in Oppau near Ludwigshafen, the published information regarding the process is extremely scanty. For this reason it may perhaps be of interest to give some description of the work undertaken and results obtained by my own Company towards the establishment of a technically sound foundation for a synthetic ammonia industry in Great Britain.

The first step in the industrial synthesis consists in the choice and adoption of suitable methods for the manufacture of nitrogen and hydrogen. The formation of ammonia is extremely sensitive to the presence of even minute traces of inhibitive substances, and it is therefore absolutely essential for the success of the reaction that these component gases be obtained not only as economically as possible but also in a state of practically absolute purity and above all free from catalyst poisons of every nature. While methods exist for the direct production of a nitrogen-hydrogen mixture, these

in general tend to give a gas containing an appreciable quantity of catalytically poisonous carbon monoxide, and for this reason we find that it is not only simpler but also more satisfactory from an economic standpoint to manufacture our gases separately and to mix them in the proper proportions as and when required.

The most economical method for the manufacture of pure nitrogen is undoubtedly that of low temperature separation from air. We utilise for this purpose the Pictet process, according to which air, cooled by exchange and by other means down to, but not below, its liquefying point, is injected, in the gaseous condition and at a pressure approximately equal to atmospheric, into a separating column (see Fig. 1) over the plates of which a descending current of liquid nitrogen is allowed to flow. This liquid nitrogen exerts an analysing influence on the air to be separated, in that it permits the passage upwards, as a gas, of the nitrogen of the air, while atmospheric oxygen is condensed by the current of liquid nitrogen and flows as a liquid nitrogen-oxygen mixture into the lower part of the column, where it undergoes continuous fractionation in such a way that it reaches the reservoir at the bottom of the separating column as liquid oxygen practically free from nitrogen. It will thus be seen that, in the process which we employ, only one-fifth of the air to be separated is liquefied, the nitrogen being kept in a gaseous condition during the separation and only a small fraction being subsequently liquefied in order to maintain the flow of liquid nitrogen, necessary for separation, over the plates of the column.

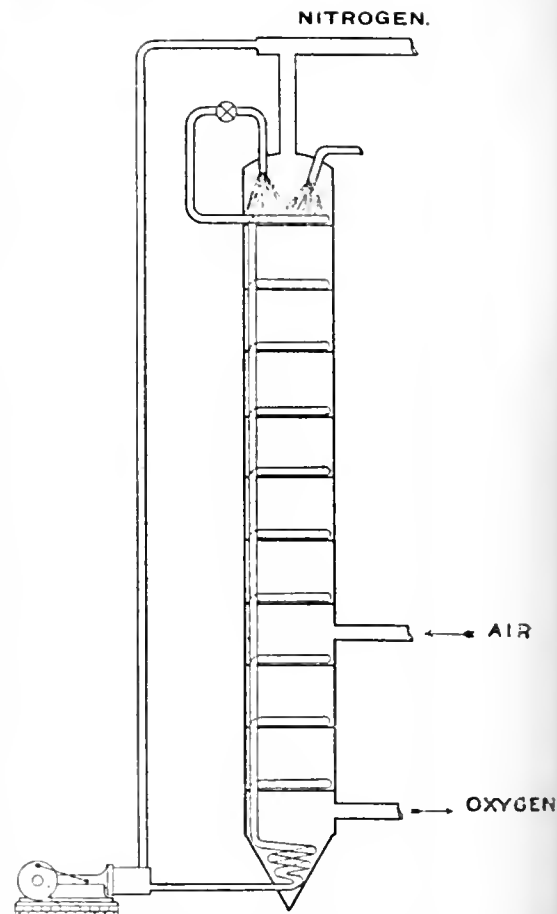
This subsequent liquefaction of a small proportion of the nitrogen produced is carried out in two ways, namely, in the first place by slight compression in closed coils contained in the oxygen reservoir and on the plates of the column, a suitable pressure for liquefaction being obtained by the use of a small compressing system, of such a nature that the pressure in the various coils can be adjusted to correspond with the temperature obtaining in the particular portion of the column in which the coil in question is situated. Thus a coil at the top of the column where the temperature is -196°C . would require only a very slightly increased pressure to induce liquefaction of the nitrogen contained therein, while a coil in the oxygen reservoir at the bottom of the column, at a temperature of -182°C . must be supplied with nitrogen at a pressure of several atmospheres, the latent heat of liquefaction in the coils supplying the heat by means of which the mixture on the lower plates of the column is fractionated.

Losses of cold due to radiation and imperfections of exchange are compensated by the liquefaction by expansion of a further quantity of nitrogen, this forming the second source of the separating liquid referred to above.

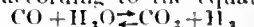
The system described has been installed on a scale giving 400 cubic metres of nitrogen and 100 cubic metres of oxygen per hour and has proved extremely satisfactory both from the point of view of the purity of the gases produced and by reason of the abnormally low power required for operation as compared with other systems.

Passing from the manufacture of nitrogen to that of hydrogen, it will be seen as the result of even superficial calculation that the cost and purity of hydrogen constitute the key to an economical synthesis of ammonia.

Rejecting electrolytic hydrogen on account of its high cost, there exist various methods of preparing hydrogen in a more or less pure condition from water gas. By the so-called continuous method, water gas and steam are passed together over a catalyst, consisting usually of activated iron oxide, when by the interaction of the carbon



monoxide of the water gas with the steam, the carbon monoxide is replaced by an equal volume of hydrogen according to the equation:—



The carbon dioxide thus produced is absorbed by compression on to water, hydrogen sulphide and other impurities being removed by iron oxide purifiers of the usual type. It is found in practice, however, that the above reaction is never complete, however great the excess of steam, and that the hydrogen produced contains considerable quantities of carbon monoxide, which is of course not absorbed by the ordinary purifiers. This may be eliminated by treatment with calcium carbide, or by compression on to heated soda lime with the formation of formates.

The same objectionable presence of carbon monoxide occurs in hydrogen prepared by the low temperature separation of water gas, by reason of the very appreciable vapour pressure of carbon monoxide even at temperatures approaching its solidifying point.

Carbon monoxide occurs also in hydrogen manufactured from water gas by the intermittent process, i.e., by the alternate steaming and reduction of iron. It is found in this method of hydrogen production owing to the instability of carbon monoxide at high temperatures, which decomposes according to the equation, $2\text{CO} \rightleftharpoons \text{CO}_2 + \text{C}$. The carbon produced is deposited on the iron contact mass during the reducing phase and reacts with the steam subsequently introduced, with the reformation of carbon monoxide during the steaming operation, this carbon monoxide contaminating the hydrogen. $\text{C} + \text{H}_2\text{O} = \text{CO} + \text{H}_2$.

We find, however, that the intermittent method, which in its usual form gives hydrogen containing from 1 to 2% of carbon monoxide, may be modified in such a way as to give hydrogen of the high purity of electrolytic hydrogen, the cost remaining approximately the same as for the ordinary impure water gas hydrogen, by utilising for reduction, instead of water gas, a gas containing sufficient carbon dioxide to prevent the separation of carbon according to the above equation. This reducing gas is obtained easily and cheaply by a modification in the method of manufacturing the water gas.

We obtain in this way hydrogen completely free from carbon monoxide and containing as its sole impurity only a little nitrogen, while by suitable modifications of the method of manufacturing even this nitrogen content may be brought down in such a way that hydrogen of 99.9% purity and even higher is produced directly from water gas without any subsequent purification save that afforded by an iron oxide-line purifying box of the usual type. This complete elimination of nitrogen is, however, of course not necessary for ammonia, but is desirable where the hydrogen is to be used for other purposes, for instance for the hardening of fats.

The following typical analyses illustrate the purity of the hydrogen produced by our process, sample 1 being manufactured without special precautions against nitrogen content, sample 2 with such precautions.

Sample 1. Sample 2.

	%	%
Hydrogen	99.81	99.94
Carbon monoxide	0.00	0.00
Carbon dioxide	0.00	0.00
Nitrogen	0.19	0.06
	100.00	100.00

For the synthesis of ammonia itself, nitrogen and hydrogen, mixed in the proportions required, are compressed to a high pressure in order to increase the equilibrium value for ammonia at the temperature at which the catalyst becomes active, this pressure having as its second effect a very considerable increase in the reaction velocity of ammonia formation.

Since the power required for the compression of a gas from a pressure, P_1 to a second pressure, P_2 , is given by the equation,

$$W = k \log \frac{P_2}{P_1}$$

while the equilibrium ammonia content for a given temperature varies approximately directly as the pressure, it follows that from the point of view of compression economy it is advantageous to work at as high a pressure as is compatible with the strength of materials and smoothness of operation. It is not, however, possible in practice to work at a much higher pressure than 200 atmospheres, and we find 180 atmospheres to be a very suitable working pressure. The very considerable increase in reaction velocity at increased pressure is, further, an additional reason for the use of as high a working pressure as possible.

The catalysts which are available for the promotion of the synthesis, neglecting rare metals of the platinum group, consist of uranium and iron. Uranium, while capable of giving decidedly higher yields of ammonia per passage than iron, possesses the drawback of being only prepared and regenerated with difficulty and of being rapidly rendered inactive by traces of water or of air in the reaction gases.

For this reason we find it preferable to employ, as is done in Germany, iron containing traces of other bodies as promoters, taking advantage especially of the cumulative action of two or even more promoters combined simultaneously in the catalyst.

In view of the lack of published results as to the actual percentage of ammonia obtained in practice from iron catalysts, the following typical figures for the relation between the time of contact of the nitrogen-hydrogen mixture with the catalyst and the ammonia percentage for an iron-potash catalyst may perhaps be of interest. The third column gives the yield of ammonia in kilos, per hour per cubic foot of catalyst space, provided that the ammonia formed is totally removed in the course of circulation, a condition which may be very nearly approached by employing a refrigerator almost at the solidifying point of ammonia ($-77^\circ\text{C}.$) with a rate of circulation such that the ammonia percentage in the gas is not too low. The temperature in this case was, as is usual, not uniform throughout the catalyst column, but varied from about $650^\circ\text{C}.$ at the beginning of the column to about $600^\circ\text{C}.$ at its end.

Time of contact with catalyst.	Ammonia in gas, %.	Yield of ammonia in kilos, per hour per cub. ft. of catalyst space.
13 secs.	0.8	6.46
26 "	1.4	3.03
66 "	2.7	2.33
105 "	3.1	1.78
18 mins.	3.7	0.89

The most economical rate of working in practice will, from the point of view of power, not necessarily be that at which the highest yield of ammonia per hour is obtained, but will be modified by the efficiency of the heat and cold interchangers and by the completeness of the elimination in the refrigerator of the ammonia formed.

Since the method employed for the complete conversion of the compressed hydrogen-nitrogen mixture into ammonia consists in passing it alternately over the heated catalyst and through this refrigerating system respectively, with alternate formation of a certain percentage of ammonia and its removal in a liquid condition, the cost of operating the process, starting with the compressed gases, consists therefore of the supply of and abstraction of sufficient heat to compensate for radiation and for the deficiencies of the heat and cold exchangers, the efficiency of the heat exchanger being very considerably increased by the by no means negligible heat of formation of ammonia itself. For the economic efficiency of the process too great care cannot therefore be paid to the construction of the exchangers connected with the heated reaction vessel and with the refrigerator respectively.

The maximum temperature which can be employed in the refrigerator is determined by the ammonia content of the gas to be separated, and by the pressure at which the synthesis is being carried out, it being necessary, since the first portions of the ammonia are formed more rapidly than successive increments, to effect as complete as possible a removal of all ammonia formed before re-passing the residual gases through the catalyst column. The following table gives the percentage of ammonia theoretically left in a gas at 150 and 200 atmospheres respectively after passing through a refrigerator at the temperature shown.

Temperature.	150 atm.	200 atm.
$^\circ\text{C}.$	%	%
0	2.7	2.1
-10	1.9	1.4
-20	1.2	0.9
-30	0.76	0.57
-40	0.47	0.35
-50	0.25	0.19
-60	0.13	0.1

The construction of the ammonia retorts presents considerable difficulty not only on account of the high pressure, together with a temperature approaching a red heat, but especially by reason of the rapid deterioration of the wall of the vessel under the influence of the ammonia mixture at elevated temperatures. In order to reduce this undesirable effect to a minimum the reaction vessel may be constructed of a material as resistant as possible to the action of ammonia and surrounded by a nitrogen jacket at the same pressure as that to which the nitrogen-hydrogen mixture in the catalyst chamber is subjected, the whole being surrounded by a wall capable of resisting the pressure, or other precautions must be taken so that the wall which bears the pressure does not become weakened. The manner in which a retort bursts, when this undesirable accident occurs, is a matter of considerable interest to the operator. A burst (as distinguished from an explosion due to admixture of air) results, as far as our experience goes, in a clean split, unaccompanied by fragments. We, nevertheless, take every precaution against accidents, especially with full sized retorts, by placing the reaction vessels in pits preferably out of doors.

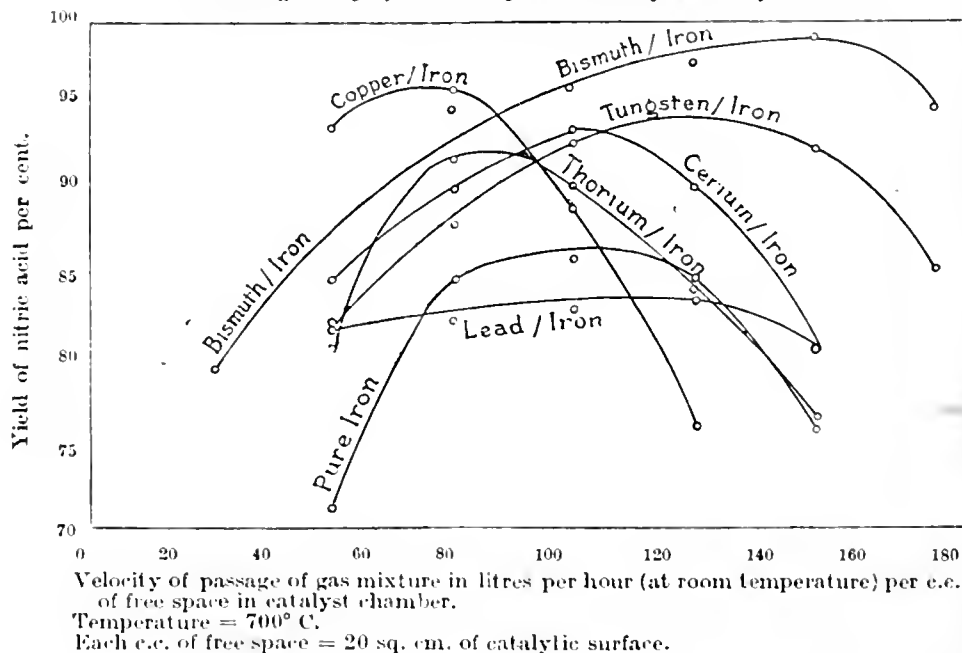
plant until a mixture results containing oxygen in proportion sufficient for explosion. We ourselves have given very considerable attention to the subject of the most suitable methods of heating, and are adopting a system which seems to combine simplicity of working with a high degree of safety.

Passing to a short consideration of the economic side of the process, the cost per ton of synthetic ammonia may be summarised from a point of view of energy in the statement that about 5½ tons of fuel suffices both for the production of the necessary hydrogen, and for the generation of the power required for nitrogen production, for compression, circulation, refrigeration, etc. The labour factor in the process is small, but on account of the comparatively high initial cost of the plant, the dead charges per ton of ammonia work out at rather a high figure. The cost of synthetic ammonia under normal conditions in this country should work out at about £10 to £12 per ton.

The synthetic ammonia, when produced, has for the majority of uses to be fixed as an ammonium salt by means of a suitable acid, or it may be oxidised to nitric acid, which may itself, if required, be used for ammonia fixation. It is at present usual to fix ammonia as the sulphate, either by

OXIDATION OF AMMONIA.

Relative efficiency of iron catalysts containing various promoters.



The choice and adoption of a suitable method of heating is by no means easy. Electric heating presents drawbacks in practice, some of which are not apparent on theoretical grounds and for this reason a system of heating has been adopted in Germany according to which air is injected into the catalyst chamber in such a way that the requisite reaction temperature is reached and maintained by internal instead of external combustion. The method possesses the advantage of making possible the use of retorts which are simple in construction, but is, on the other hand, somewhat liable to give rise to explosions owing to incomplete combustion of the comparatively small amount of air necessary to maintain the temperature, this air, if not burnt, by reason of a too low temperature in the retorts or for other reasons, accumulating throughout the entire

direct neutralisation or by interaction with other sulphates, such as calcium sulphate, without the use of free sulphuric acid.

Ammonium nitrate possesses certain advantages by reason of its high nitrogen content and particularly because no extraneous acid is necessary for its manufacture. It is, however, deliquescent and for this reason cannot be transported in sacks.

The oxidation of ammonia to nitric acid in presence of platinum was discovered by Kühnmann as long ago as 1830. The process has, however, only become of technical importance since its development by Ostwald, who in 1902 proposed as a catalyst compact platinum covered with platinum black, the ammonia and air being led over the catalyst with a high velocity in order to minimise decomposition of the oxides of nitrogen formed by the oxidation.

The process, as carried out at the present day, takes three forms :—

1. Oxidation by means of a platinum plug (Ostwald's process).

2. Oxidation by means of an electrically heated platinum net.

3. Oxidation by means of base metal catalysts. According to the Ostwald process a mixture of air and ammonia is passed along a heat inter-changer at the end of which a platinum plug is situated. The yield is good, averaging 90% or even higher, but the regulation of temperature is not so easy as in the second type of platinum plant in which electrical heating is employed. The main Ostwald patent has now expired. The use of an electrically heated net of compact platinum is finding increasing favour and presents many advantages over plant of the Ostwald regenerative type.

It may be preferable at this stage, instead of discussing the various more or less well-established plants employing platinum, to illustrate briefly the results which are obtainable with base metal catalysts taking, as typical examples of these, catalysts consisting of iron containing various promoters, and considering for the present only binary mixtures. The present war restrictions prevent a full description being given of the exact plant and conditions used for the oxidation, but the results about to be described show most decidedly that satisfactory results may be obtained without the use of platinum. We employ for the oxidation of ammonia not only air but also air enriched with the oxygen obtained as a waste product from our nitrogen plant, or even pure oxygen, the slightly increased cost of materials being more than compensated by greatly increased output and by other even more important factors.

The activating influence on iron of certain bodies such as bismuth or copper was well known at the time we began working in this direction, and the results obtained during preliminary tests with known catalysts amply justified a systematic study of the activation of iron for the oxidation of ammonia. Thus ammonia, mixed with ten volumes of air (containing sufficient oxygen for complete oxidation) gave in a preliminary experiment a yield of nitric acid equal to 90% of the theoretical.

The following typical results were obtained at 700° C., the ammonia being supplied with an amount of oxygen sufficient but not in excess of that required for its complete oxidation to nitric acid :—

Catalyst.	Time of contact in seconds.	Yield of nitric acid %.
Iron	0.03	71.0
"	0.02	82.5
"	0.015	83.5
"	0.012	82.5
"	0.01	75.0
Iron-thorium	0.03	79.0
"	0.02	88.5
"	0.015	87.3
"	0.012	82.0
"	0.01	75.6
Iron-cerium	0.03	82.5
"	0.02	87.0
"	0.015	90.0
"	0.012	87.0
"	0.01	79.0
Iron-bismuth	0.06	78.0
"	0.02	90.0
"	0.015	92.0
"	0.012	93.4
"	0.01	94.6
"	0.0086	91.0

Catalyst	Time of contact in seconds.	Yield of nitric acid %.
Iron-tungsten	0.03	80.3
"	0.02	85.2
"	0.015	89.3
"	0.012	89.0
"	0.01	89.0
"	0.0086	83.0
Iron-copper	0.03	90.0
"	0.02	92.0
"	0.015	86.0
"	0.012	75.0
"	0.01	68.0
Iron-lead	0.03	80.0
"	0.02	89.4
"	0.015	81.0
"	0.012	81.4
"	0.01	81.8
"	0.0086	79.0
Iron-antimony	0.03	80.5
"	0.02	82.0
"	0.015	82.5
"	0.012	78.8
"	0.01	75.0
Iron-potassium	0.03	75.0
"	0.02	81.0
"	0.015	83.0
"	0.012	82.0
"	0.01	77.1
Iron-uranium	0.03	77.5
"	0.02	81.0
"	0.015	82.0
"	0.012	78.5
"	0.01	77.0
Iron-calcium	0.03	36.0
"	0.02	58.0
"	0.015	64.0
"	0.012	63.0
"	0.01	57.0
Iron-zinc	0.06	51.0
"	0.03	62.0
"	0.02	67.0
"	0.015	60.0
"	0.012	37.0
Iron-manganese	0.03	51.0
"	0.02	65.0
"	0.015	75.0
"	0.012	79.0
"	0.01	76.0
"	0.0086	69.0

It will be seen on referring to the curves that the efficiency of pure iron for the oxidation of ammonia is very appreciably raised by the addition of cerium, thorium, bismuth, tungsten, or copper, the time of contact necessary for the maximum yield of nitric acid varying, as would be expected from the complicated nature of the reaction, with the particular promoter used. Thus this optimum time of contact is, for the conditions employed, about 0.01 second for bismuth-iron, 0.015 second for cerium-iron, and 0.02 second for iron-thorium. Lead exerts a curious flattening influence on the curve, the yield of nitric acid being almost independent of the time of contact.

Antimony, from its relation to bismuth, might have been expected to exert a similarly high activating effect. On testing this, however, transitory high results were obtained (91% yield with a time of contact of 0.02 second) but probably owing to the volatilisation of antimony oxide from the seat of reaction, a curve was obtained, after running for some time, more or less agreeing with that for pure iron.

The alkali metals as typified by potassium hydroxide appear to have little effect on the activity of iron, while calcium was found to depress very considerably the maximum yield of nitric acid, the same effect being obtained with zinc and with manganese.

Passing to a consideration of the economic side of the manufacture of nitric acid by the oxidation of ammonia, it will at once be seen that by virtue

of the high speed of passage of the reaction gases over the catalyst, a relatively small catalyst chamber will suffice for the oxidation of a comparatively large amount of ammonia per hour, and that secondly, since practically no power is required for the operation, the actual conversion costs, exclusive of that of the materials necessary, will be low. The power required for the production of one ton of nitric acid from ammonia should not exceed 0.015 kilowatt-year, exclusive of the cost of condensation and of concentration, a process which we are carrying out economically without the use of sulphuric acid.

Finally it may be of interest to compare, from a point of view of power, the relative efficiencies of the three most important methods for the fixation of atmospheric nitrogen, namely, the arc process, the cyanamide process, and the direct synthesis of ammonia from its elements.

In making such comparison it will be seen that in the arc process electrical energy alone is involved, while for the direct synthesis of ammonia a mixed requirement of coke (for hydrogen production, steam generation, etc.) and of power (for compression, etc.) is involved. Thus in order to obtain comparative figures it is necessary to translate the coke and other fuel required per ton of fixed nitrogen into units of power. The power equivalent of one ton of coke or coal is the number of units of electrical power which that ton of fuel would be capable of producing if it were utilised for that purpose under efficient conditions. This may be taken at 1500—1600 kilowatt-hours or 0.18 kilowatt-year.

By the arc process one kilowatt-year of power will produce about 600 kilos. of nitric acid or 130 kilos. of fixed nitrogen. For the production of one ton of fixed nitrogen (as cyanamide) by the carbide-cyanamide method, about two kilowatt-years of power plus 3—3½ tons of coal and other fuel are required, making a total power (converting coal into kilowatt-years as above) of 2.6 kilowatt-years per ton of fixed nitrogen. In other words one kilowatt-year by the cyanamide process will fix 380 kilos. of nitrogen as compared with 130 kilos. by the arc process.

Turning to the power required for the direct synthesis of ammonia, 6½—7 tons of fuel (coke and coal) are required for the generation of the necessary hydrogen and for the production of all power required for the fixation of one ton of nitrogen as ammonia, including the separation of the nitrogen itself from the atmosphere. Converting fuel into power, as before, about 1.2 kilowatt-years are required for the fixation of one ton of nitrogen by direct synthesis of ammonia. Thus one kilowatt-year will fix about 830 kilos. of nitrogen, compared with 380 by the cyanamide method and 130 by the arc process. These figures mean that from the point of view of power and material the direct synthesis of ammonia is more than twice as efficient as the cyanamide process, and more than six times as efficient as the arc process.

These striking results are modified slightly by the difficulty in operating the direct synthesis and by the cost of labour, which is lighter than for cyanamide, together with the necessary dead charges, which are heavier. The direct synthesis of ammonia, however, accompanied where necessary by its subsequent oxidation to nitric acid, presents by far the most economical method of fixing nitrogen at present known, and if only by virtue of the urgent need of the land for cheap, abundant, and non-seaborne fertilisers, deserves every attention from a standpoint of national economy.

DISCUSSION.

Mr. MORLEY remarked that many statements had appeared recently about the danger of

explosion in connection with the Haber process, and he asked if it was possible to make a practical apparatus which would reduce this danger to a minimum. Whilst it was known that the process was practicable on a small scale, with retorts of a capacity of 300 or 400 c.c., he wished to know what was the largest size of retort which could be made commercially.

Mr. MASON asked whether, if it were possible to get cheap power, electrolytic hydrogen would be a possibility.

Mr. WEBB asked whether Dr. Maxted adopted the ordinary system of absorption by means of the water towers, or whether an alkali separation or some other system was used.

Dr. MAXTED, in reply, said the danger of an explosion as distinguished from a burst could be avoided. The Germans were making ammonia to the extent of a million tons a year by the process. With regard to electrolytic hydrogen, he pointed out that most gases which would generate power would generate hydrogen, and it would be more economical to use them in the latter way. His firm was not using the usual absorption methods.

THE CHEMISTRY OF VULCANISATION.

BY D. F. TWISS, D.S.C., F.I.C.

Introductory.

Although the hydrocarbon nature of rubber was realised before the discovery of the process of vulcanisation, analysis in approximate agreement with the empirical formula C_5H_8 having been made as early as 1822,¹ the careful examination of purified rubber, both from the point of view of composition and of chemical behaviour, was not taken in hand until years after vulcanisation had become an important technical process. Possibly to some extent because of this delay, but also very largely on account of the difficulties of accurate chemical investigation with a non-crystalline substance which is obtained chemically pure only with exceedingly great difficulty and is affected in a remarkable degree by mechanical treatment, there remain yet many points in connection with the rubber industry of which the scientific interpretations are contradictory, vague, or based on quite insufficient evidence. Nevertheless, more especially during the last ten years, extraordinary advances have been made in the chemistry of rubber.

As was first clearly demonstrated by Gladstone and Hilbert² the unsaturation of the caoutchouc molecule is such that two atoms of chlorine or bromine may be added for each C_5H_8 group present, any further introduction of halogen occurring only by displacement of hydrogen. More definite information as to the intra-molecular structure of rubber was supplied by the investigations of Harries. As a result of these and other researches the caoutchouc molecule is to-day regarded as composed of a succession of $-CH_2-C(CH_3):CH-CH_2-$ groups linked together into a ring of uncertain dimensions.³ This constitution is in good accord with the possibility of the polymerisation⁴ of isoprene, $CH_2:C(CH_3).CH:CH_2$ ⁵ to caoutchouc, the movement of the double bond being commonly observed in a conjugated system of ethylenic linkings $-C=C-C-$ on the addition of a univalent atom or group at the first and fourth carbon atoms.⁶

As would be expected of an unsaturated hydrocarbon (C_5H_8), containing an ethylenic linking in each C_5H_8 group, caoutchouc forms additive compounds with many of the reagents for olefinic substances, e.g., with the halogens⁷, the halogen hydracids⁸, "nitrogen trioxide"⁹, nitrogen dioxide¹⁰, ozone¹¹, and chromyl chloride¹².

It is at first sight almost surprising that until recently so few of the reagents for olefinic compounds

have been even tentatively suggested as agents for vulcanisation. The use of chlorine, bromine, iodine, and aqueous hypochlorous acid was suggested fairly early for this purpose¹³, whilst in more recent years, benzoyl peroxide, which might be expected to react additively at a double bond as its parent compound hydrogen peroxide is known to do, and various aromatic nitro- and polynitro-compounds, which are known as a class to form additive compounds with olefinic substances¹⁵, have been stated to convert rubber into a condition resembling vulcanised rubber¹⁶. The resemblance, however, is so remote that no serious hope can at present be entertained for a successful application of these substances to technical vulcanisation, although the result is certainly of interest, as showing that such reagents can produce a change in the physical characteristics of raw rubber.

The general chemical behaviour of caoutchouc would lead to the expectation that this substance would react fairly readily with sulphur chloride and also with sulphur, the former of which has for many years been known to yield additive compounds e.g., $(C_5H_7)_2S_2Cl_2$, with olefines¹⁷. As is well known, the technical vulcanisation of rubber is invariably effected by one or other of these substances. Additional ingredients may be and commonly are added to the rubber in order to ensure desired physical characteristics such as colour, definite specific gravity, coarseness, strength, or even (in the case of vulcanisation with sulphur) increased rate of vulcanisation, but the vulcanising effect itself is produced by sulphur or sulphur chloride. At a casual glance it is sometimes possible to overlook the presence of sulphur in some published rubber mixings on account of its introduction in "antimony sulphide" or "black hypo" containing a considerable proportion of free sulphur or as some proprietary "vulcanising compound" such as an intimate mixture of sulphur and wax.

Cold vulcanisation.

Vulcanisation by means of sulphur chloride is effected at or near the ordinary temperature and is restricted to thin rubber material. The material is dipped into a solution of sulphur chloride in some suitable inert solvent or is exposed to the vapour of such a solution. Parkes, who discovered the method in 1846, used a solution in carbon bisulphide.

Various investigators have submitted this process of "cold vulcanisation" or "cold cure" to scrutiny. An obvious difficulty in the way of accurate interpretation is the fact that cold vulcanising as technically practised is largely restricted to the surface layers and is not uniform in effect at various distances below the surface of the rubber. In consequence of this, the research methods employed have in some cases necessarily deviated somewhat from the technical conditions, the most definite results having been obtained from the action of excess of sulphur chloride on purified rubber in solution in benzene¹⁸, when, whatever the excess of sulphur chloride applied, the product approximated to the composition $(C_{10}H_{16})_2S_4Cl_2$, which is analogous to that of the additive compound derived from sulphur chloride and the simple olefines, such as ethylene itself (see above). In view of the complications likely to arise from the presence of organic impurities natural to raw rubber and from the liability of sulphur chloride to vary in composition and to be affected by even slight traces of moisture which may cause the formation of insoluble sulphur (see later), the rather divergent results of earlier investigators¹⁹ are not surprising. There can be no reasonable doubt that the action of sulphur chloride on rubber in cold vulcanisation is definitely chemical and that the final product is a compound of the composition just stated. As to what may happen to the general mass of rubber when in technical practice a piece of rubber sheet

is allowed to combine with a quantity of sulphur chloride quite insufficient to convert it wholly into the final additive product, is largely a matter of speculation which receives further mention below.

Heat vulcanisation.

The discovery of the great improvement in the mechanical properties of rubber induced by mixing with sulphur and submitting to a temperature between 135° and 160° C. (Goodyear, 1839) or by dipping thin rubber articles into molten sulphur (Hancock, 1843) preceded Parkes' discovery of cold vulcanisation, but although the process of "heat vulcanisation" or "heat cure" is more general, its phenomena are even more complex and obscure.

That the chemical process in heat vulcanisation is purely additive was clearly demonstrated by Weber²⁰ who was also able to show that the limit of vulcanisation is reached when the proportions of rubber and combined sulphur approximate to the formula $C_{10}H_{16}S_4$, an observation which has received definite confirmation from the results of several other investigators²¹. Weber's views as to the formation of definite intermediate compounds, based on the assumptions that 2% forms a minimum proportion of sulphur for a satisfactorily vulcanised soft rubber and that certain discontinuities in his curve showing the percentage of combined sulphur plotted against the period of vulcanisation at constant temperature were of real significance, have, however, proved to be incorrect and due mainly to inaccuracies inherent to his experimental method. The course of the vulcanisation process under constant conditions is quite regular and smooth, the rate of combination of rubber and sulphur decreasing quite gradually as the amount of available free sulphur (and rubber) diminishes²².

Although the process of heat vulcanisation presents a more complex problem than that of cold vulcanisation, it lends itself much better than the latter to scientific investigation on account of the possibility of so selecting the temperature that the reaction proceeds with conveniently measurable velocity. The velocity of combination of sulphur and rubber is increased by raising the temperature, the temperature coefficient²³ of approximately 2.7 for 10° falling within the usual limits of the value for a chemical reaction.

The phenomena during the heat treatment of a mixture containing rubber and sulphur will obviously include physical changes such as the melting of the sulphur and the dissolution of the molten sulphur in the rubber; by the latter the sulphur will become more uniformly diffused throughout the rubber, whereas previously it was localised in solid particles²⁴. Indeed, in the Hancock process it is evident that the diffusion of the molten sulphur into the rubber must form an essential preliminary stage to vulcanisation beneath the surface. The melting and dissolving of the sulphur²⁵ have been followed under the microscope as also has the inverse crystallisation of the excessive dissolved sulphur²⁶, the latter, indeed, being well known in the so-called "blooming" or "sulphuring up" of heat vulcanised goods containing a considerable quantity of uncombined sulphur.

The adsorption theory.

With an additive chemical reaction between sulphur and a colloidal substance like rubber accompanied by a reversible solution process, the periodic recurrence of the suggestion that the vulcanisation process is not chemical but merely a physical adsorption phenomenon, is not surprising. In 1910, Wo. Ostwald²⁸ revived this theory with all the available favourable evidence, and his paper has caused the evidence to be sifted so thoroughly as entirely to dispose of the idea that vulcanisation can be a purely physical change. Ostwald's paper consisted of a review of the work of a few

earlier investigators with an explanatory commentary biased in favour of the adsorption theory. Most of the arguments, however, suffer under close examination²⁹ and have received severe criticism, especially by Loewen³⁰. Apart from accepting and applying to the purpose of his theory the peculiarities in Weber's experimental results which have since been proved to be due to mere inaccuracies and not to any corresponding abnormalities in the behaviour of the rubber-sulphur mixing²² Ostwald's claim that vulcanisation is reversible,* based on the earlier statement of Höhn, is not in accord with the present impossibility of reproducing "raw rubber" by the "regeneration" or "reclaiming" of vulcanised rubber (see later), whilst his calculation that the results of Hinrichsen and Stern³¹ and of Hübener³² on the combination of rubber and sulphur are in agreement with the adsorption formula $\frac{x}{a} = kc^n$

where x represents the quantity of sulphur absorbed, c the original concentration of the sulphur, and a the quantity of the adsorbent, whilst k and n , are constants, is vitiated by the fact that he has misunderstood the figures quoted by Hübener from Hinrichsen and Stern and has used for the calculation figures corresponding in reality with an equation $\frac{x}{a^2} = kc^n$. The

correct figures are not confirmatory of the view that the process is one of adsorption³⁰. In like manner, the statement that in vulcanisation the sulphur never passes entirely from the free condition has been proved incorrect³⁴, whilst the remarkable alteration in physical properties observed in the formation of vulcanite and the fact that vulcanised rubber yields a bromo-derivative³³ and a nitrosite³⁴ containing combined sulphur, are great obstacles in the way of the acceptance of the purely physical conception of vulcanisation. Ostwald's sweeping assertions with respect to the nature of vulcanisation have caused the chemists to establish their faith on a firm experimental basis, and have thereby served to strengthen the position of the chemical theory.

Other theories.

Various modifications of the chemical theory of vulcanisation have been suggested. Erdmann proposed the explanation that sulphur acts on rubber in a triatomic condition, which he describes as thiozone by analogy with ozone; this theory³⁵, however, lacks experimental confirmation and, in the light of our knowledge of the allotropic forms of sulphur, is improbable.

Although the occurrence of chemical reaction between rubber and sulphur during vulcanisation cannot well be denied, this change may not be exclusively chemical in nature, and endeavours, with much in their favour, have been made to represent vulcanisation as a combination of a chemical change with an adsorption process. The suggestion that the free sulphur is adsorbed before vulcanisation³⁶, appears unnecessary and is less attractive and less probable than that the chemical product of vulcanisation is adsorbed into the remaining rubber after its formation. Examination of various technical soft products vulcanised by the heat process shows that the amount of sulphur in combination with the rubber is variable³⁷, but almost without exception falls somewhere between the limits of 2% and 7% calculated on the rubber present. Bearing in mind that the only definite chemical product of heat vulcanisation is of the composition $C_{10}H_{16}S_2$ (see above) containing approximately 47% of

sulphur calculated on the rubber, it is obvious that technically vulcanised rubber represents no definite chemical compound but probably a solution or adsorption product of a more highly vulcanised product, possibly $C_{10}H_{16}S_2$, in an excess of very slightly vulcanised or sulphur-free rubber, the physical characteristics of the latter being modified by the presence of the adsorbed compounds³⁸. Ostromisslenski¹⁶, indeed, who regards his experimental results on the effect of aromatic nitro-compounds and of benzoyl peroxide as favouring such a view of vulcanisation, states that the vulcanisation of raw rubber can be effected by the addition of a small percentage of already formed caoutchouc hydrochloride or tetrabromide and subsequent heating, but his conception of a satisfactorily vulcanised rubber is rather wide. According to this view, vulcanisation in the sense of the acquisition of new physical properties by the general mass of the rubber, although not independent of the chemical combination of sulphur with part of the rubber, occurs subsequently to this combination and the small proportion of additive compound produced may be regarded as the direct vulcanising agent acting by "catalysis." The alteration in the main portion of the rubber, consequently, would be accompanied by no change in composition and must be ascribed to some alteration in the molecular condition which may be a polymerisation. Axelrod³⁹ had earlier propounded a somewhat similar theory involving the assumption that vulcanisation comprises two processes, one of which is the combination of sulphur and rubber. As is well known, heat tends to soften rubber whereas vulcanisation tends to produce the contrary effect. In Axelrod's explanation, the vulcanisation process depends on a primary softening, commonly described as "depolymerisation" or in a less committal manner as "de-aggregation"⁴⁰ of the rubber, followed by a "repolymerisation" under the influence of combination with sulphur⁴¹. Colour is given to this view by the fact that after the whole of the free sulphur has disappeared into chemical combination, further heating produces a weakening and softening effect; this indeed occurs to a greater or less extent in the "reclaiming" or "regeneration" of vulcanised rubber scrap by heating with acid or alkali, in which the material is again rendered sufficiently soft and tacky to be incorporated afresh as a diluent in rubber mixings⁴². Whether the so-called depolymerisation and repolymerisation as postulated in Axelrod's theory actually do occur alternately and repeatedly is not proven and it is possible that the two processes are independent and merely concurrent. The likelihood of modifications in the physical nature and molecular condition of rubber during vulcanisation is heightened by the results of Harries, who has shown not only that ordinary raw rubber behaves as if composed of three mutually interconvertible varieties⁴³, but also that in ordinary soft vulcanised rubber the major portion of the rubber is not in combination with sulphur although it possesses different physical and chemical characteristics from raw rubber³⁸. The very considerable change which occurs when a newly vulcanised rubber is allowed to "mature" indicates that the alteration in mechanical characteristics induced by vulcanisation may continue for a short time after the chemical change is complete⁴⁴.

This hypothesis of physical change as induced by the chemical action occurring in vulcanisation has been extended to the process of cold vulcanisation⁴⁵ in which the quantity of combined sulphur chloride is likewise quite insufficient to convert the rubber entirely into the final additive compound.

It should, however, be clearly realised that these views in no wise support the adsorption theory of Ostwald, whose claim was that no chemical com-

* For a reply to the alternative argument that an adsorption process need not be reversible, as instanced by the case of methyl violet and charcoal, see Hinrichsen, *Zeitsch. Chem. Ind. Koll.* 1911, 8, 245.

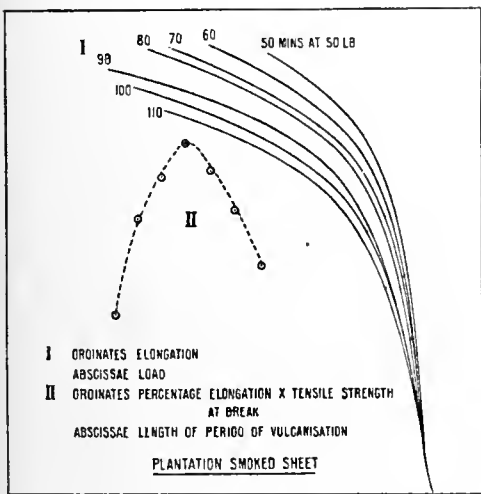
bination whatever occurred between the rubber and the sulphur, but that the latter was merely adsorbed by a purely physical process.

Rate of vulcanisation.

The rate of vulcanisation of rubber is of importance for two distinct reasons. It is desirable in works practice that the period necessary for satisfactory vulcanisation should not be too prolonged, but on the other hand, it is very important that the behaviour of various consignments of rubber should be as uniform as possible so as to permit a standardisation of procedure without need for constant re-adjustment.

Examination of the rate of cure may be made from two points of view, viz., by measurement of the resulting physical effect⁴⁶ and by determination of the extent to which sulphur enters into combination when a mixing of standard composition is given a definite "cure." With a series of samples of rubber both methods as a general rule give results which fall into the same order, but the physical method possesses an advantage in simultaneously giving an indication of the inherent mechanical value of the rubber. Investigation from both points of view concurrently is certainly most satisfactory.

In the former method a standard mixing, frequently sulphur 10: rubber 90, is adopted, and this is vulcanised for a series of gradually increasing periods at a constant temperature (e.g., in steam under 50 lb. pressure), after which the mechanical properties of strength and stretch of the samples are measured, and the period of vulcanisation necessary to produce optimum mechanical properties decided from the results (see curves 1 and 2).



The coefficient of vulcanisation, i.e.,
$$\frac{\text{combined sulphur} \times 100}{\text{rubber}}$$

corresponding with the optimum period generally has a value of about 5, but it is improbable that such a coefficient would prove the most satisfactory for all purposes⁴⁷. The results, however, are usually intended only for comparative purposes, and it is easy by their aid to detect a rubber of unusual quality either in mechanical strength or in rate of vulcanisation.

Natural accelerators.

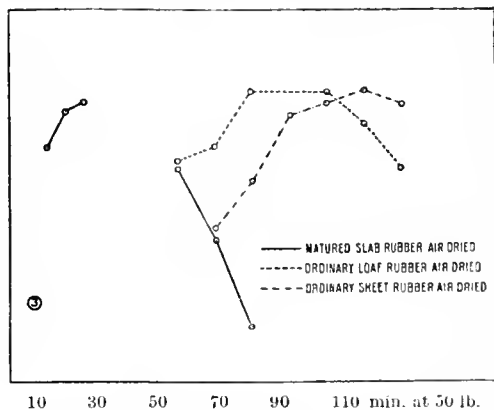
Rubber is not a pure hydrocarbon substance, but is contaminated with natural resins⁴⁸ and protein substances⁴⁹, and it has been found

that these foreign ingredients appreciably affect the rate of vulcanisation. If the resins⁵⁰ and more especially the protein matter⁵¹ be removed from the rubber the rate of vulcanisation is decreased in a marked manner, whereas if rubber is enriched in natural proteins by dissolving away part of the rubber hydrocarbon with benzene, the rate of vulcanisation of the protein-enriched rubber is enhanced. Possibly as an outcome of this discovery, the addition of a mixture of lime and albumin⁵² has been patented as a method for accelerating vulcanisation, but lime itself catalyses the vulcanisation process, and the increase in the rate of "cure" may not be due entirely to the albumin.

In the earlier days of the plantation rubber industry, considerable stress was laid on the variability in the rate of vulcanisation of "plantation Para" rubber as compared with the wild Para rubber. More recently, Eaton and Grantham, working in Malaya, have been able to discover the chief cause of this variability, and, indeed, to indicate the possibility of a step of great value in the production of raw rubber. In the ordinary plantation procedure, the rubber coagulum, obtained from the latex, is washed and creped with the intention of removing the serum as completely as possible; if, however, the soft slabs of coagulum are allowed to "mature" for several days before the retained serum is expressed, it is found that the resulting rubber vulcanises with unusual rapidity, the effect attaining its limit after a period of roughly seven days before washing and crepeing⁵². The rubber from such matured slabs when mixed with 10% of sulphur attains its optimum condition of vulcanisation in approximately one-third of the ordinary period.

Curves 3 and 4 show the behaviour of rubber prepared in this way as compared with the ordinary qualities of plantation rubber from the same estate; with the period of vulcanisation which gives the optimum results for the ordinary qualities, the special rubber is excessively over-vulcanised.

Tensile strength by percentage elongation.



The cause of this difference has been traced by Stevens⁵³, who has shown that during the maturing process, the protein matter of the retained serum undergoes decomposition with formation of organic bases which remain absorbed even after washing. Such bases are well known to possess considerable catalytic activity towards the heat vulcanisation of rubber (see later).

Although the difference in rate of vulcanisation as compared with rubber produced in the ordinary manner is less marked in technical mixings, the great advantage of a uniform supply of such rapidly vulcanising rubber for special purposes

will readily be recognised, and experiments as to the possibility of producing large quantities of rubber with a uniform high rate of vulcanisation will prove of great interest.

Inorganic accelerators.

Goodyear himself realised that the process of vulcanisation could be hastened by the inclusion of calcined magnesia in the rubber-sulphur mixing, and the use of this substance, as also of litharge and calcium hydroxide (and, to a less extent, of magnesium carbonate), has for many years been a recognised device of the manufacturer to shorten the period necessary for the vulcanisation of his mixings. Various suggestions have been made to explain the effect of these substances, but few bear critical examination; thus conversion into sulphide followed by alternate formation and

molecular proportions by independent chemical reactions as an essential part of the vulcanisation process, the facts that sulphurous acid and acid sulphites retard vulcanisation⁶⁰, and that colloidal sulphur does not give accelerated vulcanisation (see below) are diametrically opposed to this theory.

Apart from the above basic accelerators, the only inorganic accelerators which have been proposed are various metallic iodides, antimony iodide in particular⁶¹; in this case it is possible that the effect may have been due to the conjoint action of sulphur and iodine on the rubber; this method of acceleration appears never to have come into general practice.

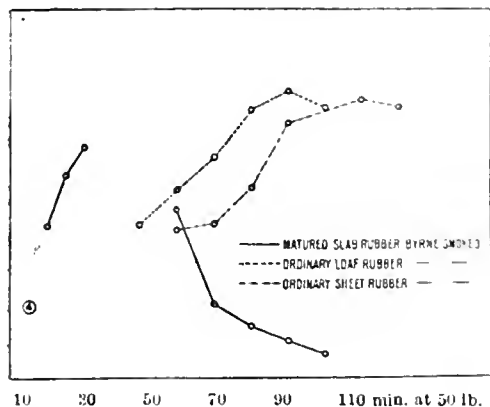
Organic accelerators.

In recent years a notable advance in the technique of heat vulcanisation has been the introduction of organic bases as accelerators. The first published statement as to the use of an accelerator of this type appears to have been in the patent specification protecting the application of the strongly alkaline base piperidine, $C_4H_{10}N$ ⁶²; a claim by Spence to priority⁶³ in the use of this and other organic accelerators is still awaiting promised details. After piperidine, the use of many organic amines was patented⁶⁴, a final claim covering the application of all organic bases of dissociation constant exceeding 1×10^{-4} . It is inconvenient to apply some of these bases in the free condition on account of their volatility, which may cause loss by evaporation or also may tend to produce porosity in the vulcanised rubber; this disadvantage may be obviated by previous conversion of the base into the corresponding carbamide⁶⁵, dithiocarbamate, carbamate, or carbonate derivative. Indeed, I have also found that the unstable base aminoguanidine forms an excellent accelerator when applied in the form of its more stable bicarbonate salt⁶⁶, whilst ammonium bicarbonate is also very effective.

One of the most powerful of these organic catalysts is aldehyde-ammonia, the effectiveness of which far outweighs what might be expected of its ammonia content, and must be regarded as a specific property of aldehyde-ammonia itself. Indeed, from the purely chemical point of view also, the behaviour of aldehyde-ammonia is somewhat abnormal, and although it must be regarded as a definite organic base its constitution is not settled beyond doubt⁶⁷.

It is a remarkable circumstance that almost the whole of the known effective* organic accelerators are basic, a rough proportionality apparently existing between their activity and their alkalinity, relatively feeble bases like aniline and methylaniline having little influence on the rate of vulcanisation. The mineral accelerators mentioned earlier are also alkaline or basic substances, and it appears highly probable that this is no mere coincidence but that the two classes of substances in common owe their influence in some way to their basic character. If this is really so, the alkali hydroxides should also be strong accelerators and experimental examination proves the correctness of this argument. For a long time it has been known that regenerated rubbers obtained by heating with alkali sometimes vulcanise with exceptional rapidity⁶⁸; Martin⁶⁹ also has demonstrated that the introduction of a small percentage of powdered caustic potash into a mixture of rubber and sulphur causes a greatly increased rate of vulcanisation, whilst Eaton more recently has shown that a similar effect is produced with rubber which when freshly coagulated has been soaked in

Tensile strength by percentage at break.



decomposition of polysulphides, by which process the sulphide acts as a "sulphur carrier"⁶⁴, is improbable, because the corresponding sulphides are less efficient than the oxides or hydroxides, whilst it is also unlikely that magnesium oxide is largely converted into sulphide during vulcanisation; even the accelerating effect attributed to antimony sulphide⁶⁵ is largely due to misconception arising out of the effect of the free sulphur commonly present in this material.

Litharge has been a favourite subject for speculation. Its effect has been attributed, at different times, to its aiding the conduction of heat into the rubber mass⁶⁶, and to the heat evolved by its oxidising action on the rubber resins or on the hydrogen sulphide arising from the interaction of the resins and sulphur⁶⁷. The rise of temperature due to such liberation of heat would cause a corresponding increase in the rate of reaction between sulphur and rubber, and it is probable that a thermal effect of this kind is produced by the direct or indirect action of the lead oxide on the sulphur⁶⁸; the occurrence of a thermal effect in litharge mixings can indeed be detected by direct measurement of the temperature of the mass during vulcanisation.

A highly fanciful explanation of the effect of litharge and other oxide accelerators has been proposed lately⁶⁹. The heating necessary for vulcanisation is assumed to cause the sulphur to attack the natural resinous matter and proteins and the litharge simultaneously, with formation of hydrogen sulphide and sulphur dioxide respectively. These two gases then react in the recognised manner, and the acceleration of the vulcanisation process is attributed to the exceptional activity of the amorphous sulphur thus produced. Apart from the improbability that two gaseous substances are formed in definite

* It is difficult to understand on what grounds certain substances have been described as accelerators: e.g., see a list of accelerators by King, *Metallurgical and Chemical Engineering*, 1916, 15, 231.

caustic alkali solution. The latter investigation, however, has since withdrawn his recommendation of this process ⁷⁰.

Several years ago, influenced by the fact that the inorganic and organic accelerators were all basic substances, I became of the opinion that both classes of substances exert their influence in a similar manner and that the relative advantage attaching to the use of organic bases depends chiefly, if not entirely, on the fact that these are soluble in rubber and therefore become more uniformly distributed and diffused, whereas the inorganic accelerators, being only sparingly soluble, remain for the most part localised in small solid particles, which, indeed, are frequently visible to the naked eye. For this reason I sought a suitable organic liquid which would dissolve in rubber and also would act as a solvent for an alkali hydroxide, because a solution of this kind would possess marked alkalinity and also would be capable of blending uniformly with rubber, thus reproducing the conditions which obtain when an organic accelerator is used, without any accompanying danger of porosity. The most suitable solvent discovered was glycerol which dissolves sodium hydroxide or potassium hydroxide, probably with formation of the corresponding glyceroxide ⁷¹. The latter alkali is more easily soluble and a solution containing approximately 25% on the total weight is easily obtained. If 1–2% of such a solution (anhydrous) is introduced into a rubber-sulphur mixing, the vulcanisation process is greatly accelerated, the effect being comparable with that of the strongest organic accelerators, as is demonstrated by the figures below. It is also noteworthy that the actual quantity of alkali used approximates closely to the 0.5% recommended for the most effective organic accelerators and that with a rubber-sulphur mixing the resulting vulcanised rubber, in both cases, possesses the same clear, dark, almost semi-transparent appearance.

In earlier experiments, I had endeavoured to effect the uniform distribution of the alkali into the rubber-sulphur mixing by introducing it in the form of a finely-powdered mixture of the alkali with lime, but although the results were certainly gratifying, they were less consistent than those obtained with the glycerol solution.

The following figures give the residual uncombined sulphur after a mixing of 95 rubber: 5 sulphur with the addition of the stated accelerator was vulcanised for 90 minutes at 40 lb. steam pressure:—

Accelerator.	% of Accelerator.	Residual free sulphur %.
(1)	—	3.60
(2) Potassium hydroxide in glycerol	2 (of solution 1:4 approx.)	0.31
(3) Sodium hydroxide in glycerol	2 (of solution 1:8 approx.)	0.61
(4) Anilinoquinidine	1	0.89
(5) Ammonium carbonate ..	1	1.39
(6) Aldehyde-ammonia	1	0.17
(7) <i>p</i> -Nitrosodimethylaniline	1	1.50

As will be observed from the above results, *p*-nitrosodimethylaniline ⁷² does not accelerate very strongly under the conditions chosen. This is due, at least in part, to the fact that the mixing selected contains a relatively low proportion of sulphur. The nitroso-compound is much more effective in mixings containing a high percentage of sulphur and it is probably because mixings containing litharge or antimony sulphide are usually intended to have a good colour and, therefore, in order to prevent excessive “blooming,” are generally prepared with a low percentage of free sulphur, that these have been found to behave less satisfactorily with the nitroso-compound (⁷³).

Mode of action of accelerators.

As the effect of accelerators in general is most distinct in mixings otherwise containing only rubber and sulphur, their action presumably must be by influence on one of the ingredients present, viz., (1) the natural protein and resinous matter, (2) the sulphur, or (3) the rubber hydrocarbon.

The first possibility is eliminated by the fact that the accelerators work equally well with rubber from which the protein matter has been removed, one of their first uses indeed being to render protein-free synthetic rubber capable of more rapid vulcanisation.

With respect to the possibility of acceleration as due to the influence of the catalyst on the sulphur, the suggestion has been made ⁷⁴ that with organic, as with inorganic accelerators, polysulphides are first formed which then effect the vulcanisation of the rubber. As has been explained already, this theory is not altogether satisfactory for the effect of the basic oxides generally.

A possibility which appears to have been previously overlooked, but which at first appeals to the imagination, involves the two allotropic forms of liquid sulphur. Molten sulphur consists of a mixture of mobile yellow *SA* with viscous deep brown *S_μ*, the exceptional behaviour of molten sulphur with alteration of temperature being due to variation of the relative proportions of these constituents ⁷⁵. When molten sulphur is cooled, the *SA* variety gives rise to ordinary soluble crystalline sulphur, whilst *S_μ* produces insoluble amorphous sulphur. In molten sulphur an equilibrium is slowly attained between these two forms, but the existence of *S_μ* is favoured by the presence of acids, whilst alkalis such as ammonia or doubtless organic bases, facilitate the conversion of *S_μ* into *SA*.

The remarkable parallel between this effect of acids and bases on the *SA* \rightleftharpoons *S_μ* equilibrium and that of acids and bases in respectively retarding and accelerating the vulcanisation process, naturally arouses a suspicion as to the existence of some connection between the two sets of phenomena. In order to test this possibility, insoluble amorphous sulphur corresponding with *S_μ* was separated from genuine flowers of sulphur by extraction of the soluble *SA* with carbon bisulphide. Comparative vulcanisation tests were then made with rubber-sulphur mixings employing this insoluble sulphur and ordinary totally soluble sulphur. Although my results actually indicated that *S_μ* combined with rubber rather more slowly than *SA* the difference was relatively slight and quite insufficient to account for the great effect of the organic basic accelerators.

Mixing.	Period of cure at 40 lb.	Residual free sulphur.
Rubber 100: soluble sulphur 10	120 minutes	8.39
Rubber 100: insoluble sulphur 10	120 „	8.81*

* This residual sulphur, after vulcanisation, is found to consist mainly of the more soluble modification.

Although this result disposes of the probability of any real connection underlying the parallel between the action of acids and alkalis in the *SA* \rightleftharpoons *S_μ* equilibrium and in the process of vulcanisation, it is of additional interest as also disposing of Dubosc's suggestion that the action of inorganic catalysts in vulcanisation depends on the production of amorphous sulphur for which he postulates exceptionally great vulcanising activity ⁵⁹.

The immediately preceding considerations to some extent narrow down the enquiry as to the mode of action of the basic accelerators. Either

the sulphur is influenced in some other way than those mentioned, or the effect must be produced on the rubber itself. On account of the colloidal nature of rubber and its obscure "depolymerisation" and "polymerisation," the investigation of the latter alternative is more difficult. Nevertheless, the knowledge that alkalis increase the stability of the independent rubber globules⁷⁶ in ordinary rubber latex and the observation that even coagulated and worked rubber retains traces of a globuloid condition⁷⁷, might be regarded as suggestive of a possibility that alkalis are likely to affect the behaviour of finished raw rubber, e.g., by influencing the inter-conversion of modifications in different states of molecular aggregation and of different reactivity. Such a possibility indeed, would be in accordance with C. O. Weber's observation⁷⁸ that when rubber is masticated with litharge only, in the absence of sulphur, the material undergoes a remarkable change in physical properties.

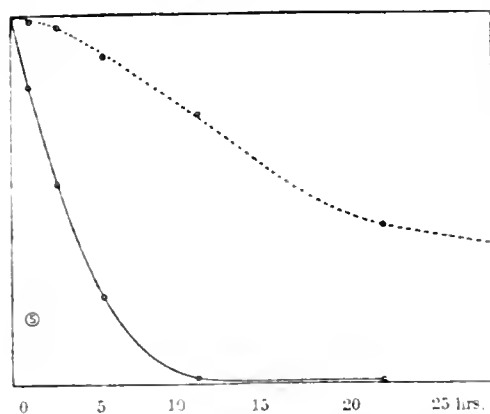
There is much more room for further investigation on the question of the chemical mechanism of the acceleration of vulcanisation.

Other considerations.

The existence of the above-mentioned soluble and insoluble modifications of sulphur is well worth bearing in mind in other directions. For instance, although it is generally accepted that the free sulphur in an ordinary rubber mixing can, for all practical purposes, be removed completely by continuous extraction for ten hours with acetone, the remaining sulphur being regarded as in combination with the rubber, the above unvulcanised mixing containing "insoluble" sulphur yielded only 27% of its sulphur in this period.

Comparative extractions were made with the two mixings containing respectively soluble and insoluble sulphur, by treating samples with acetone in a continuous extractor at the temperature of the boiling solvent; the rate of extraction is represented in the following curves.

Residual sulphur.



Any conclusions as to the reversibility of vulcanisation based on the possibility of removing sulphur from vulcanised rubber by prolonged extraction⁷⁹ even after as much as twenty hours' previous extraction, are, therefore, unjustified⁸⁰ unless definite proof is supplied as to the absence of "insoluble sulphur." It has also been stated by Bysow that in cold vulcanisation, sulphur and chlorine do not combine with the rubber in equivalent quantities⁸¹, but traces of moisture in the rubber would cause the decomposition of part of the sulphur chloride with formation of some insoluble sulphur and would account for the

apparently disproportionate quantity of "combined" sulphur.

The evidence for the supposed vulcanisation of a rubber-sulphur solution at the ordinary temperature by ultraviolet light⁸² is also unconvincing. From the observation that a rubber-sulphur solution in benzene, when exposed in a thin film to ultraviolet radiation, becomes more viscous and that after evaporation of the solvent, part of the sulphur is not removed by an ordinary ten-hour extraction with acetone, the conclusion has been drawn that the unextracted sulphur has combined with the rubber. However, ultraviolet light is already known to convert dissolved sulphur into insoluble sulphur⁸³ (or S_2 into S_8) and although the S_8 may not separate in visible particles it is quite likely to remain in ultra-microscopic colloidal suspension.* Ultraviolet light also, without the aid of sulphur can render rubber solution more viscous and improve the strength of thin rubber sheet⁸⁴.

The above alterations in the rubber-sulphur solution appear to be quite insufficient evidence of vulcanisation, and the observed changes, at least in part, may consist of independent physical changes in the rubber and sulphur respectively; indeed this possibility appears to receive some confirmation from Bernstein's doubts as to whether the sulphur in vulcanisation becomes chemically combined or merely physically adsorbed⁸⁵.

The preceding review of the chemistry of vulcanisation shows how great has been the activity in this direction, especially during recent years, but will also indicate how wide are the gaps of knowledge which at present are bridged over by mere theories and need to be filled up with a solid mass of experimental evidence.

Many of the results referred to in this paper as obtained by other investigators have been re-examined and confirmed.

For permission to publish the new results included, I am indebted to Dr. J. V. Worthington, Technical Superintendent and Director of the Dunlop Rubber Company, whilst for curves 1 to 4 and for many tests made in connection with points brought under consideration, I wish to express my indebtedness to Mr. A. W. T. Hyde, Head of the Physical Testing Laboratory of the same firm.

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* Colloidal solutions of lead sulphide in rubber solution have actually been described by Lewis and Waunsley, this J., 1912, 31, 518.

- 701, 1155. Weber, Z. angew. Chem., 1894, **7**, 112, 142; also Kirchhof, Z. Chem. Ind. Koll. 1914, **14**, 35.
- ⁶⁷ Weber, *op. cit.*, pp. 87, 91; Z. Chem. Ind. Kolloide, 1916, **1**, 33, 65.
- ⁶⁸ Hinrichsen and Kindscher, Gummi-Zeit., 1903, **18**, 251; Z. Chem. Ind. Kolloide, 1912, **11**, 191; Ber., 1913, **46**, 1291.
- ⁶⁹ Spence and Young, Z. Chem. Ind. Kolloide, 1912, **11**, 28, 1913, **13**, 265. See also Dittmar, Gummi-Zeit., 1906, **20**, 1026.
- ⁷⁰ Spence and Young, Chem-Zeit., 1912, **36**, 1162; Spence and Scott, Z. Chem. Ind. Koll., 1911, **8**, 305; Skellon, Rubber Ind., 1914, 172.
- ⁷¹ Spence and Young, Z. Chem. Ind. Koll., 1912, **11**, 28. See also Brown, Scient. Amer. Suppl., 1913, **75**, 397; Kratz, Indiarubber J., 1916, **51**, 661.
- ⁷² See, for instance, Skellon, Indiarubber J., 1913, **46**, 251.
- ⁷³ Loewen, Gummi-Zeit., 1913, **27**, 1301.
- ⁷⁴ Breuil, Compt. rend., 1903, **140**, 1142; Weber, *op. cit.*, p. 110.
- ⁷⁵ See, e.g., Höhn, Gummi-Zeit., 1899, **14**, 17, 33 (heat vulcanisation); also Bysow, Z. Chem. Ind. Koll., 1910, **6**, 281; **7**, 160 (cold vulcanisation).
- ⁷⁶ Ostwald, Z. Chem. Ind. Koll., 1910, **6**, 136; **7**, 45.
- ⁷⁷ For earlier arguments against the adsorption theory see Weber, Gummi-Zeit., 1899, **14**, 79, 99; Frank and Marckwald, *ibid.* 1903, **18**, 253; Axelrod, *ibid.* 1909, **24**, 352; and others.
- ⁷⁸ Loewen, Z. angew. Chem., 1912, **25**, 1553; also 1912, **25**, 1610, in reply to Spence and Scott's suggestion (Z. Chem. Ind. Koll., 1911, **8**, 304; **9**, 300) that adsorption of sulphur, as distinct from mere solution, precedes vulcanisation.
- ⁷⁹ Hinrichsen and Stern, Chem-Zeit., 1909, **33**, 756; Stern, Z. Elektrochem., 1909, **15**, 660.
- ⁸⁰ Hübener, Gummi-Zeit., 1909, **24**, 214.
- ⁸¹ Spence and Scott, Z. Chem. Ind. Koll., 1911, **8**, 304; Budde, Chem-Zeit., 1907, **31**, 1205; Hübener, *ibid.*, 1909, **33**, 144, 155, 648; Caspari, le Caoutchouc et la Gutta Percha, 1911, **8**, 5289; and others.
- ⁸² Alexander, Ber., 1905, **37**, 181.
- ⁸³ Erdmann, Annalen, 1908, **362**, 133, 169.
- ⁸⁴ Hinrichsen, Z. Elektrochem., 1912, **18**, 530; Harries, Fer., 1916, **49**, 1196.
- ⁸⁵ See, for example, Schidrowitz and Kaye, this J., 1907, **26**, 126; Beadle and Stevens, this J., 1908, **28**, 1213.
- ⁸⁶ Harries, *loc. cit.* Harries and Fournet, Ber., 1916, **49**, 1390.
- ⁸⁷ Axelrod, Gummi-Zeit., 1909, **24**, 352.
- ⁸⁸ Gaunt, this J., 1914, **33**, 446.
- ⁸⁹ See also Bernstein, Rubber Ind., 1914, 164.
- ⁹⁰ For instance see Alexander, Gummi-Zeit., 1907, **21**, 708; Weber, Indiarubber J., 1902, **24**, 365.
- ⁹¹ Harries, Gummi-Zeit., 1910, **24**, 850; Annalen, 1911, **383**, 157.
- ⁹² de Vries, Indiarubber J., 1917, **53**, 101; Stevens, this J., 1916, **35**, 872.
- ⁹³ Kirchhof, Z. Chem. Ind. Koll., 1914, **14**, 35.
- ⁹⁴ See Eaton and Grantham, this J., 1915, **34**, 989; also de Vries, Indiarubber J., 1917, **53**, 17; 1918, **52**, 34, 989; also de Vries, Indiarubber J., 1917, **53**, 220; this J., 1916, **35**, 501, 1142. Spence, Indiarubber J., 1916, **52**, 861; Schidrowitz and Goldsborough, *ibid.* 1916, **52**, 51, 505, etc.
- ⁹⁵ e.g., Terry, this J., 1889, **8**, 473; 1892, **11**, 970; see also Pickles, Proc. Chem. Soc., 1911, **27**, 54.
- ⁹⁶ Spence, this J., 1907, **26**, 1257; Spence and Kratz, *ibid.*, 1914, **33**, 653; Schmitz, Gummi-Zeit., 1913, **27**, 1085, 1131.
- ⁹⁷ L. E. Weber, this J., 1912, **31**, 888.
- ⁹⁸ Beadle and Stevens, this J., 1912, **31**, 999, 1099; Indiarubber J., 1912, **44**, 554; Stevens, this J., 1913, **32**, 203; 1914, **33**, 268.
- ⁹⁹ Eaton and Grantham, this J., 1915, **34**, 989; 1916, **35**, 715.
- ¹⁰⁰ Stevens, this J., 1917, **36**, 365.
- ¹⁰¹ Weber, *op. cit.*, p. 180.
- ¹⁰² See for instance, Beadle and Stevens, "Rubber," p. 59.
- ¹⁰³ Schulze, Gummi-Zeit., 1904, **18**, 749.
- ¹⁰⁴ Seidl, Gummi-Zeit., 1911, **25**, 710, 748; also Esch and Auerbach, Z. Chem. Ind. Koll., 1912, **10**, 95.
- ¹⁰⁵ Stevens, this J., 1915, **34**, 524; see also 1916, **35**, 874.
- ¹⁰⁶ Dubosc, Le Caoutchouc et la Gutta Percha, 1917, Jan.
- ¹⁰⁷ Williams, Rubber Ind., 1914, p. 291; see also Martin, Rubber Ind., 1914, p. 269.
- ¹⁰⁸ Fawcitt, Eng. Pat. 17,197, 1890.
- ¹⁰⁹ Bayer and Co., D. R. P. 265,221, 1912, Eng. Pat. 11,530, 1913.
- ¹¹⁰ Spence, this J., 1917, **36**, 118.
- ¹¹¹ Bayer and Co., Eng. Pat. 12,777, 1913; 12,661, 1914.
- ¹¹² Bayer and Co., Eng. Pat., 1913, 11,615.
- ¹¹³ Dunlop Rubber Co. and Twiss, Eng. Pat. 1916, 17,760.
- ¹¹⁴ Aschan and Vaskio, Ber., 1915, **48**, 874; Delépine, Compt. rend., 1897, **125**, 951; 1899, **128**, 105; 1907, **144**, 853.
- ¹¹⁵ See Porritt, "Chemistry of Rubber," (1913), p. 66.
- ¹¹⁶ Martin, Rubber Industry (1914), p. 205.
- ¹¹⁷ Eaton, Agricultural Bull., Fed. Malay States, 1915, **4**, 30; 1917, **167**.
- ¹¹⁸ The process has recently been patented. Dunlop Rubber Co. and Twiss, Eng. Pat. 1916, 17,756.
- ¹¹⁹ Peachey, this J., 1915, **34**, 368.
- ¹²⁰ Peachey, this J., 1917, **36**, 426.
- ¹²¹ Ostromisslenski, J. Russ. Phys. Chem. Soc., 1915, **47**, 1892.
- ¹²² Smith and Holmes, Z. physikal. Chem. 1903, **42**, 469; 1905, **52**, 602; etc.
- ¹²³ For the probability that the latex globules actually consist of rubber, see Hinrichsen and Kindscher, this J., 1910, **29**, 34.
- ¹²⁴ Schidrowitz and Goldsborough, this J., 1909, **28**, 6.
- ¹²⁵ Weber, Gummi-Zeit., 1903, **17**, 296.
- ¹²⁶ For example, see Bary and Weidert, Compt. rend., 1911, **153**, 676.
- ¹²⁷ See also Budde, Gummi-Zeit., 1909, **23**, 1143.
- ¹²⁸ Bysow, Z. Chem. Ind. Koll., 1912, **11**, 185.
- ¹²⁹ Thomas, this J., 1914, **33**, 93; Helbronner and Bernstein,

Compt. rend., 1914, **158**, 1343; Rubber Ind. (1914), 156; Olivier, this J., 1916, **35**, 644.

¹³⁰ Berthelot, Compt. rend., 1870, **70**, 941.

¹³¹ Beaver and Claremont, Eng. Pat. 23,727, 1910; this J., 1911, 1322. Spence, Z. Chem. Ind. Koll., 1912, **10**, 299, 306.

¹³² Bernstein, Z. Chem. Ind. Koll., 1913, **12**, 193, 273.

DISCUSSION.

Dr. H. P. STEVENS said that he had carried out some experiments with benzoyl peroxide, but had obtained no results up to date which were really comparable with the results obtained with sulphur. On the other hand, he did not think his own research, at any rate, went sufficiently far to enable him to make the statement that benzoyl peroxide could not be used technically, and if Dr. Twiss had made experiments of his own, it would be interesting to hear what the results had been. A point often lost sight of was the effect of temperature on physical tests. In a paper read at the last rubber conference in London, an American investigator, Wormeley, had shown that variation of temperature produced a very large effect on the results of physical tests. He had found, for instance, that a difference in temperature of 20° F.—a difference frequently met with in the test room between summer and winter—produced something like 10% difference in the tensile strength and elongation of the product. Up to now there appeared to be no appliance by which the temperature of the specimen during the test could be controlled. It was also important that previous to testing the specimen should be kept at a constant temperature. With regard to the rapidly vulcanising rubber produced by allowing the rubber to mature, he took it that such a rubber would be of greater value than the ordinary trade rubber as now supplied. During maturing oxidation took place, weakening the surface. It was interesting to hear of the author's experiments with the use of potash and soda. So far as he understood it, the results obtained with such an accelerator were in all respects comparable with those obtained with organic accelerators. There had been an idea that traces of alkali affected the stability, that was to say, the ageing qualities of rubber.

Dr. Twiss, in reply, said he had, as Dr. Stevens suggested, made experiments as to the possibility of vulcanising rubber with benzoyl peroxide and nitro compounds. The products did not compare in strength with technically vulcanised rubber. It seemed to him, however, that it was only a matter of time for substances to be found which would have an effect similar to that of sulphur chloride. As to the samples vulcanised in the presence of the alkali solution in glycerol, in the period that had elapsed since those mixings were vulcanised, now almost three years, a certain weakening was observed, but no greater than in similar mixings containing other accelerators used with considerable success by some manufacturers.

THE SCIENTIFIC NEEDS OF THE RUBBER INDUSTRY.

BY B. D. PORRITT, M.Sc. (LOND.), F.I.C.

If statistics were available to show the numbers of men with scientific training absorbed annually by various British industries during the last twenty years, that of rubber certainly would be found to occupy a very humble position on the list, far below what might be expected in view of its commercial importance, and intricate character. Moreover, it would be apparent that until the last decade a chemist was practically unknown in the majority of factories engaged in this trade. Even at the present time a technical laboratory set aside solely for the purpose of research is a rarity, and the duties of the average rubber chemist still remain essentially what they

were in the days when the advent of the much-abused specification led to the creation of a new subordinate position on the rubber manufacturer's staff.

How is it that while other trades, once equally empirical, are now managed by scientific men on scientific principles, in this important and well-established industry many works can even dispense altogether with the services of a chemist, and only a few firms recognise any necessity for carrying out what can be truthfully described as research? Is there but limited scope for the chemist in the rubber trade or has his day yet to come?

That a need exists for information and methods to ensure the production of a material of uniformly high quality, to increase the factory output, and to avoid mysterious manufacturing troubles will be readily conceded by all who have had practical experience of this intricate colloid industry.

Is the chemistry of rubber sufficiently advanced to enable a laboratory to satisfy fully these requirements? Is it, for example, possible on general principles to assign to any particular rubber mixing the exact conditions of temperature and time of vulcanisation to ensure a sound and durable product, or must the chemist resort to a practical test on a small scale? A chemist entering the rubber trade will speedily become conscious of the limitations of his scientific knowledge and the necessity for solving many of the factory problems by the old-fashioned methods of trial and error. While the laboratory may be accepted by some manufacturers as a valuable adjunct, it is, as yet, not generally recognised as an essential. In most modern industries pure science has either anticipated technology or the two have progressed hand in hand. The rubber industry is different. Its foundation rests upon the discovery of vulcanisation by Goodyear in 1839. To-day, 78 years later, the mechanism of this process and the chemical constitution of the raw material are still subjects for speculation and discussion.

The fact that rubber is a colloid will probably be advanced as an explanation to account for the imperfect state of our scientific knowledge of its properties. This may in a measure be true, but it cannot be pleaded in extenuation of the past and present neglect of research by the trade generally.

Other industries, similarly situated, have not taken up this attitude, and one has but to examine the voluminous literature dealing with the esters of cellulose and study the descriptions of the laboratories of the Eastman Kodak Co. in order to realise the immense amount of work which has been carried out in other branches of colloid chemistry.

Difficulties often may excuse failure but they seldom justify inaction.

The present is a unique opportunity for industries to consider any past difficulties, shortcomings, and failures. Abnormal trade conditions and national needs have for a while deadened trade competition and petty jealousies, and the changes in business and manufacturing methods introduced by stern necessity have forced many a conservative manufacturer to abandon the traditions of a lifetime.

For the moment, industries, corporations, and individuals are disposed to abandon obsolete methods, to consider novel suggestions, and to co-operate for mutual benefit. Thanks to this new spirit, many of our industries are now busy putting their affairs in order. Will the rubber trade neglect to seize this opportunity to achieve some measure of commercial and scientific co-operation?

It is, however, the latter question only and the means by which it may be secured with which the present paper is directly concerned.

The scientific problems of the rubber industry are not, as might be inferred from the preceding remarks, confined solely to the manufacturer of rubber goods.

As in the cotton industry—which during the past year has established a technical committee under the auspices of the Advisory Committee for Scientific and Industrial Research—the problems of the producer, the manufacturer, and the consumer are interdependent and require mutual consideration and co-ordination. To ignore this would be to neglect one explanation for the slow progress made by research in past years.

The manufacturer looks to the rubber grower for adequate, cheap and satisfactory supplies of his principal raw material. Without these he cannot satisfy the demands of the consumer for high quality goods at moderate cost or add fresh items to the already long list of purposes for which rubber has been employed in the services of mankind.

The statistics of the world's rubber supplies are too well known to need recapitulation; thanks to foresight, enterprise, and colonies possessing favourable climates and ample supplies of cheap labour the British Empire has in the course of a few years become the foremost rubber producer of the world. Science, however, has played only a minor rôle in this achievement. The scientific staff at Kew were, in a measure, instrumental in introducing the first *Hevea* seedlings into Ceylon, but subsequently fortune smiled on the young industry and science probably was regarded by the planter more as an enemy plotting his downfall by the synthesis of rubber than as an ally to assist in securing his future prosperity. This distrust has, happily, passed away, and of recent years the assistance of the chemist and the botanist has been sought with a view to improving both the yield and the quality of the product of the estates.

Investigations have been carried out by several agencies working independently, and amongst these may be mentioned the Rubber Growers' Association, the Agricultural Department of the Federated Malay States, and the Imperial Institute, the last named working in conjunction with the Government Agricultural Department of Ceylon. In addition to these British research organisations, a considerable amount of work has been carried out by the Dutch in connection with their plantations in Java.

That much valuable information has already been secured from these efforts is evident from the papers published in various journals and especially in the *Bulletins* issued by both the Imperial Institute and the Agricultural Department of the Federated Malay States, but the scope of the work hitherto undertaken is modest, and the field of research still untouched is wide.

This question recently has been the subject of a paper by one of the foremost authorities on tropical agriculture, and in it an appeal is made for co-ordination of results and increased scientific co-operation.*

These two objects have in a measure been secured for the investigations carried out by the Imperial Institute by the inclusion of some rubber manufacturers on an advisory research committee formed in London.

This co-operation, however, might well be extended to include *all* the agencies responsible for scientific work in connection with the production of cultivated rubber, since the existing resources for research are not such that rivalry or duplication of effort can be considered advantageous, or even of little consequence. The chapter on "Latex" in a well-known standard botanical

* "Present Needs of British Rubber Industry," W. R. Dunstan, *Bull. Imp. Inst.*, XIV., No. 2, p. 592-599.

work on plant physiology refers to "the present imperfect state of our knowledge" and "the need for further experimental research on this subject."*

It must be evident, therefore, that besides the more obvious practical agricultural and technical investigations into questions such as methods of planting, manuring, intercropping, tapping, coagulating, and the like, as well as the eradication of plant, insect, and fungoid pests—all matters incidental to securing a cheap and uniform product—the plant physiologist and the chemist have much to do before we can secure a clear insight into the mode of formation and the functions of the rubber latex in the tree.

The problems of the rubber producer are obviously more botanical and mycological than chemical in character, and consequently can be solved satisfactorily only by investigations carried out in an institution situated in a tropical rubber-growing country.

Such an institution would, however, be of little commercial value if the results of its research work were not made readily accessible and intelligible to those who are directly responsible for the practical management of the estates.

The dissemination of scientific information, however, is always a simple problem compared with that of inducing the public to appreciate and profit by its lessons. Herein, therefore, would seem to exist an opportunity for one of our agricultural colleges at home to render good service to the Empire. The arguments which led to the creation of our Schools of Tropical Medicine surely apply with equal force to the problems connected with the healthy development of useful tropical vegetation. By giving special consideration to the problems of tropical agriculture in its curriculum, such an institution should be able to furnish a supply of suitably educated men to fill the administrative positions on rubber and other plantations in our tropical colonies. Men so trained should be able to appreciate, welcome, and make full use of all the latest developments of agricultural science, and thereby render the work of a tropical institute of agricultural research not only of scientific interest, but also a material factor in promoting the prosperity of the world.

The scientific needs of the rubber manufacturer differ fundamentally from those of the planter. The plantation industry is of recent origin, and its staple consists of one single product obtained by methods and machinery common to every estate. Moreover, individual competition as yet can scarcely be said to exist. Under such conditions co-operation in both scientific and technical research should be a simple matter.

With the manufacture of rubber an entirely different state of affairs exists. The number of manufactured articles of which rubber forms the basis is almost infinite in variety, shape, and size, and the methods of production are correspondingly complicated. Further, keen trade competition exists amongst the various British manufacturers.

The attainment of co-operation in technical research in this trade must, therefore, be beset with many difficulties unless it be preceded by thorough commercial understanding. While an individualistic policy often may be shortsighted, so long as human nature exists in its present imperfect form in general, it must be hopeless to expect a manufacturer from altruistic motives to contribute towards assisting competitors to develop processes in which he, by the expenditure of thought, time, and money, has himself achieved a moderate degree of success.

A suggestion has been made recently by a member of the trade to the effect that an investiga-

tion into the manufacture of solid tyres would meet the approval of rubber manufacturers.* It is, however, very questionable whether their response to a proposal for co-operation to this end would confirm his expectation.

The same individual is credited with expressing the opinion "that academic research on the constitution of rubber would not be supported by the manufacturers."

Here we are faced with a definite statement that purely scientific research has no place in the ideals of the rubber manufacturer. If this correctly expressed the views of the majority of those responsible for the policy of the industry they must certainly have been unconscious of the nature and cause of the developments which have occurred in many other industries during recent years.

In common with other industries the rubber manufacturer requires primarily cheap and uniform raw materials. These must then be elaborated by efficient and economical processes into sound, durable and saleable articles. These obvious wants can be secured only by having a works laboratory to control the uniformity of the raw materials, the efficiency of the processes of manufacture, and the quality of the finished products.

As has already been stated, it is only of recent years that the need for even this limited measure of scientific assistance has received recognition in the rubber trade generally. This, however, is far from exhausting the ways in which science can be of assistance to the manufacturer.

As has been pointed out by Dr. Kenneth Mees, Director of the Research Laboratories of the Eastman Kodak Company,† the manufacturer really requires two other forms of scientific assistance in addition to the works or routine laboratory just mentioned. Over and above this, there should be means for investigating and working out "improvements in products and in processes tending to lessen cost of production and to introduce new products on the market." The solution of the problems incidental to the manufacture of solid rubber tyres would fall into this category.

The routine laboratory should find a place in every works which is worthy of the name, while the second type or technical research laboratory should be well within the means of all the more important companies engaged in the rubber trade. The absence of trade co-operation, therefore, is no excuse in the majority of cases for the neglect of technical industrial research.

These two forms of scientific assistance will necessitate not only a supply of trained scientific men but also scientific data. Satisfactory methods must be available to enable the routine laboratory to carry out the analyses and tests incidental to factory control, while scientific information regarding the chemical and physical properties of the raw material is essential for the solution of many factory difficulties and the development of new processes of manufacture. This brings us to the third description of laboratory postulated by Dr. Mees. His remarks deserve to be quoted verbatim.

"In every case where the effect of research work has been very marked, that work has been directed not towards the superficial processes of industry but towards the fundamental and underlying theory of the subject." This kind of research work involves "a laboratory very different from the usual works laboratory and also investigators of a different type from those employed in a purely industrial laboratory. It means a large, elaborately equipped and heavily staffed laboratory engaged largely on work which for many years will be unremunerative, and which, for a considerable time after its

* Haberlandt, "Physiological Plant Anatomy," 1914, English edn., p. 342, 343.

* Report of the Advisory Committee for Scientific and Industrial Research, 1915-1916, p. 24.

† "Nature," 1916, vol. 97, pp. 411, 431.

foundation, will obtain no results at all which can be applied by the manufacturer."

Herein should lie the road to progress in the rubber industry.

When the contributions to the chemistry of rubber are examined—either in scientific journals or the files of the Patent Office—the names of workers engaged in the trade will be found to be conspicuous by their rarity. Take, for example, the oxidation of rubber, the synthesis of caoutchouc, and the acceleration of vulcanisation, all fundamental questions obviously of more than academic interest. In every instance, the rubber manufacturer generally appears to have been content to occupy the rôle of spectator. He was then unconvinced of the value of pure research. Will the important technical possibilities of the organic accelerator induce him now to modify his views? Should such be the case it will be necessary to consider what means are available to meet and foster this new development of the industry.

There are very few firms in the rubber trade of sufficient magnitude to face lightly the expenditure incidental to a pure research laboratory such as has been described. Joint effort, therefore, would seem to offer the only solution of the difficulty. Co-operation in pure research, moreover, will not present the commercial difficulties which must arise out of joint investigations into technical problems.

Such an arrangement could scarcely assist the inefficient at the expense of the efficient, for the measure of advantage to be obtained from the results of co-operation in pure research must depend on the attention paid to technical research in their respective works by the individual manufacturers.

The existing agencies responsible for carrying out pure research for the benefit of industries would appear to fall into two different classes—Research Institutes, pure and simple, of which a number of examples exist in America,* and to which the recently established Research Department at the Stoke School of Pottery would seem to belong, and the Departments of Technical Chemistry which have been established in connection with certain of our younger Universities. As has already been pointed out, industries require equally both scientific facts and scientific men. The ideal institution for technical research should provide therefore the means to satisfy both those needs. Research organisations unconnected with educational institutions would seem to be exposed to two dangers. In the first place, there is a possibility that they may be regarded by the smaller and less progressive manufacturer as a means to secure an occasional limited amount of technical assistance and to avoid thereby the necessity for permanently employing a chemist in his works.

An institution which had this effect would be inimical to the very objects for which it was designed. Secondly, such an organisation postulates a fairly large permanently appointed staff, the majority of whose members probably will be in receipt of comparatively modest salaries. A tendency will consequently exist for the pick of the junior staff to be attracted to industrial and other posts holding out brighter prospects of advancement, with the inevitable consequence that the intellectual standard of the institution must suffer. As an example of this state of affairs it has been stated that in one year two firms alone acquired the services of no less than nine members of the staff of the U.S. Bureau of Standards.†

A University institution should, in a great measure, be free from these dangers. Moreover, its more independent status should protect it

from having to pander to petty fancies and enquiries of the trade at the expense of more important problems, while a constant stream of post-graduate students should both provide a supply of trained men to fill industrial posts and by the infusion of new views reduce the tendency of the investigations to fall into a rut.

Research in British Universities, however, appears to labour under two serious disadvantages. The first is a tendency to be lavish with bricks and mortar and economical in the technical equipment and salaries of the junior staff. If Universities desire efficiency and whole-hearted service from their staffs they must offer a decent initial salary to attract the most able men, and satisfactory prospects to supply the incentive for subsequent good work. The necessity for adequate remuneration must apply with special force when the department concerned is one of applied research for which the staff must combine both technical experience and scientific ability.

The second danger is that of introducing technical specialisation at too early a stage in the science curriculum. The usual three years' course is little enough time for a student to obtain a grasp of the fundamental principles of his subject, and specialisation can be secured during this period only at the expense of something far more important. A scientific training, however, cannot be said to be complete without some experience of research. The functions of a University are two-fold—it should not only impart but also augment human knowledge. A school of learning which does not foster a spirit of research in all its departments is therefore neglecting one of its most important duties. What more suitable subject for University research can exist than the fundamental problems of some important local industry? Is not the time ripe for a closer general co-operation between our Universities and industries? A limited measure of progress has already been made in connection with such trades as dyes, glass, leather, fuels, and metallurgy, but this is far from exhausting the list of important industries and Universities of repute. Were some University to express its willingness to establish a post-graduate department of research to be devoted to the chemistry of rubber, its enterprise would deserve to command the support of all connected with the trade. Granted an organisation similar to the Mellon Institute of the University of Pittsburgh* but limited in scope to one industry, possessing an efficient and adequate staff free from the distractions of elementary teaching, there could scarcely fail to result a school of specialised research, valuable alike to education and to industry.

A systematic investigation into the methods for the analysis of rubber goods would earn the gratitude of every chemist who has had any experience of the procedure at present in vogue, and of the difficulties which so frequently arise in the interpretation of the results. The methods for determining the physical qualities of ebonite furnish another promising field for useful work. The importance of this question may be judged by the fact that it at present forms the subject of an enquiry by a technical committee of the Institution of Electrical Engineers.‡

This should suffice to show the important though difficult and perhaps prosaic physical and analytical research which calls for immediate attention. Of the more fundamental problems which confront the rubber manufacturer that of vulcanisation undoubtedly must be given precedence.

The explanation of the remarkable modification in physical properties produced by heating rubber with sulphur, and of the catalytic effect of litharge and certain other substances in accelerating this

* Research Institutions in the United States—"Nature," 1917, vol. 99, p. 271.

† "Nature," 1917, vol. 99, p. 275.

‡ This Journal, 1916, p. 18.

action may possibly be found by direct investigation. It is probable, however, that investigations into the constitution of rubber, by both analytical and synthetic methods, may contribute materially to the solution desired.

What has been said should be ample to indicate the scientific needs of the rubber industry and some of the problems which await solution.

It remains for those interested in the prosperity of the rubber trade—whether they be planters, manufacturers, or users—to consider the future and co-operate in generously supporting any scheme which promises to promote the well-being of an industry which since its earliest days has been largely identified with the English-speaking race.

DISCUSSION.

Dr. TWISS said that Mr. Porritt laid a considerable proportion of blame for the lack of research in rubber on the manufacturers, and he hardly thought that all this blame was deserved. The manufacturer had little sympathetic regard for the constitution of rubber. The least important point in the practical side of rubber chemistry was the constitutional formula. Manufacturers had had a great deal of research done on the subject of rubber, but from mistaken reasons they were not allowing it to be published, and a great deal of information was locked up inside the various factories. Another point which had not encouraged the manufacturer was that the investigations which had been made were very often so disconnected. Mr. Porritt appeared to expect that the recent discovery of accelerators would prompt the manufacturers to take up academic research, but so far the papers which had been published on accelerators had been, generally speaking, crude and disconnected. It had been more a matter of testing, missing 59 times, and the 60th time happening to find an accelerator—not a genuine method of scientifically organised research. He thought Mr. Porritt's comparison of rubber with esters of cellulose was not altogether happy. There was a much greater excuse for the rubber industry not having raised its pure chemistry to a higher stage than would appear at a casual glance.

Dr. STEVENS said that rather than enter into a discussion in regard to the manufacturers' responsibility for research in the past, they should look to the future. There was now a Rubber Manufacturers' Association, comprising some of the largest firms all over the country. Now was the time for the manufacturers, through their Association, to make arrangements to start research which would be of value to the industry, or at any rate to the subscribing companies. Of course, any research of that sort in the beginning must be on almost purely theoretical lines; it was no use starting with a set of physical experiments.

Mr. SPROXTON said that Mr. Porritt had compared the cellulose esters industry favourably with the rubber industry in the matter of research, and he was pleased to hear this; but at the same time he thought their knowledge of the physical state of the cellulose esters was not quite so profound as the ponderous nature of some of the literature would lead the casual reader to believe. There was a considerable similarity between the problems in the rubber industry and those in the cellulose esters industry. It was necessary to co-ordinate the results of laboratory tests with the durability and commercial value of the final material, and that was a most difficult problem. Some such connection was supposed to exist in the rubber industry, and it was certainly the case in the cellulose esters industry. It was possible to get a sort of pseudo-toughness in plastic materials made from the cellulose esters which would mislead the ordinary observer to believe they

were just as durable as a really properly made cellulose ester plastic, and yet they were not so; they were derived from solutions of very low viscosity. Probably the same trouble arose in the rubber industry. Where a company could afford to keep a fairly numerous staff it would pay not only to employ chemists but physicists, because after the initial chemical processes were finished, in the rubber industry as well as in the cellulose ester industry, the study of the problem became almost entirely physical, and for that reason the physicist ought to find full scope for his energy and his knowledge in the factory.

Mr. F. H. ALCOCK asked the author to reconsider whether his definition of a University was a sound one. If so, it certainly was not his own idea of what a University should be.

The PRESIDENT agreed that the sting of the paper had been taken out by the one read previously, which told them that there were at any rate some manufacturers who were far-seeing and understood the value of scientific investigation, and what was more important still, allowed the results of these investigations to be brought under the notice of the industry generally. He agreed with what had been said as to the employment of physicists, and was pleased to say that he had got chemist and physicist to work together. The combination was extremely valuable, and both admitted it, especially the chemist.

Mr. PORRITT, in reply, thought Dr. Twiss and himself were in agreement in the main, although the form the institute was to take was a debatable matter. Whether technical research in the fundamental questions of technology should be carried out at the University was also debatable, though he could not see himself why it should not be satisfactorily done. He happened to be acquainted with both the rubber industry and the cellulose esters industry, and with regard to their scientific difficulties there was a considerable analogy. Mr. Sproxtton had referred to the literature being unsatisfactory. The literature on the subject of rubber and the subject of cellulose was very similar; contradictory statements abounded in both, and it was extremely difficult to find the truth.

GROUP II.

Prof. HENRY LOUIS in the Chair.

THE LOCAL METALLURGICAL INDUSTRIES.

BY PROF. T. TURNER, M.Sc.

Work in the Metallurgical Department of the University of Birmingham, in the new buildings at Edgbaston, has been suspended, these buildings having been converted into the 1st Southern General Hospital. University classes are conducted in the lecture rooms and laboratories of the Technical School. As the numbers in attendance are smaller than usual, the accommodation is ample; and there has been no interruption in the work, except such as is due to a depleted staff, and the employment, on national service, of practically the whole of the British-born students of military age. But it is not merely instruction and research which have been interfered with by the war; the energies of the whole district have been diverted and intensified, and changes have been introduced, the results of which will be seen in later years. The population of which Birmingham is the business centre is nearly equal to that of half Belgium; and the staple industries such as coal, iron, steel, copper, brass, aluminium, refractories, and engineering in many branches are all such as contribute to the national wealth in days of peace, and to the national strength in days of war. As General Groener, the Head of the German War Department, recently said: "The

whole of what is produced for fighting purposes may be likened to a pyramid, and the base of that pyramid is coal and iron." Closely associated with the production of coal and iron in this district we have the supply of refractories, and the manufacture of copper, brass, nickel, aluminium, and other metallurgical materials.

The production of iron and steel in the Staffordshire district is limited by the moderate supplies of ore in an inland centre. The output is, however, by no means negligible, and is equal to that of the whole of the United Kingdom a century ago. The basic process of steel manufacture is that which is chiefly followed, and the open-hearth furnace is taking the leading place here, as in other centres of the steel trade. The wrought iron trade, though much smaller in volume than in its palmy days, still flourishes, and all the local works have been fully employed at remunerative prices. The blast furnaces produce foundry forge and basic pig irons: the maximum output has been maintained, and it is proposed to put additional furnaces in blast.

In the brass and copper industries there has been unprecedented activity. Though no new scientific discoveries have to be recorded, many improvements have been introduced into works practice. Incidentally reference may be made to the extended use of town gas for melting purposes, with resulting increase of speed and economy. Tilting furnaces are now much more used than was formerly the case. An important local industry is that of cartridge manufacture. The results of researches conducted in the University of Birmingham, by Dr. O. F. Hudson, have been found of considerable value to local manufacturers, particularly in connection with the annealing of metals, and the composition and treatment of certain brasses which have recently had an extended application.

The local nickel industry has been taxed to its utmost capacity; not only has there been the unprecedented demand for cupro-nickel, but the nickel silver trade has been by no means idle, while there has been a demand for pure nickel goods such as were formerly imported from the Continent. An important enquiry as to the world's sources of supply of nickel has been conducted by a Commission appointed by the Canadian Government. Of this Commission, Mr. G. T. Holloway acted as chairman. The Committee visited Birmingham during the course of its inquiries; and the report which just has been issued is, and will long remain, a most valuable standard of reference in relation to the occurrence, extraction, and uses of nickel.

In no direction has there been greater expansion than in the aluminium industry. There are now several large aluminium foundries in the city, and the output of only one of these would be equal to that of the whole world a dozen years ago. The product has been largely used in connection with munitions of war, as in certain parts of shells; in aeroplane construction, and for many other purposes where strength and lightness are desired. The metal is now very generally melted by means of town gas as fuel. This has been found to be cheap, clean, and convenient. Melting is performed either in graphite crucibles, or very commonly in cast iron pots, which are preferably protected by a wash of inert material. Pure aluminium is very seldom used; the alloying metals include zinc, copper, and occasionally tin, nickel, manganese, or other metals. Researches in the properties of these alloys have been conducted, and so far as opportunities permit, are still in progress in the University laboratories.

Recently special attention has been drawn to the production of malleable cast iron, which is an industry which has long been associated with

Walsall, Birmingham, and the intermediate district. There are at present some 90 firms engaged in the local trade, and many of these conduct their business on a relatively small scale. The process generally followed is the Réaumur, or European method, of more or less complete oxidation of the carbon, as contrasted with the American or "Black Heart" process in which the carbon is precipitated as fine grained, or secondary, graphite. For the production of this malleable cast iron the raw material employed is obtained from pure hematite ores, as it is usually considered to be important to have metal which is low in phosphorus and manganese. The demand for specially pure ores for other purposes has led to attention being directed to the question as to how far other materials can be employed to replace the purer cast iron hitherto used. It is known that good material can be produced even when 0.25% of sulphur or phosphorus is present, though the details of the annealing process have to be modified somewhat to suit the kind of iron employed. The problem is how to introduce an iron of a somewhat different composition without disorganising the work of the smaller manufacturers who depend largely upon old-established methods of working. No doubt in time the larger firms will be forced in this, as in other manufactures, to adopt scientific methods, including chemical analysis and accurate temperature measurement. If this should be the result of the present difficulties the whole industry will benefit permanently. It is generally recognised that the trade is an important one; that it is capable of very considerable extension; and that it is upon the adoption of scientific methods that such extension (or extinction) will ultimately depend.

CARTRIDGE BRASS.

BY H. W. BROWNSDON M.Sc., Ph.D.

The term cartridge brass includes pure copper-zinc alloys containing 65 to 75% of copper. Such alloys are specially adapted for the manufacture of cartridge cases where the properties of malleability, ductility, and strength require to be combined in such a manner as to facilitate working, and at the same time to produce a finished product which will withstand the shock of firing in rifle or gun.

In order to meet these conditions, the raw materials used, viz. copper and spelter, must be of the highest quality and purity. The copper should be equal to electrolytically refined, and practically free from lead, iron, bismuth, arsenic, antimony, etc., and should on analysis show 99.93 to 99.95% copper. It is desirable to melt down cathode copper into ingots before use in the manufacture of cartridge brass. The spelter should analyse 99.9 to 99.95% of zinc and be as free as possible from lead, iron, arsenic, etc.

The two metals, together with a proportion of clean heavy scrap, are melted in crucibles, the molten metals thoroughly mixed and then poured into dressed cast iron ingot moulds.

A good cartridge brass should not show on analysis more than Fe 0.045%, Pb 0.025%, with traces of other constituents.

The cast metal is by subsequent rolling and intermediate annealing reduced to a definite thickness, in which form it is termed finished strip.

The changes in physical properties that the metal undergoes in passing from the ingot to the finished strip are shown by the following figures:—

	Yield point.	Tensile strength.	Elonga- tion.	Hardness, Brinell.
	tons.	tons.	%	
ingot (chill cast)	6	16	60-70	60
strip, hard rolled	over 20	30-40	10-15	150-200
finishing strip, annealed at 650°C.	6	20-23	65-75	60

The annealing operations in the manufacture of cartridge brass are carried out at temperatures in the neighbourhood of 650° C. It is not uncommon practice to work at a higher temperature than this, say, 680° to 700° C when annealing the metal in the thicker and heavier stages. By so doing, the time required for annealing is reduced. With thinner metal and products which more rapidly attain to the furnace temperature the 650° C. temperature is more closely observed, the time required being determined by the form of the product to be annealed and by the type of furnace used for the annealing. In muffle furnaces worked intermittently, the time may be $\frac{3}{4}$ hour, whilst in rotary worm-fed gas muffles, suitable for small articles, the time may not exceed 5 minutes.

Apart from the enormously increased demand during the past three years, there has been no development of interest. Output has largely dominated other considerations.

Firms already engaged in the manufacture before the war have increased their plant and developed the manufacture on pre-war lines. Other firms who have been pressed into the service of the nation have followed more or less in the footsteps of those already acquainted with the details of manufacture. The lessons to be gained, however, from the widened experience that this increased output has demanded are not few, and many details are open to be improved upon when conditions permit. In all manufacture which calls for the repeated cold working of copper alloys and the necessary alternating intermediate annealings, homogeneity and uniformity of the finished product is the chief aim, and at the same time one of the most difficult to achieve. The conditions requiring close attention are:—

- (1) The chemical composition of the alloy.
- (2) The casting of the molten alloy.
- (3) The work to which the alloy is submitted during the mechanical operations.
- (4) The annealing of the alloy between the mechanical operations.

The uniformity of the finished product may therefore be influenced at a number of stages in its manufacture, and the best final result can only be obtained by exercising scientific control and intelligent supervision at all the different stages of manufacture. The obtaining of uniform mechanical working offers little or no difficulties. The same cannot be said of the annealing between the mechanical operations. Whilst the conditions and best temperatures for carrying out the annealing are thoroughly understood, the difficulties that arise due to the handling of bulk and to the necessity of rapid production are considerable.

What may be recognised as a theoretically best method, may in practice prove too slow. Since there are several annealing operations from start to finish, even when these are individually known to vary more than desirable, an average final product may be arrived at which gives satisfaction.

Wrapped up closely with annealing is the hardness of the metal, and for carrying out this work in a satisfactory manner, the pyrometer, the microscope, and the hardness testing machine must be applied.

Another important factor militating against the uniform successful manufacture, is the difficulty of finding labour with the intelligence and

conscientious application so necessary for conducting the operations in a completely satisfactory manner.

It has been difficult during the past years of intensive manufacture to pay the necessary attention to the economical side of the manufacture. From raw material to finished product in the case of cartridge brasses, the percentage loss of material through volatilisation, oxidation, and pickling amounts to several per cent. Some of this is recoverable and during the annealing process to some extent preventable. The chief improvement to be looked for in this direction is annealing in a non-oxidising atmosphere. There is nothing new in the idea of preventing oxidation losses during annealing, but as in numerous other matters, the war has impressed upon us the shortcomings of many pre-war methods.

With the withdrawal of sulphuric acid from use for pickling purposes, and its substitution by nitre cake solutions, the value of clean annealing as against dirty annealing, has become much more emphasized, and in the future the bright annealing of all copper alloys should be aimed at.

Whilst there appear to be no great revolutionary improvements of a scientific nature ahead of us in this industry, there is no doubt that modifications of an economic nature are possible.

The manufacturer finds no difficulty in obtaining metal of the purity demanded. In the details of working, the metallurgist knows exactly what he wants both as regards annealing temperatures and work that can be put on the metal. His difficulty is in securing that uniformity of treatment which ensures complete success.

Pyrometry is an essential aid, but its application to this class of work in bulk is still open to considerable improvement. The testing of the hardness of the products during manufacture and when completed is a matter of importance, and the method to be employed is best determined by the nature of the product to be examined. Both the scleroscope and the Brinell instrument are of value, and it is a matter of detail as to which is the more suitable. The fundamental conditions involved in the manufacture are the alternating production of strains by work, and their release by annealing. The final product is commonly left in a more or less strained condition. As a means of determining the position and nature of the strains, the weakening of the metal by immersion in mercuric chloride solution, which allows the strains to develop visible cracks, is most valuable.

The success of the industry, therefore, lies in carrying out the manufacture under uniform conditions, which conditions should be governed by:

- (1) Analytical control of the metals going into the pot.
- (2) Analysis of the cast ingot.
- (3) Correct distribution of mechanical work at the various stages of manufacture.
- (4) Correct annealing checked by pyrometer, microscope, and hardness tests.

Finally, a complete examination, both chemical, metallurgical, and physical, of the finished product should be systematically made.

Of the metal worker's art, there are few examples more interesting than a brass cartridge case. The chemist has to see that the copper and spelter conform to rigid specifications before they go to the pot. The caster has carefully to apply all the details of his art (only gained by experience) to the production of a sound ingot. The roller in the mill rolls the ingot down until further work is undesirable without first removing strains and softening by means of annealing. The annealing, though helped by pyrometry, is still largely a matter demanding experience and sound judgment. Towards the end of the rolling operations, mechan-

cal precision is required to produce finished strip of uniform thickness to within 0.001 in.

During passage through the mill a keen eye of inspection is required to prevent faulty work passing through—local flaws have to be removed and any work showing defects out of the common put on one side for more expert examination and decision as to its further use.

From the strip to the cartridge case the engineer and the metallurgist have to work closely together, the former to design and produce the tools and machines which will work the metal stage by stage to the desired finished form, and the latter has to see that the metal is in no operation overstrained and that between operations strains are sufficiently removed by correct annealing conditions.

Of subtle, not thoroughly understood difficulties there are none. Success lies with a never flagging close attention to detail and continual intelligent application of scientific control.

The interest that the ammunition manufacturer takes in cartridge brass does not cease with the production of the finished cartridge case, for of the components of a cartridge the case alone is left undestroyed, the propellant and the shell or bullet being completely destroyed so far as further useful recovery is concerned.

Cases other than small arms may, if not seriously mechanically damaged, be re-formed to size and used again. Small arms cases, however, after once being fired, suffer a deterioration which not only prevents them from being used a second time, but which also prevents them from being utilised as scrap for casting cartridge brass.

The causes of this deterioration are metallic mercury and antimony salts, products from the explosion of the ingredients of the percussion cap. A portion of these products is retained on the interior surface of the case. From the point of view of re-using the case as a case, it is the weakening effect off the mercury on the strength of the brass that gives the trouble. From the point of view of using the fired cases as scrap for re-melting, it is the antimony which is the bngbear. Much may be done by washing the fired cases in suitable solutions, but even after repeated treatment in this way, when put into a heat for best cartridge metal, antimony will be found in harmful quantities in the ingot.

The economical utilisation of scrap forms such an integral part of the brass maker's business, that this question of the use of fired small arms cases as scrap under present conditions is one of considerable magnitude when the demand for cartridge brass of high purity is predominant.

The industry must, after the war, be of much diminished volume. For high quality cartridge brass there will always be a demand, and apart from quality, economical production will be the dominating factor in success or otherwise.

For permission to make this communication I have pleasure in expressing my thanks to the King's Norton Metal Co., Ltd. To Mr. R. A. Ernest Payne, the Company's General Manager, I am deeply indebted for much helpful criticism. For valuable suggestions and data my thanks are also due to Mr. H. Rogers, Works Manager.

DISCUSSION.

Mr. ALEX. E. TUCKER said that the heat at which the strips were cast was most important. Were they cast as hot as possible? Then, again, in regard to the manufacture of fine tube the author was emphatic on the point that he received virgin metals of a high grade, but he (the speaker) had often found that copper banding used on cartridges contained a quantity of arsenic. He agreed as to the value of the mercuric chloride test.

Mr. F. JOHNSON asked as to the percentage of lead in cartridge brass.

Mr. H. L. HEATHCOTE said he was glad to see some figures as to the tensile strength of cartridge metal. It was a disadvantage if the yield-point exceeded seven tons to the square inch. If it was greater it would lead to flaws extending. For testing the hardness of finished munitions they had devised a pair of pliers in one leg of which the cartridge case was placed. The other leg carried a cylinder and a spring, and by closing the pliers the indentation gave an index as to the hardness of the metal.

Dr. BROWNSDON, in replying to Mr. Tucker, said they worked at the lowest pressure possible right through. It was not unusual to find traces of arsenic in certain kinds of copper. The amount of lead that could be present in a cartridge case was as high as 40%; by that he meant that a case with 40% of lead would fire satisfactorily, but it spoiled easily in the annealing. Then again, if they were stored they might split in the mouth. The purer they were the better. He had been able to trace trouble in cartridge brass to phosphorus. It arose from the scrap metal, and it tended to cause metal to crack when in a strained condition. If it was put in for de-oxidising purposes it should be got rid of as quickly as possible. In regard to the percentage of antimony the quantity was small, probably 0.06 or 0.07%. Mr. Heathcote's tests were valuable, and the colour methods of pyrometry were also good. Much remained to be done in the latter direction, and that method had a great future.

ON THE SUPERHEATING OF SLAGS AND METALS DURING REFINING, SMELTING, AND ALLOYING OPERATIONS.

BY J. E. FLETCHER, M.I.MECH.E.

1. In the production of wrought iron and steel or ingot iron in the open hearth furnace, it is becoming clearer that the mechanism of refining and alloying is that of the intimate reactions which occur between the various constituents of the pig iron, ore, and scrap charged and those of the slags used in the efficient carrying out of such processes.

The finished cold cast products are crystalline composite masses made up of more or less carbonized or otherwise alloyed crystals separated from each other by boundaries which probably always contain minute particles or films of isolating matter. It is known that such films often contain the iron oxides FeO and Fe_2O_3 together with silicates of iron and manganese. There is further evidence that occluded gases in a fine state of division occur within the crystal boundaries. Such films must tend towards the non-welding of the adjacent crystal faces when the molten or liquid-plastic crystals are being drawn together in their passage to the solid state.

The high temperatures needed in the ferrous alloy processes make the study of the reactions and of the constitutional changes in both slags and alloys exceedingly difficult; there is a sense, however, in which it may be said that the reactions at high temperatures are more simple than at lower ones. Thus M. Charpy succeeded in cementing or carbonizing iron filings by heating at 650°C . for about forty hours in potassium cyanide, the alloy produced being the iron carbon eutectic containing 1.3% carbon and melting at about 1130° to 1135°C . Similarly after heating for 85 hours the alloy containing 6.67% carbon and 93.33% iron (Fe_3C) was produced. With only three hours' heating at 1130°C . the 4.3% carbon eutectic alloy resulted. Moissan, at the temperature of the electric arc, succeeded in carbonizing iron to a content of about 4% in three minutes, and the author, in a like period, also at the temperature of the electric arc, obtained an alloy containing 5.5% carbon. Later Ruff and Goecke

produced a 9.6% carbon iron alloy by cementation in an electric furnace at 2220° C., the time required at this high temperature being relatively short. These experimenters concluded that there is a progressive formation of the carbides Fe₃C, Fe₂C, and FeC, at increasing temperatures until at about 2700° C. gasification of the alloy (FeC+Fe) takes place.

II. The refining and alloying slags in iron and steel processes may be divided into three types. Those having temperatures of formation, fusion, and equilibrium (1st) higher, (2nd) approximately the same, and (3rd) lower than the fusion and equilibrium temperatures of the metallic alloys in contact with the slags.

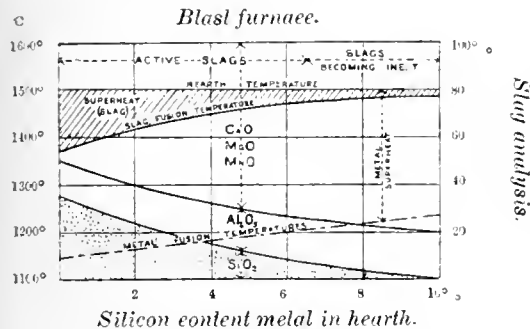


FIG. 1.

The slags of type (1) are representative of blast furnace working, where the pig iron fusion temperatures are in the neighbourhood of 1140° C. Such slags have the composition:
CaO+MgO+FeO+MnO=50 to 55 per cent.,
SiO₂+Al₂O₃+P₂O₅=45 to 50 per cent.,
the fusion temperatures of which are in the region of 1400° C.

The slags of type (2) are typical of the puddling process where the fusion and softening temperatures of the metal being operated upon vary from 1130° to 1450° C., the slags having fusion temperatures varying between 1080° C. and 1350° C. and being silicates of iron and manganese of the approximate analysis:
FeO+Fe₂O₃+MnO=70 to 80%. SiO₂=20 to 30%.

The slags of type (3) are representative of the open hearth steel melting processes. Here the metal fusion temperatures vary from 1130° to 1500° C. whilst the slags fuse between 1100° C. and 1350° C. and have the typical analyses:
CaO+MgO+FeO+MnO=40 to 50% (acid process).
SiO₂+Al₂O₃=50 to 60% (acid process).
CaO+MgO+FeO+MnO=80 to 70% (basic process).
SiO₂+P₂O₅=20 to 30% (basic process).

III. Now obviously the temperatures of refining, smelting, and alloying chambers or hearths of the furnaces being operated must be kept higher than those of the slags or metals under treatment. Hence in case (1) the blast furnace metal is superheated above its fusion point; in (2) the puddled iron and slags may be kept nearly at their proper fusion temperatures, and in (3) the slags are superheated above their fusion temperatures.

Taking as concrete examples the cases cited:
(1) *Blast furnace slags.*—Here the slag fusion temperature is higher than that of the contact metal. The temperatures of the tuyère zone are in the region of 1500° C., the slag fusion temperatures being between 1350° C. and 1450° C., whilst the underlying metal is melted at roughly 1140° C. The slag and metal are therefore continuously superheated above their fusion temperatures. The metal in the hearth is primarily of eutectic composition or thereabouts, viz., 4.3% carbon and 95.7% iron.

The result of superheating this eutectic is first to render the contained carbide of iron, Fe₃C, unstable. The higher it is heated above its melting point, 1130° to 1135° C., the greater is this instability apparent and its sensitiveness to refining or alloying action increased. Similarly the oxide constituents of the slag which are reducible at the hearth temperature become unstable under conditions of superheat, the silica, SiO₂, and phosphate of lime, 4CaO.P₂O₅ being readily reducible.

At the hearth temperature, 1500° to 1600° C., the slag tends to adjust its composition by parting with SiO₂ and P₂O₅ until it attains equilibrium consistent with the degree of superheat. If given sufficient time at, say, 1500° C., an equilibrium corresponding to the slag composition 20% Al₂O₃, 80% CaO, MgO would arrive in the case of a smelting using a working slag of primary non-superheated analysis 30% SiO₂, 15% Al₂O₃, 55% CaO, MgO. The 1500° C. saturated slag would then be inert, there being no further reducible constituent present in the slag. The metal in contact with the slag would also have moved towards stable equilibrium and it can be shown that in the case of ferro silicon manufacture an alloy of composition C 0.5%, Si 9.3%, Fe 90.2% would result when the slag becomes inert. The fusion temperature of resulting slag and metal would be about 1450° C. (In this case phosphorus, sulphur, and manganese have been omitted for the sake of simplicity.)

It is impossible at present to state the composition which corresponds to the stable equilibria of slags at varying temperatures or of the metallic alloys in contact therewith, but it may be inferred from the foregoing that by proper adjustment of the primary slag composition it is possible by correct temperature control to regulate the alloying actions in the metal.

It is clear that the cast iron becomes alloyed with silicon and phosphorus at the expense of its carbon the more readily as the slag is superheated and hence free to act on a superheated metal (unstable) in contact with it. Fig. 1 illustrates the changes in the composition and temperature of equilibrium during the progressive alloying of a white iron with silicon. The active and relatively inert conditions of the slag are indicated by the shaded area marked "superheat." The higher the superheat the more active the slag and the more unstable the metalloid compounds in the metal attacked.

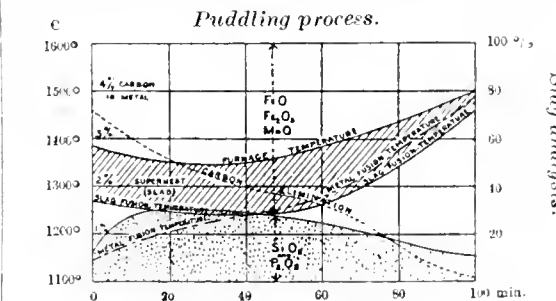


FIG. 2.

There are, doubtless, cases where, as in certain pneumatic refining and smelting processes, the excess of oxygen leads to oxidation of the metal underlying the slag. Such oxides may there rise to the surface and enter the slag which under certain temperature conditions may become more active, increasing the slag superheat because of the addition of iron oxide to the slag and coincidently lowering its fusion point. Carbon in a pig iron charge may thus be oxidised at the expense of iron oxides FeO, Fe₂O₃ in the slag, iron passing back into the metal; such action is coincident

with or preceding the silicon or phosphorus transfer. Thus a blast furnace slag may become rich in FeO, the resulting pig iron being white. Iron has then been reduced from the slag in preference to silicon and the total carbon content of the pig iron is lower than in the case where a normal slag free from FeO has been employed.

Puddling slags. In the puddling process the slags are of the type $(\text{FeO}, \text{Fe}_2\text{O}_3, \text{SiO}_2)$ having temperatures of fusion and equilibrium not much different from those of the pig irons which it is desired to refine. Here it is necessary to desilicise, dephosphorise and decarburise the pig iron underlying or in contact with the slag. The initial fusion temperature of the pig iron to be refined is about 1110° C., that of the first superposed slag being, say, 1260° C. This slag is therefore superheated and consequently active. Unlike the blast furnace slag the puddling slag is basic and continues so throughout the process. There is no deterrent or inert constituent such as lime or alumina, hence temperature variations rapidly alter the slag constituents. The active iron oxides in the slag attack the unstable iron phosphide and silicide in the pig iron and primarily furnish the oxide for gasifying the unstable carbon in the superheated iron carbon alloy and for oxidising the silicon and phosphorus which are also but feebly stable at temperatures above 1100° C. There is an automatic adjustment of the slag composition throughout the process. At the beginning and end of the operation the temperatures are higher than during the intermediate stage. The initial and final slags are therefore high in $\text{FeO}, \text{Fe}_2\text{O}_3$ and low in SiO_2 , whereas in the intermediate stage the slag is more silicious and more readily fusible. During "rash" or careless working the end of the operation is conducted at too high a temperature hence the slag is too highly superheated and adjusts its composition by robbing the iron bath or sponge. The iron oxide thus added to the slag is largely the result of oxidation by the furnace gases (rich in O and CO_2). Fig. 2 illustrates the foregoing actions. It is seen that the superheat is not so great as in the blast furnace operation. Fig. 3 shows the

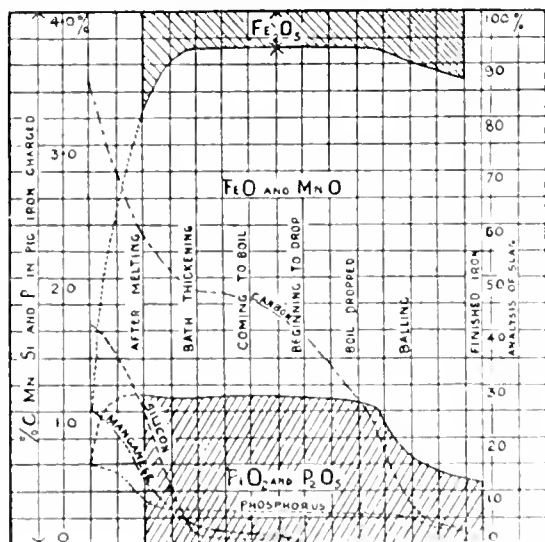


FIG. 3.

progress of refining and the coincident adjustment of slag composition during the complete puddling process and illustrates most clearly the effect of superheat on the slag and metal equilibria.

IV. (A) In the production of certain alloy steels the effect of superheating the working slags

results in the pronounced separation of the most readily reduced slag constituent. Thus in the making of manganese steel in the open hearth furnace the primary slag covering the molten pig iron charge was a rich ferrous slag of the composition approximately $\text{FeO}, \text{Fe}_2\text{O}_3 = 80\%$, $\text{SiO}_2 = 20\%$, fusible at about 1300° C. Into this a pyrolusite ore of analysis $\text{MnO}_2 = 85\%$, $\text{CaO}, \text{MgO} = 5\%$, $\text{SiO}_2 = 10\%$, was gradually added. The MnO_2 becomes MnO on superheating, the FeO being changed to Fe_2O_3 by the O liberated from the MnO_2 . It was then found that the FeO and Fe_2O_3 in the slag, if increased by further additions of hematite ore (Fe_2O_3) and lime caused a rapid reduction of the Mn from the slag, Mn entering the liquid metal. When the

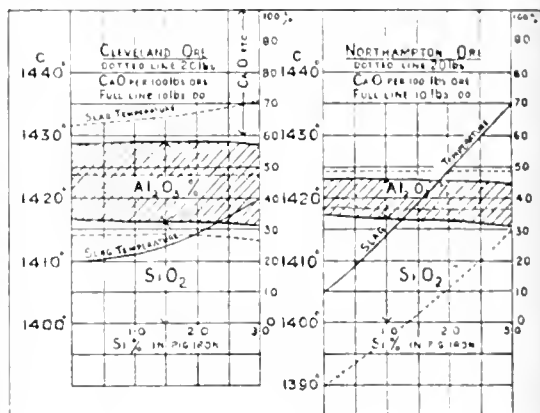


FIG. 4.

slag contained over 50% of Mn then manganese entered the metal whereas if the slag was adjusted so as to contain above 50% of Fe, then iron was reduced from the slag in preference to manganese. An increase in the superheat in either case increased the rapidity of the reduction. The temperature was not measured but it was noticed that the higher MnO slags were more fluid than the rich FeO slags and were apparently fusible at a lower temperature. Hence at the practically constant furnace temperature the high MnO slags were more highly superheated than the high FeO slags, hence more unstable and the Mn in consequence more readily reduced.

(B) The refining of alloys may be illustrated in the case of the elimination of manganese in the puddling or open hearth steel processes. Thus the reaction between the slag constituent FeO, Fe_2O_3 and the alloy constituent Mn_3C in the pig iron is of the type:

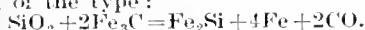


Manganous oxide displaces the iron oxides in the slag, the manganese in the pig iron being replaced by pure iron from the reduction of the iron oxides. Superheating the slag renders the $\text{FeO}, \text{Fe}_2\text{O}_3$ more active whilst superheating the molten pig iron increases the instability of the Mn_3C . In the interaction CO gas is liberated. The slag is enriched by the entrance of MnO at the cost of the iron oxides $\text{FeO}, \text{Fe}_2\text{O}_3$. Professor Turner's view that in such actions the active oxides $\text{FeO}, \text{Fe}_2\text{O}_3$ are the reducing agents has been taken. They are in the state of least stability and hence in the condition to react with the other unstable compounds present when by superheat their stability is decreased. Possibly at the moment of exchange it is the ferrous oxide which reacts with the Mn_3C in a reversible sense thus: $-3\text{FeO} + \text{Mn}_3\text{C} \rightleftharpoons 3\text{MnO} + \text{Fe}_3\text{C}$.

Superheating the oxide FeO in an oxidising atmosphere leads to the formation of Fe_2O_3 (as in the production of "Bull dog slag" by calcining

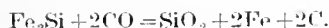
puddling furnace tap cinder). On the other hand liquid Fe_2O_3 when in contact with molten Fe alloys is readily converted to FeO provided a reducing or neutral atmosphere is maintained in the working chamber.

Alloying a metallic mass underlying a rich slag. In silicising the white eutectic iron in the hearth of the blast furnace the SiO_2 in the slag interacts with the Fe_3C in the carburised white iron in a reaction of the type:

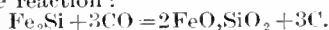


The carbide of iron in the eutectic metal is displaced by silicide of iron and pure iron is coincidentally set free. CO gas is liberated and the slag is impoverished by the loss of the silica SiO_2 . This exchange is affected by the superheating of the slag, the silicate of lime or magnesia therein becoming unstable. The interaction between the SiO_2 and the unstable superheated Fe_3C is thereby promoted as shown.

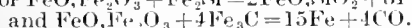
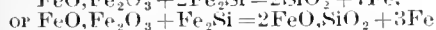
(c) *Liberation of occluded gases.* When cast iron is heated considerably above its melting point the occluded gases, which are not inconsiderable in quantity and consist mainly of CO and H, are set free. An examination of the microstructure of a pig iron which has been thus heated towards its boiling point reveals particles of silica surrounded by an envelope of ferrite together with flakes of coarse graphite. It would appear that a reaction has taken place in this case between the escaping CO gas and the silicide of iron Fe_2Si thus:



The slaggy particles appearing in the microstructure are probably a silicate of iron formed as per the reaction:



In some cases such silicate slag rises to the surface of the metal which has been desilicised to some extent by gaseous means. Again, sometimes iron oxide particles occur mechanically mixed and distributed throughout the cast iron or steel mass as a result of over-oxidation or over-blowing in the hearth or bath of the furnace or converter. The effect of superheating such an alloy is further to refine the metal thus:



H. Brearley has illustrated this action in his book on case-hardening, where a slag globule is shown surrounded by a ferrite envelope, and generally in iron and steel, slag streaks are associated with adjacent ferrite.

V. The mechanism of refining and alloying through the offices of the slags is shown in the tables Nos. 1 and 2. In the blast furnace a portion of the carbon in the carbide, Fe_3C , is liberated in the CO gas formed and pure iron is freed to unite with the Si and P as silicide of iron, Fe_2Si , and phosphide of iron, Fe_3P . These actions occur when the slag is superheated.

The automatic adjustment of a typical blast furnace slag is shown in Fig. 4, where, during the alloying of the iron in the blast furnace hearth with silicon (the resulting pig irons having 0 to 3.0% silicon), the slag composition alters thus:—

	SiO_2 .	Al_2O_3 .	$\text{CaO},$ $\text{MgO}.$	Slag softening temp.
	%	%	%	°C.
Before alloying with Si	23.5	20.7	47.1	1435
With 1% Si in pig iron	23.1	21.5	48.9	1440
With 2% Si in pig iron	27.5	21.7	49.7	1440
With 3% Si in pig iron	26.5	22.2	50.3	1445

As the slag adjusts itself during the loss of Si the fusion temperature of the slag is raised. Hence a higher hearth temperature and resulting

slag and metal superheat become necessary as the more highly silicious pig irons are made.

Table 2 illustrates the mechanism of refining action in cupola, open hearth, and puddling operations. Here the pig iron being refined is superheated above its melting point, and the silicide, phosphide, and carbide of iron being thereby rendered unstable react with the similarly unstable slag oxides (in this case the iron oxides). Silica and phosphoric acid escape to the slag and CO gas is liberated. The iron set free by the decomposition of the silicide, phosphide, and carbide of iron and that added by deposition from the slag oxides, together with the primary iron crystals in the original pig iron (if containing less than 4.3% carbon) yield a refined product more or less free from silicon, phosphorus, manganese, and carbon.

VI. It is evident from the foregoing that intimate contact between the metal and the slags in smelting, refining, and alloying operations are imperative if successful results are to follow.

In the blast furnace the reduction of the ores must be largely through gaseous (CO) influence. It is not possible for sufficiently uniform carbon (coke) contact with the oxide of iron (Fe_2O_3 , etc.) particles to take place. The slag blanket which covers the metal in the hearth of the furnace is agitated by the splashing and penetration of the drops of liquid metal and slag as they descend from the upper portions of the tuyère zone. Hence there is a greater contact between slag and liquid metal than at first appears. The relationship between the area of slag contact and the iron smelted per hour is of practical importance. The

ratio: $\frac{\text{area of slag contact (sq. ft.)}}{\text{iron smelted per hour (tons)}}$ is, in the case of modern hot blast furnaces 15 to 25. In the days of cold blast furnaces the ratio was as high as 40 sq. ft. of slag contact per ton of iron smelted per hour.

In the foundry cupola the ratio for modern furnaces is 0.7 to 1.0 sq. ft. per ton of iron melted per hour, and in the open hearth steel melting furnace the ratio: $\frac{\text{area of slag contact}}{\text{metal refined per hour}}$ is 20 to 30. In modern rapid practice in large furnaces the ratio is tending to increase, shallow baths and large area of slag contact being necessary for intensive outputs.

The more viscous and light the slag, the greater is the need for large contact area. During mechanical or natural agitation the heavier slags penetrate the metal surface in direct proportion to their density. In the heavy yet mobile puddling slags the rapidity of the refining action is readily explainable and the low viscosity combined with the continuous hand or mechanical rabbling promotes better contact between the metal and oxide particles.

It can be shown that in the alloying of silicon with iron through contact of the carbide of iron with the silica of the slag, in the blast furnace process, the relative surfaces of contact of these two constituents are as 1:1.26 approximately, whereas in the decomposition of Fe_2Si in the refining operation of puddling, the ratio of contact areas between Fe_2Si and the oxides $\text{FeO} \cdot \text{Fe}_2\text{O}_3$ is as 1:1. Hence it follows that more homogeneous interactions occur in the latter process. It is interesting to note that the

ratio: $\frac{\text{area of slag contact (sq. ft.)}}{\text{metal refined per hour (tons)}}$ is about 50, twice that of the open hearth steel process, the area of contact being sufficiently large to enable efficient washing and rabbling of the metal and slag to be carried out.

VII. *The liquid crystal phase.* Dr. Desch, in his recent invaluable contribution to the Institute of Metals, drew attention to the possible existence

of a liquid crystal phase at temperatures higher than the fusion point of metallic alloys. In the study of ferrous alloys the observed variations in the viscosity of hyper eutectic alloys when heated above their melting points, the decomposition of the carbide or carbides in carbon iron alloys as influenced by the presence of silicon, phosphorus, etc., resulting in a graphite-bearing viscous state, and the microscopic examination of such alloys when quenched from the superheated condition, all strengthen the view that above the liquidus curve of the phase diagram there may be



FIG. 5.

a liquid crystal phase. It is difficult to determine such a phase and its temperature limits, but there is much to suggest that liquid iron crystals more or less carbonised and siliconised in ordinary cast irons and steels do exist, and that their carbonisation and siliconisation are effected more rapidly as the temperatures approach the purely liquid phase.

Taking the fusion points of iron and iron carbide Fe_3C as 1500°C . and 1850°C . respectively, it might be found that a line drawn between the two (possibly not a straight line but a drooping curved one) would be the frontier line between the purely liquid and the liquid crystal phases.

In such a case the primary nuclei for crystal growth would occur within the liquid crystal phase and would not depend upon the freezing action in the now recognised solidus phase. Thus graphite may be precipitated in the liquid phase and act as the nucleus for the primary liquid crystals. Similarly silico-ferrite crystals may commence to form at the same or a higher temperature in the liquid phase and start a secondary ferrite liquid crystallisation.

It is in such considerations that the difference between crucible (a furnace with walls superheated above the temperature of the liquid crystal phase) melting and cold hearth melting appears. Just as the steam bubbles in a boiler rise most strongly from the zones next to the heating surfaces, so the occluded gases and convection currents within a molten metal in a crucible rise most powerfully from the zones next to the heated walls. These details may have much to do with the fineness of crystalline structure in the final cast metal and with the homogeneity or otherwise of such structure.

The fineness of such structure is related to the crystal boundary question and to the freedom from gaseous or refining oxide and slaggy inclusions within such boundaries.

VIII. It is instructive in this connection to trace the successive series of iron (liquid crystalline) deposition in the refining processes.

In Table 3 the possible order of iron crystalline deposition is shown in three well-known variations of the open hearth steel making processes.

The first stage of the operation in each case is that of melting the charge. In the liquid thus formed are the primary crystals (melted or as liquid crystals) originally present in the pig iron or steel scrap. The next iron addition to the bath is due to the decomposition of Fe_3Si , the Si entering the slag and liberating the iron of the silicide, coincidentally there being added to the liquid mass free iron reduced from the iron oxides of the slag. Manganese carbide is next attacked by the slag oxides and MnO enters the slag, being displaced by pure iron reduced from the iron oxides in the slag. After this comes the carbon elimination, the carbide Fe_3C on decomposition yielding its Fe to the bath and simultaneously adding pure iron reduced from the iron oxides in the slag. Finally when iron ore (Fe_2O_3) in excess of purely refining requirements is added to the slag, further iron is reduced and makes the final contribution to the mass of refined metal. The analyses and estimates given in the table are only approximate but are believed to offer a comparative view of the order of iron crystallisation during refining in the three types of steel making. Whether the iron increments are actually liquid crystals is as yet open to question.

IX. *Refined iron structures and superheating conditions.* In the U.S.A., J. E. Johnson, jun., the well-known blast furnace expert, has produced a cast iron which approximates in character to the finest charcoal cold blast iron such as is made in Sweden. By adding a cast iron which has been partly refined in a Bessemer converter to an ordinary foundry iron molten from the blast furnace the following actions occur.

The Bessemerised metal low in carbon content and containing considerable quantities of occluded gases and oxide particles is much higher in temperature than the blast furnace metal to which it is added. The superheating action on the latter



FIG. 6.

metal lays the unstable carbon and silicon as carbide and silicide of iron open to a secondary refining action. Some of the graphite is probably oxidised and iron oxide from the Bessemer metal becomes reduced within the mass. The result is a lower carbon iron with smaller nuclei of graphite than is found in hot blast pig irons. The relative action of slow and rapid refining is typified in the production of practically carbonless iron in the puddling and open-hearth furnaces well illustrated in the two photomicrographs, figs. 5 and 6 (100 diameters). Here the same raw materials were used in the open hearth and puddling operations, the resulting refined irons being of similar analysis. The two irons were similarly reheated, piled, and rolled. The difference in the size of the ferrite crystals is very pronounced, the puddled iron having much the coarser structure. The open-hearth iron, melted and refined under high superheat conditions, unassisted by artificial bubbling and agitation, has a finer crystallisation than the puddled iron, which is refined at lower temperatures. This latter action, carried out in a bath which is itself composed of active reducing oxides, must obviously tend to a coalescence and welding of adjacent iron grains or crystals which is impossible in a bath where the refining action proceeds by way of contact only with a superincumbent slag of low specific gravity and high viscosity. It goes without saying that the question of crystalline metallic structure is inseparably connected with the slag functions. Micrographic analysis cannot reveal the true character of the boundary films, the process of polishing the slag inclusions being altogether unsatisfactory when it is desired to reveal the characteristic structures at high powers of magnification. It would appear to be therefore of increasing importance to study the crystalline boundary problem in the light of the foregoing conclusions, bearing in mind the facts that the crystals or crystallites begin to grow in a liquid carrying oxides, slaggy, gaseous, or metallic.

These oxides, during their own decomposition, may form secondary crystals, or, in their passage to the slag covering, become entrapped as films within the contracting crystal boundaries.

Table 3.

Analyses of materials.	C.	Si.	Mn.	Fe.	Fe ₂ O ₃	SiO ₂	S & P.
Pig iron ..	3.8	1.5	0.8	93.9	—	—	not estimated
Steel scrap	0.2	0.1	0.7	99.0	—	—	—
Ore	—	—	—	—	60.6	10.0	—

Pig and ore process—charge 75% pig 25% ore.
(1) Primary crystals in pig iron = 30.5 initially present in pig iron.
(2) Iron crystals from Fe₂Si decomposition = 4.3 refining of silico-ferrite.
Iron crystals from slag reduction = 3.3
(3) Iron crystals from Mn₃C decomposition = 0.7 refining of eutectic.
(4) Iron crystals from Fe₃C decomposition = 40.0
Iron crystals from slag reduction = 9.6
(5) Iron crystals from ore reduction = 11.6 alloying by iron reduced from ore.

Pig and scrap process—charge 50% pig, 50% steel scrap.
(1) Primary crystals in pig iron = 18.5
(2) Primary crystals in scrap iron = 44.0
(3) Crystals from Fe₂Si decomposition = 2.9
Crystals from slag reduction = 1.9
(4) Crystals from Mn₃C decomposition = 1.1
(5) Crystals from Fe₃C decomposition = 25.6
Crystals from slag reduction = 6.0

Pig, scrap and ore process—charge $\frac{1}{3}$ of each.
(1) Primary crystals in pig iron = 14.6
(2) Primary crystals in scrap iron = 34.5
(3) Crystals from Fe₂Si decomposition = 2.4
Crystals from slag reduction = 1.6
(4) Crystals from Mn₃C decomposition = 0.8
(5) Crystals from Fe₃C decomposition = 20.0
Crystals from slag reduction = 4.9
(6) Crystals from ore refining = 20.2

TABLE 1.
Typical alloying actions in blast furnace.

Superheated unstable constituents.				Resulting alloys in metals.				Constituent ejected from metal.	
	In slag.	lb.	In metal.	lb.	Compound	lb.	Free.	lb.	lb.
.....	SiO ₂	60	Fe ₂ Si	360	Fe ₂ Si	140	Fe	224	CO
.....	P ₂ O ₅	142	Fe ₃ P	990	Fe ₃ P	398	Fe	504	CO
.....	MnO (1)	213	Fe ₃ C	180	Mn ₃ C	177	—	—	FeO
.....	FeO (2)	216	C	36	—	—	Fe	168	CO
Reactions.									
.....	SiO ₂	+	2Fe ₃ C	=	Fe ₂ Si	+	4Fe	+	2CO
.....	P ₂ O ₅	+	5Fe ₃ C	=	2Fe ₃ P	+	9Fe	+	5CO
.....	3MnO	+	Fe ₃ C	=	Mn ₃ C	+	—	+	3FeO
.....	3FeO	+	3C	=	—	+	3Fe	+	3CO

TABLE 2.
Typical refining actions in cupola, open hearth steel, and puddling processes.

Superheated unstable constituents.				Result of refining, new constituents added.				Gases ejected.	
	In slag.	lb.	In metal.	lb.	To slag.	lb.	To metal.	lb.	lb.
.....	FeO, Fe ₂ O ₃	232	Fe ₂ Si	280	SiO ₂	120	Fe	392	—
.....	FeO, Fe ₂ O ₃	232	Mn ₃ C	177	MnO	213	Fe	168	CO
.....	FeO, Fe ₂ O ₃	464	Fe ₃ P	398	P ₂ O ₅	142	Fe	504	—
.....					FeO	216			
Reactions.									
.....	FeO, Fe ₂ O ₃	+	2Fe ₂ Si	=	2SiO ₂	+	7Fe	+	—
.....	FeO, Fe ₂ O ₃	+	Mn ₃ C	=	3MnO	+	3Fe	+	CO
.....	2(FeO, Fe ₂ O ₃)	+	2Fe ₃ P	=	P ₂ O ₅	+	9Fe	+	3FeO

THE ANALYSIS OF SOME ALUMINIUM ALLOYS.

BY J. H. STANSBIE, B.Sc.(LOND.), F.I.C.

The very rapid increase in the use of aluminium and its alloys for a variety of purposes has brought the metal into great prominence, and the analysis of the alloys for manufacturing needs has become of considerable importance. Much excellent and accurate work has been done in investigating methods of determining the impurities in the commercial metal and the constituents of its alloys. One of the latest contributions to the subject is by Mr. Withey of the National Physical Laboratory.

For works purposes, however, the methods of the investigator take up too much time, and shorter though less accurate ones must be used. But, considered from the practical point of view, this is not of importance, for as a rule an alloy is analysed because either it is found to be suitable for the work to which it is to be put, or it has failed to pass the usual tests, and the reason for its failure must be made clear. Now it may be contended that an analysis which gives the content of a constituent to within 0.1 per cent., or, in some cases, even more, is sufficiently accurate for the manufacturer, as he cannot hope to get within closer limits in making an alloy from a given formula.

A description of methods by which fairly rapid analyses of aluminium alloys may be made will, perhaps, be found useful, and may invite criticism as to their application. The writer claims nothing in the way of originality, but only the adaptation of known reactions to his needs; and will be pleased to know of any modifications which will either shorten the work or make it more accurate.

The alloys of aluminium which generally come under investigation contain one or more of the following metals:—zinc, copper, manganese, nickel, magnesium, tin, lead, and iron. The last two metals are commonly present as impurities introduced by the metals used in the production of the alloys. In some cases, however, the percentages of both lead and iron indicate that they have been purposely added. Silicon is always present as an impurity in the principal metal.

Preparation for analysis. If the alloy is supplied in bulk, sawings obtained by means of a moderately fine metal saw give good results. Turnings, drillings, or borings are not so convenient.

Silicon, copper, and manganese.

Treat 1 gram of the sawings with a mixture of 5 c.c. of nitric acid and 20 c.c. of dilute sulphuric acid (1 in 4). Digest on the hot plate till the metal is nearly all dissolved; add 1 or 2 c.c. of hydrochloric acid, and evaporate to fuming. A cover glass placed on the beaker should not condense any moisture. Treat with water and heat till all soluble matter is dissolved. Filter through an ashless filter into the beaker used for electrolysis.

Silicon. Ignite the filter paper in a weighed platinum crucible and weigh. Add 1 or 2 c.c. of hydrofluoric acid to the crucible and evaporate to dryness. Moisten the residue with water and add 2 or 3 drops of strong sulphuric acid from the end of a glass rod. Heat carefully and ignite at a red heat. Weigh. The loss in weight is taken as silica and is calculated to silicon.

As is well known, the residue may contain silicon as well as silica, but this may be neglected for present purposes. If the presence of lead is suspected the filter should be burnt in a porcelain crucible and transferred to the platinum one for evaporation. Any lead sulphate which passes through the filter will not interfere with the succeeding operations.

Copper. Add 2 c.c. of nitric acid to the solution in the beaker for electrolysis, and deposit the copper

on a clean platinum cathode. If a rotating cathode is used a current of 2 amperes at a pressure of 4 volts gives good results. The addition of nitric acid causes the copper deposit to be cleaner. The weight of the deposit gives the copper content.

Manganese. Transfer the solution from the electrolytic beaker to a conical flask. Add from 1 to 2 grms. of sodium bismuthate and shake well for 3 or 4 minutes. Set aside for a short time to settle, and then filter through an ignited asbestos filter, using a filter pump. Wash well with a 2% nitric acid solution. Add a measured volume of standard ferrous ammonium sulphate in excess. Titrate back with potassium permanganate solution. The percentage of manganese is calculated from the volume of the iron solution required to decolorise the solution containing the manganese as permanganate.

A solution of ferrous ammonium sulphate containing 10 grms. of the salt and 10 c.c. of strong sulphuric acid in 500 c.c. is of convenient strength and 1 c.c. = 0.000562 grm. of manganese. This solution undergoes very little change on standing.

The permanganate solution should be of approximately the same strength, and the simple plan is to run in another 5 c.c. of the ferrous solution to the original solution, titrating back as before. In this way the value of 5 c.c. of the solution (ferrous) in terms of the permanganate is known, and a simple multiplier found for determining the excess of the ferrous salt added in the first instance. Then vol. of ferrous solution oxidised $\times 0.000562$ = weight of manganese in 1 gram of the alloy.

Copper, iron, lead, zinc, nickel, manganese, magnesium.

Add 60 c.c. of 10% sodium hydroxide solution to 2 grams of the sawings and digest on the hot plate till all action ceases. Allow to cool, add a little water, but keep the bulk of solution small. Filter through a pulp filter, collecting the filtrate in an electrolytic beaker. Wash the residue with small quantities of hot water. The beaker containing the filtrate and washings should not be more than two-thirds full.

The solution contains aluminium and zinc, and is subjected to electrolysis. The zinc is deposited on a copper-coated cathode by a current of 0.6 to 0.8 ampere passed for about 45 minutes, using a rotating cathode. The deposit should be well washed with cold water from a wash bottle while over the electrolytic beaker, and then vigorously moved round in a beaker containing distilled water to remove the last traces of the soda solution. It is then ready to be dipped into alcohol, dried, and weighed. The weight of zinc in 2 grams of the alloy is thus obtained.

Messrs. Ibbotson and Aitchison state that the zinc deposit is free from aluminium and this is also the writer's experience. The deposits of copper and zinc may be dissolved from the cathode, and redeposited without loss of weight.

The solution may be used if required for the determination of the aluminium, but in that case it should be diluted to 500 c.c. and 50 c.c. taken. It is sufficient, however, to take the aluminium by difference, when the other constituents have been determined.

The black residue on the pulp may contain copper, iron, lead, nickel, manganese, and magnesium, and is treated with nitric acid (5 c.c. of strong acid and 7 c.c. of water) in small quantities at a time, washing with hot water after each addition. The solution is collected in an electrolytic beaker, 3 c.c. of sulphuric acid added, and the copper deposited on the cathode. A check on the metal is thus obtained. If lead is present it will show on the anode. In that case the peroxide is allowed to dissolve off the anode and the solution evapor-

ated to fuming. A little water is added, and the beaker allowed to stand for the lead sulphate to settle. The lead is determined in the usual way. If more than 1% of iron is present, the pulp will be dark coloured, and should be treated with hydrochloric acid and washed. The washings are added to the filtrate containing the bulk of the iron. If manganese is present it is already known from the preceding operations.

A few c.c. of hydrochloric acid to form ammonium chloride is added to the filtrate, or to the solution if lead is absent, and then ammonia in slight excess, together with 10 c.c. of ammonium acetate if manganese is present. It is then boiled for two minutes, and the precipitate containing iron and aluminium filtered off. (Traces of aluminium are always retained on the pulp, and pass through with the other metals when the residue is dissolved.)

The filtrate may contain manganese and magnesium. The former is removed by hydrogen sulphide, and the filtrate from the sulphide boiled to expel excess of gas, or the manganese may be separated by bromine and ammonia in the usual way. The magnesium is precipitated as phosphate. This method is recommended by Mr. W. Gemmell.

The precipitate containing the iron and aluminium is dissolved in hydrochloric acid, the solution neutralised with sodium carbonate, and one or two drops of the acid added to clear. The solution is then raised to boiling, and poured slowly into a boiling solution of sodium hydroxide containing about 5 grams of the alkali. The iron is thus precipitated free from alumina, and is filtered off. The precipitate after well washing is dissolved in hydrochloric acid, reprecipitated by ammonia, and the iron determined.

An alloy containing tin can be treated directly in the usual way with nitric acid, and the tin separated as oxide.

The analysis of the alloy given below was carried through on the lines indicated above :

Aluminium	= 83.16 (by difference)
Zinc	= 11.54
Copper	= 3.30
Iron	= 0.62
Manganese	= 0.49
Silicon	= 0.23
Lead	= 0.31
	100.00%

The Rev. F. G. Belton has furnished me with the following description of a process for the determination of nickel in aluminium alloys which he is investigating with, up to the present, very fair results.

1 gram of the alloy is dissolved in 25 c.c. of caustic soda solution (100 grams in 500 c.c.) and allowed to digest for about two hours. The solution is diluted somewhat with water and filtered through a pulp filter, the residue is washed with hot water, and dissolved in 5 c.c. of concentrated nitric acid to which has been added 7 c.c. of water. To the solution thus obtained is added 3 c.c. of concentrated sulphuric acid and the copper is estimated electrolytically. The solution is now made up to about 150 c.c. and 10 grams of tartaric acid together with 3 grams of ammonium chloride are added to keep in solution any aluminium that may be present. Ammonia is added to the solution in slight excess; too great excess is to be avoided as it retards the precipitation of the nickel. The distinctly alkaline solution is now heated to about 50° C.; a higher temperature is to be avoided. A sufficient quantity of dimethylglyoxime (prepared as a 1 per cent. solution in absolute alcohol) is added to precipitate the nickel as dimethyl nickel glyoxime. The precipitate is flocculent and bright red in colour, and does not settle easily. It is allowed to stand for about 15 minutes at 50° C. and then filtered either on pulp or ordinary filter

paper, the latter seems preferable when the nickel is present in fairly small quantities. The dimethyl nickel glyoxime is slightly soluble in water, and the precipitate should be washed with a dilute solution of ammonium nitrate. As the nickel compound is volatile it should be dried as follows :—The wet filter paper containing the nickel is wrapped up in a second wet filter paper and placed in a porcelain crucible (when a pulp filter is used it is best to wrap up in two wet filters); this is introduced at once into the front of the muffle so that it may char quickly; when the charring is complete the crucible is placed in the hottest part of the muffle, and the precipitate is ignited to green nickel oxide.

DISCUSSION.

Mr. JOHNSON said he could testify to the care and interest with which Mr. Stansbie had got together the details of his paper. They had dealt at the local laboratories with many of the alloys.

Mr. HEATHCOTE said that sometimes iron was found to be present in aluminium castings, but where it came from he could not say.

Mr. LANTSBERRY stated that when 25 alloys had to be examined in a day, and it was found that some methods necessitated the use of expensive apparatus, one had carefully to consider which method should be used. Nickel was sometimes contaminated with iron. That was due to the fact that insufficient tartaric acid had been used.

Mr. STANSBIE, in replying, said that by the use of sodium sulphide all zinc could be precipitated.

ELECTROLYTIC COPPER.

BY F. JOHNSON.

The commercial electrolytic refining of copper commenced in the year 1860 by Elkington at Pembrey, S. Wales, batteries being used as a source of current. A very high-grade commercial copper (best select) had been produced by the Welsh process, but its purity was variable and its electrical conductivity neither sufficiently high nor regular; the process moreover failed to recover the precious metals.

In the "eighties," however, electrolytic copper refining was established, on a satisfactory footing and has since then grown and developed with remarkable rapidity and technical success.

The series and multiple systems are both in vogue, the former having been restricted in its use owing to the employment of a suitable generator for the multiple system.

In a paper read at the International Engineering Congress at San Francisco, Sept. 20—25, 1915, A. C. Clark stated that the quality of electrolytic copper had greatly improved. Early production was irregular in quality, owing to the presence of impurities, and sold at a discount from the price of Lake copper. At the present day the disparity in price still exists, although electrolytic copper is now uniform in quality and purer than Lake copper. The early irregularities in quality were due to engine or generator troubles, insufficient circulation of electrolyte, undue variation in temperature, irregular chemical composition of solution, etc. The present-day cathodes of electrolytic copper are usually tough and smooth and assay 99.96% copper, the conductivity being frequently 102% of that of Matthiessen's standard (the best then supposedly obtainable) in 1865.

Cathodes are now melted in furnaces having a capacity of over 200 tons. Silica brick has now been replaced by magnesite or chrome brick, and a considerable saving in slag production and cost of repairs has thus been effected.

The author has many times given attention to

the substitution of a neutral or basic material such as chrome or magnesite brick for silica brick in copper refining furnaces, but has invariably had to reject the idea on the grounds of expense. It is a significant fact that in the large refineries of the United States, according to the direct testimony of a practical American metallurgist, the introduction of these bricks has actually resulted in economies in slag production and repairs. Such economies would be inevitable, but whether they are so great as to more than outweigh the increased initial cost is not stated.

It would appear as though a trial on a manufacturing scale in this country would not be without justification.

The cathodes are introduced into the furnace by charging machines and metal is tapped from the furnace and run into ingots or wirebars by the aid of some form of casting machine. In the Clark and Clark casting wheel used at the Raritan works, the copper is tapped from the furnace into a ladle, six bars being poured simultaneously into moulds set radially on the casting wheel.

Addicks, in a paper read at the same Congress, claims that the cost of refining on these lines is less than half that of refining in the best of the old hand-ladled furnaces.

Furnaces are charged at the rate of 140 tons per hour. Melting is accelerated by forced and induced draught and boilers are fired by the waste furnace-gases. With increase of size of furnace, coal consumption has decreased from 20% with an 18-ton charge to 10% with a 270-ton charge. Silica is not allowed to come in contact with the bath of metal, thus resulting in a reduction in slag production from 4 to 1%. Crushed coke of low sulphur content is used instead of charcoal to cover the charge, poling being carried out exactly as in the older process. Fettling is practically unnecessary in the basic lined furnace. The metal is ladled out at the rate of 40 tons per hour.

The figures quoted appear almost grotesque in their magnitude when compared with those of English practice, and it is extremely doubtful whether the latter will ever conform to the high efficiency of copper metallurgical practice in the United States, owing to the fortunate position which that country enjoys in her possession of such vast mineral resources. There are, moreover, other very striking points of difference between English and American practice. Most English refineries are worked in conjunction with rolling mills and in many instances firms have to manufacture an extraordinary variety of materials.

It is no uncommon thing in an English refinery to produce in a single week arsenical billets and cakes, B.S. ingots, and high conductivity wirebars from the same furnace.

It is generally arranged for a charge or so of ingot copper to succeed an arsenical charge prior to melting a charge of electrolytic copper, the ingot charge serving to wash the furnace and being less susceptible to the contamination of any residual arsenical copper from the preceding charge. Owing, therefore, to the fluctuating character of the trade and the multifarious requirements of customers in a country where hitherto the volume of trade has never been sufficiently large to justify the enormous initial expenditure involved in the American system of specialisation, furnace refining plants remain small and electrolytic refining is left almost entirely to the United States, a relatively small amount being also done in Australia and Japan. Nevertheless, high conductivity copper wire, sheet, etc., of first class quality is produced in this country and great credit is due to English refiners for being able to maintain such a high standard of quality in spite of their severe handicap.

There is something to be said in favour of the old system of hand-ladling as regards the physical condition of wirebars and cakes. As the author

has pointed out, the level "set" of wirebars, etc., is entirely the result of a compromise between occluded gas and cuprous oxide. With excess of the former the metal would be "overpitch" and spongy, whilst an excess of the latter would result in the metal being "underpitch" and brittle.

With hand-ladling, solidification proceeds as the mould fills and little time elapses from the moment the last ladleful is in the mould until the moment of complete solidification; hence the opportunity afforded for the escape of occluded gas is small and the "set" will be normal.

With machine ladling, unless the rate of pouring be retarded, the mould will fill very rapidly, there will be a greater lapse of time before filling of mould and solidification, and therefore greater opportunity for the release of occluded gas. With less gas in the metal, shrinkage will have less opposition and will occur at local points, forming minute "pipes" or shrinkage-cavities which have communication with the outside air and therefore become oxidised. Their formation is also encouraged by the rapidity with which the mould is filled.

The occurrence of these may be detected by the appearance of black specks on the surface of a solidifying ingot or wirebar. Their presence is obviously inimical to the production of perfect homogeneity of structure and would adversely affect the physical properties of wire, sheet, or rod, to say nothing of their responsibility, in part, for troubles in the mill.

* In the United States, furnaces are classified into anode and cathode furnaces. In the former the charge consists of rough Bessemerized pigs which undergo a refining in part and are cast into slabs of special size and shape which serve as anodes in the electrolysing vats.

The electric current passing from these anodes through a strongly acid bath of copper sulphate deposits copper on specially prepared cathode starting sheets, which, when coated to a sufficient thickness, become the cathodes of commerce, and are transferred to a cathode furnace, in which they are melted, brought to correct "pitch," and ladled out into ingot, cake, or wirebar.

The recovery of precious metals from the electrolysing vats, in the form of insoluble slimes, plays a big share in the commercial success of the process.

Addicks, in a paper to the American Inst. of Metals, vol. VIII., 1914, p. 165, makes the following remarks:—"It is quite evident that copper entering an electrolytic refinery must entirely lose its identity and that the purity of the resulting cathode copper will depend upon the conditions under which electrolysis is carried out rather than upon the momentary quality of the day's anodes. Therefore it is not necessary to consider whether the input be converter bar, black copper or Lake mineral when buying electrolytic, but simply whether the product meets the accepted standards of quality of electrolytic copper."

"Electrolytic cathodes should be very pure. They generally run about 99.95% copper, much of the remaining 0.05% probably being hydrogen.* The metallic impurities generally total about 0.02%. Except for the fact that individual cathodes may vary more or less in impurity content, they are ideal material for brass making. Copper producers, however, have never encouraged the sale of cathodes as there is apt to be some shrinkage in weight during shipment owing to the comparative ease with which nodules or small pieces can be detached either accidentally or intentionally. Also cathode shipments unbalance the work in a refinery in proportion to their magnitude, as melting cathodes into market shapes is a distinct part of the process."

* See note on hydrogen later.

" This melting is done in a reverberatory furnace and originally was an exact duplication of the fire-refining already described.

" As the cathode copper is already pure, a simple melting is all that should be required, but molten copper is so susceptible to contamination that until recently the gases from combustion, iron in the rables, etc., were absorbed to a sufficient extent to require actual refining. At the present time large quantities of cathodes are being added to the molten charge during ladling and earlier, basic furnaces being substituted for acid ones—thereby suppressing slag formation—and attention is being paid to keeping coal ashes from blowing over from the firebox so that a true melting without refining is being approached. It is well known that cathode copper when drawn into wire will show an electrical conductivity some 2% higher than the same copper after a subsequent fire refining. This is probably due partly to the fact that chemical impurities in the cathode are chiefly present as a mechanical mixture due to adherence of anode slimes which are dissolved in the copper when melted, making a high resistance matrix around the copper crystals when the metal is cast and cooled; and partly to contamination during melting.

" It seems probable that the conductivity of perfectly pure soft copper is in the neighbourhood of 103% of the Matthiessen's standard in common use."

The author is not in agreement with Addicks regarding the explanation offered of the increase in resistance by the formation of an intercrystalline matrix. As will be shown later, it is the impurities which enter into solid solution which have the most serious influence on electrical conductivity and that influence persists even after the elimination by annealing of any concentration of impurity at the crystal boundaries, such as may result from "coring" or micro-chemical heterogeneity. Arsenic, for instance, is discernible under the microscope in cast specimens by the existence of arsenic-rich fringes surrounding "cores" richer in copper.

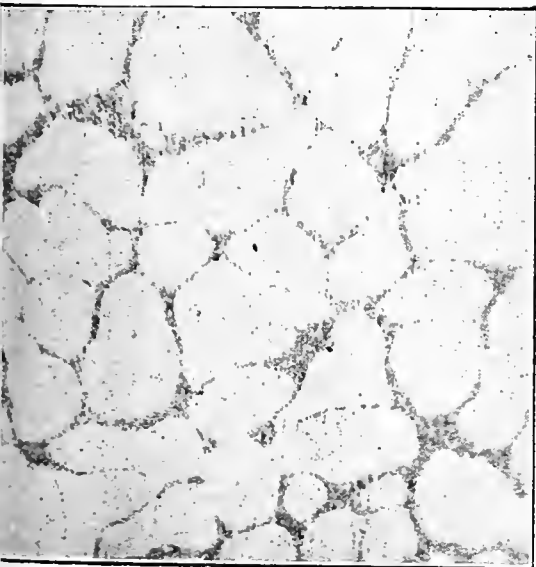


FIG. 1.

Copper containing 0.26% oxygen as cast. Magn. 200 dia

When such copper is drawn into wire (and this process requires many annealing operations) the "cored" appearance will have completely disappeared and the structure will not be distinguishable from that of pure copper, but the resistance

will nevertheless be not appreciably less than that of the cast specimen.

Whilst dealing with the question of intercrystalline matrices it is a matter of interest to point out that in commercial copper no substance forms so definite and unmistakable a matrix as cuprous oxide (in the form of copper-cuprous oxide eutectic); and yet no substance has, in equal proportions, so harmless an influence upon conductivity.



FIG. 2.

Copper containing 0.20% oxygen. Magn. 200 dia.
Annealed 5 hours at 900° C.

From the accompanying photomicrographs, prepared by the author, it will be seen how annealing causes coalescence of the cuprous oxide globules in the eutectic and eventually would destroy the intercrystalline continuity of the latter. What effect, if any, this coalescence has upon conductivity the author has not yet determined.

Refining of anode slimes.

The old fire-refining processes are still in vogue but are looked on with some disfavour owing to the high metal losses.

By simply fusing the slimes three products are obtained, viz. :—

Bullion, containing lead, copper, and the precious metals.

Matte, containing copper, silver, selenium, and tellurium.

Slag, containing arsenic, antimony, and similar readily oxidised metals.

The formation of matte may be largely reduced by roasting the dried slimes before melting and dissolving out the oxides of copper as sulphate. The base bullion is refined in a small reverberatory furnace with basic hearth by the use of air under pressure, and nitre. Part of the slag is returned to the anode furnaces, part remelted to cause a separation of entangled prills of metal, and the remainder recharged into the refining furnace.

Silver is parted from gold usually by an electrolytic process, the gold slimes being treated for the recovery of platinum and palladium. The flue dust from the silver refinery is leached and the selenium recovered by reduction with sulphur dioxide.

When the anodes assay 99%, and over, the remainder may contain any proportion of arsenic, nickel, etc., if the electrolyte contains from 2.5 to 3% copper and 12% free sulphuric acid. Purification of the electrolyte may be effected by diverting a proportion every day into separate tanks

containing insoluble anodes. Copper and arsenic, etc., are deposited under special conditions at the cathode in a loose condition.

During the process of electrolysis, the solution, if stationary, will, owing to the differential rates at which the anode passes into solution and the copper deposits on the cathode, become heterogeneous in composition. There is a tendency to stratify or form layers of various compositions. In order to avoid this stratification, with its attendant troubles of short circuiting, disintegration of anodes, irregularly shaped cathodes, etc., the electrolyte is usually circulated. The rate of circulation is important, as if too slow, the stratification is not obviated and if too rapid the cathodes are contaminated by the suspended slimes, thus lowering their purity and resulting in losses of the precious metals.

Pyne ("Solution stratification as an aid in the purification of electrolytes," Amer. Electro-Chemical Society, 1915) proposes to take advantage of this stratifying tendency in order to secure a low copper content in the daily portion withdrawn for purification, and thus dispense with the operation of one of the two sets of insoluble anode tanks. This is effected by having two outlets, one at the bottom and one at the top, and so regulating the inlet flow that a weak solution withdrawn from the upper outlet is delivered to the insoluble anode tanks, while the strong solution withdrawn from the lower outlet is returned to the circuit.

Schröder (Australian Mining Standard, 1910, 44, pp. 659 to 660, and 1911, 45, pp. 7 to 8) found that the loose cathode deposit in the second set of insoluble anode tanks contained Cu 71%, As 3.5%, Bi 1.6%. The firm cathodes were not so impure, containing Cu 98.2%, As 0.18%, Bi 0.25%.

Influence of impurities on conductivity.

The table below gives analyses and physical properties of some well-known brands of commercial copper. An examination of the figures given will reveal the variety of the impurities and the minuteness of the proportion in which these impurities exist. Thus it is necessary that the chemist whose

a study of the figures, it is hardly possible that the oxygen content could be so low in wirebar-copper as is shown in two cases quoted by Guillet. It is notorious that the extremely pure electrolytic copper produced in the United States requires less oxygen than the less pure European brands, but the author has never found by direct determination proportions of oxygen so low as 0.0191 and 0.0063% in commercial copper.

The conductivity of two samples of Lake copper is given as over 101%, in spite of the presence of 0.07% of silver, which, according to Addicks, would, *per se*, lower the conductivity to practically 100%. Arsenic, iron, nickel, and sulphur are also present, and considerably more oxygen than in the samples quoted by Guillet, yet the conductivity is superior to that of Guillet's purer samples.

Hofman states that the conductivity of cast copper is about 3.5% lower than that of annealed wire. The author is not prepared to accept this figure, but judging by the results of his annealing experiments, showing the breaking up of continuity of the eutectic and causing coalescence of the cuprous oxide globules, as already described, it would appear that some improvement in conductivity might be expected to accompany such structural change. The increase in density as a result of the closing up of pores by rolling and drawing would also contribute towards increase of conductivity.

The influence of oxygen both throughout the refining process and as a permanent constituent of the finished metal is of profound importance.

It may be accepted as an indisputable fact that there is at present no known method of producing commercial ingots, wirebars, etc., of copper, having a level surface other than by the process of "poling." This process, as the author has already indicated, introduces gases into the copper which oppose the natural shrinkage of the metal and in the proportion necessary for the production of "tough-pitch" copper do not have an appreciably harmful influence. Any such influence is either mitigated by the subsequent mechanical treatment of the metal or, if the copper is destined to be used for making alloys, eradicated by

Chemical analyses of refined copper.

Element.	Lake, wire bar.	Lake, arsenical ingot.	Electrolytic, wire bar.				Best selected English.
Cu + Ag	99.900	99.4385	99.970	99.895	99.9548	99.9780	99.5510
Cu	99.890	99.4131	99.967	99.893	99.953	99.976	99.530
Ag	0.0096 (2.8 oz.)	0.0254 (7.41 oz.)	0.0027 (0.79 oz.)	0.0020	0.0015	0.0020	0.0210
Pb	0.0031	0.0027	0.0024	0.0072	0.0010	0.0056	0.1331
Bi	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
As	0.0062	0.3183	0.0006	0.0001	0.0000	0.0001	0.0071
Sb	0.0000	0.0000	0.0000	0.0006	0.0000	0.0008	0.0037
Se + Te	0.0020	not det.	0.0000	0.0022	0.0026	0.0014	0.0066
Fe	0.0028	0.0056	0.0023	0.0028	0.0038	0.0044	0.0044
Ni	0.0000	0.0135	0.0030	0.0010	0.0028	0.0018	0.1112
Zn	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S	0.0016	0.0071	0.0026	0.0023	0.0026	0.0016	0.0074
O (by diff.)	0.0753	0.2143	0.0191	0.0888	0.0315	0.0063	0.1705
Conductivity, annealed	96.43	—	100.84	99.78	100.45	100.70	—
Conductivity, hard-drawn	93.81	—	97.93	96.65	97.64	97.93	—
Difference due to hard drawing	2.65	—	2.91	2.13	2.81	2.77	—
Tensile strength, lb. sq. in.	67,599	—	65,000	67,800	66,300	66,550	—
Twists in 6 in.	17	—	18	27	34	53	—
Elongation, per cent.	103	—	1.65	1.15	1.04	1.08	—
Bends, annealed	11	—	14	14	14	22	—
Diam. of wire, in.	0.080	—	0.080	0.080	0.080	0.080	—

duty it is to make analyses of modern brands of copper must be a man of first-class training and considerable experience.

There is one feature of the analyses that calls for criticism and that is the reporting of the oxygen content by difference. As may be gathered from

remelting. It has been shown that "poling" removes the excess of oxygen in a furnace charge, and it is now necessary to explain that if the process were continued until the last traces of oxygen were removed, the resulting metal would be "overpoled" and unfit for use for two reasons:—

(1) The copper here would contain too much dissolved arsenic, and all ingots or castings would be spongy owing to the release of such gas during solidification.

(2) The protective influence of the oxygen which is of necessity retained in the "tough-pitch" copper extends beyond the checking of gases from dissolving in excess to the neutralising of the harmful effects of certain impurities.

Thus all furnace-refined copper will contain some oxygen in the form of cuprous oxide, and the author is convinced that the lower the oxygen content can be kept, with safety, the better, since with the useful functions already mentioned the technical advantages of oxygen cease.

The influence of oxygen on the conductivity of copper for electrical purposes has been dealt with by Addicks (Trans. Amer. Inst. Min. Eng., 1906, p. 18), T. Johnson (Proc. Birmingham Metall. Soc., 1906), and Hoffman, Hayden, and Hallowell (Trans. Amer. Inst. Min. Eng., 1907, 38, 147). Addicks and the last-mentioned investigators prove that the electrical conductivity of electrolytic copper is improved by the presence of a certain small quantity of oxygen. Addicks, indeed, after investigating the influence of a large number of impurities, found that oxygen alone has a beneficial influence, but beyond that proportion which is usually found in "tough-pitch" copper, the conductivity again commences to fall. The author (J. Inst. Metals, No. 1, 1912, pp. 242-243) has suggested that this influence of oxygen is not a direct but an indirect one, the oxygen having the ability to change the condition in which certain impurities in minute traces exist in copper. If, for instance, a trace of antimony (of the order of 0.002%) is retained in electrolytically-deposited copper, the antimony will be retained in solid solution in the copper if melted down free from access of oxygen, and the copper in consequence will not possess its highest possible conductivity.

The admission of a small percentage of oxygen, however, affects the condition in which antimony can exist in copper as shown by the author (J. Inst. Metals, No. 2, 1912). Greaves (J. Inst. Metals, No. 1, 1912) has also shown that the electrical conductivity of antimonial copper is slightly raised by the addition of oxygen.

Therefore, it is not surprising that, by preventing some of the antimony from entering into solid solution as dissolved Cu_3Sb —in which condition it doubtless exerts its maximum deleterious effect—the oxygen indirectly improves the electrical conductivity.

Naturally, that antimony which was prevented from entering into solid solution was combined with oxygen in certain proportions, forming "oxides" or isolated particles which would not offer the same resistance to the passage of an electrical current as the antimony would do when retained in solid solution.

The figures of Addicks are interesting and are given below.

Oxygen.	Elec. conductivity.
%	%
0.020	100.7
0.050	101.4
0.100	100.5

Influence of arsenic upon electrical conductivity.

Addicks, T. Johnson, and Hiorns and Lamb have given some attention to this subject and although there is some disparity between their results, they all agree that small quantities of arsenic are absolutely fatal in copper required for electrical purposes. A selection of results is given here-
with:—

Percentage of arsenic.	Investigator.	Electrical conductivity.
0.004	Addicks.	% 99.6
0.007	Addicks.	96.8
0.013	Addicks.	93.2
0.04	T. Johnson.	92.4
0.05	Hiorns and Lamb.	79.4
0.06	T. Johnson.	82.0
0.098	Hiorns and Lamb.	69.5
0.14	Addicks.	62.4
0.182	Hiorns and Lamb.	61.1

It will be noticed that the last result of Hiorns and Lamb disturbs the comparatively satisfactory agreement between the previous results. Such discrepancies as exist are probably explainable by the fact that none of the investigators attempted to determine the amount of oxygen (if any) in their alloys. That this element can affect the influence of arsenic on the conductivity of copper has been shown by Greaves (J. Inst. Metals, No. 1, 1912).

The following is an example from Greaves' paper:—

Composition.		Relative conductivity. (Copper = 100).	Relative conductivity. Copper-arsenic without oxygen.
Oxygen.	Arsenic.		
% 0.10	% 0.49	% 35.2	% 42.4

The most systematic study of the influence of impurities on conductivity has been made by Addicks and a review of his results establishes some important points in connection with the relations between influence on conductivity and structural condition.

A large number of the elements have a comparatively slight effect, whilst some have an effect which seems out of all proportion to the minute quantities involved.

If these elements are classified according to their physico-chemical behaviour, when alloyed with copper, some clue will be afforded as to the reasons for their differing influences on conductivity.

Group 1. Elements which exist as insoluble constituents, either pure metal or compound, viz.:—Lead, bismuth (as pure metals), oxygen, sulphur, tellurium (as compounds).

Group 2. Those which enter into solid solution but not as intermetallic compounds, viz.:—Silver, gold, zinc, iron, tin, (cadmium?).

Group 3. Those elements which enter into solid solution as compounds, viz.:—Antimony, silicon, phosphorus, arsenic, aluminium.

It will be seen that, roughly, this grouping of the elements has a connection with influence on conductivity.

The specific resistance of the individual element is not an index as to its influence on conductivity (cf. figures for silver and lead), nor is its place in the Periodic Table of Mendeléeff, nor its atomic volume.

The author does not put forward his grouping as a complete solution of the problem, but it appears to be a step towards establishing a solution. Other factors which probably enter into the question are the specific resistance of the elements, and of the compounds which are held in solid solution. For instance the intensity of the effect produced by silver, gold, zinc, and iron increases in the order of these metals in the table of conductivities. Tin appears to act in an exceptional way.

The most striking fact, however, is the profound depression of conductivity produced by an impurity which enters into solid solution as a compound, e.g.

phosphorus as Cu_3P , arsenic as Cu_3As , aluminium as Cu_3Al , and antimony as Cu_3Sb .

In this category silicon acts in an exceptional manner as, according to Vigoureux and Lebeau (*Comptes Rendus*, 1906, 142, 87 and 151) it forms the compound Cu_3Si , which enters into solid solution.

The impurities given in Group I, which exist as insoluble constituents, have an influence on conductivity roughly proportional to the quantity present, which is, in commercial electrolytic copper, practically negligible.

Influence of annealing upon cold-rolled copper.

In a most interesting paper by Bardwell (*Bull. Amer. Inst. Min. Eng.*, 1914, 2075) the effect of annealing temperatures on electrical conductivity and the mechanical properties is described.

Six cold-rolled rods of copper, the oxygen content of which varied between 0.036 and 0.070%, were annealed in an electrically heated muffle. There was a great similarity in the behaviour of all six specimens. A very small increase in electrical conductivity is produced until a temperature of 300°C . is reached, at which temperature the increase is extremely rapid, reaching a maximum at 430°C . Above 650°C . there is a marked falling-off in conductivity.

This falling-off in conductivity as a result of annealing at too high a temperature is a result which one would scarcely have been led to expect from a knowledge of works practice. There is no indication given that the electrical conductivity would be recovered by subjecting the over-annealed samples to further cold-drawing and annealing at a safe temperature. The increase in conductivity at 300°C . occurs conjointly with a rapid fall in tensile strength and increase in elongation. These points are well brought out in the curves in Fig. 3.

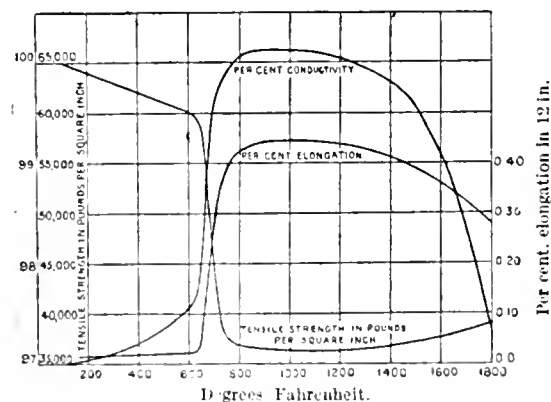


FIG. 3.—Variation of Physical Properties of Copper Wire with Variations in Annealing Temperature.

The falling off in conductivity at high annealing temperature is so serious as to call for further investigation and confirmation.

Credner (*Z. physik. Chem.*, 1913, 82, 457) attributes the increased resistance of a stretched wire to the orientation of the lamellae. He claims that there is no evidence of the formation of an amorphous phase. Torsion or bending is said to produce cavities with accompanying increase of resistance which is not removed by annealing. Bardwell points out that twinning is conspicuous in the crystals of annealed copper, the appearance of "polysynthetic" twin crystals coinciding with decrease in conductivity and elongation.

The author is of the opinion that until a rational and generally accepted explanation of the

hardening of metals by cold work is established, the increase in electrical resistance accompanying that phenomenon cannot be satisfactorily explained.

In conclusion, it may safely be said that there appears to be no prospect of any marked improvement in the purity, quality, and conductivity of electrolytic copper if produced under the best modern conditions.

Conductivity is affected adversely by heat, by impurities, and by hard drawing. Of no single element can it be said that its introduction to copper has any other effect than a lowering of electrical conductivity. In the case of oxygen, its power of altering the chemical condition in which other impurities exist and thus lowering their power of resistance may bring about a corresponding gain in conductivity, which may more than offset the loss of conductivity caused by the oxygen *qua* cuprous oxide. Those impurities which are most detrimental to the working properties of copper have least effect upon electrical conductivity. There is (according to Bardwell) a critical annealing temperature range beyond which a falling-off of conductivity may be expected.

The papers by Dr. Lantsberry and Mr. Kent Smith will be published later.

DISCUSSION ON PATENT LAW REFORM.

Dr. A. RÉE, in opening the discussion, said:—A good many people are taking an interest in Patent Law reform now, who gave no attention to this rather dry and uninteresting subject a few years ago. The fact is, they are at last realising that much that is not quite satisfactory in our industrial position may perhaps be due to our Patent Laws, which work in some respects against rather than in favour of this country as a whole. Gradually a system has arisen which has tended more and more to obscure the original and most important object of a Patent Law, the furthering of new industries in the country granting this greatest of monopolies. And when you come to think of it, it is not so very surprising that this should have happened. The formulating of the laws, their interpretation and administration, are almost necessarily left to what may be broadly described as certain professional elements, particularly to lawyers and patent agents, many of whom naturally look upon these questions from an entirely different point of view to that of the business man and manufacturer. For the former is primarily concerned in looking after the interests of his clients and incidentally his own, for which no one can legitimately blame him. And yet this is no doubt partly responsible for a good deal that is unsatisfactory. In the formulating of new measures and recommendations, manufacturers and business men have rarely been consulted, and if they have, their views have generally been subordinated to those of the professional element. And who has guarded the interests of the State? Practically no one. Hence have arisen some of the worst abuses.

In no department has this been more apparent than in the much-discussed question of compulsory working and licences. About 30 years ago these subjects became what I believe Americans would call live ones in the Manchester Chamber of Commerce, and they have continued to occupy the attention of its Engineering, and especially its Chemical, Section, almost ever since. We worked for years and years, trying to get the Board of Trade to realise the need for the reforms we advocated, particularly in respect to compulsory working. Finally, we came within measurable distance of success. It was when our present Prime Minister was President of the Board of Trade. With that extraordinarily quick per-

ception that is his, he saw at once the great possibilities of benefit to this country if the measures for which we stood were adopted. The 1907 Act embodied these measures, and had Mr. Lloyd George remained a little longer at the Board of Trade, we should not to-day have to ask for a reversion to the condition of things in respect of the compulsory working clauses which obtained and were incorporated in that 1907 Act, but which were rendered so largely nugatory by a judgment of Lord Parker shortly after that Act was passed.

Well, now, since the war the eyes of a great number of people have been opened to the mistake of granting foreign owners of British patents all those great and far-reaching privileges that a patent monopoly confers without exacting from them any sort of countervailing advantage to this country. We were really working under the most quixotic form of protection imaginable, viz., the protection of the foreign holder of British patents to the detriment of the home manufacturer. The former secured his patent in order to prevent manufacture here, not in order to establish a new industry, far and away the most important reason for the granting of a patent monopoly. The German owners of British patents were, needless to say, fully aware of those benefits to themselves. It is not, therefore, surprising to find that they were the most embittered opponents of any measures destined to alter the laws in the direction desired by the Manchester, as well as by the Associated Chambers of Commerce. For years and years every device was used to prevent the attainment of the objects the latter had in view. This went so far that I understand representations were made that if we changed our laws in the direction of enforcing compulsory working this would inevitably lead to retaliation. It is amusing that this threat was used by the representatives of those German concerns who themselves had at the time clauses in their Patent Act far more stringent than ours.

The question is frequently asked why will not compulsory licences do instead of compulsory working? The former were tried here for a great many years and were a complete failure, i.e., practically no licences were applied for over a period of at least 20 years. The principal reason was that most chemical patents require years of experience in working before they become a commercial success. Suppose indeed after a long period one were to obtain a licence for, say, a complicated chemical process, all one would get would be almost useless. To have an industrial success, the licensee would have to devise special plant and all kinds of ingenious contrivances, which count for so much in the successful carrying out of an invention. These the foreign patentee would know but there would be nothing to compel him to divulge them to the licensee. The patentee would be years ahead in any case and would consider it quite natural to hamper and delay the licensee in every conceivable way. Unless indeed the latter had the goodwill of the patentee, which was rather unlikely after a big fight in the Law Courts involving great expense in time and money, all the licensee would finally get would not be worth having. How many chemical patents are there that are worked strictly in accordance with the final specification? Hardly any, those who have most experience will, I feel sure, admit. This is an explanation why so much of the legislation of the past decades in this respect has been a failure and why, in fact, compulsory licences were not sought. (To prevent and forestall criticism may I, however, make the reservation that what I have just stated does not apply to war time, when of course a totally different condition of things obtains.)

The question is sometimes put, What beneficial results can you point to as the result of the intro-

duction of compulsory working? Well I can cite many instances of industries that have been started in this country as a result of the 1907 Act or in anticipation that compulsory working would be introduced and effectively carried out. I will only mention the following: Linotype machinery, the British Westinghouse Co., the British Shoe Machinery Co., the Diesel engine manufacture, artificial silk, artificial stone and tiles (Hatschek patents), safety razors, metallic filament lamps, cinematograph films, gramophones, cash registers, artificial indigo, and a few pharmaceutical and artificial food products. However if there were only the well-known case of artificial indigo, I think that would in itself show how beneficial and in fact essential it is that there should be compulsory working. I have gone into this case so fully elsewhere that I feel it is unnecessary to recapitulate the details here.

It should always be borne in mind, that the compulsory working clauses in the 1907 Act were only effectively in force for about 15 months, i.e. until Lord Parker's judgment. Further there is this most important consideration, emphasised by the Comptroller-General in 1914, viz.—that he had good reason for believing that the fear of revocation of foreign-owned British patents worked abroad and not here had resulted in a good many foreign patentees granting licences on reasonable terms to British manufacturers to work their patents here. I am afraid, however, that this applies chiefly to mechanical patents and not to chemical ones. The latter are now a days often exceedingly complicated and to make them an industrial success needs years of intricate study and the devising of complicated machinery and the discovery of ways and means of carrying on all kinds of operations, which the patentee knows but does not communicate to the licensee. If the patentee had to work here himself he would take care to work under the most approved conditions known to him, and then on the expiry of the patent the manufacture would be established here on sound and competitive lines, instead of becoming a permanent monopoly abroad.

A very important point is also that compulsory working is more essential for us in this country than anywhere else. For where you have protective duties and industrial conditions are also otherwise favourable, it is manifestly to the patentee's interest to work his patent in that country himself or grant licences to existing manufacturers, giving the latter all the benefit of his acquired knowledge beyond what is contained in the patent specification. But under our system of fiscal policy a foreign patentee had not that inducement to manufacture here. So we needed the spur of compulsory working to induce him to do so on the penalty of losing his patent if he failed to comply. Only thus was it possible to counteract the positive evil that had grown up, whereby the granting of a patent to a foreigner who worked it in his own country but not here, resulted in the worst form of protection imaginable—a protection and a monopoly in favour of the foreigner, generally a German, to the detriment of the British manufacturer and to the serious loss and inconvenience of this country generally.

Now to make the compulsory clauses really effective we must revert to an interpretation of them, that existed prior to Lord Parker's judgment in the Hatschek case. The onus of proving non-working or inadequate working here of British patents worked abroad rested until then on the patentee. The need for this was already clearly stated by Mr. Lloyd George. Then came this unfortunate judgment of Lord Parker. The arguments used for putting the onus of proving inadequate working on the applicant for revocation were mainly on the grounds that it is unreasonable to call upon a defendant (the patentee) to

prove or disprove plaintiff's case. This really reduces the clause to an absurdity. For it is obvious that all the patentee has to do is to refuse any information as to adequate manufacture here, and how then is applicant to proceed to discover the facts? He may produce one witness after another to say that he is unaware of any manufacture in this country, but that is no proof of non-working. As the patentee escapes revocation of his patent if he works it here on an adequate scale, he should be prepared to justify his plea and prove that he manufactures here or that there is a good cause why he does not manufacture here. Then as to the contention that it would be contrary to the first principles of English law that defendant should be called upon to prove or disprove plaintiff's case, there are surely innumerable cases where this is done. Thus take the trader who applies to the Railway Commissioners for a lower rate and is entitled to call upon the Railway Co. (defendant) to prove that the rate is a reasonable one. Or take the case of the law in regard to receivers of stolen goods, where the obligation of accounting for the possession is thrown upon the supposed receiver (defendant). Or the case of the publican who as defendant has to show justification for serving men who may be drunk, rather than placing the onus of proof on the police. Or again the applicant for revocation ought to have the same means of discovery as any plaintiff in a Chancery suit, viz., by interrogatories.

It is of the utmost importance that a small amending Act be passed whereby the onus of proof of working is again put on the patentee. When this has been done we shall revert to the condition of things that was contemplated by Mr. Lloyd George in his Act of 1907.

In my advocacy I am primarily concerned for what I regard as the benefit of the State, which ultimately means all of us. I should like us to revert in fact to the original Patent Act, the Statute of Monopolies. My principal object, I confess, is to do all I can to stop what has been going on so long on a very large scale, i.e., Germans taking patents here to prevent manufacture here, working them abroad however, we thus creating a protected market for them there, at our expense, fostering their industries and damaging ours.

It should not be enough that part of the invention should be worked here but the whole of it. Thus did the Comptroller-General decide in an action for revocation, I think, in 1909. The importance of insisting on this will be apparent to all who have had close knowledge of what happened at the outbreak of the war, when one of the difficulties was not so much the production of certain patented products but the impossibility of obtaining certain intermediate substances necessary for the manufacture of the former.

I hope I have made it clear that those of us who advocate revocation do so not because we desire to destroy the patent but solely to enable us to use the threat of revocation of British patents worked abroad but not here.

Had we really insisted on this years ago in the case of chemical patents we should to-day have an organic chemical industry rivalling that of Germany. I dispute absolutely that it is primarily a question of education. If the patent law had been what the Associated Chambers of Commerce have asked for two or more decades ago there would have been plenty of suitably trained English chemists to carry on. A demand creates a supply. With a big demand for these chemists the Universities and higher Technical Colleges would have trained chemists not only as capable and brilliant as they have in the past, but in numbers fully adequate for the requirements of the industry.

Mr. A. G. BLOXAM said that Dr. Rée not only wanted to alter the Patent Laws but also to

abolish the principle of free trade. Both Germany and Austria had altered their patent laws in a manner that was retaliatory. As regards retaliation, he mentioned that very shortly after the Patent Act of 1907 had been passed, the patent laws of Germany and Austria had been altered as regards compulsory working, to make the law correspond with our 1907 Act. The effect was that German patents granted to foreigners would be revoked if the process were worked mainly abroad.

Dr. Rée said that the German system of compulsory working had been originally even more severe than ours.

Mr. J. W. HINCHLEY said that in taking out a patent you were practically giving your business away. The State got the benefit entirely; the man who worked out the process was not protected. It was time they had special rights for inventors. Recently some special secret methods had been sold for large sums of money; if those methods had been patented they would have become known, and could not have had the same value. He thought that some State action other than Patent Law was desirable in the case of inventors.

ECONOMY OF ACIDS IN METAL TRADES.*

BY E. KILBURN SCOTT, A.M.I.N.S.T.C.E., M.I.N.S.T.E.E.

PART I.—NITRE CAKE INSTEAD OF ACID.

The acids used in the metal trades are sulphuric acid and hydrochloric acid; *aqua fortis*, a mixture of sulphuric and nitric acids; and also, since the war, a solution of nitre cake sometimes called "sulphate acid."

Sulphuric acid may be divided into rectified sulphuric (R.O.V.) or white acid, and brown sulphuric or B.O.V. At one time a good deal of rectified acid was used for pickling, especially for cartridge metal and copper, but it is now practically all absorbed for explosives supplies. Brown sulphuric acid is still obtainable for pickling purposes, but only in limited quantity. Hydrochloric acid is principally employed for the hollow-ware and galvanised iron trades, but some makers of steel tubes also use it.

Aqua fortis is for "dipping" brass articles, and is usually made up of 6 parts crude sulphuric acid, 2 parts crude nitric acid, and 4 parts of water.

After losing its strength slightly, the *aqua fortis* is used as a second bath (fiss) to which a little salt may be added. It finally becomes ordinary pickle.

Nitre cake is a waste product from the manufacture of nitric acid and consists principally of acid sodium sulphate. It is produced in very large quantities in the numerous plants which have been erected or extended since the war, for making nitric acid for explosives.

As obtained from nitric acid manufacture it usually contains 30% of free sulphuric acid, but may have 35% or even more. It generally also contains 1% to 2% of nitric acid. A second source of nitre cake is from sulphuric acid manufacture, and in this case the cake may contain 20% to 30% of free sulphuric acid.

It is important to note that nitre cake varies and even that made by any one firm may vary from time to time. Most of it now consists of a mixture of acid sodium sulphate and sodium sulphate. It is not all acid sodium sulphate as used to be the case when plenty of acid was available, because the Government insists on a minimum of sulphuric acid being used in the manufacture of nitric acid.

* Taken as read.

Analysis of nitre cake made by a north country firm gave:—

Sulphuric acid	31.56
Sodium sulphate	63.99
Moisture	3.85
Iron and aluminium oxides	0.137
Magnesium oxide	0.190
Insoluble	0.365
Calcium oxide and chlorides	Traces

The amount of moisture depends on how long the cake has been exposed to weather. When freshly made there is no moisture, but when it has been standing a few weeks, even if under cover, the moisture may be several per cent. It is advisable to use nitre cake as soon as possible after it is made.

At one time nearly all nitre cake was either dumped on to vacant land or into the sea. A considerable amount is now utilised, however, especially that made in factories near to industrial centres.

Uses for nitre cake. Before the war, practically the only uses for nitre cake were for making hydrochloric acid, Glauber salts, and salt cake; a small amount was also sold to manure manufacturers, and to glass works.

It has now many uses, *e.g.*, in the textile trades it is used for:—Extraction of grease from wool suds; extraction of grease from piece scouring suds; refining of grease; stripping colour from rags, for making shoddy; removing cotton from mixed fabrics for shoddy; dyeing rags in the shoddy trade, etc. It is also used for calico bleaching, in the mineral water industry, and for paper making.

Nitre cake had been tried in the manufacture of sulphate of ammonia, one sample giving:—

Ammonia	24.01
Free acid	0.88
Moisture	2.70
Sodium sulphate	3.20

which corresponds to a consumption of over 7% of nitre cake, equal to about 2½% of acid saved.

The Sulphate of Ammonia Association recommends that the percentage of nitric acid in the cake should not exceed 0.05%, and the amount of nitre cake should not exceed 10% by weight of the acid used.

The cake is dissolved in water until the solution shows 100° Tw. (sp. gr. 1.5) at 200° F. and the mother liquor from the saturator, used for dissolving, is run into the saturator as hot as possible, and continuously with the acid.

Handling. When freshly made, nitre cake is fairly easy to handle, but when wet and soggy it is inconvenient. It acts injuriously on wood and attacks the iron work of carts and trucks, and as a consequence, ordinary railway rolling stock may not be used for conveying it.

When stored for any length of time, it should be kept under cover, for if rain falls on it, the acid drainage will do damage to foundations, etc. A suitable floor for a storage room is asphalt or else stone flagging with joints asphalted. The floor should be sloped and provided with a catch pit, so that drainage acid can be collected and used for making solutions or sold as sulphate acid.

A point to note is that when a warm solution of nitre cake is run into earboys there is danger of the earboy breaking when sodium sulphate crystallises out.

Nitre cake is injurious to cloth, and therefore where it has to be handled by workmen, their clothes must be protected by sacking and they should wear wooden clogs. For protection of the hands, pieces of sacking may be used, and the skin kept well greased, but the best protection are rubber mits made for the purpose by St. Helens Cable Co., Ltd.

Dissolving nitre cake. The use of nitre cake with which this paper is particularly concerned,

is in connection with metal trades, and the following notes on various ways of preparing the solution may be of interest.

One method is to use a separate bosh, preferably at a higher level than the usual pickling boshes, so that the solution can gravitate down. The water in the bosh must be heated by a steam pipe along the bottom, or by blowing steam in at the end; the hotter the water the quicker the cake dissolves.

Nitre cake can be thrown into the bosh, as received from the suppliers, but it dissolves much more quickly when broken into small pieces by a spiked hammer.

The solution in the pickling bosh must always be kept hot, so as to prevent deposition of crystals of sodium sulphate on the work. This is more especially the case if the articles to be pickled are cold.

If, after the solution has been prepared, it is allowed to cool (as for example during a week-end), sodium sulphate crystals will separate. They should be shovelled out before starting work again.

A great deal of the trouble which has been experienced with nitre cake has been due to users not knowing how to get rid of the sodium sulphate crystals. As mentioned above, commercial nitre cake of to-day is not simply acid sodium sulphate but is a mixture of that with the neutral salt, sodium sulphate. The latter can be got rid of by making a solution in a tank at a temperature of about 60° Cent., and then letting it cool to about 30° Cent. The sodium sulphate crystallises out and the solution containing the acid is then drawn off from the top. This makes quite a good substitute for brown sulphuric acid.

The crystals of sodium sulphate can be washed, after having been moved from the tank, to get rid of the small amount of acid, and this slightly acid liquor then used to make the solution of the next bath.

For pickling brass the solution of nitre cake should show about 5% of sulphuric acid on titration. Below 3% is too weak and over 7% is unnecessarily strong.

To keep the pickle up to strength, supplies of solution are added as required. If the bosh is long enough, a portion may be partitioned off at one end with perforated boards and fresh cake placed therein.

Another method of preparing the solution is to fill barrels with nitre cake and allow water to dribble through. By filling with cake and water over night, a supply of strong solution is ready by morning.

In Yorkshire it is the custom to make a hot solution in wooden tanks by steam. Equal weights of nitre cake and water give an acid strength about one-sixth that of brown sulphuric acid. The solution is raised to an upper tank by an ejector made of antimonial lead, the ejector being placed below the level of the solution so as to remain charged.

Another method of dissolving the cake is to have a long sloping trough fitted with baffles. The cake, in small pieces, is placed in the trough and then water flowing down gradually dissolves the cake.

A tank suitable for dissolving 10 or 12 tons of nitre cake per day may be 20 ft. by 10 ft. by 4½ ft. deep, and if arranged above ground is built of 3-inch planks tongued and the joints pulled together by bolts ¾-inch diameter; 10-lb. lead makes a suitable lining. Two feet from the bottom there should be a platform made of wood slats each 4 inches wide by 1½ in. thick, and 1½ in. apart. Large pieces of nitre cake can be thrown on to such a platform, and water is then run in, until the pieces are submerged. A steam pipe coil arranged along the bottom heats the water, and the cake should dissolve in a few hours. A steam supply should be fitted to the delivery pipe, so as to dissolve crystals that may form in it and stop the pipe, when the solution gets cold.

It is convenient to have two such tanks, on brick piers 4 ft. high, leaving a space between, for the delivery wagon. One tank is being filled and the nitre cake dissolved in it whilst solution is being drawn from the other.

One firm in Birmingham has built tanks for dissolving a canal boat load (30 tons) at a time. The tanks are at the side of the canal with the top at about ground level. The walls are of acid-proof brick, lined with lead, and a wooden platform is provided as described above. Cake is tipped straight on to the platform from barrows.

Strength of solution. If a gallon of water (10 lb.) is used to dissolve 10 lb. of nitre cake containing 30% of free sulphuric acid, it gives $1\frac{1}{2}$ gallons of solution containing about 22% of acid. To make a 7% solution $2\frac{3}{4}$ gallons of water must be added. Therefore 1000 lb. or, say, $\frac{1}{2}$ ton of nitre cake should give 400 gallons of 7% pickling solution.

Calculating on the basis of pure sulphuric acid, the acid in nitre cake is purchased at a lower price, but on the other hand more handling has to be done, so the labour cost is greater.

Assuming the price of nitre cake at £1 a ton, as against, say, £7 for sulphuric acid, then according to results obtained with tubes, 3 tons or £3 worth of nitre cake will do as much as £7 worth of sulphuric acid. This gives a saving of £4 for a given amount of work, but from this must be deducted the extra cost of labour.

In normal times it is doubtful if there will be any advantage in using nitre cake, but perhaps by the time things become normal again, up-to-date means of making nitric acid from atmospheric nitrogen will have been adopted. Although nitre cake is now made use of, it is only by great waste of money that it is produced at all.

Method of using. When nitre cake was first tried in the metal trades one heard many complaints about it not being suitable, and so on. Many of these were, however, due to the cake not being used properly. Some tried to dissolve it cold. Others who did employ heat, had trouble with the sodium sulphate crystals, found on Monday morning after the solution had cooled, and they failed to remove them before starting work.

On one occasion a workman who offered objections to using nitre cake, was found to have tested the solution with a hydrometer, and consequently had made the pickle too weak.

The extra viscosity of nitre cake solution makes it less suitable for tubes and for articles which have small holes. Viscosity can be reduced by using a higher temperature, but then there is trouble with steam and fumes.

An interesting fact which came to my notice, was that the surface of tubes and malleable iron castings had a bright bluish tinge after pickling with nitre cake solution, whereas they quickly went rusty after pickling with brown sulphuric acid. The manager said he preferred nitre cake to brown acid.

No doubt impurities in nitre cake account for the results in some cases being different from others. The nitric acid which some cake contains, is certainly advantageous for pickling brass and copper.

For removing borax from brazed tubes nitre cake solution is not very effective, as shown by Mr. Dugard's tests: Tube No. 1, tested in brown vitriol 10% solution for 5 mins.; the borax was quite removed. Tube No. 2, tested in brown vitriol 5% and sulphate acid 20% for 20 mins.; the borax was removed. Tube No. 3, tested in brown vitriol 2½% and sulphate acid 20% for 20 mins.; the borax was not quite removed and the tube was dirty inside. Tube No. 4, tested in sulphate acid 20% solution for 50 mins.; the borax was not removed, and the tube was dirty inside.

For pickling iron and steel it would appear that arsenic is some advantage, e.g., certain firms use arsenious oxide as a "restrainer," for the purpose of checking the action of acid on the steel, after removal of scale. The manager of a tube-making firm in Birmingham informed me that he had used it for some years, because it prevented penetration into the steel, and reduced fumes.

The arsenious oxide used is what is known as "white arsenic," produced in the first stage of extraction. It is sold in the form of a powder, and about one pound is used to each gallon of acid.

Arsenic is objectionable to some industries, for example, it would not do for pickling cartridge metal or for galvanising and tinning.

A large proportion of the nitre cake made in the Birmingham and Wolverhampton districts is sent to tinplate works in South Wales. Makers there were amongst the first to use nitre cake on a large scale.

PART II.—OTHER METHODS OF SAVING ACID.

Although a good deal has been said regarding uses of nitre cake, I am not at all in sympathy with the policy of certain parties, of forcing it "willy nilly" on to all kinds of manufactures. Nitre cake does not suit many small firms and industries.

Considerable economies in acid can also be made in other ways, some of which are more effective than using nitre cake, because they are in the direction of reducing the acid or dispensing with it altogether.

The shortage of acid and the high price has had a beneficial effect on Birmingham metal trades, because manufacturers have learnt to do with less acid, and in some cases to dispense with it. When the war is over, the economical methods will be retained.

Much acid was formerly used for pickling the scale from brass stampings, but many firms now find they can do without the acid. It was also used to pickle hard scale from forgings and castings, so as to make them easier to machine. The extra hard steel now available for tools cuts much better. Cutting is also eased by leaving more metal on so that the point of the tool can get well below the hard scale.

Regarding *aqua fortis*, it is of interest to note that employers who have been accustomed to leave everything to the "dippers" have on investigation been able to reduce consumption considerably, in some cases by a half.

In the ordinary Birmingham brass trade many articles are "dipped" in *aqua fortis* which might just as well remain in the condition in which they leave the foundry and stamping shop. Where appearance is of great importance they might very well be painted or lacquered. Many munitions parts are "dipped," which would be better without it. Even when parts are "dipped" they are often stored so long that they become discoloured. In fact buttons, buckles, and Webb equipment fittings are sometimes made dull, so as not to be conspicuous and reflect light.

I know one firm which used over 36 carboys of *aqua fortis* per week for dipping military buttons and ornaments. Another firm doing exactly the same work have managed to dispense with the use of *aqua fortis* altogether, by barrelling. The scouring barrel is filled with granite chips and water, the burnishing barrel contains steel bicycle balls and Hudson's dry soap and water, and the "drying out" barrel contains beech sawdust.

One firm employed in making steel conduit uses a long steel barrel for cleaning scale from fire-welded steel tubes. The tubes are rumble round along with leather "mosings" and in about half an hour are sufficiently clean for the enamelling process.

Considering how much quicker and more effective is hot pickle than cold pickle, it is surprising to find so many firms in Birmingham using the latter. It is partly due to steam not being available. Gas jets can be easily applied under a bath, and one manager who did this assured me that his consumption of acid had been considerably reduced. A bath geyser might be used for the purpose.

Quick quenching removes scale very easily, and for this reason pickling boshes should be close to the muffles. In some of the older works the boshes are at a considerable distance away, which gives longer time for cooling, and formation of scale.

Spent pickle. The practice of running spent pickle down the drains, which in some factories is done every 24 hours, causes great waste of acid and of the metals dissolved. Spent acids also may be a disadvantage to the system of treating sewage.

To show what can be done by being alive to the problem, the case of a firm making rifle ammunition cartridges may be cited. Before the war they used sulphuric acid pickle of about 6% strength and the spent pickle was wasted. To-day the method is to use pickle of 6% only after the first annealing, as there is more scale at first, due to the greater bulk of metal. For the following annealings pickle of only one-sixth the strength is enough.

The metal passes through automatic muffles and the hot metal falls direct into concrete vats lined with lead, containing pickle of only one per cent. strength. As a result, the acid now used for a given amount of work is only about one-third. The pickle is continuously circulated through an overhead tank where it is regenerated by addition of new acid. The pickle is cooled in the process, and no doubt the quick quenching which results helps to save acid.

There appears to be a good opening for a central recovery plant to treat spent pickle which could be collected from various firms. The corporation of Birmingham and the Chamber of Commerce might usefully consider this question.

The metal taken by "spent pickle" down the drains amounts to an enormous figure. Even where the metal to be pickled is copper, few firms take the trouble to recover the dissolved metal. It is well worth while.

Deposition of copper on iron has been employed, but it is hardly suitable because the amount of metal is so small as compared with the amount of liquor that most of it may be washed away.

The most promising way is to treat the spent pickle with lime. This first neutralises the acid and forms calcium sulphate and water and then the lime reacts with the copper sulphate again to form calcium sulphate, the copper going to make a rich slime or mud which is easily removed for treatment.

The liquors which go into drains from large firms contain a considerable amount of metal in mechanical suspension. This can be removed by a Frue Vanner machine as used in gold mining.

Even commoner metals may be worth recovering; for example, in the pickling of hollow-ware over 50 lb. of metal is lost for every ton of articles pickled. The sheets now used for hollow-ware are either close annealed sheets or open sheets, direct from the rolls, and the loss is about 60 lb. per ton according to the conditions of surface. When metal is pickled, the loss is not only that represented by removal of scale but is also the loss of metallic iron dissolved away by the acid.

Hydrochloric acid. The acid for pickling hollow-ware is hydrochloric acid, and it may be of interest to add that the amount used by Birmingham firms, namely, 1½ to 2½ carboys per ton of metal ware, is very much in excess of what is used originally to pickle the sheets from which the hollow-ware is made. South Wales makers use

much less, which may be due to mechanical means taken to agitate the work.

Movement of the work, or of the pickle, or both, expedites any pickling process and saves acid. An ideal way is to have the pickle continuously circulating through the boshes, and this is done by several firms.

Owing to the high price of spelter, various other methods of treating hollow-ware have been introduced, for example aluminium paint and black japan. Although to be satisfactorily watertight, buckets should be galvanised, the Army Contracts Department now accepts buckets which are painted.

Hydrochloric acid is used by one of the most important firms in Birmingham district making high-class steel tubes. They say they prefer this acid because it does not act so quickly and attacks the steel less than sulphuric acid. The acid is also used cold, and this ensures that all the tubes are acted upon equally. When a bosh is heated by steam passing through a pipe, the nearest tubes are acted on more vigorously.

Another advantage is that boshes for hydrochloric acid do not require to be lined with lead. One type of bosh which works well is 16 ft. by 2 ft. by 1½ ft. and built up of 3-inch planks cramped together between posts, driven into the ground. No bolts are used. The bosh is lined with boards 1½ in. thick, and a mixture of pitch and tar run in between the boards and the planks.

Sand-blasting. Considerable economy of acid is possible by sand-blasting, especially where hard scale surfaces of forgings and the burnt sand of castings have to be removed. A sand-blast plant comprises the blasting mechanism, air compressor and receiver, and exhaustor for returning the abrasive for use again. The abrasive is fed through a slot controlled by a valve, and is caught by the current of air and driven through the discharge nozzle. The air pressure is about 10 lb. per square inch. For cleaning scale and core sand from iron, steel, or brass castings, chilled iron shot is used.

A room sand-blast plant has a glass roof with ventilators, and perforated steel grid floor. The abrasive falls through the grids into a hopper from whence it is drawn by an exhaustor to the top of the sand-blast apparatus. An exhaustor fan changes the contents of the room four times a minute. A cyclone separator separates the dust and fine core sand, leaving the abrasive and heavy core sand. The operator works inside the room, directing the blast nozzle by hand, and he is provided with a helmet, as protection from rebounding abrasive.

A barrel sand-blast plant consists of a rotating cylinder supported at its circumference on rollers. Small castings or forgings to be treated are placed in the barrel and the abrasive directed through the ends of the cylinder against the articles. A slow rotary movement causes the castings, etc., to tumble over one another, thus bringing new faces under the action of the abrasive.

For a chamber sand-blast plant the operator stands outside the chamber, and passing his arms through suitable openings, directs the blast on to the articles to be cleaned. He observes the operation through a window. This plant is used for cleaning brazed joints of cycle frames, handlebars, and casements.

A sand-blast machine for cleaning shells has a fixed vertical blast, the shell being supported over it by a ball and socket joint. The shell can thus be turned round and rocked sideways in order that the abrasive may reach all the interior. Formerly it was the custom to remove scale from shell blanks with acid, and also to use acid for cleaning the inside of the machined shells before varnishing. It has been found, however, that acid enters the pores and by oozing out afterwards is detrimental.

A firm in Birmingham making reflectors used to employ a large amount of acid for pickling the scale from small forgings. Now they do not use any acid because the work is done by sand-blast machines.

Electro pickling. Although electro pickling has been successfully employed abroad, it does not succeed in this country. One method of pickling employs direct current and the electrical action is much the same as that which takes place in an ordinary plating bath, the scale being split off mechanically by formation of gas beneath.

The other method employs alternating current; the current flows rapidly in each direction according to the periodicity of the circuit. It might be thought there would be little effect and yet there is. It is probable that the amount of scale removed per unit of energy is as much with alternating current as with direct current.

One pickling bosh in which alternating current is used measures 4 ft. long by 2 ft. square. It is made of planks, and rests on four ordinary drain pipes filled with cement, which act as insulators. Electrodes of sheet iron 2 ft. sq. and $\frac{1}{4}$ in. thick are fixed at each end.

The electrolyte—hydrochloric acid, salt, and water—has an acidity of about one per cent. Alternating current is supplied at 15 volts and 50 periods per second by a small motor generator. When reflectors are being pickled, they are placed in a wooden crate between the electrodes, so that the liquid can circulate freely between. During one test 14 shades each 18 inches diameter and 2 $\frac{1}{2}$ lb. weight took 210 amps., at 14 volts, or just under 3 kilowatts for 10 minutes. At $\frac{1}{4}$ d. a unit, the cost of electric energy was therefore about $\frac{1}{4}$ d.

Clean annealing. In going around various factories I have remarked on the many varieties of annealing furnaces in use, and the extravagant claims put forward, especially for those which happen to be home made. As a matter of fact nearly all are bad.

Where an ordinary coal-fired muffle and a Bonecourt muffle were working side by side, a test of the loss in annealing and cleaning copper gave 0.74% loss for the ordinary coal-fired muffle, and 0.18% loss for the Bonecourt muffle.

Several attempts have been made to anneal in a neutral atmosphere to prevent oxide being formed and one non-sealing muffle which has been successfully applied to non-ferrous metals is that of Bates and Peard.

It consists of an air-tight annealing chamber the openings to which are sealed by water. The annealing chamber is fired by gas, oil fuel, or coal, as is most convenient. The metal is conveyed by an endless chain belt, being first drawn through one water seal, then through the hot part of the chamber, and out through the other seal.

In the Birmingham district, a Bates and Peard muffle is used for annealing small brass articles, and another for copper sheets. High resistance wires and copper wire are also being annealed by this type of muffle.

The Vaughan Hughes muffle for non-ferrous metal works in a somewhat similar way to the above, and several are in use in the Birmingham district. It is sealed with water, and the annealing chamber is kept filled with superheated steam.

Rolls of copper and brass strips may be close-annealed with little or no sealing by placing them in steel pans and luting in with wet clay. When in the annealing furnace the moisture in the clay is made into steam and then the metal is in a non-sealing atmosphere. When ready, the pans are quickly withdrawn and placed under water.

The annealing furnace of Metalloids, Ltd., uses an atmosphere of purified producer gas, and does more than others, in that it reduces any oxide

that may be present. The process consists in passing the articles to be annealed through a heated muffle and a cooling chamber in both of which there is an atmosphere of specially purified producer gas. The hydrogen present in the gas acts on the oxide and reduces it to iron, steam being also formed.

Electric muffles. Electrically heated muffles present so many important advantages over any others that they are bound to come to the front for special work. At a future date I hope to have something to say about them, but may mention now that I have seen steel tubes come out of a new type of electric muffle as bright as a sword blade although they had undergone a temperature of over 800 °C.

J. Walter, of the Gas Research Department, Birmingham, has developed a water seal for an electric muffle by which steel articles can be heat-treated without sealing and plunged directly into water at the right temperature. The muffle tube is arranged vertically and its lower end projects into a water bath.

The articles to be heated are suspended by a wire in the hottest part of the muffle tube which is filled with coal gas to prevent sealing. When the correct temperature is reached the wire is released and the articles fall into the water.

ANNUAL DINNER.

The Annual Dinner of the Society was held in the Grand Hotel on Thursday evening, over 150 members attending.

The toast of "The King" was proposed by the President, Dr. Carpenter, and the toast of "The Society of Chemical Industry" by Dr. R. S. Morrell, the President responding. Prof. H. Louis proposed "The Birmingham and Midland Section," response being made by Mr. E. W. Smith and Mr. F. R. O'Shaughnessy.

FRIDAY MORNING.

SCHEMES FOR CO-OPERATIVE INDUSTRIAL RESEARCH.

BY HERBERT W. ROWELL.

[ABSTRACT.]

Co-operative research is entirely unknown in Britain, while it has been established for several years with considerable success in other countries.

The schemes suggested below are put forward as outlines which might profitably be considered by groups of manufacturers, and the essential points considered are:—

(1) That a properly equipped laboratory and experimental station should be established on such a scale that it could afford to employ experienced industrial research men of high grade to organise and supervise the research and experiments.

(2) That the manufacturer may safely entrust all the details of his processes to the organisation without risk to business interests.

(3) That discoveries made should be the property of the manufacturers initiating and bearing the cost of the experiments.

(4) That the cost of experiments should be decidedly less than if the manufacturer had employed his own staff and laboratory and that the probability of success should be greater.

A group of manufacturers of, say, sulphuric acid, tar products, or pig iron would pool investigation into raw material, methods of manufacture, improved products, disposal of by-products, outside competition, and so forth for their common

good. A full-sized factory could be run in connection with the laboratory to provide exact working data and efficiency methods and help pay the cost of research.

In future it must be British industry against foreign competition instead of a single manufacturer against his home industry and the world in general, and this involves buying and selling agreements and other safeguards which are arranged in other countries, and can be arranged here, and it certainly involves more efficient employment of capital, material, and labour, and eventually means more profits and lower prices.

At the other end of the scale we have something on the lines of the Mellon Institute in Pittsburgh. This scheme practically amounts to a consulting chemists' laboratory on a very large scale (and such exist in the United States) and therefore on more successful lines. A fairly large program of circumscribed dimensions must be definitely laid down, and there are other drawbacks which make the value of the scheme doubtful to a small works.

There is no doubt that the first scheme of co-operation throughout a trade is the most profitable to all concerned, but there seems to be no probability of the British manufacturers combining in this wholesale way for many years to come.

Something less ambitious, organised in such a way that it can be developed into the full scheme as progress is demonstrated, seems to meet our present state. The tar trade may be taken as the first example, for it seems to be faced with both a commercial and technical revolution after the war. Coke ovens and large gas plants are partly refining their own products in competition with the tar distiller.

Methods of distilling and fractionating are altering and require alteration, and the products of distillation will have to be marketed in a different state of purity and the values of tar products—never very stable—are likely to be altered considerably.

If the tar distillers can have commercial agreements as to raw materials, sulphate of ammonia, and creosote, why not in standard tests and products and in research and development of the trade?

The tar producers and distillers could subscribe, say in proportion to their capital or turnover, to constitute a central laboratory and experimental works, while control testing and efficiency of existing plant would remain a matter for the attention of the individual works. This laboratory could have two functions, one an analytical department for devising specifications and standard methods of analysis and acting as a referee laboratory for the trade, and the other a research department with an experimental works and staff of chemical engineers attached to it.

If a research department could make pitch equal to natural bitumen, tar oils into fuel, and lubricant equal to petroleum oils, or discover a use for creosote oil equal to the present demand for timber preservation—and these things are by no means impossible—it would cover its cost many times over.

Other matters of a non-competitive nature which might be taken up are the carriage of dangerous goods, better and cheaper packages, safety measures against fire, explosion, and industrial disease, and fuel economy.

The quantities and value of the coke, gas, and so-called by-products can be greatly modified by alteration in the method of working as well as in the design of apparatus, and as coke ovens, gas plants and recovery plants are usually in charge of an engineer, the chemical aspect of the problem does not get full consideration. A coke-oven plant would call upon the research organisation to enquire into the efficiency of all or part of its plant or have experiments made on a more suitable

type for its particular class of coal. The tar distiller could have his tar supplies tested on a works scale and be advised of a better plan of working them to obtain a more profitable fractionation. There are great possibilities in this which cannot be shown on a small scale laboratory test. The distillers in general could have experiments made in washing and purification of the various products, and the numerous problems of fractionation, distillation, and filtration which trouble the works could be solved on practical lines for the mutual benefit of the subscribers.

As a second example we may take the iron trade. The steel industry has received special and successful attention in this country during the last decade, but the smelting and casting of iron is still done in the same way and in many cases by the same plant which was antiquated 20 years ago.

Ideas for new types of plant have been imported from America in a few cases, while the Americans have developed dry blast, fuel economy, rapid working, slag cement, and the working of low-grade ores by the liberal application of research.

A combination of iron masters, foundry men, and mild steel makers, quite apart from the remainder of the steel trade, could profitably institute a research organisation to standardise pig iron grades and foundry mixings in the first place and then develop improved smelting methods, more economical charges, heat treatments, foundry methods, and iron and mild steel foundry mixings for standard purposes.

If such an organisation could make blast furnace slag worth a shilling a ton or reduce production costs by a shilling per ton of pig, its existence would be very amply justified.

As the last example, we might take the large number of works in the Birmingham district—mostly small concerns—which melt, cast, roll, stamp, and otherwise work alloys of copper, zinc, tin, nickel, lead, and other non-ferrous metals. Practically none of these works employs a chemist or metallurgist because of the comparative cost, yet they all feel the need of expert advice.

Except for certain mysterious dopes which are added to meltings—often without practical effect—some foundry methods, and a few very special alloys, which can easily be analysed, there are no secrets in the trade and business interests would not be adversely affected by the institution of a co-operative laboratory.

Quite a modest affair could be started for analytical work and general advice on technical problems but designed to expand into a full research department and experimental works where fuel consumption and furnace design, crucibles, heat treatment of castings, casting methods, micro-structure, rolling and stamping and finishing problems could be solved.

SOME PRINCIPLES OF INDUSTRIAL RESEARCH ORGANISATION.

BY HERBERT W. ROWELL.

[ABSTRACT.]

Industrial research covers a wide range of scientific activity, from chemical and physical work in the laboratory and experimental department, to the lay-out and design of plant, and to the final details of economic production.

The only fit person to undertake the control of research and the development of industrial technique is the scientifically trained chemist, engineer, or physicist, as the nature of the work demands, because he has the best mental equipment and method for discovering the true cause lying behind an observed effect or for combining causes to produce a desired effect.

All matters of research and experiment in an industrial organisation should be centralised to one laboratory under the control of one person, even if the organisation is interested in various types of manufacture in separate works. The laboratory should be as liberally equipped as finances will allow, and should include floor space and machinery sufficient to carry out experiments on something approaching a works scale. In large organisations this should include a unit experimental factory, and in small organisations the experimental floor may profitably be used for the manufacture of small lines required as raw material for various works operations, or for direct sale where the bulk of output is small and skilled supervision is required, without interfering with the experimental value of the room to the research department.

The initiation, organisation, and carrying through of all research and experiments up to the experimental works stage, should be in sole charge of a trained chemist or physicist, with works experience, responsible directly to the executive. Research and experimental work should not be under the direct control of the works, but the research department should depend almost entirely on the advice of the works managers in matters of existing methods and troubles in manufacture, and to a great extent on what matters require investigation.

While the initiation of research should lie principally with the head of the research department, there should be some safeguard for giving credit for ideas and improvements to those who originate them. Suggestion bureaux for works employees and direct report to the executive in the case of management staff are used by a number of firms.

Wherever possible the results of research should be covered by patent rights, and where the publication of discoveries, methods of analysis, and similar matter does not seriously damage commercial interests, the results should be contributed to the common stock of scientific knowledge. Every distinct item of research should be properly planned, and all available information on the subject collected, and properly indexed, and digested, before starting practical work, although re-planning will probably be necessary as the work proceeds. The cost of work should be estimated where possible, or a definite sum allotted to the work by the executive for experimental plant and laboratory expenses.

No experimental work should be done in the manufacturing departments except such as is required in starting a new machine, or process, after working on a smaller scale in the experimental departments, or such as is required in enlarging the production of a machine or process without alteration of the principle on which it operates. Loss of production and leakage of information are usually more costly than a special experimental machine.

DISCUSSION.

Mr. B. F. HOWARD said that the author had stated that co-operative research was entirely unknown in Britain; but how did he know whether or not every piece of research which was done was not co-operative? There was no means of knowing how the results of research were utilised. He also put forward the view of buying and selling agreements as if that was something new. There again how did the author know what buying and selling agreements there were? These things were not published; they would lose their point if they were. He submitted that this principle of co-operative buying and selling went on to an enormous extent throughout the chemical industry. There was also a tendency in the paper to assume that manufacturers

had never had any technical education. It was also assumed that the works chemist was a genius and the members of the Board were absolutely ignorant of all chemical problems. He considered that statement too sweeping, although it was possibly true in some cases.

Mr. E. W. SMITH pointed out that there was a considerable amount of co-operative research work going on in this country. The brass industry in Birmingham was particularly mentioned by the author. There was an extensive metallurgical research laboratory run by the Corporation to which a very large proportion of the brass casters in the city came with their problems. The results of that research were of general value. The work that was being done was entirely co-operative and fulfilled all the conditions Mr. Rowell had laid down. Surely it was known that for many years a considerable amount of co-operative research had been going on in connection with the gas industry. The Institution of Gas Engineers had its Committees working in conjunction with municipal authorities, and chemists had been engaged for years on technical research work, the results of which had been available to the whole industry.

Dr. C. A. KEANE said that the system of Industrial Research Fellowships at the Mellon Institute had been very successful. Dr. Bacon had informed him that during 1916 the contributions had doubled, and they had over 80 men engaged in industrial research work at the Institute. They were not altogether without knowledge of such organisations in this country. Experiments were being made in more than one institution on somewhat similar lines to the Industrial Fellowship system of Pittsburgh. Every encouragement should be given to such efforts. Some manufacturers' associations were already interested in the work at Pittsburgh, and in one case an application had been made for details of the scheme. The Industrial Fellowship scheme had shown one way, he did not say it was the only way, in which the Universities could be utilised. They could ask manufacturers, and especially the small manufacturers, whether there were not problems which they could submit to educational institutions. The terms were not difficult to arrange, so as to protect the manufacturer and also the institution. But it was fundamental to recognise that the men in charge of these institutions were honourable men to whom confidence could be given and to whom also authority could be given. The experience of the war had shown that academic chemists were capable of being trusted and doing work of considerable national importance. One of the great difficulties in training chemists for industrial occupations was to get in touch with the requirements of the industry itself. There had been an appalling loss of chemical efficiency owing to the system which had prevailed in the past. They had not recognised their responsibility towards younger men and the necessity for making them fit for higher and wider occupations. If by means of the schemes outlined they could lead the best demonstrators to take up industrial work it would be of very great value in the future. The association of industry with teaching institutions would undoubtedly activate the abilities of the educational chemical staff. There had been a tendency in the past for the staff to become irresponsible, and something which would endow them with an element of responsibility must be a great advantage.

Prof. W. A. BONE deprecated certain statements of the author in regard to the backwardness of the British manufacturer. For example, he said that the Americans had developed slag cement. He did not know whether the author meant that Americans were the first to develop that, because

that was not so. It had been developed in England. He had also spoken of the development of dry blasts. Dry blasts had been tried in several English works and in no case had the capital expenditure been justified by the fuel expenditure.

Mr. ROWELL, in reply, said that the American method of working dry blasts did not suit the English practice. He knew dry blasts had been worked in this country but he did not say it would pay in every case here. It had not paid in every case in America. He agreed with Dr. Keane that the universities must be associated with industrial research. As to buying and selling agreements, he was urging that they must be taken up more frequently than they were now. There must be trusts in the matter of buying and selling and in connection with research. The bigger the trust was the more it could spend on research and the better would be the results obtained.

THE ARTIFICIAL SILK INDUSTRY.

BY LEONARD P. WILSON, F.C.G.I.

The material known as artificial silk, and sometimes wrongly described as imitation silk, is now in such general use for producing a large number of textile materials, that there is no doubt whatever that although the commercial production of artificial filaments is practically no older than this century, it has made for itself a permanent position in the world of industry. For artificial silk has ceased to be what it once was, only suitable for fancy goods, more ornamental than useful, and now is produced in filaments of almost unlimited length, of uniform diameter, and of any thickness from less than a thousandth to a sixteenth of an inch, possessing any desired lustre, from the most brilliant to quite dull, capable of being dyed to any shade, and of a sufficient tenacity either dry or wet, to be used in any textile operation.

There was a period of a hundred and fifty years between the time of the suggestion of the French scientist, Réaumur, that silk might be made artificially from resins or similar materials and the date of the first patent, that of the Swiss, Andemars, for the production of artificial filaments, this latter having been made possible by the discovery and investigation of cellulose nitrate. From this time, about 1885, to the end of the century, a great deal of valuable preliminary work was done both in this country and abroad, with the aim of producing artificial fibres for textile use or the production of electric lamp filaments. Of our own countrymen whose work was noteworthy at this time are Crookes, Wynne, Powell, Swinbourne, Swan, Millar, Cross, Topham and Stearn, but they did not achieve commercial production during this period; abroad, however, Comte Hilaire de Chardonnet began to manufacture artificial silk in 1891 at the rate of 100 lb. per day at Besançon, and although his success was not uninterrupted, he was producing about 1000 lb. per day before anything was made on an industrial scale in this country.

All the early artificial silk was made by the Chardonnet process (Eng. Pats. 6045 of 1885, 2211 of 1886, 5270 of 1888, etc.) or modifications of it, which had for a basis guncotton dissolved in ether-alcohol; this solution was of very high viscosity and was formed into filaments by forcing it through glass jets which had a bore of between two and ten thousandths of an inch, and which were immersed in water to remove the alcohol from the solution as it emerged, and so to form a semi-solid fibre which was picked up and together with a number of others wound on a spool. The whole machine was enclosed and warm air was passed through

it to remove the volatile solvents still held by the thread, which was thus further hardened; the ether and alcohol were condensed, and so a considerable proportion was recovered; the amount of solvent lost, however, was always very great; this and the great danger from fire were among the causes which made this process costly and undesirable. Moreover the finished thread consisted of cellulose nitrate which depreciated very much on keeping owing to decomposition and the formation of acid compounds; it was very inflammable and difficult to dye. These defects were partially overcome when the denitration process was introduced, treatment with calcium or ammonium hydrosulphide being employed to remove the greater part of the nitro groups—sufficient always remains to give a deep blue colour with diphenylamine and sulphuric acid, and to show about 0.05 to 0.15% of nitrogen on combustion. Unfortunately denitration reduced the weight of the product, together with its strength both in the dry and wet state and its extensibility. In spite of this, however, Chardonnet silk was well received because of its brilliant lustre, which was considerably greater than that of natural silk. In addition to the method already mentioned of forcing the solution into water, or "wet spinning," another known as "dry spinning" is now employed by the Chardonnet Company, the solution of high viscosity being forced through the jets into air, when the solvent rapidly volatilises and a thread is formed which can be wound upon a running bobbin. The machine employed for this process is one of the simplest used in the production of artificial silk; the nitrocellulose solution is fed through a pipe to which are fitted a number of fine glass jets, from which the liquid is drawn on to rollers or spools running at a comparatively high speed, the filaments are gathered into groups of the number required to form the composite thread before reaching the roller, and are wound on it with a backwards and forwards traverse motion to keep the threads separate. The whole machine is enclosed in a cover through which warm damp air is passed to remove the volatile solvent, which is then condensed by passing the air through a spray of amyl alcohol; the ether and ethyl alcohol of the solvent are collected in this, which is then redistilled, giving a fairly good recovery. During drying the threads become lustrous, strong and elastic; they are then twisted and wound into skeins, denitrated, and finally bleached. In addition to the factory already mentioned at Besançon, nitrocellulose silk was produced at Spreitenbach in Switzerland, Kelsterbach and Bobingen in Germany, Padua and Pavia in Italy, Obourg in Belgium, Sarvar in Hungary, and Wolston, near Rugby, in England. The last named was among the least successful, and the manufacture was continued there for only a short time and with considerable loss.

It is not uninteresting at this point to notice that those artificial silk processes which were destined to be partially or wholly replaced by one more successful, have failed more quickly in this country than on the Continent, where temporary success has often been achieved by processes which have had none here; while the method which has attained the foremost position and has largely displaced the others, has been more successful in England than abroad, although it was taken up some years earlier in France and Germany. Whether this is due to a more stringent process of selection in British industry or to better technical work in the one successful case I am not prepared to say. On the Continent nitro silk had for some years a period of great financial success, but at the beginning of this century it had to meet increased prices of raw materials and the competition of two other processes, cuprammonium and viscose,

and some of the effects of this are to be seen in the selling prices and profits of the Chardonnet Company, as follows:

	Price per 1 lb.	Dividend.
1899	18. 9d.	6 1/2
1901	—	8 1/2
1903	17s. 3d.	12 1/2
1905	—	60
1907	—	30
1909	8s. 9d.	0

A few years later the same thing was to be observed with the Vereinigte Kunstseide-Fabriken A.-G. of Elberfeld, whose dividends were:—

	Dividend.
1904	0
1906	3 1/2
1908	20
1910	10
1912	0

The one exception to this state of affairs was the Belgian factory at Tubize, which was producing with success up to the beginning of the war, and is now said to be manufacturing nitrocellulose for German military purposes. It is stated that it has been able to continue to make a profit on account of the low price at which it could obtain alcohol, and the importance of this may be gathered from the statement that in 1907 the Besançon works consumed from 4 to 5 litres of alcohol for each kilogram of artificial silk produced.

Lehner, who had learnt the Chardonnet process in the Spreitenbach factory, improved its details by several important modifications (Eng. Pats. 11,831, of 1891, 22,736 of 1892, 24,003 of 1893, etc.). Instead of a solution containing 20% of cellulose nitrate, he used 10%, and further reduced the viscosity by the addition of sulphuric acid or other mineral acids. This permitted him to reduce very much the pressure required for filtering and forcing the solution through the very fine jets from that of the 50 to 60 atmospheres as used by Chardonnet; the more dilute solution at the same time allowed the use of jets of larger bore for the same size of filaments or the production of finer filaments from the same size of jet.

Lehner patented the addition of oils, resins, and solutions of waste natural silk in acetic acid to the nitrocellulose solution, but silks having properties indicating the presence of these constituents have not been seen on the market. He, like Chardonnet, used water to coagulate the thread, and produced at his works in Switzerland as much as 2800 lb. per day.

Patents have been taken out by Du Vivier (Eng. Pats. 2570 and 2571 of 1889) who nitrates his cotton with a mixture of sulphuric acid and dry potassium nitrate and carries out the operation at the unusually high temperature of 60°–80° C.; he also adds to his nitrocellulose albumin or gelatin; this process, however, does not appear to have been carried on commercially, and the same remark applies to the numerous other methods of inventors who have attempted to produce silk from nitrocellulose.

The difficulties and defects in the processes of producing silk from nitrocellulose, led to much research after other methods and substances suitable for the production of artificial fibres, and the next process to be developed was that which made use of a solution of cellulose in ammoniacal copper oxide for spinning; a Frenchman, Despaissis, took out the first patent (Fr. Pat. 203,741) in this con-

nection in 1890, but his subsequent early death led to the lapsing of the patent and nothing further was done until Pauly took out his first patent (Ger. Pat. 98,641; Eng. Pat. 28,631 of 1897) in Germany seven years later. Then followed a long series of patents and much work in which Bronnert, Fremery, and Urban were also prominent (Eng. Pats. 20,801 of 1900, 1283 of 1905, etc.), and the processes of these workers have been the basis of manufacture by the Vereinigte Glanzstoff Fabriken A.G. of Elberfeld and its subsidiaries with factories in Germany at Oberbruch and Niedermorschweiler, St. Polten in Austria, Givet in France, and Flint in Wales. This company has been extremely successful, and for the year 1913, the last before the war, paid a dividend of 34% on a capital of seven and a half million marks.

The process employed in the factories of the Glanzstoff companies starts with cotton, and indeed it appears that all cuprammonium manufacturers find other forms of cellulose unsuitable. This cotton, generally in the form of linters, is boiled with about ten times its weight of a solution containing 0.25% of caustic soda and 0.5% of sodium carbonate for 1½ hours at a pressure of about 2½ atmospheres. The liquid is run off, the cotton is washed, hollandered, and centrifuged until it contains about its own weight of water, and then again boiled with a fresh amount of liquid of half the strength for the same time as before. The cotton is then washed with water and bleached in a weak solution of sodium hypochlorite, containing 0.1% of available chlorine; the operation takes five or six hours at the ordinary temperature; all traces of chlorine are removed by washing with thiosulphate solution followed by water. The purified cotton is again beaten for a short time in a hollander, then centrifuged until it contains less than 50% of water, when it is ready for solution. The cuprammonium solution is prepared by filling a large iron vessel with copper turnings and covering them with ammonia solution containing 14% ammonia; air is blown through the solution, which is kept at a temperature below 4° C., and in about one day the copper is dissolved.

To this solution is added a small quantity of caustic soda and, if necessary, copper sulphate to raise the copper oxide content, and 2500 pounds of it is then run into the mixer, into which has been put 500 pounds of the above-described wet purified cotton. Solution takes about six hours, and during the whole of the operations and the subsequent filtering a temperature lower than 5° C. must be maintained, otherwise copper is thrown out of solution and spinning becomes impossible.

The spinning operation is not unlike that first employed in the nitrocellulose process, in that the cellulose solution is forced through glass jets into a liquid in which coagulation takes place. As at first employed this coagulating liquid or spinning bath consisted of sulphuric acid, and a concentration of about 50% H₂SO₄ was found to be most suitable. This bath neutralised and dissolved the ammonia, and a great part of the copper went into solution in it also, the remainder being removed from the thread in subsequent operations; the copper and ammonia which accumulated in the bath were both recovered. For a number of years past, however, this spinning bath has been displaced by an alkaline solution, at first by one containing 40% of caustic soda (Eng. Pat. 21,988 of 1904), to which later various additions have been made, the most interesting, and successful of which is glucose (Eng. Pat. 27,707 of 1907); the effect of this is to reduce the copper so that it is precipitated as a reddish mud in the bath itself making it easy of recovery, and also making the filaments visible during

spinning. Before this addition the bath soon became coloured blue by the copper which went into solution, and it was difficult or impossible to detect broken filaments or other spinning defects in the bath; with the addition of this reducing agent, however, there is no such coloration and the blue filaments can be distinctly seen against a pinkish background. The spinning jets are either glass tubes of about 0.1 mm. bore attached singly by rubber connections to the main supply pipe, or sets of two to eight tubes in one piece similarly attached to the machine, or as an alternative to capillary tubes, glass caps about three quarters of an inch in diameter and about an inch in depth are made, having a flat bottom and flanged top for attachment, the bottom being perforated with ten to twenty or even more holes of about 0.1 mm. diameter; these holes are made by fusing fine wires through the glass, and then dissolving them out by means of a suitable acid. The thread as it comes from the spinning bath is wound on to large glass bobbins of about six inches diameter, and on these is immersed in acid, washed free from all traces of acid, and then dried at a temperature of about 50° to 60° C. The filaments are now in a finished condition, but before the thread can be handled it must be twisted, which is done from small wooden bobbins on to which the thread is run from the larger glass ones. A further slight bleaching is given if necessary after winding into skeins.

Linkmeyer has patented and worked several modifications of the cuprammonium process, but his methods do not differ from those described to an important extent. Thiele's processes (Eng. Pats. 8082 and 8083 of 1902) have greater differences and are more interesting; he established a small factory at Yarmouth to manufacture under his patents, but it had not the success it appeared to deserve, and ceased working about five years ago. The thread produced was considerably finer than the others which had been put upon the market and of about the same dimensions as natural silk, which on this account it closely resembled in appearance and feel, having less lustre than the coarser filaments made by other processes. On account of its interesting properties the process of manufacture may be described for comparison with that already given for the more commonly used cuprammonium methods. Egyptian cotton was used as a starting material, and 50 kilos. of this was boiled for five hours, at a pressure of two and a half atmospheres, in 500 litres of 2% caustic soda, to which a little soluble oil was added; the liquid was then run off, the cotton was washed in the boiling kier and then treated with a 1½% solution of hydrochloric acid for half an hour, again washed, and bleached for 20 minutes in a solution of sodium hypochlorite containing one gram per litre of available chlorine, again soaked in acid of half the previous strength for about three-quarters of an hour, then finally washed free from acid, and centrifuged till it contained 50% of water.

The wet cellulose was pulped in a hollander, and filter pressed, then a weight of the cake equivalent to 20 kilos. of absolute cellulose was added to 260 kilos. of a 15% solution of copper sulphate contained in the hollander, and while running, the solution was cooled by means of brine pipes to 0°C. Copper hydroxide was then precipitated on the fibres by the addition of 265 litres of a 6.5% solution of caustic soda. The fibres thus impregnated were separated by filter pressing, and the cake was dissolved in 80 litres of 0.880 ammonia in an iron vessel. The resulting solution was diluted if necessary in order that it should contain 8% of cellulose.

Before spinning the solution was kept for about four weeks at a temperature of about 15° C. The

thread was formed by forcing the cuprammonium solution through a steel jet, having apertures of 0.75 mm. diameter, into a 0.25% solution of caustic soda contained in a long funnel-shaped tube, down which the solution steadily passed; by this means the relatively thick streams of cellulose solution coming from the jet were partially set and gradually drawn out to a great fineness; at this stage the thread passed into a stronger solution of 5% caustic soda, and so on to a bobbin. The filaments were then fixed by immersion in 5% sulphuric acid, after which, while still wet, the thread was twisted and reeled; the skeins were finally soaked in 1% acid, washed, and dried at a temperature of about 40° C.; the silk needed no bleaching.

Other cuprammonium processes of some importance were those of Friedrich, Bemberg, and Crumiere which differ in details from those already described. Cuprammonium silk, although it has perhaps left its most flourishing period in the past on account of the recent competition with viscose silk, has undoubtedly at present a strong hold on the market, on account of its superiority for certain purposes. This depends on its characteristic hard glasslike lustre, useful where strong effects are required, as in laces, edgings and the like, and on the smooth rounded section of its filaments, which makes it particularly suitable for braiding or knitting.

Viscose silk, the latest of the three important forms of artificial filaments to appear on the market in quantity, is the only one which is entirely English in its origin and development. Like the other artificial silks which have been described, it is a form of cellulose, but unlike them its starting material is not cotton but wood, and as it differs from them in its beginning so it differs right through its stages of manufacture, both in processes and machinery, reactions and methods, until the final product is obtained, and this also is distinguished from the others by its greater covering power and lustre, and its greater resistance to dyeing and finishing processes, and to wear. For these reasons it is thought by some competent to judge, that although its manufacture is more complicated than the older processes, it will ultimately supplant them.

Cellulose xanthate, which forms the basis of the viscose silk process, was discovered by Cross, Bevan, and Beadle in 1892, and is formed by the interaction of cellulose, sodium hydroxide, and carbon bisulphide; when dissolved in water or dilute caustic soda it forms a golden brown thick syrup and to this the discoverers gave the name viscose on account of its high viscosity. It was perhaps unfortunate that the same name had been given about a dozen years before to one of the products of certain slime-forming bacteria, by Béchamp, but now the supplanter firmly holds the title. Viscose silk like those earlier in the field had its years of experiment and probation, and although the solution was discovered in 1892 (Eng. Pat. 8700 of 1892, Cross, Bevan and Beadle) and the first spinning process followed nearly six years later (Eng. Pat. 1020 of 1898, Stearn), while the centrifugal receiver which has been largely used for viscose silk spinning was invented in 1900 (Eng. Pat. 23,158 of 1900, Topham), it was not until 1905 that Messrs. Courtaulds erected a factory at Coventry and thread was produced commercially in this country; even then success was not immediate, and for this reason the original viscose patent was renewed for the maximum period.

An earlier start was made on the Continent, and works were established at Sydowsaue near Stettin by Fürst Henkel von Donnersmarck, at Arques les Batailles near Dieppe, Venaria near Turin, and Alost in Belgium. The first named ceased operations some years ago and the same

remark applies to a later factory at Barcelona. More recently viscose works have been put up at Emmenbrücke in Switzerland, Moscow, Pirna in Germany, and Chester near Philadelphia, while others are said to be contemplated in England, the United States, and Holland; in addition to these most of the nitro and cuprammonium factories are using viscose to replace their former processes, wholly or in part, so that viscose silk factories may now be said to number about thirty. Norwegian spruce forms the usual starting material and contains about fifty per cent. of cellulose, which is obtained in a comparatively pure form by boiling the wood, after cutting it into small pieces, in a solution of calcium bisulphite under pressure, with subsequent bleaching. The pulp is then formed into sheets in a paper machine, dried, and cut to a convenient size for handling. The formation of alkali cellulose is the next stage in the process of manufacture, and this compound is produced by steeping the sheets of pulp in a strong solution of caustic soda, of a sufficient strength to produce mercerising; the excess of soda is then removed by pressing and the alkali cellulose which is thus obtained of constant composition is ground into crumbs in a mill.

It has generally been the practice to pack these crumbs in boxes and keep them to mature, the temperature and time of maturing, together with the quality of the cellulose employed, determining the viscosity of the viscose ultimately produced. Margosches in "Die Viskose," p. 41, states that in this process the alkali has a direct action upon the cellulose, and that to obtain a proper result the reaction should be carried on at a low temperature and with exclusion of air. It has been discovered, however, that oxidation is essential to the process, and that it can be accelerated and controlled by the use of suitable oxidising agents such as sodium peroxide (Eng. Pat. 13,655 of 1914, Courtauld, Glover, and Wilson), and that the use of catalysts, such as hydroxides of iron or nickel, usefully promotes this oxidation (Eng. Pat. 14,675 of 1914, Courtauld and Wilson).

The alkali cellulose after maturing is treated with carbon bisulphide, when a cellulose sodium xanthate is formed as a brown sticky mass, which is dissolved in a dilute caustic soda solution. This xanthate has the composition $(\text{Cell})_n\text{NaS}>\text{CS}$, but hydrolysis breaks it down with successively decreasing amounts of the xanthate group, $(\text{Cell})_n\text{NaS}>\text{CS}$, $(\text{Cell})_n\text{NaS}>\text{CS}$, and so on until cellulose or cellulose hydrate is reached, and it is at an intermediate stage or "ripeness" between these two extremes that viscose is used for spinning purposes. The exact ripeness which is most satisfactory depends upon a number of factors which include the strength of the xanthate, the composition of the spinning bath, and the kind of product which is to be made. This hydrolysis takes place spontaneously under ordinary conditions and with varying rapidity according to the temperature, and as the proportion of xanthate to cellulose decreases the solubility is reduced. For this reason the solid xanthate, though soluble in water when recently made, is dissolved in dilute caustic soda, and after a series of filtering operations to remove all undissolved fibres, is ready for the spinning operation.

Stearn patented spinning baths of ammonium salts and these were used for some time; the thread produced consisted of cellulose ammonium xanthate, was soluble in water and had to be decomposed or fixed by subsequent treatment in dilute acid; also because the threads were very soft as well as soluble when freshly spun, a bath of sulphate of iron was used to give a coating of ferrous sulphide to the filaments and so prevent them from sticking together during the twisting operation.

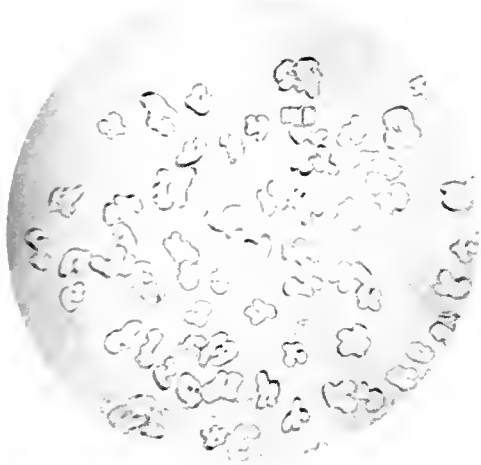
Subsequent improvements in spinning baths were the use of mineral acid (Eng. Pat. 2529 of 1902, Stearn and Woodley), solutions of sulphuric acid and sulphates (Eng. Pat. 10,094 of 1906, Müller) the use of glucose, other sugars or organic hydroxylic compounds in a bath containing acid and sometimes salts (Eng. Pat. 21,405 of 1907 and 5595 of 1908, Courtauld and Wilson) and the use of zinc salts in acid spinning baths (Eng. Pat. 406 of 1911, Courtauld and Napper). These patents mark the stages of progress in this portion of the manufacture, but many others have been granted for special conditions of temperature and strength of solution, and an interesting set of processes originated in America with Waddell, Waite, and Ernst who used sodium bisulphite solutions for coagulating the thread.

The viscose is forced through jets into one or other of the spinning baths mentioned above; the jets, perforated with a number of holes, are generally of metal, platinum being often used for the purpose. Two mechanical methods of spinning have been commonly used in the viscose process; one resembling that employed in the cuprammonium process, of drawing on to bobbins, in many cases of glass, washing and drying the thread thereon, winding on to smaller bobbins and twisting from these as is done with natural silk; the other and more interesting is the Topham centrifugal box already mentioned.

In this process the thread after leaving the coagulating bath passes over a roller, through a vertically reciprocating tube into a circular box rapidly rotating on a vertical spindle; centrifugal force throws the thread to the side of the box, where it builds up into an annular cake, the requisite twist being given to the thread by the revolution of the box at several thousand turns per minute. When the box is full, the cake of thread is removed and reeled into skeins, which are then appropriately finished, being first immersed in acid, if a neutral spinning bath has been used, or if an acid bath, then the skeins are washed to remove all traces of the spinning bath, freed from sulphur and other impurities, and if desired bleached and dried. The thread is then ready for the textile manufacturer, although it often at this stage has further treatment such as giving a soft finish with soluble oil or soap, or sizing with gelatin or starch, according to the purpose for which it is required.

The description of the three main processes, nitro, cuprammonium and viscose, which has been given comprises the whole industrial history of artificial silk up to the present, but a number of other methods and materials have been suggested and patented. The earliest and at one time perhaps the most promising, because it was for long successfully worked in the manufacture of electric lamp filaments, was the zinc chloride process (Eng. Pat. 16,805 of 1884, Wynne and Powell); in spite of much work it has not been satisfactorily applied in the manufacture of artificial silk. Probably the breakdown of the cellulose, necessary to obtain a solution, is too great for a thread of sufficient tenacity to be obtained on reprecipitation, and the same thing may be said of the solutions of cellulose in sulphuric acid or phosphoric acid (Ger. Pat. 72,572, Langhans).

Several cellulose compounds, ethers and esters, have been put forward as suitable materials for artificial silk. The general properties of these are similar, in that an organic solvent is necessary which would entail the use of a spinning process similar to that used for nitro silk, with all its disadvantages, and the threads when produced are impervious to water and therefore cannot be dyed without quite special methods. Among these substances are ethylcellulose (Eng. Pat. 6387 of 1913, Lilienfeld) and cellulose acetate, for which about one hundred patents have been



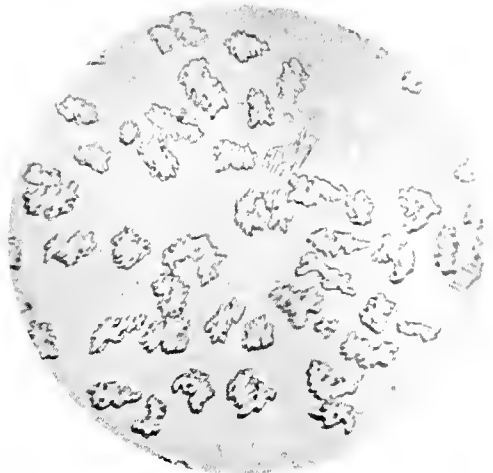
I. Nitro



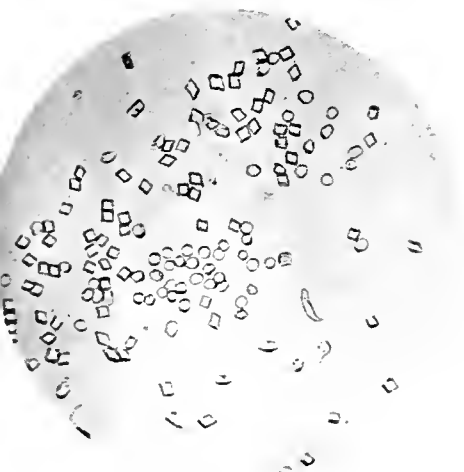
IV. Viscose, smooth



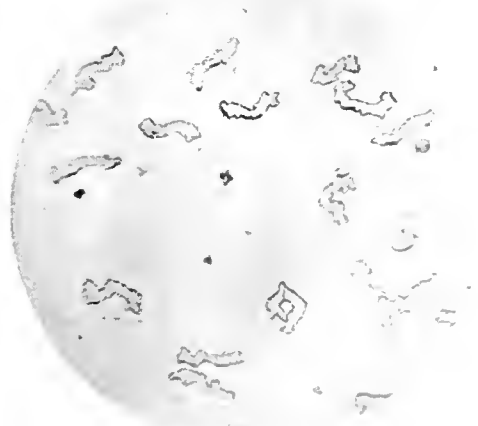
II. Cuprammonium



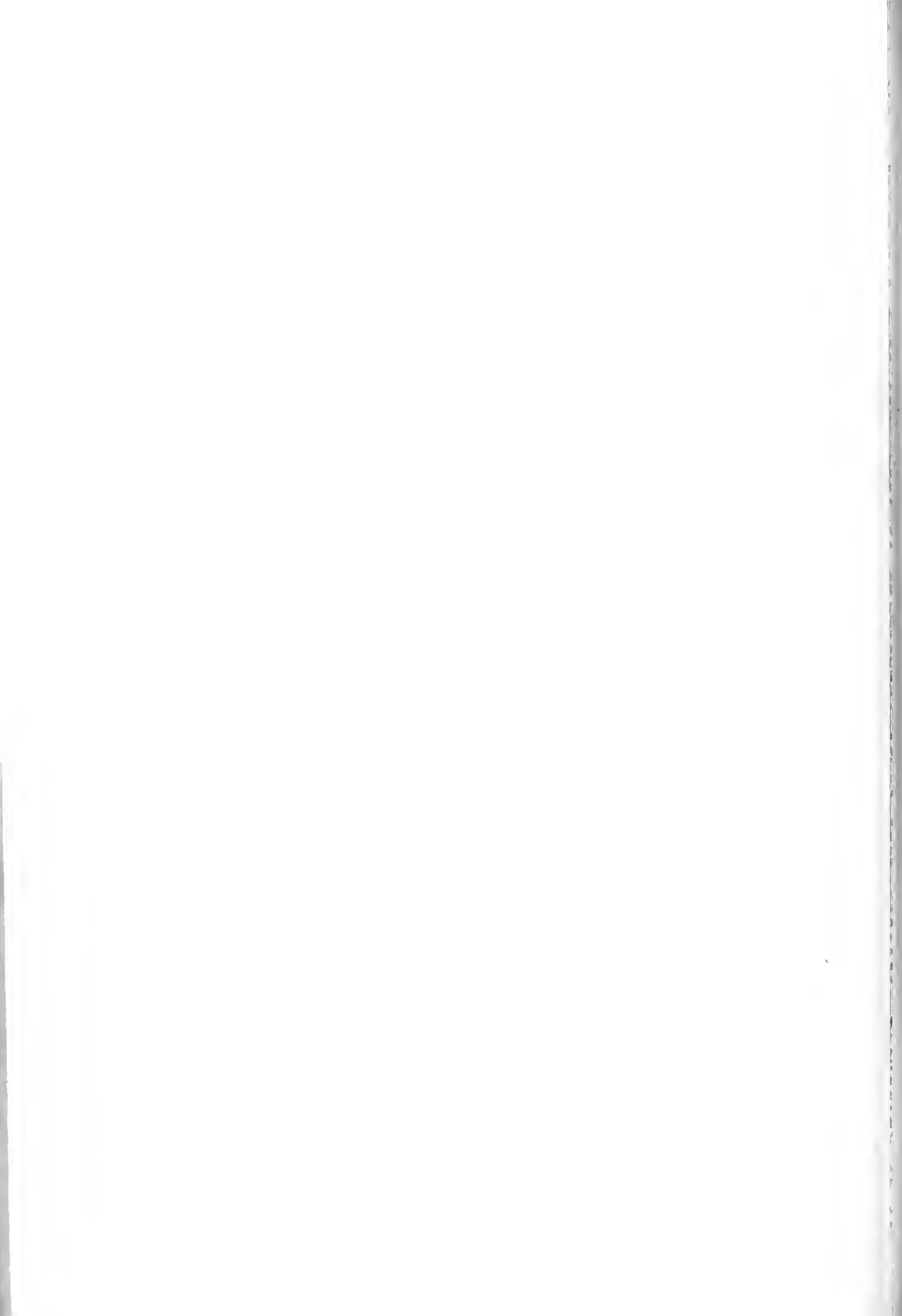
V. Viscose, irregular



III. Cuprammonium



VI. Viscose, thin



granted, the earliest being Eng. Pat. 9676 of 1894. Cross and Bevan; a patent for cellulose formate has also been published (Eng. Pat. 15,700 of 1910, Vereinigte Glanzstoff Fabriken A.-G.).

The use of non-cellulose materials has been advocated for the production of artificial silk on many occasions, one of the earliest and best known being that of Millar of Glasgow, who patented the use of gelatin for the purpose (Eng. Pat. 15,522 of 1894); in this case the soluble gelatin after formation into thread was hardened with bichromate, tannic acid, alum, etc. Todtenhaupt (Eng. Pat. 25,296 of 1904) has patented the use of casein, and others have made similar claims for ossein, fibroin, and albuminoid substances.

Among the many inventors in the field there are of course those whose madness does not amount to genius, and processes have been advanced which have failed to obtain appreciation. In one case the cellulose of mulberry leaves, being the food of the silk worm, was stated to be an excellent material for the production of artificial fibres, and oil of chrysalides was put forward as an ingredient in solutions for spinning; while in order to twist the filaments together and avoid the use of the power required to rotate heavy bobbins or boxes, it has been proposed to pass the thread through a revolving tube while both ends of the thread are prevented from twisting; and a German would-be inventor having seen the drawing of an English machine, obtained a patent for it, but described it in the position in which he had seen the drawing, upside down.

Because the commercial varieties of artificial silk are all forms of cellulose, there are no outstanding differences which distinguish the product of each process from that of the others, and although an expert can often identify a specimen as nitro or viscose for example, by inspection, in many cases it is not easy to distinguish between the products of different processes, so that it is no uncommon thing for a consumer to complain to a viscose silk manufacturer that a certain batch of silk is uneven in size, or dyes irregularly, and examination to prove that the sample sent to substantiate the complaint is composed partly of viscose and partly of nitro silk.

The products with least difference are cuprammonium and viscose, for both are forms of cellulose hydrate, not to be distinguished from one another by analysis, and in many cases having the same shape of cross section, and a similar affinity for dyestuffs. The most definite method of identification in this case is that published by Maschner (Färber Zeit., 1910, XXI. 352). About 0.2 gm. of the silk is put in a test tube and 10 c.c. of concentrated sulphuric acid is poured upon it; cuprammonium silk at once turns yellow, changing in a few minutes to a yellowish red, and within half an hour the silk dissolves leaving the acid of a pale yellowish brown; viscose silk turns to a reddish brown in a minute or two, and dissolves to a brown liquid. Concentrated phosphoric acid of about 1.7 specific gravity appears to be a means of distinguishing between cuprammonium spun in an acid bath and that spun in an alkaline bath, the latter giving a brown colour, while the former, together with viscose and nitro silks, gives no coloration.

Nitrocellulose silks, whether denitrated or not, always give a deep blue colour with diphenylamine in concentrated sulphuric acid; care must of course be taken that no dyestuff or dyestuff residues, left after bleaching a dyed silk, are present at the time of testing.

Mention has been made of the cross section of fibres; this is instructive but not always distinctive. Nitrocellulose is smooth in shape but not invariably regular in form and may perhaps best be described as lobate (Fig. I.). Cuprammonium is always rounded and smooth, whether spun by the Glanzstoff process (Fig. II.)

or the Thiele or similar process (Fig. III.). Viscose, however, may be of almost any section, owing to the fact that wider chemical variations are possible in the condition of the xanthate than can obtain in the other cellulose solutions, and the complicated constitution of the spinning baths also allows of a wide range of conditions; because of this it may happen that a slight temporary variation in one of the conditions of manufacture will produce a different section in some of the thread, causing it to have a different feel or appearance when woven or knitted into a cloth, providing trouble for all concerned; also by carefully choosing the conditions and adhering very closely to them thread may be produced which is specially suitable for braiding, knitting or weaving, etc. (Figs. IV., V., and VI.). Thanks are due to Messrs. Courtaulds Limited for permission to use the photomicrographs, which were made in their laboratory, and to Mr. Stokes, who prepared the sections.

The tenacity of artificial silk, both when wet and dry, is a matter of great importance, and although some years ago artificial silk left much to be desired in this direction and is not now by any means as strong as natural silk when wet, so great an improvement has been made in recent years, that no trouble is experienced when putting it through any reasonable textile or finishing process, and it will stand wear and washing excellently, so that artificial silk is now in common use not only for braids and fancy goods, but for both knitted and woven underwear and dress fabrics.

There has been on the market during the last two or three years a considerable amount of silk which has a breaking tenacity of 1.7 grams per denier when dry and 0.75 gm. per denier when wet; what progress this means may be seen from the following table:

	Ten. dry, g. per denier.	Ten. wet, g. per denier.	Extensibility, %
Chardonnet silk ..	1.1	0.25	8.0
Lehner silk	1.4	0.36	7.5
Cuprammonium (Glanzstoff)	1.3	0.5	12.5
Viscose, 1907	1.1	0.35	15.0
Viscose, 1913	1.4	0.55	17.0
Viscose, 1917	1.75	0.75	14.0
Natural silk	2.5	2.0	21.0

With regard to dyeing, it may be said that artificial silk behaves generally like cotton, except that for most dyestuffs it has a somewhat greater affinity; it likewise absorbs moisture to a greater extent than does cotton and is commonly sold as having 11 % humidity.

This outline of the manufacture of artificial silk gives a very imperfect idea of the amount of chemical work involved, for in addition to the control of the processes, necessitating in some works several hundred quantitative chemical and physical tests daily, there are numerous problems presented by products, waste materials, effluents and water supply, which need constant attention, and there is, further, that almost illimitable field of research, cellulose, of which much has been written, and comparatively little is known; the artificial silk industry, however, has probably done as much, directly or indirectly, to increase the knowledge of the subject as has been done by the other great industries of cotton, paper, and explosives which also depend on cellulose, and without doubt in the future will further extend this branch of science.

DISCUSSION.

Mr. S. J. PENTECOST asked what method of bleaching was used. When the dyer was dealing

with artificial silk he had some troubles at times, though not so many as formerly. He found that the affinity for dyestuffs had altered greatly during the past 10 years, and it had now about the same affinity as cotton. The question of the treatment of the fibre with soluble oil or softening was one which affected the dyer, and he asked whether threads made for lace and hosiery were treated either by soluble oil or softening?

Mr. WRIGHT enquired whether distilled water was used in the process; if not, whether the author considered it would be any advantage in avoiding the introduction of lime or magnesia. If distilled water were used some of the difficulties of dyers would possibly be overcome.

Mr. F. SPROXTON alluded to the author's statement that artificial silk absorbed moisture to a greater extent than did cotton, and was sold as containing 11% of moisture. How did that 11% compare with the wood pulp from which it was made?

Dr. H. P. STEVENS said that the author had stated that it was not possible to use wood pulp for the manufacture of cuprammonium silk. Was that the only reason why he considered the cuprammonium process would be replaced by the viscose process? In connection with the former, he mentioned that the silk was wound off on cylinders, while with regard to the viscose cylinders he alluded to the Topham spinning box. Could not that be used equally well in connection with the cuprammonium process? What was the object of allowing the solution to mature for months before use?

Dr. R. H. PICKARD asked the precise meaning of the sentence regarding 11% humidity. Did it mean it contained 11% of moisture as sold? He thought cotton would contain more than 5%—probably nearly 8%.

Mr. WILSON replied that sodium hypochlorite solution was used for bleaching. Much of the dyers' trouble was due to purchasing unbleached thread, and then bleaching with the Lancashire cotton bleach: that caused irregular dyeing. The aim had been to make the affinity of artificial silk for substantive dyestuffs the same as that of cotton, and that had been approximately attained. The treatment with softening materials was not general. The greater part of the thread as sent out to textile manufacturers was untreated; it was sized or softened according to the requirements of the manufacturer. The question of using distilled water had to be set aside owing to the huge quantities of water required. If trouble were found with soap or soluble oil in a thread it was probably due to its having been bleached with calcium hypochlorite rather than sodium hypochlorite. Washing with hard water was another reason for trouble in the spinning bath; softer water should be used. The 11% humidity referred to the silk as it was sent out: it lost 11% of moisture on drying for about 6 hours at 100° C., and that figure was taken as a standard. It would absorb more, and it could be produced with considerably less. Wood pulp contained about 8 or 9% as a rule, but varied very much: it was sold on a basis of 10%. Manufacturers did not use wood pulp for the cuprammonium process because they found cotton easier to work with. Wood pulp, unless well produced, did not give a good thread in cuprammonium solution. The same answer applied to the Topham box. He did not see, however, why it should not be made to work; at one factory in Germany two processes were used: the Topham box for one part of the viscose, and glass cylinders for the cuprammonium. As to the question of keeping the solution for some weeks before use, he thought there were particles which took a long time to come properly into approximate solution; certainly the cuprammonium solution was improved if kept for about

that period. If only kept a few days the results were quite inferior.

The PRESIDENT called attention to the fact that Messrs. Cross and Bevan had placed the sum of £20 at the disposal of the Society as a prize for an essay on "The Interconnection of Economic Botany and Chemical Industry"; and their friend, Mr. Latham, of Weybridge, had presented £300 as a grant towards research undertaken by such one of the competing essayists as might be judged to be of conspicuous ability. He mentioned that in connection with this paper since the industry concerned was one which had arisen out of the successful discoveries made by Messrs. Cross and Bevan.

A RESUME OF THE PRESENT POSITION OF THE ACTIVATED SLUDGE PROCESS OF SEWAGE PURIFICATION.

BY EDWARD ARDERN, M.Sc.

Since the inception in December, 1912, of the Manchester experiments which led to the activated sludge process, the results of which were first communicated to this Society in April, 1914, a number of investigators have undertaken experimental work on the subject, accounts of which are to be found in numerous contributions to the scientific and technical literature of this country Canada and the United States.

The results of the early investigations were such as to encourage trials of the process on a working scale and during the past 2 or 3 years considerable developments in large scale practice have taken place in America and also in this country despite the retarding influence of war conditions.

It has been thought desirable therefore to collect and summarise the data which has accumulated as the result of experience gained in the operation of working scale installations, with the view of ascertaining how far the process has been demonstrated a practical proposition, and in which direction further information is required.

The number of large scale units actually in operation or in course of construction renders it impossible to make reference to each individual plant. It is therefore proposed in the present paper to deal more particularly with typical installations with which the writer is personally acquainted or in regard to which authentic information is available.

MANCHESTER.

Dayphulme (Main Works).—A rectangular tank 25 feet by 16 feet by 8 feet deep (water level), has been in operation at these works on the fill and draw system for the past three years.

Certain alterations in the arrangement of the tank have been made from time to time as the result of experience gained with its operation.

Some nine months ago the tank was entirely remodelled in the light of the most recent knowledge in regard to tank design and method of air admission.

The floor of the tank is now constructed on the ridge and furrow system with rows of diffusers placed along the furrows, such that the net diffuser area is about one-sixth the total tank area.

The diffusers, which were supplied by Messrs. Jones and Attwood, Ltd., consist of shallow ear iron trays, 1 foot square (over all), with an insulating cover of porous material having a central orifice for the admission of air to the under side of the tray.

There is an overhead system of air supply pipe with down pipes, each fitted with tee pieces so that they may serve two or three diffusers.

The purified effluent, after settlement of the sludge, is discharged from the tank through a sectional stand-pipe.

A novel feature of the installation is a mechanical arrangement (devised and patented by Messrs.

Jones and Attwood, Ltd.) whereby a pulsating air supply is automatically obtained.

Attached to each air pipe serving a row of diffusers is an ordinary mushroom type valve which is operated by a pressure diaphragm receiving its air pressure intermittently from one of a series of pilot valves. The pilot valves are operated from a cam shaft which is turned by an air wheel immersed in oil.

The design of the cams at present employed gives a ratio of the time of admission of air to the diffuser to the period of rest of 1:2; the actual time of these periods can be varied by regulating the speed of the cam shaft. As a general rule each set of diffusers receives air for 5 seconds at intervals of 10 seconds.

The above ratio may of course be varied by substituting cams of a different design to those in use.

With the exception of disturbance due to excessive quantities of oily matter or to the presence in the sewage of strongly inhibitory trade effluents, no difficulty has been experienced in obtaining an entirely satisfactory purification of Manchester sewage with an average aeration period of from 4 to 6 hours, as will be seen from the following analytical returns.

Results in parts per 100,000.

	Screened sewage.	Effluent.	Purification.
4 hours' oxygen absorption...	10.40	1.60	85
Free and saline ammonia ..	2.86	2.06	—
Albuminoid ammonia	1.00	0.17	83
Nitrite and nitrate	—	0.30	—
Dissolved oxygen absorption after 5 days' incubation at 65° F.	—	1.20	—
(Royal Commission test)			

The above aeration period allows the tank to receive 3 fillings per day and as the water level is lowered 6 feet at each discharge the daily volume of sewage dealt with is 45,000 gallons.

For some time past, however, the problem has been complicated by the presence in the sewage of an undue proportion of difficult trade effluents, consequent on the very great activity in the chemical industry in the Manchester district, with special reference to the production of explosives.

In the absence of other units or a reactivation sludge tank, which would provide active sludge for inoculation in case of disturbances thus caused, it has been necessary to allow periodically an increased aeration period in order to maintain an entirely satisfactory effluent which readily passes the standard suggested by the Royal Commission on Sewage Disposal viz., not more than 2.0 parts of dissolved oxygen per 100,000 absorbed after incubation for 5 days at 65° F.

The most important development in connection with this tank has been the success of the pulsating gear by means of which it has been possible to reduce the air consumption by practically 50%, i.e., from 15 cubic feet free air per sq. foot tank area per hour to about 8 cubic feet. The working pressure is from 4½ to 5½ lb. Calculated on a 6-hour aeration period and allowing three fillings per day the air consumption is equal to 1.28 cubic feet free air per gallon sewage treated. Assuming a well-designed air compressor suitable for the purpose and power equivalent to 0.5 pence per electrical unit, it has been estimated that the compressed air would cost about 12s. 6d. per million cubic feet. On this basis the air cost is equal to 16s. 6d. per million gallons treated.

The experience gained with this tank has also demonstrated:—

1. The necessity for effective removal of

excessive quantities of oily matter (trade discharges) from the sewage, which is liable to have an emulsifying effect and thus prevent satisfactory clarification.

2. The importance of adequate removal of heavy suspended matter such as grit, sand, etc., or otherwise difficulty may be experienced in the accumulation of the sludge, with the likelihood of the formation of deposits of de-aerated sludge which undergo secondary decomposition and thus produce conditions which are inimical to the complete success of the process.

3. The advantage of a filtered air supply in obviating trouble with diffusers.

4. In the case of certain industrial sewages the necessity for the provision of a re-aeration tank for economy in the maintenance of the process.

MANCHESTER.

Withington Works. The experimental investigation of the application of the activated sludge process to the purification of the weak domestic sewage (50 gallons per head) dealt with at these works gave results * which were so far in advance of those obtained with the trade sewage, at Davyhulme, that it was decided to lay down a large-scale unit with the view of studying the process under working conditions.

Such a plant, which is designed to be operated on the continuous-flow system, is now in course of construction and it is hoped will be ready for use before the end of the present summer.

The aeration chamber, which is 100 feet long, is divided longitudinally into 5 channels each 4 feet wide. The depth of the tank measured from the diffusers to the water level is 5½ feet. Its total capacity is 55,000 gallons.

The floor of the tank is constructed in concrete on the ridge and furrow system, the ridges having a slope of 35 degrees to the horizontal.

Aeration is effected through rows of diffusers placed in the furrows, which are at 6ft. 9 in. centres. The diffusers are of course arranged transversely to the flow of sewage.

The sewage and sludge on flowing through the whole length of channels, i.e., 500 feet will thus pass over 75 different diffuser areas, which should secure effective mixing of the sewage and sludge and obviate to a large extent the possibility of short circuiting.

An overhead system of air pipes is provided and the air will be admitted to the diffusers through a series of down pipes which are arranged so that one pipe serves two diffusers. Valves are attached to the various distributing pipes so that the air supply may be regulated and equally distributed.

The diffusers are each 1 foot square over all, so that their total area is approximately one-seventh of the aeration tank area. The ratio of the net diffusion area to total tank area is practically 1:10.

The removal of the sludge from the purified effluent will be effected in a deep pyramidal settlement tank the dimensions of which are 23 ft. 6 ins. x 26 ft. 6 ins. in plan, with a depth from water level to apex of tank of 23 ft. 6 ins.

The sides of the tanks are constructed with a slope of 60 degrees to the horizontal.

The inlet and outlet arrangements of this tank have been designed on the basis of the results obtained by Mr. W. Clifford, Manager and Chemist of the Wolverhampton sewage works, from a careful study of the principles involved in the correct design of settlement tanks of this type.

The mixture of purified effluent and sludge is admitted to the centre of the tank through a 15-inch pipe which discharges within a guard chamber 6 feet square and 10 feet deep, in a manner

* Arden, this J., No. 2, Vol. 36, 1917.

designed to dissipate, as far as possible, the energy of the incoming liquid. The final effluent leaves the tank over a peripheral outlet cill.

The total capacity of the tank is 27,000 gallons or practically one half that of the aeration chamber.

The sludge is discharged by hydraulic head from the apex of the tank through a 6-inch return pipe to a separate chamber fitted with diffusers. The sludge is lifted from this chamber to the aeration tank by air lift, or surplus charge may be discharged on to drainage beds.

The installation is designed to deal with 250,000 gallons of sewage per day, which after accounting for the volume of sludge employed will allow an aeration period of 1 hour and a stay of 2 hours in the settlement tank.

This plant is being constructed under the advice and direction of the writer.

Messrs. Jones and Attwood, Ltd., are responsible for the whole of the equipment (apart from air compressor) and in consultation with the writer also for the general design of the plant.

The structural work involved is being carried out by the Corporation Main Drainage staff under the direction of Mr. Bertram Meek, the Acting City Engineer.

The air supply will be obtained from a belt-driven Reavell air compressor designed to deliver 500 cub. feet free air per minute at anything up to 15 lb. pressure. It is anticipated that the normal working pressure will be about 4 lb.

In view of the excellent results obtained at Dayhulme, in all probability a pulsating gear will be provided at an early date.

SALFORD.

The first really large scale plant in this country was brought into operation at the Salford sewage works in June, 1914, where tanks already equipped for aeration purposes were readily adapted to meet the requirements of the activated sludge process.

A full description of this plant together with the results obtained may be found in papers by S. E. Melling,* F.I.C., and W. H. Duckworth,† the Works Manager.

The plant was laid down under the advice of Mr. Melling, the Consulting Chemist to the Corporation, who is responsible for its control.

The original tank was operated on the fill and draw method but subsequently a continuous-flow system was also brought into use. Both these plants have now been in operation side by side for some time past.

In each case, aeration is effected through a system of perforated pipes laid on the floor of the tanks, which are rectangular in shape.

In the continuous-flow system the settlement of the sludge is effected in a series of 4 square tanks, with sloping sides. The settled sludge is periodically pumped back to the inlet end of the aeration chamber.

The total capacity of the aeration chamber is 12,000 gallons and of the settlement tanks 6000 gallons.

For experimental purposes both plants have been operated under various conditions and rates of flow.

Despite certain disadvantages the plant is under excellent effluents are invariably obtained, with a continuous rate of flow of 51,000 gallons per day, which allows an aeration period of approximately 4 hours and a stay of about 2 hours in the sedimentation tanks.

With the fill and draw tank entirely satisfactory effluents are obtained with an aeration period of

not more than 3 hours, which allows a daily volume of 132,000 gallons to be dealt with.

The Salford investigations have been very valuable in demonstrating on a working scale the principle of the process, and in thus confirming at an early date the original Manchester experimental work.

The results obtained have been an undoubted incentive to other authorities.

Admittedly, however, they have not assisted in determining the practicability of the process, as the volume of air employed is prohibitive from the point of view of cost.

The reconstruction of this plant on the most up-to-date lines is therefore awaited with interest, as in the writer's opinion there is every reason to believe that under suitable conditions equally good results will be obtained with a reasonable air consumption.

WORCESTER.

This plant was designed and installed by Messrs. Jones and Attwood, Ltd., under special agreement with the Worcester Corporation, whereby the payment for the installation was conditional on the successful operation of the process so as to comply with certain requirements in regard to the character of the effluent obtained, and the volume of sewage treated.

The installation, which is designed to deal with 750,000 gallons (day weather flow) per day, was brought in operation in April, 1906.

The writer is indebted to the firm* and to Mr. T. Caink,† the City Engineer of Worcester, for the following information relative to this installation which is the largest in operation in this country.

The tank placed at the disposal of the firm was 80 feet long by 72 feet wide and 18 feet deep. It was divided longitudinally into 9 bays 8 feet wide, which were subdivided by 3 transverse walls, thus forming 36 compartments.

In the adoption of this tank for the trial of the process, five bays are used as the aeration chamber and the other 4 bays for settlement purposes.

The five aeration bays are arranged as follows:—The first bay though 8 feet broad at the top is only 5 feet at the bottom due to the batter of the outside wall. The bottom of the first bay is arranged with ridge and furrows at 5 feet centres, the furrows each containing 5 air diffusers each 12-inch square over all, which are of course placed transversely to the flow of sewage. The lower part of each transverse wall is cut away, making an opening 3 feet deep right across the tank above the top of the ridge. The ratio of total diffuser area to tank area in this bay is 1:5 or 1 to 7 if the actual diffusion area is considered.

The other four aeration bays are arranged in pairs, each pair making a circulating tank. The bottoms of these bays are formed with ridges and furrows, saw-tooth form, at 10 feet pitch, with 80 diffusers in each furrow, so that the ratio of diffuser area to tank area is 1:10 or 1:14 for actual diffusion area.

Advantage is taken of the transverse walls which are used as baffles and these together with intermediate wooden baffles give a baffle alongside each line of diffusers which checks the back flow and allows the rising current of sewage to flow forwards, thus giving a much more rapid horizontal circulation than would be obtained by the natural flow of sewage.

The mixture of purified effluent and sludge leaving the aeration chamber enters the settlement tanks underneath a timber baffle 8 feet below the surface. The settled sludge is removed from a

* S. E. Melling, F.I.C., this J., No. 23, Vol. 33.

† W. H. Duckworth, Proceedings of Association of Managers of S.D. Works 1914; ditto, 1915; Proceedings of Association of Mun. and County Engineers, 1916.

* Activated sludge System. Booklet, No. 52, Messrs. Jones and Attwood, Ltd.

† Activated Sludge Process of Sewage Purification—Experiments at Worcester, by T. Caink, City Engineer. Meeting of Association of Managers of S.D. Works, July 7th, 1917.

series of collecting sumps through a system of pipes to the inlet sewage chamber.

The settlement tanks have been partially reconstructed since the plant was brought into operation, as will be seen later.

A similar system of air distribution pipes is employed to that described in the Withington plant.

The air compressor is of the Ingersoll-Rand horizontal type and is belt driven by electric motor (d.e.) capable of developing 40 B.H.P. When running at 235 r.p.m. it has a piston displacement of 615 cubic feet per minute and an actual delivery of 562 cubic feet.

The total capacity of the aeration chamber is given at 317,000 gallons, which after allowing 20% for the volume of activated sludge present gives an average aeration period of about 8 hours when working at the rate of 750,000 gallons per day.

In actual practice it is found the volume of this sludge returned to the aeration chamber is considerably in excess of 20% of the volume of sewage treated.

The total capacity of settlement tanks is sufficient to allow a 2 hours' detention when working at the above rate. As a matter of fact, however, for the greater part of the period the plant has been in operation, the whole of the settlement bays have not been in use.

The Worcester sewage cannot be termed a strong sewage as the flow is equal to approximately 40 gallons per head, and although the City Engineer states that a variety of trade effluents are discharged into the sewers, there appears none of an inhibitory character present in the sewage.

Apart from stoppages due to structural alterations to the settlement tanks, the plant has been in continuous operation for the past 14 months.

During this period the rate of flow has varied from 600,000 gallons to rather over a million gallons per day. The average daily flow dealt with may be taken at about 750,000 gallons.

In the following table are given the average results of analyses made by the Worcester City Analyst of the screened sewage (9 samples) and final effluent (12 samples) from June, 1916, to May, 1917.

Results in parts per 100,000.

	Screened sewage.	Final effluent.	Purification.
4 hours' oxygen absorption	3.70	0.56	85
Albuminoid ammonia	0.76	0.14	82
Suspended solids	14.3	0.72	—

The following are the analytical returns for snap samples taken by the writer on the occasion of a visit to the Worcester sewage works on July 13th, 1916, when a rate of flow of 825,000 gallons per day was recorded.

Results in parts per 100,000.

	Screened sewage.	Final effluent.	Purification.
4 hours' oxygen absorption	3.90	0.46	88
Free and saline ammonia	2.00	1.86	—
Albuminoid ammonia	0.89	0.06	93
Nitrite and nitrate (as NH_3)	—	0.33	—
Dissolved oxygen absorption after 5 days' incubation at 65° F.	—	0.76	—
(Royal Commission test.)			

The final effluent was perfectly clear and colourless and contained very little suspended matter.

These results indicate that a high degree of

purification is obtained with the production of an entirely satisfactory effluent.

It has been found unnecessary to run the compressor at full speed in order to keep the sludge in suspension in the aeration chamber. Under normal conditions the compressor speed is 160 r.p.m. which gives a free air delivery of 384 cubic feet per minute and about 20 B.H.P. The working air pressure is 9 lb.

This volume of air employed is equal to only 7 cubic feet per square ft. tank area per hour and is inclusive of the air used by air lifts for returning the sludge to the aeration chamber.

Working at the rate of 750,000 gallons per day the air consumption is equal to 0.7 cubic feet free air (actual delivery) per gallon of sewage treated.

The electric motor driving the compressor absorbs 16 units per hour which at $\frac{1}{3}$ d. per unit, the cost at Worcester, is equal to 32s. per million gallons sewage treated when working at the above rate.

Recently, sand drainage beds have been constructed to receive the surplus sludge but the results of their operation are not yet available, nor is it possible to say with any certainty the volume of sludge produced per million gallons dealt with.

It is stated that practically throughout its operation no trouble has been experienced with the working of the aeration chamber. So far as can be ascertained the sludge is kept in full suspension and there is no evidence of any serious sludge deposits.

Up to the present, the settlement tanks appear to be the limiting factor in regard to the volume of sewage which the installation is capable of dealing with.

From the commencement this portion of the plant gave unsatisfactory results, with strong evidence of the retention of sludge and subsequent return to the aeration chamber of sludge in a more or less septic condition, with consequent disturbance of the purification process.

At intervals the floors of the 1st and 2nd settlement bays have been reconstructed so that they now have a slope of 60 degrees to the horizontal.

This alteration appears to have overcome the difficulty of sludge retention, but owing to the insufficient capacity of the two converted settlement bays in operation, appreciable amounts of suspended solids pass away in the effluent if the rate of flow is increased seriously over 1,000,000 gallons per day.

There seems every reason to believe that with improved settlement conditions this plant would be able to treat satisfactorily a considerably larger volume than is at present being dealt with, with corresponding decrease in air costs.

The outstanding feature of this installation is the low air consumption which is obtained without the assistance of a pulsating air supply. It may be noted that it is not more than one half the volume employed in the American installations, and is very considerably less than the estimate based on the early investigations.

STAMFORD (LINCOLNSHIRE).

The sewage of the borough of Stamford is exceptionally strong, as the flow does not exceed 20 gallons per head of population and it contains an undue proportion of abattoir refuse.

It is therefore of interest that Messrs. Jones and Attwood Ltd., have designed and installed an activated sludge plant at the Stamford sewage works under an agreement with the Corporation on similar lines to the Worcester agreement.

Tanks previously employed as closed septic tanks have been adapted for the purpose of this plant.

The installation is designed to deal with the screened sewage at the rate of 100,000 gallons per day on the continuous flow system.

The aeration chamber is 80 feet long by 14 feet wide & 6 feet deep from water level to diffusers; its total capacity is 43,700 gallons.

It is divided longitudinally so as to form a channel 7 feet wide and 150 feet long, the last 10 feet of the return arm of the channel being occupied by a small Dortmund settling basin whose capacity is 3500 gallons. A further settlement tank is provided which brings the total capacity of the settling tanks to 8000 gallons.

The floor of the aeration channels is formed in ridge and furrows with rows of 7 diffusers (each 1 sq. foot over all) occupying the furrows which are placed transversely to the flow of sewage. The ratio of the diffuser area (gross) to tank area is approximately 1 to 6 or of net diffusion area to tank area of 1 to 9.

The compressed air supply is obtained from a suitably designed compressor worked by an oil engine which cannot be regarded as efficient, the total power absorbed being 1 B.H.P.

The volume of air supplied for diffusion and air lifts for return of sludge from settlement tanks is 125 cubic feet per minute (working pressure about 4 lb.) which amounts to just over 7 cubic feet per sq. ft. tank area per hour and on the basis of 100,000 gallons treated per 24 hours is equal to 1.8 cubic feet free air per gallon of sewage.

By the courtesy of Messrs. Jones and Attwood, Ltd., the writer is enabled to give the following average results of analyses of screened sewage and effluent made by Mr. E. Gaul, M.Sc. (Manchester University), between April and November, 1916.

Results in parts per 100,000.

	Screened sewage.	Final effluent.	Purification.
4 hours oxygen absorption...	10.91	1.67	% 90
Free and saline ammonia ..	4.27	3.40	—
Albuminoid ammonia	1.49	0.195	86
Nitrite and nitrate	—	0.28	—

On account of the inefficiency of the oil engine the actual power costs are high although the air consumption is low. This cost is given at 3d. per hour, which is equal to 6s. per 100,000 gallons or 60s. per million gallons sewage treated. In this consideration the strength of the sewage must be borne in mind, the aeration period allowed amounting to nearly 9 hours.

As in the case of the Worcester plant some difficulty has arisen in regard to the satisfactory operation of the settlement tanks. It is understood, however, that a reconstruction of the floors of these tanks and alteration of inlet and outlet arrangements have effected considerable improvement in their efficiency.

Mr. Ryman, the Borough Engineer of Stamford, reports recently that labour difficulties during the past few months have prevented this plant from being operated throughout the twenty-four hours. At the present time it is only at work for ten hours out of the twenty-four, during which period it is operated at the normal rate of 100,000 gallons per 24 hours.

Despite the fact that working under these conditions the sludge is not aerated for a period of 14 hours day by day, which must be distinctly disadvantageous to the maintenance of an active sludge, the Borough Engineer states that satisfactory effluents are still obtained.

AMERICAN INSTALLATIONS. MILWAUKEE, WIS.

The following description of this plant which was the first large scale American installation is taken from an article in "Engineering News."

*"Engineering News," New York, October 12th, 1916, Vol. 76, No. 15.

The installation, which was built by the Milwaukee Sewage Commission, of which George H. Benzenberg is chairman, L. Chalkley Hatton, chief engineer, and William R. Copeland, chemist and bacteriologist, was designed to deal with 1,600,000 gallons (U.S.A.) on the continuous-flow system and was put into operation in January, 1916.

It consists of eleven circular tanks each 30 feet in diameter. Eight of these are used in series for aeration purposes, one for settlement of sludge, and two for the re-aeration of the sludge prior to its return to the aeration tanks.

Two curved divisional walls are built in each aeration tank so as to form a channel of a total length of 912 feet, through which the mixture of sewage and sludge flows in its passage through the eight tanks. The floor is furrowed and lines of diffusers are fitted along the furrows longitudinally with the flow of sewage.

Air diffusion is effected by 12-inch square "filtros" plates which are set in cast-iron frames and which afford an air-supply beneath the centre line of each plate.

The ratio of diffusing surface to tank surface is 1 : 8.5.

The depth of these tanks from water level to diffuser is 10 feet, the average depth being 9 feet.

The holding capacity of each is 45,000 gallons or 360,000 gallons (U.S.A.) for the group.

The capacity of the sludge re-aeration tanks is similar, so that their total capacity is 90,000 gallons (U.S.A.)

The sedimentation tank is constructed with sloping sides at an angle of 45 degrees, terminated in a 48-inch cast-iron pipe which extends 23 feet 3 inches below the bottom of the tank. Its holding capacity is 33,000 gallons (U.S.A.), excluding 2260 gallons (U.S.A.) held by the 48-inch pipe.

The sludge is raised by air-lift to the sludge aeration tanks from which it is returned by a gravity pipe to the sewage inlet channel.

Compressed air is supplied by a Connersville position blower of the Boston type, with a capacity of 2406 cubic feet of free air per minute compressed to 5 lb. per sq. inch.

The total cost of sewage treatment by this plant is stated to be between six and seven dollars per million gallons (U.S.A.) exclusive of sludge charges.

The cost of sludge disposal, dewatering or drying is given at \$3.17 per million gallons, making a total charge of from \$9 to \$10. A gross return from the sale of dried sludge is expected of about \$6 per million gallons treated, which brings the cost of treatment and sludge disposal to between \$3 and \$4 per million gallons, including all overhead charges.

The following quotation from a letter from Mr. T. Chalkley Hatton to Mr. Hammond published in the paper previously referred to, summarises the experience with this plant up to the autumn of 1916.

"The plant was designed to treat 1,620,000 gallons of raw, coarse screened sewage with a four-hour aerating period, and 25 per cent. of activated sludge retained in the aerating tanks, and produce an effluent showing a removal of at least 95 per cent. of suspended matter and bacteria, with a dissolved oxygen content of five parts per million.

"Owing to the design of the sedimentation basin we have not been able to treat more than 1,400,000 gallons through the plant, and in fact 1,200,000 gallons is the limit from which we can get a satisfactory effluent. We provide for a 27-minute sedimentation with 1,620,000 gallons flowing through. Our observations to date lead us to the belief that one hour's sedimentation period would be nearer correct.

"We believe that our aerating capacity is sufficient to treat the full amount designed for,

but owing to the small porosity of the plates which runs from 1.85 to 4.50 cubic feet of air per minute per square foot of surface under 2 inches water pressure; and the failure of the air filter to intercept all of the dust and oils, the diffusion of air throughout the aerating tanks is not as uniform as we should like it, this results in the deposition of sludge upon some of the plates and the uneconomical use of the air, and the building up of pressure.

"From our experience here we believe we can practically overcome these difficulties in the design of the air filter; in changing the design of the bottom of our tanks; placing our air diffusers closer together and increasing their porosity; and particularly by intercepting the mineral matter, which now reaches the plant in great quantities, by well-designed grit chambers.

"The effect of cold weather upon the operation of the process is to increase the amount of air necessary and to decrease the nitrate in the effluent, but during February, March, and April we secured an average of 98% removal of suspended matter, 95% removal of bacteria, 3 to 5 parts of dissolved oxygen, no nitrates, a stability of 108 hours without dilution, and a very clear effluent in spite of the fact that the temperature of the raw sewage varied from 34° F. to 49° F., and the outside temperature from 14° F. below zero to 46° F. above."

The writer is indebted for the following information relative to other typical American plants to a paper presented by Mr. George T. Hammond, Brooklyn, N.Y., to the Congress of the American Society of Municipal Improvements, in November, 1916, which gives a complete account of the numerous activated sludge plants in operation in the States and Canada.

HOUSTON (TEXAS).

An interesting experimental plant designed by the city engineer Mr. E. E. Sands, was in operation at Houston, Texas, from September 1915, to June, 1916.

It consists of a continuous-flow plant with aeration tank approx. 28 feet by 11 feet by 7 feet 9 inches (greatest depth), the capacity of which is 10,400 gallons (U.S.A.), and a settlement tank 14 feet by 11 feet by 7 feet 5 inches deep with a capacity of 3300 gallons.

The aeration chamber is hopper-shaped, 11 feet 2 inches wide at the top and 14 inches at the bottom. The aeration is effected through diffusers ("filtros" plates), 12 inches square, placed in furrows at 3 feet 6 inches centres along the central axis of the tank.

The sludge is settled in a pyramidal settlement tank, from which the sludge is returned by hydraulic head through a 3-inch pipe to the inlet of the aeration chamber.

According to Hammond, for some months this plant treated 86,000 gallons of sewage per day with the production of an effluent the relative stability of which was 95% and the oxygen consumed varied from 1.0 to 1.6 parts per 100,000.

At this rate, an aeration period of 2.3 hours would be given after allowing for 20% sludge in the tank.

The air consumption was 6800 cubic feet per hour, which is equal to 1.6 cubic feet per gallon (U.S.A.) of sewage treated.

As the results of experience gained with this plant, certain improvements in design have been embodied in the large scale plant which it is understood is now in course of construction.

These improvements are concerned mainly with the design of the settlement tank, the sides of which it is considered should have a slope of 60 degrees to the horizontal and the arrangement of the diffusers transversely to the flow of sewage instead of parallel as in the above plant.

CHICAGO, ILL. (MESSRS. ARMOUR & CO.).

As the result of a fairly extensive trial of the application of the activated sludge process to the purification of stock-yard sewage, it has been found that despite the abnormally strong character of this sewage, satisfactory purification can be maintained with an eight-hour aeration period, working on a continuous flow system.

Owing to the poor distribution of air effected by the diffusers employed, due to their uneven porosity, they have been replaced in this installation by iron pipes perforated with $\frac{3}{8}$ inch holes, 2 inches apart and staggered, with improvement in the air distribution.

The air consumption is stated to be about 3 cubic feet per gallon of sewage treated and the cost is given at 37s. 6d. per million gallons treated.

The problem of dewatering and drying the resultant sludge has been investigated. The results are not yet available but it is suggested that decantation followed by treatment in a Worthington press as used at Milwaukee appears to give the best results.

ILLINOIS STATE WATER SURVEY.

(Champaign, Ill.)

This plant which has been laid down under the direction of Prof. Edward Bartow, who was responsible for some of the earliest studies of the activated sludge process, was designed to treat 200,000 gallons of domestic sewage per day.

The aeration chamber is a rectangular concrete tank 17 by 36½ feet in plan and 9½ feet deep, with a capacity of 36,000 gallons.

Three longitudinal walls divide the tank into 4 compartments. The bottom of each compartment is built with hopper sides.

Aeration is effected through "filtros" plates embedded in concrete on the floor of the compartments. The channel below the "filtros" plates is divided into sections so that each set of 6 plates is separated from all the others. A one-inch air pipe leads to each set of plates from a 3-inch continuous air main.

The settlement tank is built of wood and has a hopper bottom. It is 6 feet by 10½ feet in plan and 10½ feet deep at the lowest point, and has a capacity of 3700 gallons.

The sludge is withdrawn from this chamber by air lift and can be discharged either into the sewage feeding the aeration chamber or on to drainage beds.

It is stated that satisfactory effluents are obtained with a stability of from 5 to 16 days. The effluent is clear, odourless, and sparkling, but at times contains small quantities of sludge.

Owing to insufficient capacity of the settling chamber it has been necessary to run the plant at considerably less than one half the designed capacity. Additional settling chambers are being installed which it is anticipated will enable the plant to be operated at the normal rate.

Other investigations in regard to the practical application of the process have been carried out at Brooklyn; Baltimore, where tanks previously in use as Imhoff tanks are being employed, Cleveland, San Marcos, and Edmonton, and experimental work has been continued at the Lawrence Experiment Station of the Massachusetts State Board of Health.

Taken as a whole, the results obtained from the operation of the various American installations are most encouraging.

Apart from certain failures in regard to air distribution, the difficulties met with may be ascribed to a very large extent to the fact that at the time these plants were installed only meagre information was available in regard to the most suitable design of plant to adopt.

The Milwaukee plant has suffered from the start from the consideration given to the possibility

of conversion to an entirely different method of sewage treatment in case the activated sludge process did not prove successful, while the trial of the process at Baltimore has been handicapped by endeavouring to adapt an existing plant which appears most unsuitable for the purpose.

The experience gained with the American installations has been valuable in indicating where improvements may be effected in their design, with especial reference to the obviation of short circuiting of the sewage in the aeration chamber and the settlement and return in a fresh condition of the activated sludge to the aeration tanks.

Plants embodying improvements in these directions should be more likely to meet the actual requirements of the process, and thus give a better purification at a lower cost.

SUMMARY.

An endeavour is made in the following paragraphs to summarise the present position of affairs and to indicate where further information is required.

Briefly stated, the problem of the successful application of the activated sludge process to the large scale treatment of sewage is to determine the most economical and efficient method by which the activated sludge may be kept in intimate contact with the sewage under strictly aerobic conditions.

The process may be carried out in a till and draw tank or in a continuous flow system.

The original experimental work was undertaken on the lines of the former method, and there can be no doubt that for a given air consumption it gives a more effective purification than the latter method, for the reason that there is no possibility of short circuiting of the sewage and there is practically no difficulty in obviating deaeration or putrefaction of the sludge.

In comparison with the continuous-flow system it suffers however from the following main disadvantages (i). Absorption of fall, required for the discharge of the tanks; (ii.) increased operation attention; and (iii.) increased possibility of diffuser difficulties by the constant periodical settlement of the sludge on the floor of the tank.

For these reasons the general tendency for large scale operation is towards a continuous-flow system in which it is of course necessary to provide a separate settlement tank and to make provision for the return of the sludge to the aeration chamber.

With regard to the design of the aeration chamber, the experience gained so far indicates fairly clearly this should be rectangular in plan and that the main tank should be sub-divided so that a long length of travel is assured with the idea of reducing the likelihood of short circuiting.

It is generally conceded that within limits the deeper the tank the greater the economy in power required for aeration purposes, but of course the questions of site conditions and cost of construction are involved in this consideration.

In the majority of cases porous diffusers have been employed as a means of aeration, but some difference of opinion exists as to the practicability of their general adoption.

In this respect certain American experience is distinctly adverse. In one instance, at any rate, they have been replaced by perforated pipes, and Hammond is of opinion that a perforated pipe grid offers advantages over porous tile diffusers.

On the other hand, diffusers have operated satisfactorily in various other plants, and at Milwaukee, although certain difficulties have been experienced with the diffusers employed, it is believed that these difficulties may be overcome by a more suitable type of diffuser and air filter. In fact, Chalkley Hatton, judging from experimental investigations, states that the amount of air used by the method of perforated pipes is too great to make the process attractive to them at Milwaukee.

Recent English experience with the latest type of porous tile is more favourable to the use of diffusers. As previously stated, very little if any diffuser trouble has arisen at the Worcester plant, which experience is corroborated by the use of similar diffusers at Davyhulme and Withington.

It is, however, advisable that they should be so fitted that they can be removed without difficulty for periodical inspection and cleansing, if required.

In the writer's view, it is also important to provide stop valves by means of which the air supply to each set of diffusers may be regulated, in order to ensure as far as possible an equitable air distribution, as it is obvious that uniform distribution is essential for economy in air consumption.

Care should be taken in the design of the aeration chamber to obviate the formation of sludge deposits, which are liable to undergo secondary decomposition and thus produce conditions inimical to the complete success of the process.

Up to the present, this point has been met generally, by constructing the floor of the tank on a ridge and furrow system, the diffusers being placed in the furrows.

Experience has shown that the diffused air should be admitted transversely to the flow of sewage rather than parallel to the central axis of the tank, as being more likely to obviate short circuiting.

There are obvious objections to this type of tank, such as cost of construction, and reduction in capacity by reason of the space occupied by the ridges. Attention is therefore being directed towards obtaining a suitably designed flat-bottomed tank.

The question of the ratio of diffusion area to tank area is important. This ratio has varied widely from 1:3 to 1:10 or even more. Further information and experience is required before any definite conclusions can be arrived at, and of course the question is largely influenced by the general design of the tank.

While discussing the question of diffusers, reference should be made to the possibilities of a pulsating air supply, as it affects their use to an appreciable extent.

Obviously the less volume of air applied to the diffusers the greater the liability to trouble; on the other hand economical operation requires the air consumption reduced to the minimum.

It follows, therefore, that if a pulsating air supply be employed, the total air consumption may be considerably reduced without diminishing the volume of air passed through the diffusers when they are in actual operation. If, therefore, the intermittency can be so arranged as to avoid settlement of sludge on the diffusers, a definite advantage is secured.

Experience at Davyhulme with the pulsating gear, to which reference has been made, indicates that this method of operation is full of possibilities in the direction of securing economy in air consumption.

It is, of course, well known that only a small proportion of the air employed when using diffusers, is required for the maintenance of the bio-chemical changes involved in the purification process, and for this reason attention should be drawn to an interesting series of experiments described by Mr. J. Howarth,* Manager of the Sheffield Sewage Works.

These experiments were undertaken largely as the result of difficulties met with in the use of porous tile diffusers, and are concerned with the aeration of sewage in contact with activated sludge, by air currents induced by mechanical means. The effect of a combination of aeration with a very low air consumption, and mechanical agitation, is also studied.

*Proceedings of the Association of Managers of S.D. Works, 1916.

This question is almost entirely one of cost in which purely engineering considerations are involved. The writer therefore awaits with interest the outcome of the extension of this investigation which he is informed by Mr. Howarth is under consideration.

The next point to consider is the design of the settlement tank and return of the sludge to the aeration chamber.

It is in this respect that practically the whole of the plants already in operation have failed in some degree to meet the requirements of the process.

This failure in design has had usually a two-fold effect. The first, a limiting one on the flow which can be treated satisfactorily, by reason of the inadequate settlement afforded, if the flow exceeds a certain rate, and the second, the inability to avoid sludge retention which results in the return to the aeration chamber of sludge in a more or less putrefactive condition, obviously to the disadvantage of the process.

The first difficulty may be easily overcome by increasing the capacity of the settlement tanks. Further research is, however, required to determine the best form of the inlet and outlet arrangements of the upward flow settlement tank, which appears to be the most suitable type to adopt, with the view of securing efficient settlement with the minimum tank capacity.

Apparently the second difficulty has arisen through having insufficient slope on the sides or bottom of the tank. Experience has shown that to ensure a constant flow of sludge from the tank as it deposits, so as to return it in a fresh condition, this slope should be not less than 60 degrees to the horizontal.

In the paper by Mr. Caink, City Engineer of Worcester, a flat bottomed tank is suggested, fitted with a travelling perforated pick-up pipe through which the sludge will flow by hydraulic head.

The outstanding feature of the activated sludge process is the recovery of a considerable proportion of the total nitrogen content in a form available for agricultural purposes. The amount of nitrogen in dried sludge varies from 4 to 6%, dependent on the character of the sewage treated, and it also contains appreciable quantities of phosphate.

The problem of dewatering and drying the sludge so as to render it transportable is therefore of great importance.

Considerable information has been obtained in America (Milwaukee and Chicago) in regard to the probable cost of these operations.

In this connection the following further quotation from Mr. Chalkley Hatton's letter to Mr. Hammond, previously mentioned, is of interest.

"After quite an elaborate experiment on the dewatering and drying of sludge, we find that there are very few problems connected therewith that has not already been solved in industrial establishments where materials of like character must be treated.

There is no difficulty in either one of two kinds of presses (the Berrigan press or the Simplex) of reducing the moisture from 99% to 70%; and there is no difficulty by either the direct or indirect dryer to reduce this moisture from 75% to 10% or lower."

As stated when considering the Milwaukee plant, the cost of this disposal of sludge is given at 13s. 3d. per million gallons, while the anticipated yield from the dried sludge is 25s. per million gallons, with a consequent reduction in the actual cost of treatment of about 12s. per million gallons.

In addition to the use of filter presses for the preliminary treatment of the sludge, there are possibilities in regard to the use of centrifugal machines, or the application of electrical treatment

whereby the sludge particles are granulated and the water readily separated.

A careful study of the conditions requisite for the success of the latter proposal is required. Preliminary experiments by Mr. E. Gaul, M.Sc., encourage the hope that in this direction a practical means of dewatering the sludge may be developed.

In considering this question of sludge disposal, reference should be made to the success of the method adopted by Mr. W. Clifford of the Wolverhampton sewage works, where during the period from September to May the whole of the sludge resulting from the precipitation tank treatment of the Wolverhampton sewage is piped direct to the various farm lands in the vicinity of the works.

The writer suggests this method as a means of utilising to the full the agricultural value of the sludge, in cases where the situation of the outfall works renders it a practical means of disposal.

In this way the bacterial content of the sludge would be maintained, and thus in addition to the proven food value of the sludge the soil would receive whatever advantage is due to bacterial inoculation.

While the actual cost of the process will be governed, of course, by the cost of available power, it will be seen from the foregoing that sufficient information has been already obtained from the operation of large-scale installations to show the practical nature of the activated sludge process, at any rate as applied to the purification of domestic sewage, despite the fact that these early installations have not fully succeeded in meeting the requirements necessary for the complete success of the process.

If, therefore, anticipations in regard to improvement in design of plants are fulfilled and especially if, as appears likely, full advantage can be taken of the value of the resultant sludge, there can be no doubt that the process will demand the serious consideration of all who are concerned with the design of sewage purification plants.

DISCUSSION.

Mr. WATSON said that Mr. Arden had done most excellent pioneer work. The process of air-blowing into sewage was not exactly a new one. It had been first done, many years ago, by Dr. Angus Smith, and by Waring, in America, 20 or 30 years ago, and since then a great deal of useful work had been done. Five years ago, when called upon to advise the Metropolitan Commission of New York on the question of the sewage disposal of New York, attention had been called to the question of air-blowing into sewage, and he had expressed the opinion that it was then out of the question. Investigators in the United States who had since gone more fully into it had come to the conclusion that it was necessary first to activate the sludge. By air-blowing, continued for some hours at a time, a remarkable change was worked in the condition of the liquid itself. No one could suggest that the process was not a practical process, but the question of cost was very important, and had not been very carefully gone into. Mr. Eddy, of Worcester (Mass.), had run two experimental plants in juxtaposition; the one was a percolating filter; the other, a tank through which air was blown. He calculated that the percolating filter was considerably cheaper, notwithstanding the fact that the electric current only cost $\frac{1}{4}$ d. per kw.-hr. There was no doubt as to the results that could be obtained when the power was suitable and good. He pointed out, however, that up to now only experimental plants had been worked.

Mr. E. HALLIWELL drew attention to Mr. Arden's suggestion that, with the exception of disturbance due to excessive quantities of oily matter or to the presence in the sewage of strongly

inhibitory trade effluents, no difficulty had been experienced in obtaining an entirely satisfactory purification of Manchester sewage with an average aeration period of from 4 to 6 hours. Was Mr. Ardern prepared to back that statement up in the case of winter frosts, in the case of breakdown of machinery, in the case of increased flow in wet weather, and other changes which usually obtained at sewage works? The question of the sludge was the essence of the problem. Mr. Ardern had shown in a recent paper that the quantity of sludge obtained by the activated process was twice as much as was produced by any other method. It was to be hoped that the sludge would prove to be of manurial value.

The PRESIDENT said that the question appeared to be one largely of the utilisation of the air. Only 1% of the air was utilised in the process, and when they were dealing with a huge project such as that of sewage it seemed that the cost entailed must be considerable if they could only use that small percentage.

Mr. F. R. O'SHAUGHNESSY expressed the opinion that the process was not past the experimental stage. One important point had been emphasised by the speakers about the process, and that was its vulnerability. Other merits apart, there was no more vulnerable process than the activated sludge process: there was also to be considered the uncontrolled influx of various trade wastes of various kinds. There was the danger of the installation being ruined by flood, or excessive flow. The great drawback to existing processes, by contact or percolation beds, was that they were inelastic or fixed: the advantage of the activated sludge process was its elasticity.

Mr. ARDERN, in reply, said he was prepared to admit that, with regard to this problem, practically nothing of a practical nature had been done in this country. Mr. Chalkley Hatton was responsible for the statement as to the reduction of moisture to 70% by presses—the Berrigan or the Simplex, at Milwaukee. He agreed that ordinary sludge did not lend itself readily to dewatering by pressing. He believed there were possibilities in the electrical treatment of the sludge. If sludge were submitted to low voltage and low amperage current, there was a marked effect in its granulation, and a rapid reduction in the water content. He was not, however, prepared to say what the cost of sludge recovery would be. His view was that winter in this country would have no material effect on the process. They had worked at Withington during winter and summer—in the former when the temperature was below zero; and apart from a reduction of nitrogen content, the value of the sludge had not been impaired. Whilst he appreciated the possible difficulties of trade waste in huge quantity, he did not think it would interfere in the way suggested. He had abstained from giving definite figures as to the cost of the process, but the working of their purely pioneer installations had given such results as to suggest that the process would be able to compete with existing processes. He added that Mr. Eddy did not use two plants working side by side: the figures were arrived at for a definite plant, the activated figures being estimated and not for a plant under his control. To his (Mr. Ardern's) mind Eddy had over-estimated the air costs; they had reduced that cost by one-half in this country.

THE FUTURE OF THE FINE CHEMICAL INDUSTRY.

BY ERNEST W. MANN, B.Sc.(LOND.), F.I.C., Ph.C.

[ABSTRACT.]

Under the past conditions of chemical training, the trained technical research worker has been a

rara avis; under present conditions he is hardly likely to be forthcoming, since the supply of raw material in the person of the graduated student is practically nil.

We are probably all agreed that something in the nature of a post-graduate course is required to enable the student to bridge the very considerable step between the University laboratory and the works, but we are not so well in agreement as to what form the training should take. The State Committee on research advocates the extension of the technological departments already in existence in connection with some of our Universities. Sir Thomas Barclay has proposed the establishment of state research laboratories under joint manufacturing and academic control, working on industrial problems and throwing the results of their work open under licence or royalty. There are many advantages in the latter scheme. One important advantage is the bearing it would have on the economical utilisation of research talent—a very important aspect of the future of technical research—the co-ordination of effort and prevention of waste. It is no doubt common knowledge that since 1914 the problems connected with the manufacture of numerous synthetic chemicals have been under investigation in many laboratories and probably in the end each has arrived at practically the same result.

At the present time, with German competition eliminated, American competition handicapped, and competition of the far East only just perceptible, it is a comparatively easy matter for certain manufactures to be carried on in a small way, and yet profitably. But what chance have they on such lines in the future? Take, for example, salicylic acid, now possibly manufactured by a dozen or more firms in this country with an entire output barely sufficient to supply our home needs; compare this with the output of a single German house before the war, greater than all put together.

Is there room for so much individual effort, and should not some steps be taken to concentrate production and thus to reduce manufacturing costs to such a point as will enable this country eventually to compete with the old-established and large-scale German plants?

There is another possible method by which efficiency can be tested and stimulated, that is by the interchange of manufacturing costs. The knowledge so gained would necessarily be an incentive to efficiency, since no one would rest content until his costs were reduced at least as low as those of any of his competitors.

Another important question on the manufacturing side is supply of trained labour. The shortage of skilled chemical workers is very great indeed, and unless remedied this may handicap us to a very large extent in the future. It may be that under after-war conditions the explosives works may be able to liberate men who have had training in chemical processes, and who will form a nucleus for the formation of a craft of skilled workers. Compulsory attendance at continuation and technical schools, with an obligation on the employer to afford facilities for such attendance will also assist towards this end.

Turning now to the question of markets, the first point that naturally occurs is the relation of the home market to foreign competition, and how far the infant industry is to be protected under post-war conditions. I imagine there will be general agreement that a tariff is essential, for a time at any rate, to prevent the trade being extinguished by the dumping which otherwise would be inevitable. Presumably wholly unmanufactured raw material would be free from duty and the rate of duty would increase proportionately to the complexity of the manufacturing processes involved. Consideration would have to be paid to

the influence of duties on semi-manufactured raw materials on the markets in the colonies and neutral countries, and it may be necessary to arrange for rebate of this duty on goods exported to such markets.

DISCUSSION.

Mr. B. F. HOWARD asked the author for his opinion on the matter of duty-free alcohol, and its probable effect on the English manufacturer in relation to Continental or other competition.

Mr. F. SPROXTON said that the general trend of Mr. Mann's paper appeared to be that in the future the chemical industries would be run principally by large manufacturing firms, and not by small ones. However much that was to be regretted for sentimental or other reasons, he felt they could not escape it. Regarding the question of alcohol, he said that many chemical manufacturers did not really know what facilities could be obtained in duty-free alcohol. If manufacturers wanted the Government authorities to make fresh regulations to help them in their industries, then they must be prepared to devise some scheme to afford the Government protection of their revenue. Manufacturers of fine chemicals would have to contribute towards the constant attendance and supervision of Inland Revenue officials, and here again the large works would have an advantage. Another point was in relation to attendance at Continuation and Technical Schools. If the migration of factories continued as it had done, the supply of educated boys would become a serious question. In large cities little difficulty was experienced in getting boys who had had a certain amount of technical training, and who were prepared to continue it. But if one worked, as he did, in a factory nine miles from a large town there was great difficulty in getting educated lads. He strongly believed in the policy of manufacturers providing facilities by which boys could be technically trained in the works at which they were engaged, and this should be done in their working time, and without any wage deduction. Members of the trained staff might take the classes. Personally he was able to speak of the result of such a system: it had been satisfactory, and had paid for itself over and over again. A certain amount of expense was, of course, involved, but the Board of Education would make a grant on condition that they approved the syllabus, and that the classes were open to the general public. There were at first sight objections to the latter condition, because it appeared that if the public attended, the members of the staff could not be on such intimate terms with the students as they would like, and moreover questions relating to the problems of the factory would have to be restricted. In their own case, however, the public had shown no disposition to attend.

Mr. E. K. SCOTT said that research workers should be protected from exploitation by the financing classes. In the United States what was known as Industrial Fellowships were provided: the system had been introduced at the Kansas University, and it had developed enormously. It seemed to him that some such system was needed in this country. His hope was that the individualistic system would be continued. At the same time he recognised that research work could not be carried on so satisfactorily by small firms as by a central institution, aided by the Government.

Mr. HEAVEN expressed the hope that good results would be obtained from the Ministry of Reconstruction. Was it not possible to continue some of the work done during the war by the Ministry of Munitions, and make it, if necessary, an appendage to the chemical industry; or come to some arrangement whereby individualistic

efforts would not be lessened, but that there would be some form of mutual control?

The PRESIDENT pointed out that this matter was under consideration by the authorities.

Mr. MANN, in reply, expressed his interest in what Mr. Scott had said on the subject of Industrial Fellowships. His firm had not experienced any difficulty, nor had to incur any expense in getting facilities from the Board of Customs for obtaining alcohol. The only condition was that the alcohol had to be denatured under their supervision.

VOTES OF THANKS.

The CHAIRMAN moved a resolution thanking those who had read papers at the meeting. The success of the Congress had been very largely due to the admirable character of the papers, which had been prepared under circumstances of great difficulty.

Mr. F. R. O'SHAUGHNESSY seconded the resolution, which was carried unanimously.

On the motion of Dr. R. H. PICKARD, seconded by Dr. DUNN, a hearty vote of thanks was accorded to Dr. Carpenter for having occupied the chair during the Congress.

VISITS TO WORKS.

On Friday afternoon parties of the members visited the following works, etc.:—Birmingham Gas Department's "Woodall-Duckham" Continuous Verticals and Cyanogen Plant, Windsor Street Gas Works; Birmingham Gas Department's Physical and Metallurgical Laboratories of the Industrial Research Department; King's Norton Metal Company; H.M. Factory, Oldbury (Chance and Hunt, Ltd., Managers); Dunlop Rubber Co.; Birmingham Drainage Board's Sewage Works; Messrs. Kynoch's Works.

EXHIBITION OF CHEMICAL WARE.

During the meeting an interesting exhibition of chemical apparatus and supplies was open in the University buildings. The following firms exhibited specimens of their products:—J. Barsham Green and Son, Doulton and Co., A. Gallenkamp and Co., Ltd., W. and J. George, Ltd., Philip Harris and Co., Ltd., Hind and Laund, Ltd., Kestner Evaporator and Engineering Co., Ltd., Macintyre and Co., Produits Chimiques Centrale, Shanks, Ltd., Southall Bros. and Barclay, Ltd., Standley, Belcher, and Mason, Ltd., Worcester Royal Porcelain Co., Ltd.

The display included examples of glassware, chemical porcelain, filter papers, microscopes, balances, pyrometers, ball mills, and electric furnaces; the various articles shown gave some idea of the great progress that has been made in these industries in Great Britain during the past three years.

London Section.

Meeting held at Burlington House on Monday, June 4th, 1917.

MR. A. R. LING IN THE CHAIR.

SOME OBSERVATIONS ON CRUDE BENZOLS.

BY PERCY E. SPIELMANN, PH.D., B.Sc., F.I.C., AND G. CAMPBELL PETRIE, F.I.C.

The object in view when examining these distillates was to attempt to extract more information from them than is obtainable by means of the retort test—a test which has little to recommend

it, and nothing to support it, scientifically—and at the same time to employ methods which, by their nature, will recommend them to the simplest works laboratory.

For this reason no preliminary treatment was carried out; the samples were examined as received.

A number of coke-oven benzols were analysed by the more recently established methods for content in benzene, toluene, xylene (closely approximate), paraffin, and carbon bisulphide, and these results were compared with certain simple operations to be described. Means for a preliminary "reconnaissance" has thereby been found, giving results more closely accurate than were at first anticipated.

Although from the general and strictly scientific standpoint, empirical and semi-empirical relations may be somewhat distasteful, no apology is offered for drawing attention to such as have been found in the present instance, as they appear likely to be of genuine value to the tar industry.

Benzene and toluene. (A) It has been found that if 100 c.c. of crude benzol be distilled from a distilling flask (columns 50–52) such as is now so widely used in connection with Government tests and specifications, the amount obtained up to 90° C. can be made proportional to the quantity of benzene present, and that from 90° to 120° C., proportional to the quantity of toluene in the sample.

distil at least a litre over a Young 12-pear head, and to note the rise of temperature for every 5 or 10° passing over. In Fig. 2 are shown three such curves, quite ordinary and characteristic of the operation, which indicate from their shape that there is a considerable quantity of benzene and some toluene present; but how much is not obvious—it is not immediately clear how the curve is to be interpreted quantitatively.

Benzene estimation. It has been found that when such curves are plotted in the manner shown on mm. paper (Fig. 2), the horizontal distances between the 5° mark and the point where the curve cuts the 92.5° C. line, gives a close measure of the percentage of benzene present.

Example.

No.	From curve.	By analysis.
	%	%
4.	59	52
5.	67	65
6.	40	38
7.	46	46
8.	60	58
9.	40	36

Toluene estimation. Further, it has been found that the quantity of toluene is proportional to the

TABLE NO. 1.

1	2.	3.	4.	5.	6.	7.	8.	9.	10	11.	12.	13.	14.
No.	Sp. gr. (15.5° C.).	Colour.	Distillate up to 170° C. %	Sp. gr. (15.5° C.).	Residue above 170° C. %	After H ₂ SO ₄ and NaOH treatment. Loss %.	Sp. gr. (15.5° C.).	After steam distillation. Loss %.	Sp. gr. (15.5° C.).	Total loss on treat- ment. %			
						Calc. on cr. dist.	Calc. on cr. ben- zol.	Calc. on cr. dist.	Calc. on cr. ben- zol.			Calc. on cr. dist.	Calc. on cr. ben- zol.
1	0.8935	Dirty brown	84.74	0.8810	14.2 (liquid)	8.2	6.9	0.8841	3.0	2.4	0.8789	11.0	9.3
2	0.9130	Yellow (fluores- cent)	80.40	0.8890	19.0 (solid)	7.0	5.6	—	3.0	2.4	0.8844	10.0	8.0
3	0.9300	Slightly yellow	71.65	0.8917	28.0 (solid)	7.5	5.4	0.8883	3.0	2.15	0.8860	10.5	7.5
4	0.9015	Light brown (fluorescent)	81.95	0.8800	17.0 (solid)	5.2	4.3	—	5.3	4.34	0.8791	10.5	8.6
5	0.8859	Brown	94.7	0.8826	4.8 (liquid)	7.2	6.8	0.8840	3.8	2.6	0.8814	11.0	10.4
6	0.9031	Practically colour- less (blue fluor- escence)	75.0	0.8761	24.5 (semi- liquid)	14.5	10.9	0.8805	3.5	2.6	0.8760	18.0	13.5
7	0.9000	Reddish brown	85.0	0.8837	14.0 (solid)	10.0	8.5	0.8826	2.5	2.1	0.8793	12.5	10.6
8	0.8858	Reddish	87.4	0.8764	11.6 (solid)	8.0	7.0	0.8845	3.5	3.05	0.8778	11.5	10.0
9	0.8712	Practically colourless	93.0	0.8656	6.0 (liquid)	14.0	13.0	0.8782	6.0	5.58	0.8675	20.0	18.6

The solid constituent in the residue above 170° C. (column 6) was, in each case, naphthalene.

These ranges include such substances as paraffin, and, in the lower fractions, carbon bisulphide also; but the results obtained are not rendered any the less trustworthy, as, in any case, a closer approximation that of 2–3% is not to be expected.

In Fig. 1 is shown the relation between the volume obtained by the distillation test, and the percentage of toluene and benzene present in the sample; there are also drawn the lines for the total quantity of benzene, toluene, etc., obtained by the distillation test, and also by the retort test (columns 48–52).

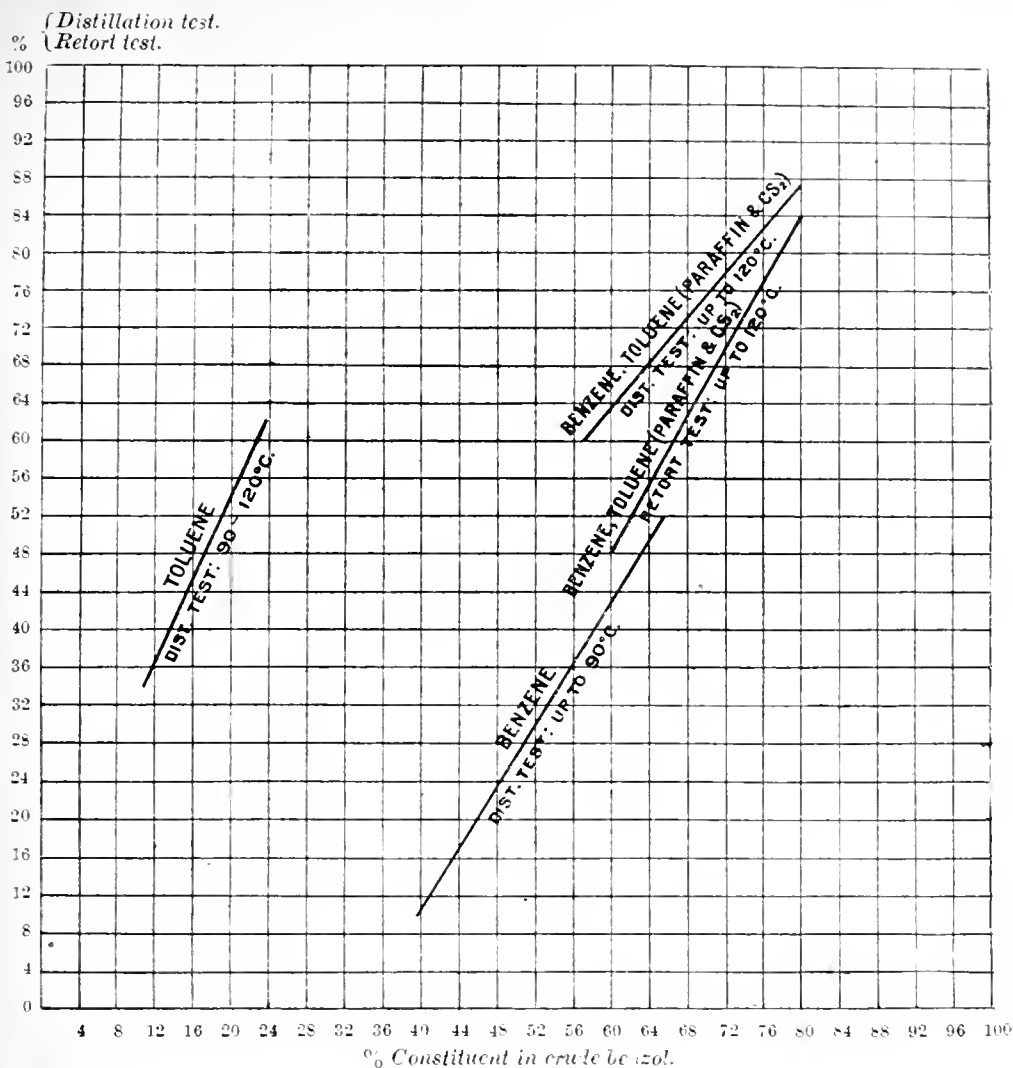
It was noticed that the distillation test results lie more regularly than the retort test points.

(B) Another mode of examining crude benzols, yielding appreciably more accurate results, is to

number of mm. of maximum deviation of the experimental curve from the smoothed curve shown dotted on the graph.

This relationship is read off by means of the graph (Fig. 3).

No.	Deviation, mm.	Toluene.	
		From curve.	By analysis.
4.	3.8	14.6	14.0
5.	3.5	14.0	14.0
6.	4.0	15.0	16.0
7.	8.0	18.0	19.0
8.	5.5	16.0	13.0
9.	13.0	22.0	22.0



% Constituent in crude benzol.
FIG. 1.

TABLE No. 2.
Distillation for analysis.

No.	15.		16.		17.		18.		19.		20.		21.	
	Fraction up to 90° C.				Fraction: 90°—140° C.								Spr.gr. of fraction up to 90° C. after CS ₂ extraction (15.5° C.).	
	Calc. on dist.	Calc. on cr. benzol.			Sp. gr. (15.5° C.).	Calc. on dist.	Calc. on cr. benzol.				Sp. gr. (15.5° C.).			
1	63.3	47.7			0.8829	34.0	25.7				0.8728		0.8822	
2	79.7	57.7			0.8870	18.0	13.0				0.8746		0.8838	
3	79.5	51.0			0.8889	19.2	12.3				0.8735		0.8832	
4	70.6	51.8			0.8835	26.0	19.0				0.8727		0.8833	
5	78.4	66.0			0.8840	19.6	16.5				0.8768		0.8827	
6	60.0	36.9			0.8803	35.1	21.5				0.8710		0.8798	
7	60.0	44.6			0.8840	34.8	25.8				0.8731		0.8828	
8	77.1	59.6			0.8821	19.4	15.0				0.8679		0.8815	
9	49.3	36.7			0.8763	41.1	30.5				0.8628		0.8751	

Fraction up to 140° C. (columns 52, 53).—A useful coincidence which becomes apparent is that the percentage of liquid obtained by the distillation test up to 120° C. is very closely approximate to the percentage of washed liquid boiling up to 140° C.—a fraction which is of particular interest.

Paraffin (columns 5, 26, 36—39, 40).—This was determined in the fraction up to 90° C. (column 26) by the method of Spielmann and Wheeler (this Jour-

nal, vol. 35, 1916), and the fraction from 90° to 140° C. (columns 36 and 38) by that of Colman (Journal of Gas Lighting, 1915) whilst a direct absorption method (column 40). (Wilson and Roberts this Journal, 1916, vol. 35, page 684), was also used, from which the graph in Fig. 4 was plotted.

It was noticed that the portion of the crude sample fractionated up to 170° C. shows a very varying specific gravity, and that where it was

possible to compare, the specific gravity corresponded fairly well with the quantity of paraffin found by analysis in the washed fraction from 90° to 140° C. (column 40). This is shown in the accompanying graph, which is put forward tentatively, as it is based on only four samples (Nos. 5, 6, 8, 9), quite insufficient for the establishment of a definite rule. But if further work should substantiate it sufficiently accurately, it would provide a simple method of estimating paraffin.

The distribution of paraffin in the fractions up to 90° C., 90°—107° C., 107°—115° C., and 115°—

140° C., did not yield as decisive results as were hoped for, partly on account of the small quantities present in the fractions, and partly because known methods of analysis are not sufficiently precise. It is obvious, however, from the figures in the table columns that in the fractions of rising boiling point there is a distinct diminution in percentage followed by a rise.

Loss on acid washing (columns 7—11).—The fact, that during the distillation of coal, a low temperature favours the production of paraffin, and a high temperature that of aromatic hydrocarbons, is illu-

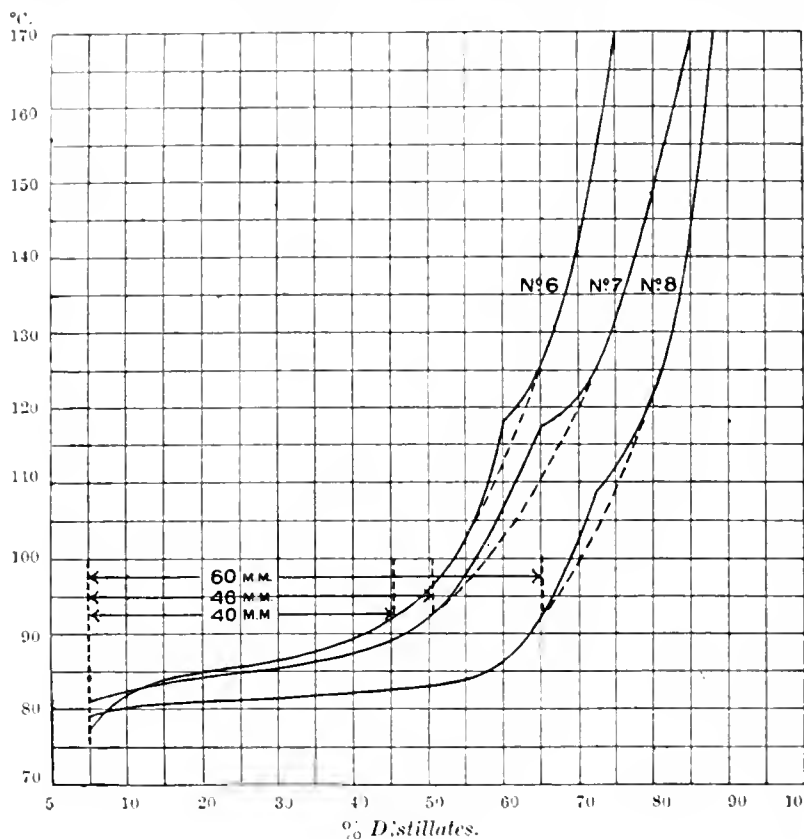


FIG. 2.

TABLE NO. 3.

Composition of fraction up to 90° C.									Composition of fraction: 90°—140° C.													
	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	
No.	Benzene %.		Toluene %.		Paraffin %.		Carbon bisulphide.		Benzene %.		Toluene %.		Xylene %.		Paraffin as benzene %.		Paraffin as toluene %.		Paraffin in fraction by direct meth. % on dist.	Residue above 140° C. %.		
	Calc. on dist.	Calc. on cr. ben- zole.	Calc. on dist.	Calc. on cr. ben- zole.	Calc. on dist.	Calc. on cr. ben- zole.	Calc. on dist.	Calc. on cr. ben- zole.	Calc. on dist.	Calc. on cr. ben- zole.	Calc. on dist.	Calc. on cr. ben- zole.	Calc. on dist.	Calc. on cr. ben- zole.	Calc. on dist.	Calc. on cr. ben- zole.	Calc. on dist.	Calc. on cr. ben- zole.		Calc. on dist.	Calc. on cr. ben- zole.	
1.	88.55	42.2	10.2	4.9	1.0	0.5	0.25	0.12	23.6	6.1	62.8	16.1	13.6	3.5	0	0	0	0	—	2.7	2.0	
2.	92.0	52.6	8.0	4.6	0	0	0.00	0.52	22.6	2.9	64.0	8.3	13.4	1.8	0	0	0	0	—	3.3	1.6	
3.	92.5	47.2	5.2	2.6	0.7	0.35	1.60	0.82	19.4	2.4	62.0	7.6	18.6	2.3	0	0	0	0	—	1.3	6.7	
4.	92.5	47.9	7.0	3.6	0.5	0.3	0	0	21.5	4.1	59.5	11.3	19.0	3.6	0	0	0	0	—	3.4	2.5	
5.	93.0	61.4	5.7	3.8	1.0	0.7	0.30	0.20	21.6	4.1	61.5	19.2	13.9	2.3	0	0	0	0	2.5	2.0	1.7	
6.	88.3	82.6	9.1	3.3	2.4	0.9	0.20	0.07	25.0	5.4	57.6	12.4	17.0	3.7	0	0	0.4	0.09	5.2	1.9	3.0	
7.	89.2	39.8	10.0	4.5	0.5	0.3	0.30	0.12	22.5	3.8	56.1	14.5	21.4	5.5	0	0	0	0	—	5.2	3.9	
8.	91.85	54.7	6.1	3.6	1.8	1.1	0.25	0.15	19.8	3.0	63.0	9.5	15.7	2.3	0	0	1.5	0.28	8.0	3.5	2.7	
9.	82.6	30.7	11.0	4.0	5.1	1.9	0.30	0.11	17.4	5.3	58.5	17.9	20.6	6.3	0.5	0.15	3.0	0.91	9.5	9.6	7.1	

minated by the work published mainly in America, by Rittman, Egloff, and Moore, and others (U.S. Bureau of Mines Publications; Journal of Industrial and Engineering Chemistry; Metallurgical and Chemical Engineering) on the cracking of various petroleum fractions and of purified hydrocarbons, both paraffinic and aromatic. (See also: Jones and Wheeler, Transactions of the Chemical Society, 1915, 107, 1318; Jones, this J., 1917, 36, 3; Whitaker and Crowell, J. Ind. Eng. Chem., 1917, 9, 261.)

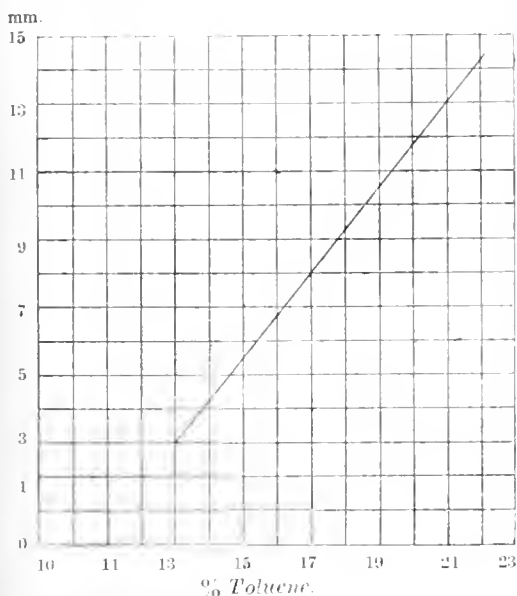


FIG. 3.

formed to the general definition for crude benzols, namely, that they should distil over up to 170° C.; most of them contained a considerable proportion of naphthalene (column 6).

For the present discussion, therefore, the fraction up to 170° C. (columns 1, 5) obtained in the laboratory is taken as representing a crude benzol as it should normally be produced.

Sp. grav. at 15.5°C. of crude benzol distillate up to 170°C. over a 5-bulb "Young" dephlegmator head

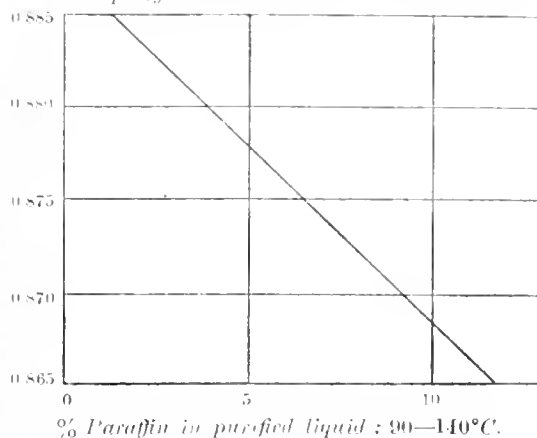


FIG. 4.

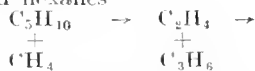
If the quantities of benzene, toluene, and xylene found in the fraction up to 170° C. be plotted against the loss on acid washing of this fraction (Fig. 5), it is seen that the two main constituents do actually occur in their inverse connection with one another; and when these are added together

TABLE No. 5.

No.	47.	48.	49.	50.	51.	52.	53.
	Preliminary distillation to 170° C.	Retort test.		Distillation test.			Purified dist. up to 140° C.
	1st drop ° C.	1st drop ° C.	vol. under 120° C.	1st drop ° C.	vol. under 90° C.	vol. under 120° C.	
1.	57	91	63.0	81	17	71.0	73.4
2.	60	88	62.0	78	31	70.5	79.7
3.	58	92	51.0	78	25	63.0	63.35
4.	55	90	61.0	77	25	70.5	70.8
5.	66	84	83.7	79	52	87.0	82.6
6.	60	92	48.0	85	13	59.6	58.5
7.	50	91	58.8	81	12	67.5	70.5
8.	50	87	73.0	78	14	80.0	74.7
9.	40	90	65.4	75	10	71.5	67.5

All this work appears to establish the connection between the various substances found according to the following scheme:—

Pentanes and hexanes



naphthenes (alicyclic hydrocarbons) → higher benzene homologues → lower benzene homologues → benzene → (diphenyl) → naphthalene → anthracene → carbon and gas.

On this basis, therefore, it may be expected that the amount of loss on washing with acid would be inversely proportional to the quantity of aromatic substances present, and that the quantity of benzene and toluene found would be inversely proportional to one another.

In the present case of the crude benzols as obtained from the various makers, very few con-

and combined with the figure of xylene, the total aromatic substances in that fraction show a remarkable constant inverse relationship with the loss on acid washing.

It may be a daring suggestion that the loss on acid washing may be taken as a measure of the three aromatic substances present in such a sample, yet the startling regularity of the plotted line almost compels its acceptance.

It should be pointed out that the sulphuric acid washing may have been more drastic than is considered necessary in a works laboratory, but for analytical purposes this was desirable.

From the figures it appears that the phrase, "loss on acid washing," should be precisely defined in meaning, as there is a considerable difference between the loss occurring after chemical treatment (columns 7, 8) and the total treatment (13, 14), including subsequent distillation.

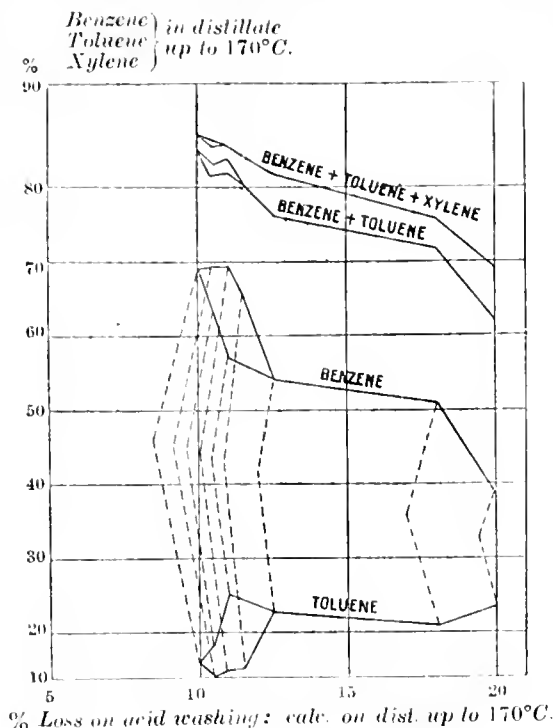


FIG. 5.

TABLE NO. 4.
Total benzene, toluene, and xylene.

No.	43.		44.		45.	46.
	Benzene, %		Toluene, %		Xylene, % (closely approx.)	Ratio, Benzene Toluene
	Calc. on crude benzol.	Calc. on dist. up to 170°C.	Calc. on crude benzol.	Calc. on dist. up to 170°C.	Calc. on crude benzol.	
1.	48.3	57.0	21.0	21.8	4.0	2.3
2.	55.5	69.0	13.0	16.1	2.0	4.3
3.	49.6	64.2	10.3	14.1	2.5	4.8
4.	52.0	64.4	14.9	18.2	4.0	3.5
5.	65.5	69.1	13.9	14.7	2.5	4.7
6.	39.0	50.9	15.8	21.1	4.0	2.4
7.	45.6	53.7	16.0	22.4	6.0	2.4
8.	57.7	66.1	13.1	14.9	3.0	4.4
9.	36.0	38.7	22.0	23.5	7.0	1.6

Meeting held at Burlington House on Monday,
July 2nd, 1917.

MR. ARTHUR E. LING IN THE CHAIR.

THE USE OF BREWERS' YEAST IN BREAD-MAKING.

BY JULIAN L. BAKER, F.I.C.

The possibility of using brewers' yeast in bread-making has in the past attracted much attention, and, indeed, this is not surprising when the selling prices of brewers' and distillers' yeast are compared. Prior to the war distillers' yeast was worth about £30 per ton. Now the relative prices are in the neighbourhood of £2 to £4 and £100.

Apart from the natural desire of brewers to deal profitably with a valuable by-product, the disposal of waste yeast in many cases presents difficulties. Some local authorities refuse to regard yeast as a trade refuse and the brewer not infrequently has

to destroy it at his own expense, or have it carted away and put on the land as a manure.

During the last few years there has been an increasing demand in certain localities for brewers' yeast by yeast-extract manufacturers, and the exigency of the war has greatly increased the output of the extract.

In some centres yeast is dried and used as a constituent of cattle foods. Although the value of yeast is recognised, geographical difficulties, uncertainty of markets, and the low price realised have prevented the brewing industry from developing the profitable disposal of waste yeast.

Many references dealing with the attempted alteration or transformation of brewers' yeast into a yeast suitable for bread-making purposes will be found in the British and foreign journals. In most of the papers which have been published, the variation in the doughing conditions obtaining in bake-house procedure is overlooked. Thus, it is obvious that in a quick doughing process of 3 to 4 hours, a high yeast rate and a strong yeast will be necessary. Most bakers employ a quick doughing process, and the poor repute of brewers' yeast is largely due to its failure under such conditions. With the present statutory flour, given a sufficiently long rise, perfectly good loaves can be made with brewers' yeast alone. The shape of the loaf is an important factor and a set of conditions which will produce a good "Coburg" or tin loaf will be unsuited for the cottage loaf.

A few years ago my colleague, Mr. Hulton, and I carried out a series of investigations on flours used for bread-making, and their behaviour towards brewers' yeasts ("Considerations affecting the 'strength' of wheat flours," this J., 1908, 368; "The behaviour of wheaten flour towards bakers' and brewers' yeast"; *ibid.*, 1909, 778-781; "The toxicity of flours towards *Saccharomyces cerevisiae* (top-fermentation, brewery yeast)"; *ibid.*, 1909, 781-781; "The toxins in cereals," J. Inst. Brewing, 1910, 395-408; Part II., *ibid.*, 1910, 431-435). There is no evidence that the two yeasts are other than the same species of *Saccharomyces cerevisiae*, and an explanation was necessary to account for the difficulty and slowness of brewers' yeast in fermenting flour.

In 1895 Jago (Science and Art of Bread-making, p. 223) recorded experiments in which he shows that brewers' yeast, while quite as capable of fermenting solutions of sugar as distillers' yeast, is relatively inactive towards a mixture of flour and water. H. Lange (this J., 1907, 1104) and F. Hayduck (*ibid.*, 1908, 85) state that many cereals exert a toxic effect on yeast which the presence of certain substances can overcome. In one of our papers (*ibid.*, 1909, 778) we brought forward experimental evidence to prove that the difference in behaviour of brewers' and distillers' yeast during the rising of the dough is due to the susceptibility of the former and the immunity of the latter yeast to the toxins in the flour. We further showed that a partial immunity can be conferred on brewers' yeast by the use of certain salts, thus enabling it to approach, though never to equal, the activity of distillers' yeast when allowed to ferment flour dough under similar conditions.

Our work convinced us that there was no simple process which would confer sufficient strength on brewers' yeast to enable it successfully to ferment the white flours at that time used. In the course of our work we also found that brewers' yeast when grown consecutively three times in a whiskey mash wort, acquired to a large extent the properties of a distillers' yeast, such properties showing little deterioration when the yeast was grown successively three times in brewers' hopped wort. Distillers' yeast would seem to owe its toxin immunity to the fact that it has been produced in an unboiled wort made from cereals, such as barley and rye, containing toxins. Only those cells that can withstand

and reproduce in such an environment survive and this selected immunity is transferred to the resulting crop.

The distribution of the toxin in the barley and wheat corn was a matter of some interest, and experiments showed that the whole meal was less toxic to brewers' yeast than the white or "patent" flour portion, and that the husk portion was anti-toxic in character. With the advent of less highly refined flours containing larger quantities of husk and other non-starchy matters, I thought it likely that brewers' yeast would effect a stronger panary fermentation. Laboratory experiments on the lines described in one of my previous papers (this J., 1909, 788) showed that the gas yield from "statutory flour" fermented with brewers' yeast was considerably higher than from white flour under similar conditions. The anti-toxic character of this flour was, however, insufficient to enable brewers' yeast to be used alone for bread-making involving quick doughing processes. Excellent loaves were made with brewers' yeast and statutory flour by the "long" process, and if the doughing period is immaterial—as, for example, in home baking—there is no reason why brewers' yeast should not be used. (c.f. Table, Scottish Trials.)

In certain economical considerations concerned with the food supplies of this country which became imperative at the commencement of the year, the large quantities of grain (120,000 quarters monthly) used by distillers was the cause of anxiety. To restrict the output from distilleries would entail not only a diminution of the quantity of alcohol required for munitions and other important purposes, but it would also lessen the output of yeast.

If the national interests demanded so extreme a measure, alcohol for munitions could be obtained—as has been suggested in the House of Commons—by rectifying the spirit now in bond. Although this would liberate some grain for food purposes the bakers would be anxious as to their yeast supplies, and it is in the highest degree undesirable that the staple food product of the country should be endangered or prejudiced.

Those responsible for the food supplies naturally inquired if brewers' yeast in any form could be used for bread-making, and I was asked by the Royal Commission on Wheat Supplies as to the possibilities in this direction. I suggested that a portion of the grain used by distillers might be released if satisfactory evidence could be obtained that a blend of brewers' and distillers' yeast was suited for bread-making. I was asked to go into the matter further and carry out the necessary baking trials and report to the Commission. My inquiry lasted some five weeks and the Chairman of the Commission has very kindly allowed me to submit the results to the Society of Chemical Industry.

At first sight the problem would appear to be a fairly simple one, but the doughing conditions in different parts of the country, indeed, in many cases in the same town, vary so widely that to draw safe conclusions from trials in two or three bake-houses is not possible. Moreover, the possible variation in "strength" of brewers' yeast obtained from the various systems of fermentation and the lack of uniformity in the statutory flours were difficulties which had to be contended with. I anticipated reluctance on the part of the bakers to carrying out any trials, bearing in mind the bad reputation brewers' yeast has in the bakehouse, but happily I was mistaken, and I should like to take this opportunity of acknowledging the assistance I received from all of them.

It was arranged that yeast crops from the following fermentation systems should be experimented with:—

(1) Dropping and cleansing. (2) Union. (3) Skimming. (4) Lager. Porter yeast from Ireland was also used.

Brewers' yeast, as has already been stated, can be used in bread-making, without any washing or other treatment. There is, however, some risk of imparting a yeasty and slightly bitter flavour to bread unless the yeast is well washed to remove adhering beer and other impurities, and then submitted to a simple treatment, which not only improves its strength but renders the product uniform. The washing is effected with a very dilute solution of brine and the treatment consists of a short but brisk fermentation in a dilute mash-tun wort. I hope shortly to give a more detailed description of the process to be adopted, which will differ in details from that used in the breweries I visited. I may add that the process is simple and inexpensive, and can be worked with the plant found in an ordinary brewery of good design. The pressed brewers' yeast as a result of this treatment should have lost its characteristic bitter flavour and it ought to keep quite as well as pressed distillers' yeast.

I arranged for the washed and treated brewers' yeast to be distributed to two "machine" bakers and two "hand" bakers in each of the five districts I worked in. Previously I visited the bakers and asked them to conduct baking trials under the same conditions as to yeast, water, and salt rate, and temperature ordinarily obtaining in their bake-houses.

In the majority of cases this was done.

The yeasts generally employed were:—

(A) 33% brewers' yeast with 66% distillers' yeast.

(B) 50% brewers' yeast with 50% distillers' yeast.

(C) 100% brewers' yeast.

(D) 100% distillers' yeast.

Baking trials were carried out at the following centres:—London, the Midlands, West of England, West of Scotland, and East of Scotland. The trials with the Irish porter yeast were made in the West of Scotland.

The loaves were forwarded to the offices of the Royal Commission on Wheat Supplies and criticised independently by two experts appointed by the Commission. These experts were asked to give their opinion as to the palatability, soundness, and flavour of the loaves and as to whether the use of brewers' yeast in admixture with distillers' yeast affected the commercial value of such loaves.

In all some 120 loaves were made, and, to illustrate the nature of the results I have included two typical sets—one from a Midland, the other from a Scottish town.

Before discussing the results it will be germane to refer to an important point which will be raised should the use of mixtures of brewers' and distillers' yeasts be recommended for bread-making. The bakers will require information as to the extent the brewers' yeast has helped in the raising of the dough. Some of them I have questioned consider that the brewers' yeast did no work; other bakers were of the opposite opinion. There is ample evidence that under some conditions, brewers' yeast will make as good a loaf as distillers' yeast and it is therefore evident that brewers' yeast can raise dough. Moreover, an inspection of the results will show that the bread made with mixed yeast of which 33 and 50% was brewers' yeast was not necessarily one-third or one-half as good as compared with the ordinary trade loaf. In a number of instances the experts considered the loaves made with the mixed yeasts superior to the control commercial loaf made with distillers' yeast alone. Neither was the doughing period longer nor the baking slower in proportion to the amount of brewers' yeast in the mixed yeasts.

I endeavoured, with the assistance of my colleague, Mr. Hulton, to obtain experimental evidence of the gas yields obtained when mixtures of brewers'

and distillers' yeast were allowed to ferment aqueous suspensions of flours under the conditions described in a former paper (this J., 1909, 778); 20-grm. portions of statutory flour were made into thin pastes with 50 c.c. of a 0.5% solution of sodium chloride

the mixture of yeasts contains more than 50% of brewers' yeast the volume of CO₂ evolved is higher than the sum of the yields of the constituents. Thus a mixed yeast consisting of 20% brewers' yeast and 80% distillers' yeast ferments flour in

MIDLAND TRIALS.

Baker.	No. of loaf.	Yeast rate per 280 lb.	Brewers' yeast, %	Distillers' yeast, %	Time in dough, hours.	Baker's opinion.	Opinion of Expert X.	Opinion of Expert Y.
A.								
Machine baker.	1	lb.	33	66	5½	Brewers' yeast worked slowly. No difference between loaves 1 and 4.	Fairly good loaf	Fair loaf
	2	3	50	50	5½		Fairly good loaf	Fair loaf
	3	4½	100	—	5½		Bad loaf	Poor loaf
	4	3	—	100	5½		Good loaf	Best loaf
B.								
Machine baker.	1	3	33	66	5	1 and 2 good loaves. Not so bold or bulky as 4. Flavour of 1 and 2 superior to 4.	Fair loaf	Good loaf
	2	3	50	50	5		Fair loaf	Good loaf
	3	4½	100	—	long process		No good	No good
	4	3	—	100	4		Best loaf	Fair loaf
C.								
Hand baker.	1	7½	33	66	4	All loaves good. No. 4 the best.	Good loaf	Good loaf
	2	7½	50	50	4		Fair loaf	Fair loaf
	3	15	100	—	long process		Poor loaf	Poor loaf
	4	3	—	100	3		Fair loaf	Fair loaf
D.								
Hand baker.	1	3	33	66	4	Good loaf Good loaf Poor loaf Good loaf	Good loaf	Good loaf
	2	3	50	50	4		Best loaf	Good loaf
	3	7	100	—	8		Fair loaf	Fair loaf
	4	1½	—	100	4		Good loaf	Fairly good country bread

SCOTTISH TRIALS.

Baker.	No. of loaf.	Yeast rate per 280 lb.	Brewers' yeast, %	Distillers' yeast, %	Time in dough, hours.	Baker's opinion.	Opinion of Expert X.	Opinion of Expert Y.
E.								
Machine baker.	1	lb.	33	66	4½	All fair loaves. No. 5 the best. No. 1 fermented more easily than No. 2. No. 3 being slow.	Fair loaf	Fair loaf
	2	3½	50	50	4½		Good loaf	Fair loaf
	3	7	100	—	4½		Best loaf	Best loaf
	4	3½	—	100	4½		Good loaf	Good loaf
	5	Parisian barm	—	—	overnight sponge		Good loaf	Good loaf
F.								
Machine baker.	1	5	33	66	4	All good loaves. Considers that bakers with experience of Parisian barm could easily work brewers' yeast.	Good loaf	Fair loaf
	2	5	50	50	4		Fair loaf	Good loaf
	3	15	100	—	5		Fair loaf	Fair loaf
	4	Parisian barm	—	—	overnight sponge		Best loaf	Best loaf
G.								
Hand baker.	1	5	33	66	4	Good loaves with exception of No. 3. Loaves 1, 2 and 3 would be better by overnight sponge.	Fair loaf	Good loaf
	2	5	50	50	4		Good loaf	Good loaf
	3	7	100	—	4		Fair loaf	Poor loaf
	4	5	—	100	4		Best loaf	Good loaf
H.								
Hand baker.	1	3	33	66	—	All good loaves with exception of No. 3. Difficulty in working brewers' yeast alone.	Good loaf	Good loaf
	2	3	50	50	overnight sponge		Good loaf	Fair loaf
	3	3	100	—	—		Fair loaf	Fair loaf
	4	3	—	100	—		Best loaf	Best loaf

and the weighed quantities of yeast mixed in. The fermentation was conducted at 110° F., the following gas yields being recorded at the expiration of 4 hours.

Weight of yeast.	c.c. CO ₂ .
0.5 grm. distillers' yeast	207
0.5 grm. brewers' yeast	25
1.0 grm. distillers' yeast	260
0.5 grm. distillers' yeast	262
0.5 grm. brewers' yeast	1

It will be noticed that 1 grm. of a mixture of equal parts of brewers' and distillers' yeast has the same fermentative power as 1 grm. of distillers' yeast alone. If the two yeasts worked independently the yield should have been the sum, viz., 207+25=232, whereas the volume found was 262 c.c. Similar results were obtained in other experiments. If

exactly the same way as an equal weight of distillers' yeast and if the volumes of CO₂ be plotted against time, the respective curves are superimposed.

The evidence afforded by these results, taken in conjunction with the baking trials, proves fairly conclusively that when distillers' yeast is mixed with brewers' yeast the latter yeast does not act merely as a diluent but contributes its *quota* or more to the fermentation of the dough.

Before any Public Authority can suggest or recommend the use of mixtures of distillers' and brewers' yeast to bakers some evidence will be required as to the amount of brewers' yeast available for this purpose.

At the present time the output of beer is limited to 10,000,000* barrels per annum. The yeast crop varies with the system of fermentation and the kind of beer brewed.

*Since this paper was written the barrellage has been increased by one-third.

In general terms every standard barrel of wort of a gravity of 1055° will produce 4 lb. of yeast, of which quantity 1 lb. will be required for pitching purposes. The 3 lb. surplus will amount to about 250 tons weekly.

Some years ago I had occasion to collect data as to the amount of waste yeast in London. The output of beer in the United Kingdom was then (1900) slightly over 39,000,000 barrels. The following quantities of waste yeast could at that time be obtained from eight of the leading London breweries:

Brewery A	30 tons per week.
" B	20 " "
" C	20 " "
" D	15 " "
" E	12 " "
" F	10 " "
" G	9 " "
" H	8 " "
	—
	124 " "

On a basis of 10,000,000 barrels probably 35 to 40 tons of yeast could be collected weekly in the Metropolitan area.

It should be borne in mind that at the present time the demand for brewers' yeast is small, so much so that in many instances it does not pay brewers to use yeast presses. But, if brewers' yeast can find a use in the bread-making industry, there will be a strong incentive for every brewer to wash and treat his waste yeast as its value will then probably rise to £15 or £20 or more per ton.

CONCLUSIONS.

The following conclusions may be drawn from this enquiry:—

(1) That brewers' yeast from any part of the United Kingdom is suitable for mixing with distillers' yeast. A mixture of brewers' and distillers' yeast will effect a satisfactory fermentation of dough. In such mixtures the brewers' yeast does not act as a diluent but is contributory to the fermentation.

It would appear that in the case of pan (tin) bread a mixture of equal parts of brewers' and distillers' yeast can be used. With the "Coburg" type of loaf one of the judges was of the opinion that whilst sound bread may be made with 50% of brewers' yeast, 33% should not be exceeded.

(2) When mixtures of the two yeasts containing 33 or 50% of brewers' yeast are used, the doughing period will be slightly prolonged if the yeast rate is low. For example a five-hour dough may be increased by one hour.

(3) Under the ordinary "quick doughing" process brewers' yeast by itself is useless. With a "slow dough" good loaves were made using only brewers' yeast.

(4) If, in the national interests, it should be decided to restrict the quantity of distillers' yeast supplied to bakers, the deficit could be replaced by brewers' yeast within the limits referred to in (1) without seriously interfering with existing conditions of manufacture or altering the commercial value of the loaves.

On the other hand if bakers were to adopt "slow doughing" methods the quantity of distillers' yeast now used could be reduced possibly even to ½ lb. per sack of flour of 280 lb. From what I have been able to gather there would be grave objections brought forward by the bakers to this course, one of the most important being the question of labour.

(5) Brewers' yeast by itself will produce palatable loaves, so that, in the case of emergency, it could be used. The drawbacks referred to at the

end of the last paragraph would however apply in even greater force.

(6) Some 700 tons per week of distillers' yeast is used for bread-making.

With the present barrelage of beer about 200 to 250 tons of brewers' yeast would be available for the baker at a price much lower than is paid for distillers' yeast.

(7) My own opinion, based on the results of the enquiry I have just concluded, is that the bakers would be able to use a mixture of equal parts of brewers' and distillers' yeast without any serious inconvenience to their trade or disadvantage to the public. If the 200 to 250 tons of brewers' yeast were to replace an equivalent amount of distillers' yeast, a very considerable quantity of grain being used to make the latter would be liberated for human consumption.

DISCUSSION.

Mr. T. WATSON LOVIBOND said that it was a well-known fact that brewers' yeast had been used for bread-making in former years. He thought that there was an absence of uniformity of conditions in the experiments described, and he could not help feeling some lack of confidence in the opinions given by the experts. The mode of comparison adopted seemed hardly fair.

Mr. KIRKLAND said that, speaking as a practical man, he thought that bakers could manage very well without brewers' yeast. He could not help thinking that Mr. Baker had been hampered in his experiments by being at the mercy of people who were unscientific. He thought that useful results were more likely to be obtained in small bakeries than in large ones. With regard to the opinions of experts, he would point out that loaves might be made to have any desired appearance, in spite of the fact that they had been baked under different conditions and with different yeasts. Could the author explain why distillers who made bakers' yeast used brewers' yeast for seeding? There was no difficulty in using brewers' yeast for baking, but it was slower and the plant in the United Kingdom would have to be increased if the baker had to depend upon it entirely. The Scottish bakers in former years made their barn for baking purposes from brewers' yeast.

Mr. W. WATERS BUTLER recalled lectures on bread-making by Sir William Tilden given at Birmingham over thirty years ago. The views held on the subject of bread-making were conflicting. Some contended that neither brewers' nor distillers' yeast was necessary. It was quite certain that thirty or forty years ago nothing but brewers' yeast was used by the baker, and that the loaves kept moist for a longer period and were of a better flavour than those of to-day. He asked Mr. Baker if any "improvers" had been used in the flours from which the loaves he had described were made.

Mr. BAKER replied that "improvers" had not been used.

Mr. BUTLER, continuing, said that he had been shown what the baker described as a good loaf which had been made from the yeast of his own brewery, and he had subsequently ascertained that the fermentation from which the particular yeast had been derived had been "dressed" with malt flour. He thought that the use of raw grain and sugars in modern brewing had exerted a weakening effect on the yeast. He hoped Mr. Baker would continue his experiments and that they might lead to an increase in the use of brewers' yeast for bread-making.

Mr. W. B. OAKDEN asked whether, if distilling was entirely suppressed by prohibition, there

could be found a substitute for yeast as suitable for bread-making.

Mr. WATKINS doubted if the difference between bakers' and brewers' yeasts was due to toxins in the flour. He thought that brewers' yeast had insufficient proteolytic power to deal with unpeptonised material such as gluten in flour and hence the weakness of brewers' yeast in dough fermentation: bakers' yeast on the other hand was sufficiently rich in proteolytic enzymes to peptonise gluten and thus furnish itself with the peptones requisite for its healthy growth and reproduction.

Mr. ANDERSON (Vice-Chairman of the Wheat Commission) said that he had been much interested in watching the progress of Mr. Baker's work. He thanked the Society for their hospitality and touched upon the close connection between the scientific work done by the members and the task of the Royal Commission.

Dr. G. C. DIXON (Royal Commission on Wheat Supplies) said that the results of the experiments carried out by Mr. Baker on the use of brewers' yeast in bread-making had already been carefully considered by the Royal Commission. They were now anxious that brewers' yeast should be used for that purpose to as large an extent as possible. Information had often been received to the effect that one of the objections to brewers' yeast for baking was that there was a risk of its not keeping sufficiently well to allow for its transport from one part of the country to another. They were, therefore, still somewhat doubtful as to the best method of using brewers' yeast effectively, and wished to know whether any of the chemists present had ever considered the possibility of mixing brewers' yeast with distillers' yeast during the fermentation process, and whether that would be an effective way of improving its keeping qualities.

Dr. FYLEMAN said that he had carried out some satisfactory experiments in bread-making with brewers' yeast previously washed with a dilute salt solution.

The CHAIRMAN said that there could be no doubt that the two yeasts, namely, that commonly used by bakers and that produced by brewers, were identical as regards species, and he hoped that Mr. Baker in continuing his experiments would find a means of converting one into the other by some simple means. With regard to the use of brewers' yeast, Mr. Baker had assumed that an increase of 4 lb. per barrel was obtained in the brewery, leaving a surplus of 3 lb. per barrel over and above that required for subsequent pitching. He would remind them that the 10,000,000 barrels allowed to be brewed between now and November would be increased in bulk considerably owing to a reduction in gravity, but this reduction in gravity would mean a reduction of yeast outcrop. The question of securing sufficient yeast for pitching was one of the most pressing to brewers at the present time. It was well known that the best yeast was obtained from an 18 to 20 lb. beer. The outcrop from a beer at higher or lower gravity was less satisfactory both in quality and yield.

Dr. L. T. THORNE said that in his experience previous aeration of brewers' yeast in sweet wort much increased the rapidity of its action towards dough.

Mr. W. SCOTT, speaking as a brewer, said that although brewers' and distillers' yeasts were of

the same species each had gone through such very different treatment that they were not interconvertible as far as bread-making was concerned. He had found that if brewers' yeast were washed with dilute salt solution in the pressed state it kept better. By using a much larger quantity of brewers' yeast the speed would be increased and at the same time valuable nutritive matter would be added to the bread.

Mr. KERSHAW asked whether the so-called German yeast was a product of the brewery or distillery.

Mr. E. HILL said that it seemed to him that the solution of the problem of the utilisation of brewers' yeast depended largely on the question of nutrition. If one yeast cell were added to a solution of cane sugar, the yeast cell died; if, however, several yeast cells were added to cane sugar solution some lived and grew, the reason for this being that the surviving cells obtained the necessary nourishment from the other yeast cells which had died. If the table of results were examined it would be seen that while only a small quantity of CO₂ was obtained from the brewers' yeast, a mixture of equal parts of brewers' yeast and distillers' yeast generated more gas than the total gas obtained when each quantity of the respective yeast was fermented separately. This was probably due to the fact that a greater part of the brewers' yeast died, and acted as a manure for the distillers' yeast and remaining brewers' yeast, which then grew quickly to give a good yield of gas. He would therefore suggest that experiments be made using a mixture of brewers' yeast with some fertiliser such as killed yeast cells, or the liquid obtained by the autolysis of yeast.

Mr. BAKER, in reply, reminded Mr. Lovibond that the baking trials had been carried out under the ordinary conditions obtaining in the respective bakehouses, the only factor which varied having been the yeast. The essential object of the investigation had been to ascertain if a blend of the two yeasts could produce sound commercial loaves and the bakers had not been asked to do their best with the mixtures of brewers' and distillers' yeasts and brewers' yeast alone.

The experts had had the loaves before them and they had judged separately and without knowledge of the baking conditions. Under such circumstances it might be fairly concluded that genuine opinions, free from any bias, had been expressed.

He would like to take this opportunity of thanking Mr. Kirkland for several suggestions made during the course of the investigation and for baking trials carried out at the Borough Polytechnic. He believed that the distillers who made yeast had been most careful to select their "seed" from previous distillery fermentations.

Brewers' yeast, like distillers' yeast, possessed proteases and there seemed no reason for believing that the one yeast differed from the other to any marked extent in enzymic activity.

He doubted if there would be any advantage in Dr. Dixon's suggestion of carrying out fermentations with the mixed yeasts. Raw brewers' yeast would not keep well, but if it were washed and treated it would have the same life as distillers' yeast.

He did not share Mr. Hill's views as to the brewers' yeast dying and affording nutriment to the distillers' yeast. In such mixed fermentations there was no undue proportion of dead yeast cells.

Journal of the Society of Chemical Industry.

No. 15, Vol. XXXVI.

AUGUST 15, 1917.

No. 15, Vol. XXXVI.

Official Notices.

CONTRABAND OF WAR.

A Proclamation, dated 2nd July, adds to and amends the lists of articles to be treated as contraband of war, and consolidates and re-issues them in alphabetical order, as follows:—

Schedule I.—Absolute contraband. Abrasive materials (see "Emery"). Acetic acid and acetates. Acetic anhydride. Acetic ether. Acetones, and raw or finished materials usable for their preparation. Albumen. Alcohols including fusel oil and wood spirit, and their derivatives and preparations. Aluminium, and its alloys, alumina, and salts of alumina. Ammonia. Ammonia liquor. Ammonium salts. Aniline and its derivatives. Antimony, and the sulphides and oxides of antimony. Apparatus which can be used for the storage or projecting of compressed or liquefied gases, flame, acids, or other destructive agents capable of use in warlike operations, and their component parts. Arsenic and its compounds. Arsenical ore. Asbestos. Asphalt. Balata (see "Rubber"). Barium chlorate and perchlorate. Barium sulphate (barytes). Bauxite. Benzine (see "Mineral oils"). Benzol and its mixtures and derivatives. Bitumen. Bleaching powder. Bone black. Bones in any form, whole or crushed; bone ash. Borax, boric acid, and other boron compounds. Bromine. Cadmium, cadmium alloys, and cadmium ore. Calcium acetate, nitrate, and carbide. Calcium sulphate. Camphor. Capsicum. Carbolic acid (see "phenol"). Carbon disulphide. Carbon, halogen compounds of. Carborundum (see "Emery"). Carbonyl chloride (see "Phosgene"). Caustic potash. Caustic soda. Celluloid. Cerium, and its alloys and compounds. Chloride of lime. Chlorides, metallic (except chloride of sodium), and metalloidic. Chlorine. Chromium and its alloys, salts, compounds and ores. Cobalt and its alloys, salts, compounds and ores. Copper pyrites, and other copper ores. Copper, unwrought and part wrought; copper wire; alloys and compounds of copper. Cork, including cork dust. Corundum (see "Emery"). Cotton, raw, linters, cotton waste, cotton yarns, cotton piece-goods, and other cotton products capable of being used in the manufacture of explosives. Cresol and its mixtures and derivatives. Cyanamide. Diamonds suitable for industrial purposes. Electrolytic iron. Emery, corundum, carborundum, and all other abrasive materials, whether natural or artificial, and the manufactures thereof. Explosives, materials used in the manufacture of. Explosives specially prepared for use in war. Fatty acids. Felspar. Ferro-alloys of all kinds. Ferro-silicon. Fibres, vegetable, and yarns made therefrom. Flax. Formic acid and formates. Formic ether. Fusel oil (see "Alcohols"). Gases for war purposes, and materials for production thereof. Glycerine. Goldbeaters' skin. Gutta-percha (see "Rubber"). Haematite iron ore. Haematite pig-iron. Hair, animal, of all kinds, and tops, and noils and yarns of animal hair. Hemp. Hides of cattle, buffaloes, and horses. Hydrochloric acid. Incendiary materials for war purposes. Insulating materials, raw and manufactured. Iodine and its compounds. Iridium and its alloys and compounds. Iron (electrolytic). Iron pyrites. Kapok. Lead and lead ore. Leather, undressed or dressed, suitable for saddlery, harness, military boots, or military clothing. Leather belting; hydraulic leather; pump leather. Light producing materials for war purposes. Lithium (see "Strontium").

Lubricants. Manganese and manganese ore. Manganese dioxide. Mercury. Metallic sulphites and thiosulphates. Mineral oils, including benzine and motor-spirit. Molybdenum and molybdenite. Monazite sand. Motor-spirit (see "Mineral oils"). Naphtha (see "Solvent naphtha"). Naphthalene and its mixtures and derivatives. Nickel and its alloys, salts, compounds and ores. Nitrates of all kinds. Nitric acid. Oleum (see "Sulphuric acid"). Osmium and its alloys and compounds. Oxalic acid and oxalates. Palladium and its alloys and compounds. Phenates. Phenol (carbolic acid) and its mixtures and derivatives. Phosgene (carbonyl chloride). Phosphorus and its compounds. Photographic films, plates, and paper, sensitised. Pitch. Platinum and its alloys and compounds. Potassium salts. Powder specially prepared for use in war. Prussiate of soda. Quebracho wood (see "Tanning substances"). Quillaia bark. Ramie. Resinous products. Rhodium and its alloys and compounds. Rubber (including raw, waste, and reclaimed rubber, solutions and jellies containing rubber and any other preparations containing balata and gutta-percha, and the following varieties of rubber, viz.: Borneo, Guayule, Jelutong, Palembang, Pontianac, and all other substances containing caoutchouc), and goods made wholly or partly of rubber. Ruthenium and its alloys and compounds. Sabadilla seeds and preparations thereof. Selenium. Silk, artificial, and the manufactures thereof. Silk, in all forms, and the manufactures thereof; silk cocoons. Skins of calves, pigs, sheep, goats, and deer. Smoke-producing materials for war purposes. Soap. Soda lime. Sodium. Sodium chlorate and perchlorate. Sodium cyanide. Solvent naphtha and its mixtures and derivatives. Starch. Steel containing tungsten or molybdenum. Strontium and lithium compounds, and mixtures containing the same. Sulphur. Sulphur dioxide. Sulphuric acid; fuming sulphuric acid (oleum). Sulphuric ether. Talc. Tanning substances of all kinds, including quebracho wood, and extracts for use in tanning. Tantalum and its alloys, salts, compounds and ores. Tar. Thiosulphates (see "Metallic sulphites"). Thorium and its alloys and compounds. Tin; chloride of tin; tin ore. Titanium and its salts and compounds; titanium ore. Toluol and its mixtures and derivatives. Tungsten and its alloys and compounds; tungsten ores. Turpentine (oil and spirit). Uranium and its salts and compounds; uranium ore. Urea. Vanadium and its alloys, salts, compounds and ores. Vegetable fibres (see "Fibres"). Waxes of all kinds. Wire, steel, and iron. Wood spirit (see "Alcohols"). Wood tar and wood tar oil. Woods of all kinds capable of use in war. Wool, raw, combed, or carded; wool waste; wool tops and noils; woollen or worsted dyaruss. Xylol and its mixtures and derivatives. Zinc and its alloys. Zinc ore. Zirconia. Zirconium and its alloys and compounds.

Schedule II.—Conditional contraband. Algæ, lichens, and mosses. Casein. Charcoal (see "Fuel"). Explosives not specially prepared for use in war. Foodstuffs. Forage and feeding-stuffs for animals. Fuel, including charcoal, other than mineral oils. Gelatine, and substances used in the manufacture thereof. Glue, and substances used in the manufacture thereof. Lichens (see "Algæ"). Mosses (see "Algæ"). Oils and fats, animal, fish, and vegetable, other than those capable of use as lubricants, and not including essential oils. Oleaginous seeds, nuts, and kernels. Powder not specially prepared for use in war. Yeast.

PROHIBITED EXPORTS.

By an Order-of-Council dated July 13th, 1917, carnauba wax is removed from Class (C) to Class (A) in the list of prohibited exports (see this J., 1917, 523), and the following headings are added:—(A) Potassium bicarbonate and mixtures containing it; (C) sera, except anti-tetanus serum; (C) sodium sesquicarbonate; (A) castor oil and articles and mixtures containing it.

CREOSOTE AND OTHER TAR OILS.

RESTRICTIONS ON USE AND ON DEALINGS.

The Minister of Munitions has made an Order, under date 13th July, relative to the use of creosote and other oils produced from the distillation of coal tar. The Order is to the following effect:—

For the purposes of this Order the expression "creosote" shall mean creosote, green oil, sharp oil, and any oil produced from or containing an admixture of oil produced from the distillation of coal tar, or any of them.

No person shall as from 13th July until further notice, except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions, use any creosote (whether as a solvent or otherwise) for or in connection with:—

(i.) The water-proofing, preservation, or treatment of timber or wood of any kind or description.

(ii.) The manufacture, repair, preservation or treatment of any road or path in the United Kingdom, or any part of such road or path.

No person shall as from 13th July until further notice offer to sell, or except for the purpose of carrying out a contract in writing existing prior to such date for the sale of creosote, enter into any transaction or negotiation in relation to the sale of creosote, except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions.

All applications for licences under this Order should be made to the Director General of Munitions Supply, Ministry of Munitions, Whitehall Place, London, S.W.1., and marked "Creosote Licence."

The Minister of Munitions has made a further order, dated 13th July, requiring all users or consumers of creosote oil, green oil, sharp oil, anthracene oil, or other oils with a specific gravity of 1.000 or more, distilled from coal tar, and all oils with a specific gravity of 0.950 or more distilled from other tars, to furnish the following particulars, within fourteen days from the above date, to the Controller of Mineral Oil Production, M.P.S.3, 8, Northumberland Avenue, London, W.C. 2:—

1. The source or sources from which their present supply is obtained.

2. The quantities of such oils used or consumed by them from 1st January, 1917, to 30th June, 1917.

3. The quantities of such oils which it is anticipated will be used or consumed by them from 1st July, 1917, to 31st December, 1917.

4. Full details of the purposes for which such oils have been or are intended to be used or employed.

IMPORTS INTO FRANCE AND ALGERIA.

The *Board of Trade Journal* of July 26th contains a list, reprinted from the *Journal Officiel* of July 13th, showing the various goods which may be imported into France and Algeria without licence, and a list of articles formerly allowed to be imported without licence but not now included in this list.

CARNAUBA WAX.

The Army Council gives notice that they intend to take possession of all stocks of carnauba wax, excepting stocks of less than two tons, that are at present or may hereafter arrive in the United Kingdom. All persons having in their custody or control any such stocks are required to make a return thereof, with full particulars of quantity, description and cost price, to the Director of Army Contracts, Room 79, Imperial House, Tothill Street, London, S.W.1.

London Section.

Meeting held at Burlington House on Monday, July 2nd, 1917.

MR. A. R. LING IN THE CHAIR.

DETERMINATION OF PHENOL IN COMMERCIAL CRESYLIC ACID.

BY J. J. FOX, D.S.C., AND M. F. BARKER, B.S.C.
Government Laboratory, London.

It has recently become of importance to ascertain the amount of residual phenol left in cresylic acid after the bulk of the crystallisable phenol has been removed in the factory. The matter is not so simple as might appear at first sight and it has engaged the attention of many workers. Of the various methods proposed from time to time only three need be mentioned here. A process which promised well is that suggested by Schryver (this J., 1899, 18, 553) who employed sodamide. This substance is acted on by the three cresols in such a manner that the same amount of ammonia is produced by the interaction of equal weights of the cresols and sodamide, whereas an equal weight of phenol gives more ammonia. Unfortunately the difficulties encountered under ordinary laboratory conditions render the process difficult to work. J. M. Weiss* (J. Franklin Inst., 1912; see this J., 1913, 692) made a number of experiments on mixtures of phenol with varying proportions of the cresols, and on the basis of his results devised a process which probably gave a more accurate measure of the phenol present in a mixture than any of the older processes. Still more recently R. Masse and H. Leroux (Comptes Rend., 1916, 163, 361; see this J., 1916, 1148) gave an account of a method which furnishes a measure of the amount of crystallisable carbolic acid likely to be obtained under ordinary working conditions. The process requires 3 or 4 litres of tar acid for the test. The last two methods appear to assume that all the phenol is collected in the fraction of the tar acids distilling up to about 200° C. and that the distillate at various temperatures is of constant composition. Our tables show that this is by no means the case. In view of this the method described below was worked out and has been used by us for some time past. It depends on the fact that the addition of a suitable proportion of *o*-cresol furnishes a mixture from which the whole of the phenol can be recovered in the first fraction of the distillate. The proportion of *o*-cresol to be added in an estimation is ascertained by a preliminary distillation of the tar acids. The volume of the cresylic acid distilling between 195° C. and 202° C. is noted, an equal volume of *o*-cresol is added to the original tar acids, and the process is carried out with this mixture in the manner described later.

The solidifying point of the tar acid distillate before the addition of *o*-cresol is not a certain measure of the proportion of phenol present

* Since this paper was communicated, an important contribution to the subject has been made by J. M. Weiss and C. F. Downs (J. Ind. Eng. Chem., 1917, 9, 569; see this Journal, p. 861).

inasmuch as the three cresols yield totally different freezing point curves when mixed with phenol. A slight description of these curves* will make this clear. *o*-Cresol and phenol yield a freezing point curve which falls regularly as the proportion of cresol is increased up to about 30%; from this point up to about 65% cresol the curve is almost horizontal and then rises regularly. *p*-Cresol and phenol, according to Lunge, yield a curve consisting of two branches (G. Lunge, Chem. Ind., 1885, page 6, and Lunge, "Coal Tar and Ammonia," Part I, 1916, p. 277) and we have confirmed this. *m*-Cresol yields a peculiar curve containing two well-defined minima; a slight break occurs with 33% of cresol, and sharp changes in direction with 49% and 94% and a maximum point with about 66% cresol. Two points are brought out by these curves: (1) the difficulty of utilising any one of the cresols for the determination of the phenol present from the solidifying points, and (2) the necessity of utilising only those portions of the curves which correspond to mixtures rich in phenol. For this reason we add to the distillate sufficient pure phenol to produce a mixture containing at least 80% of phenol. The curves for the solidifying points which we use have been constructed in three ways, namely (1) from mixtures of *o*-cresol and phenol directly, (2) from a distillate collected up to 195°C. obtained from a mixture of pure cresols in the proportions 70% *o*-cresol, 15% *m*-cresol, and 15% *p*-cresol, and (3) from the corresponding distillates obtained from about one hundred samples of commercial cresylic acid which showed no phenol and in which the first fractions of tar acid distilling over were rejected. In practice it was found that the three curves lie very close to each other, especially (2) and (3), and that the errors introduced by using any of the three curves are of little importance for this kind of work. The following results show the degree of accuracy with which we have been able to estimate the phenol in cresylic acid.

% Phenol in original mixture.	% <i>o</i> -Cresol.	% Other phenols present.	% Phenol found.
4.7	66	<i>m</i> - and <i>p</i> -Cresols } 29.3	4.8
10.0	55	<i>m</i> - and <i>p</i> -Cresols } 35	9.7
10.2	45	<i>m</i> - and <i>p</i> -Cresols } 30.4	9.5 (after adding <i>o</i> -cresol)
		Xylenols } 14.4	
14.0	0	<i>m</i> - and <i>p</i> -Cresols } 86	10.9 (before adding <i>o</i> -cresol)
			13.7 (after adding <i>o</i> -cresol)

The following are the data for three curves of solidifying points which are used by us:—

% Phenol.	Solidifying points (°C.).		
	(1) <i>o</i> -Cresol alone.	(2) Mixture of pure cresols.	(3) Commercial distillate.
100	40.2	40.2	40.1
95	37.6	37.4	37.4
90	34.9	34.6	34.5
85	32.2	31.9	31.7
80	29.3	29.2	28.9

The curve of Masse and Leroux (*loc. cit.*) is only slightly different from any of the above. They give in their paper the following data:—100% phenol—40.2°C., 66% phenol—20.0°C.

The effect of *o*-cresol and *p*-cresol on the solidifying point is obviously eliminated by the process here

described. It should be noted that the amount of phenol determined by this method is the *total* amount present and not necessarily the quantity of phenol *extractable* from the mixture in a pure state, nor is the process intended to be a substitute for Lowe's method of assaying crude carboic acid. Good commercial *o*-cresol is as a rule sufficiently pure for use without further treatment, but it is desirable to assay it by this process as if it were a mixture and make the necessary allowance. Our practice is to dissolve the *o*-cresol in excess of sodium hydroxide solution (sp. gr. 1.2) and remove naphthalene, etc., by distillation with steam. The alkaline liquid is acidified and the separated *o*-cresol is fractionally distilled. The first portions of the distillates are rejected and the middle constant boiling fraction is collected separately for use. It should have the physical characteristics described here.

Physical constants of the cresols used in constructing the tables.

	<i>o</i> -Cresol.	<i>m</i> -Cresol.	<i>p</i> -Cresol.
Boiling point at 760 mm.	191.8°	202.1°	202.5°
Freezing point	30.1°	—	36.0°
Sp. gr. 15.5° C.	1.0516	1.0387	1.0388
Sp. gr. 25° C.	1.0449	1.0334	1.0334
Refractive index* at 40° C. (n_D)	1.53719	1.53322	1.53187
$d\rho/dt$	—0.00047	—0.00040	—0.00038

The *o*-cresol used has a slightly higher boiling point than that described by Perkin (J. Chem. Soc., 1896, 69, 1182) and a slightly higher specific gravity at 25°. The higher boiling point rules out phenol as a possible impurity and the higher specific gravity shows that *m*-cresol, *p*-cresol, and xylenols are not present in our specimen.

The process used for determining the boiling points of the mixtures is that described in Young's "Fractional Distillation," 1903 edition, page 58, but the flask employed was similar to that used by Northall-Laurie (Analyst, 1915, 40, 384).

The cresols absorb moisture fairly readily and on this account any apparatus used is, wherever possible, attached to drying tubes containing calcium chloride.

It will be noticed that there are slight discrepancies between the physical constants of the chemically pure cresols as described in the literature and those given for the same cresols in our tables. The deviations are small and do not affect the accuracy of the tables to any degree of practical importance. The differences arise from the fact that the chemically pure cresols cannot be prepared in quantities sufficient for any lengthy series of experiments except by very laborious processes. The specimens actually used in the specific gravity and boiling point determination were prepared from the commercially pure substances by fractional distillation and crystallisation, or by sulphonation and recovery of the phenol from the sulphonic acids.

Process.—100 c.c. of the cresylic acid is shaken with 200 c.c. of sodium hydroxide solution (sp. gr. 1.2) and the liquid is treated with ether to extract naphthalene and neutral taroils. Three extractions with the ether are made, using 20 to 30 c.c. of ether each time, but more ether may be used if found necessary to obtain a sharp separation. The ether is washed with a little water once or twice and the washings are added to the strong soda solution from which the ether may be expelled by warming gently. The cooled soda solution is acidified carefully with sulphuric acid (1:1), the containing vessel being kept cold in

* These values are due to Mr. S. C. Bradford, B.Sc., of the Science Museum, South Kensington, to whom we are indebted for a large amount of work on the refractive indices of phenol and cresol mixtures.

* The complete curves are of considerable interest in other respects and will be dealt with fully in another connection.

running water or by immersion in a bath of cold water. The tar acids are allowed to separate and the clear lower aqueous layer is removed and extracted with ether, the ethereal solution being added to the main quantity of tar acids. Free sulphuric acid is removed from this ethereal solution by washing it with nearly saturated sodium sulphate solution. The ethereal solution is now dried by adding calcium chloride in small pieces. The calcium chloride must be freshly ignited and allowed to cool in an atmosphere of carbon dioxide. The dried liquid is transferred to a flask, the calcium chloride washed with dry ether, and the liquid distilled. To remove all the ether the tar acids must be heated to about 120° C.

The tar acids are now distilled and collected in fractions. The most convenient form of apparatus for 100 c.c. of tar acids is a 300 c.c. round-bottomed flask with a neck about five inches long fitted with a Young's still-head with four-pear bulb. If long-necked flasks are not available then an eight-pear bulb (or a rod and disc column) still-head should be used. A short bulb thermometer graduated in 0.5° C. from 90° upwards is used, the centre of the bulb of the thermometer being 1 cm. below the side tube of the fractionating column. Corrections for emergent stem are made as usual. The first distillation is carried up to 210° C. (Distillate A) when all the phenol, practically all the cresols, and a little xylol comes over. There should not be more than traces of water if the drying of the ether has been efficiently conducted. This fraction is redistilled and the first fraction up to 195° C. is collected separately in a tared vessel and weighed. The fraction from 195° C. to 196.5° C. is also collected separately. Provided the fraction distilling up to 195° amounts to about 50% of the volume of the tar acids which have been collected in the first fractionation (A), the phenol can be estimated at once by the freezing-point method described below. If, however, this fraction is much less than 50%, sufficient pure *o*-cresol is added to the fraction (A) to yield at least 50% of distillate up to 195°. The amount of *o*-cresol to be added will depend upon the amount of distillate up to 195° C. obtained from the redistillation of fraction (A). From our experience we find that an amount of *o*-cresol equal in volume to the fraction of (A) distilling between 195° C. and 202° C. suffices. The fraction up to 195° C. in whatever manner obtained, is weighed. The traces of moisture picked up during the operations are removed by adding ignited calcium chloride to the weighed distillate. The freezing point of this distillate is now determined after the addition of sufficient phenol to an aliquot portion to yield a mixture containing at least 80% of phenol.

About 15 grms. of the liquefied mixture of phenol and distillate is required for the determination of the solidifying point. The liquid is placed in a test-tube 6 in. × $\frac{3}{4}$ in. and this is inserted into an air-bath consisting of another tube 6 in. × $1\frac{1}{4}$ in. The apparatus is placed in a bath of water at about 20° C. The solidifying point is then taken, a thermometer graduated in tenths of a degree being used. The liquid is stirred regularly—once a second—with a stout copper wire stirrer. Excessive supercooling must be avoided. At the solidifying point the thermometer rises to a maximum and remains stationary for some time. This point is taken as the solidifying point. Reference is now made to the curve of solidifying points of known mixtures of phenol and cresols for the amount of phenol in the mixture. To estimate the amount of phenol in the original sample the following calculation is made:—

A = Aliquot portion of distillate up to 195° C.

B = Amount of phenol added to yield the mixture containing at least 80% of phenol.

C = Amount of phenol determined from the solidifying point in the mixture.

The amount of phenol in A is (C - B). If the total weight of distillate up to 195° C. is W the percentage of phenol in the original sample is given by:—

$$\frac{W \times (C - B) \times 100}{A \times 100 \times \text{Specific gravity}}$$

if the 100 c.c. of the sample originally taken was measured out at 15.5° C. which is the temperature of the determination of the specific gravity.

The distillate collected between 195° C. and 196.5° C. is tested for phenol with bromine water as described below.

The presence of phenol in the distillate up to 195° C. may be confirmed in two ways. The specific gravity of the distillate of tar acids at 15.5° C. is determined and should be less than 1.0516 if phenol is absent. Any higher value certainly indicates phenol; a lower value may be due to *m*- and *p*-cresol mixed with *o*-cresol or phenol, or both.

The following test with bromine water reveals the presence of phenol in this distillate; 0.1 to 0.2 c.c. of the distillate is placed in a stoppered 100 c.c. cylinder with 10 to 15 c.c. of water and a few drops of strong hydrochloric acid. The mixture is well shaken and 80 c.c. of saturated aqueous bromine solution is added. In the presence of phenol (less than 5%) a voluminous, light, flocculent precipitate is formed. The presence of cresols does not interfere with this test. The cresols alone form oily or heavy granular precipitates which subside almost immediately.

The bromine precipitate may be advantageously examined under the microscope. The precipitate from pure phenol consists entirely of small, detached needles which are almost colourless by transmitted light, whilst that obtained from the cresols appears nodular and has a much deeper yellow colour under the same conditions. Higher magnification shows these nodules to be aggregates of very small needles.

The solidifying point of the phenol used for the determination must be re-determined from time to time because phenol absorbs traces of moisture readily and the solidifying point is lowered appreciably after a fresh bottle has been opened for some time. This, however, does not interfere with the use of the curves. The correction for the solidifying point of the phenol is added to or deducted from the observed solidifying point of a mixture according as the re-determined solidifying point is higher or lower than that of the phenol used in constructing the curves. The boiling points given in this description refer to pressures in the neighbourhood of 760 mm.

If the cresylic acid contains large amounts of naphthalene, neutral tar oils, or bases, a preliminary examination is made on a separate quantity to determine the proportion of tar acids. Any of the ordinary methods may be used for this purpose. After the proportion of tar acids has been ascertained such an amount of the sample is taken as will yield at least 100 c.c. of tar acids. These are separated by means of aqueous sodium hydroxide and treated in the manner described above.

Specific gravities at 15.5° C.

% Phenol.	<i>o</i> -Cresol.	<i>m</i> -Cresol.	<i>p</i> -Cresol.
0	1.0516	1.0387	1.0388
5	1.0529	1.0404	1.0401
10	1.0543	1.0422	1.0420
15	1.0557	1.0440	1.0438
20	1.0570	1.0457	1.0457
25	1.0584	1.0476	1.0475
30	1.0597	1.0492	1.0495
35	1.0610	1.0513	1.0514
40	1.0623	1.0532	1.0534
45	1.0636	—	1.0554
50	—	—	1.0574
55	—	—	1.0594

Specific gravities of mixtures of m-cresol and o-cresol.

% o-Cresol.	Sp. gr. at 15.5° C.
0	1.0387
5	1.0393
10	1.0400
15	1.0407
20	1.0413
25	1.0420
30	1.0427
35	1.0433
40	1.0440
45	1.0446
50	1.0453
55	1.0459
60	1.0466
65	1.0472
70	1.0478
75	1.0486
80	1.0493
85	1.0499
90	1.0506
95	1.0512
100	1.0516

Specific gravities of mixtures of phenol with a mixture of o-cresol and m-cresol.

% Phenol.	% o-Cresol.	% m-Cresol.	Sp. gr. 15.5° C.
0	79.9	20.1	1.0403
5	75.9	19.1	1.0421
10	71.9	18.1	1.0439
15	67.9	17.1	1.0457
20	63.9	16.1	1.0476
25	59.9	15.1	1.0494
30	55.9	14.1	1.0511
35	51.9	13.1	1.0530
40	47.9	12.1	1.0549

Boiling points of phenols and the cresols. °C. (corr.) 760 mm.

% Phenol.	o-Cresol.	m-Cresol.	p-Cresol.
0	191.0	202.3	201.7
5	190.3	201.3	200.1
10	189.8	199.4	198.4
15	189.4	197.7	196.7
20	188.9	196.2	195.3
25	188.5	194.8	194.2
30	188.1	193.6	193.0
35	187.7	192.5	191.7
40	187.4	191.4	190.8
45	186.8	190.5	189.8
50	186.4	189.9	189.0
55	186.0	189.3	188.1
60	185.6	188.6	187.5
65	185.2	187.8	186.8
70	184.8	187.7	186.1
75	184.3	186.4	185.4
80	183.9	185.5	184.8
85	183.4	184.8	184.2
90	183.0	184.0	183.5
95	182.6	183.2	182.9
100	182.2	182.4	182.3

Specific gravities of mixtures of phenol with a mixture of p-cresol and m-cresol.

% Phenol.	% m-Cresol.	% p-Cresol.	Sp. gr. 15.5° C.
0	49.3	50.7	1.0384
5	46.8	48.2	1.0403
10	44.4	45.6	1.0422
15	41.9	43.1	1.0441
20	39.4	40.6	1.0460
25	37.0	38.0	1.0479
30	34.5	35.5	1.0497
35	32.1	32.9	1.0517
40	29.6	30.4	1.0537
45	27.1	27.9	1.0556
50	24.6	25.4	1.0576

Boiling points of mixtures of o-cresol and m-cresol.

% m-Cresol.	B. pt., °C. (corr.) 760 mm.
0	191.2
5	191.7
10	192.3
15	192.7
20	193.2
25	193.8
30	194.3
35	194.7
40	195.3
45	195.7
50	196.2
55	196.7
60	197.3
65	197.9
70	198.5
75	199.2
80	199.7
85	200.3
90	201.0
95	201.7
100	202.3

Boiling points of mixtures of phenol with a mixture of o-, m-, and p-cresols.

% Phenol.	% o-Cresol.	% m-Cresol.	% p-Cresol.	B. pt. °C. (corr.) 760 mm.
0	32.0	43.4	24.6	197.8
5	30.4	41.2	23.4	196.8
10	28.8	39.1	22.1	195.6
15	27.2	36.9	20.9	194.6
20	25.6	34.7	19.7	193.5
25	24.0	32.6	18.4	192.5
30	22.4	30.4	17.2	191.6
35	20.8	28.2	16.0	190.8
40	19.2	26.0	14.7	189.9
45	17.6	23.9	13.5	189.1
50	16.0	21.7	12.3	188.3
55	14.4	19.5	11.1	187.6
60	12.8	17.4	9.8	186.8
65	11.2	15.2	8.6	186.2
70	9.6	13.0	7.4	185.5
75	8.0	10.8	6.2	184.9
80	6.4	8.7	4.9	184.3
85	4.8	6.5	3.7	183.7
90	3.2	4.3	2.5	183.2
95	1.6	2.2	1.2	182.7
100	0.0	0.0	0.0	183.2

% Phenol.	% o-Cresol.	% m-Cresol.	% p-Cresol.	Distillation of 100 c.c.—Temperature taken every 10 c.c.									
				0 c.c.	10 c.c.	20 c.c.	30 c.c.	40 c.c.	50 c.c.	60 c.c.	70 c.c.	80 c.c.	90 c.c.
0	20.0	60.0	20.0	200.0	201.0	201.0	201.5	201.5	201.5	202.0	202.0	202.5	202.7
5	19.0	57.0	19.0	199.0	199.7	200.0	200.5	201.5	201.5	202.0	202.0	202.5	202.7
10	18.0	54.0	18.0	197.0	198.0	198.5	198.7	199.0	199.5	200.0	200.5	201.5	202.0
15	17.0	51.0	17.0	195.0	195.5	196.0	197.0	197.5	198.5	199.0	200.0	201.0	202.5
20	16.0	48.0	16.0	194.0	195.0	195.5	196.0	197.0	197.5	198.0	198.5	199.0	201.5
25	15.0	45.0	15.0	192.5	193.0	193.5	195.0	196.0	197.0	197.5	198.5	200.0	202.0
30	14.0	42.0	14.0	192.0	192.5	193.0	193.5	194.0	196.0	197.0	198.0	201.0	202.0
35	13.0	39.0	13.0	190.5	191.0	191.5	192.0	193.5	194.5	195.0	196.5	198.0	200.5
40	12.0	36.0	12.0	190.0	190.5	191.2	191.7	192.5	193.5	194.0	195.5	197.5	200.0
45	11.0	33.0	11.0	189.5	190.0	190.5	191.0	191.5	192.5	193.0	194.5	196.5	197.9
50	10.0	30.0	10.0	188.5	189.5	190.0	190.7	191.5	192.5	194.0	194.5	195.0	197.0
55	9.0	27.0	9.0	188.0	189.0	189.5	189.5	190.0	190.5	191.6	192.0	193.0	195.0
60	8.0	24.0	8.0	187.0	187.5	188.0	188.5	189.0	190.0	190.5	192.0	194.0	196.0
70	6.0	18.0	6.0	186.0	187.0	187.5	188.0	189.0	189.0	189.5	190.0	191.0	192.5
80	4.0	12.0	4.0	185.5	186.5	187.0	187.0	187.0	187.5	188.0	187.7	190.0	192.0
90	2.0	6.0	2.0	185.0	185.5	185.5	185.5	186.5	186.5	186.5	187.0	187.5	189.0

THE ABSORPTION OF ATMOSPHERIC GASES BY WATER.

BY J. H. COSTE.

In 1803 Henry published his discovery that "under equal circumstances of temperature, water takes up, in all cases, the same volume of condensed gas as of gas under ordinary pressure. But, as the spaces occupied by every gas are inversely as the compressing force, it follows that water takes up of gas condensed by 1, 2, or more additional atmospheres, a quantity which ordinarily compressed would be equal to 2, 3, etc., the volume absorbed under the common pressure of the atmosphere."¹ Dalton, in the same year, working in close touch with Henry, extended this law, showing its application to gaseous mixtures. He wrote:—

"If a quantity of water free from air be agitated with a mixture of two or more gases (such as atmospheric air) the water will absorb portions of each gas the same as if they were presented to it separately in their proper density, *e.g.*, atmospheric air, consisting of 79 parts of azotic gas and 21 parts oxygenous gas per cent.

Water absorbs $\frac{1}{4}$ of $\frac{79}{100}$ azotic gas = 1.234
 $\frac{1}{4}$ of $\frac{21}{100}$ oxygen gas = 0.778."²

Very little attention appears to have been given to the actual absorption by water of the gases of the air, or of other gases, until, in 1855, Bunsen and his pupils investigated many gases, including air. Another aspect of the same question, however, received more attention, that is, the actual gaseous content of sea water. In 1836—7 from the French exploring ship "Bonite," nine samples of water were collected in the Indian, Pacific, and Atlantic Oceans, and submitted to analysis in the laboratory of the College of France. The results of these analyses were published by Fréay or Darondeau,³ but it is difficult to obtain much information from them. It is obvious that the oxygen was largely used up, but the proportions of nitrogen are rather extraordinary. In 1843 Morren investigated the gaseous content of the surface water near St. Malo at various seasons of the year. He found that sea water contained appreciably less oxygen and nitrogen than fresh water, and that the oxygen content was greatest and the carbon dioxide least in bright weather. Lewy repeated this work at Langune in 1846.⁴ Hayes⁵ in 1851 found that the oxygen was less at great depths than at the surface. In 1855 Pisani did some work on the ratio of oxygen to nitrogen at Brijak Déré. H.M.S. "Porcupine" was sent out in 1869 and several samples of water were collected with suitable precautions and boiled out. W. L. Carpenter, J. Hunter, and P. H. Carpenter successively undertook this work. Hunter published his results in an interesting paper,⁶ which provoked some discussion.⁷ Jacobson^{7a} did some work in the Baltic in 1871, and in the North Sea in 1872. Tornøe,⁸ Dittmar,⁹ Hamberg,¹⁰ and Pettersson,¹¹ from 1876 to 1889, carried out various pieces of useful work in connection with the Norwegian North Atlantic, "The Challenger," and Nordenskiöld's expeditions. The subject was also investigated by Winkler, Roscoe and Lunt, and Bohr from the more purely theoretical point of view from 1889 onwards. Many useful papers dealing rather with the public health point of view have appeared in this and other Journals, many by British workers. Attention will be called to these in due course.

I. The solubility of the gases of the air in water.—Bunsen did most of his work on the solubility of gases in his absorptiometer, agitating definite volumes of gas and water, and noting the diminution of volume of the gas due to absorption by the liquid, observing, of course, the temperature and pressure. This method is, in practice, only applicable to pure gases, since the volume of a mixed gas must be almost infinitely large relatively to

that of the water if the composition of the gas is not to be altered by selective absorption of its constituents. He therefore investigated the case of air and water by making a series of experiments on the absorption coefficient of nitrogen, and by boiling out water saturated with air at 0° C., at 13° C., and at 23° C.* From the data thus obtained, and his accurate knowledge of the composition of air, he was able to calculate the absorption coefficients of air and of oxygen. He concluded that "it is clear that the composition of the air dissolved in water at various temperatures is always constant. The mean composition is: oxygen, 31.91%; nitrogen, 65.09%."¹² Since his three experiments gave 31.91, 34.73, and 35.08% of oxygen respectively, the conclusion appeared to be justified. It was in fact shared by the later workers, Roscoe and Lunt, and Pettersson, and Söndén, who, however, like all subsequent workers, obtained rather less oxygen and more nitrogen than he did. This conclusion appears to be inaccurate, although the differences at various temperatures are not great.

Tornøe⁸ appears to have been the first to point out that the percentage of oxygen in the mixture of oxygen and nitrogen was a decreasing one—even within the range of Bunsen's three experiments. This was confirmed by Dittmar,⁹ Winkler,¹³ and Bohr and Bock.¹⁴ The values obtained for this ratio at varying temperatures by different workers are given in Table I.

TABLE I.

°C	Tornøe.		Dittmar.		Winkler.		
		Sea.	Dis-tilled.		1888.	1901.	1904.
0	35.03	34.40	34.7	35.1	35.47	34.91	
5	34.93	34.24	34.4	—	35.3	34.69	
10	34.24	31.09	34.3	34.8	35.13	34.47	
15	34.11	33.93	34.0	—	34.96	34.25	
20	—	33.78	33.7	34.3	—	34.03	
25	—	33.62	33.6	33.7	—	33.82	
30	—	33.47	33.1	—	—	33.60	
40	—	—	—	—	—	—	

Roscoe and Lunt¹⁵ found from 10°—25° C. a mean percentage of oxygen 33.64, Pettersson and Söndén¹¹ for 0°—14° C. found 33.56, but their highest percentage, 33.88, was found at 0° and their lowest, 33.24, at 14°.

The following table (II.) gives a general survey of the scope and methods of the various workers on this subject. Without discussing the work at length, a few comments may be useful. Bunsen's work stands alone as that of a pioneer, and cannot be criticised like that of other workers. Tornøe worked with a boiling out apparatus (Jacobson's)^{7a} very much like Bunsen's; he was very careful about the saturation of his water, using both supersaturated and unsaturated water, which he brought into equilibrium with the air by shaking. Dittmar's work was extremely thorough and careful. He had the valuable help of Mr. Lennox in making his glass apparatus. Bohr, later with Bock, used two forms of absorptiometer and also a boiling out apparatus. They also used great care in saturating the water, and determined directly the coefficients of both oxygen and nitrogen. Hamberg¹⁰ did not investigate the oxygen content of water, but he made a series of experiments on salt water of different strength from 0 to 3.5% NaCl. Winkler^{13, 16} used his own elegant iodometric process for oxygen, a simple boiling out process, and later an absorptiometer of good design^{17, 18}. He seems finally to have preferred the values calculated from determinations of the oxygen in water (iodometric) and i

* The action of oxygen on mercury was a reason again attempts at direct determination of the absorption coefficient of oxygen.

TABLE II.

Summary of work on absorption of atmospheric gases (oxygen and nitrogen) by water, showing the gases investigated, and the methods used, etc., by various workers.

	1855.	1877.	1878.	1884.	1885.	1885.	1888.	1889.	1889.	1889.	1891.	1891.	1900.	1901.	1904.	1904.
.....	Bunsen.	Hüfner.	Tornoe.	Dittmar.	Bohr.	Ham- berg.	Wink- ler.	Wink- ler.	Roscoe and Lunt.	Petters- son n. Sondén.	Wink- ler.	Bohr. Bock.	Braun.	Wink- ler.	Wink- ler.	Clowes and Biggs
Investigated water	"N ₂ ", O ₂	—	"N ₂ ", O ₂	"N ₂ ", O ₂	+	"N ₂ "	"N ₂ ", O ₂	O ₂	"N ₂ ", O ₂	"N ₂ ", O ₂	"N ₂ ", O ₂	"N ₂ ", O ₂	N ₂ + — solutions of salt A	"N ₂ ", O ₂	"N ₂ ", O ₂	O
ter	—	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
.....	Bu, Bo, A	S, P	S, Bo	Bu, P Dist.	A	Bu, P	Bu, Bo, Ch	Ch	S, P	Bu, Bo	A	Bu, A, P	—	A	Pre- vious work collated and revised	Ch
of tem- per., °C.	0°-23°	20°-40°	0°-45°	0°-47° sea-5-35° or higher	20°	0°-25°	—	—	10°-25°	0°-14°	0°-80°	7°-100°	5°-25°	0°-100°	—	13°-16°
ce to graphy	12	—	8	9	•	10	13	16	15	11	17	14	58	18	19	20

Methods of saturation—Bu = bubbling. S = shaking.

Methods of determination—Bo = boiling out. P = pumping. A = absorptiometric. Ch = chemical.

• Published in Copenhagen.

the air boiled out of water,¹⁹ thereby obtaining rather higher values for nitrogen than those calculated from the absorption coefficients of the two gases. His work and Bohr's cover a greater range of temperature than any other, and his values are probably the best of any. Roscoe and Lunt determined the volumes of the gases pumped out from water at four temperatures, 10°, 15°, 20°, and 25°, and extrapolated to 5° and 30°. The results agreed well with one another, but some of the details are not clear, and the work appears only as an appendix to a paper on Schützenberger's process. In the accompanying diagram (Fig. I, p. 848) Winkler's values for oxygen and nitrogen dissolved in distilled water¹⁹ between 0° and 30°C. and Dittmar's values for sea water, are given as continuous curves; the others are shown at the points where determinations were made. The values for sea water are much lower than those for fresh water. The ratios O:N appear to be the same as for fresh water, but the actual amounts are about 20% lower, varying appreciably with the salinity of the water. Hamburg¹⁰ investigated the effect of such variations on the nitrogen content, whilst Clowes and Biggs²⁰ determined, by Winkler's method, the oxygen content of several mixtures of salt and fresh water. As Hamburg's results are less accessible to members of this Society than are those of my colleagues I give them in Table III.

The solubility of nitrogen in water of varying salinity has also been investigated by Braun.⁵⁸ J.C. Philip⁷³ has discussed the general question of the influence of other solutes on the solubility of gases.

TABLE III.

Volumes of nitrogen at n.t.p. contained in salt water saturated with air at a dry pressure (Bar. 760 + t.a.v.) of 760 mm. (Hamburg).

°C	0% NaCl.	1% NaCl.	2% NaCl.	3% NaCl.	3.5% NaCl.
	c.c.	c.c.	c.c.	c.c.	c.c.
0°	19.14	17.71	16.45	15.34	14.85
5°	16.93	15.76	14.70	13.75	13.32
10°	15.14	14.16	13.26	12.44	12.06
15°	13.73	12.88	12.10	11.38	11.04
20°	12.63	11.87	11.17	10.54	10.25
25°	11.81	11.09	10.45	9.88	9.62

The curves (Fig. II.) show that Hamburg's smoothed values for nitrogen agree fairly with Clowes' and Biggs' actual values for oxygen, also that the falling off of nitrogen with increasing salinity is greater at lower temperatures.

The content of oxygen and nitrogen in sea water itself—not, by the way, a very definite

liquid—is shown in the curve and points (Fig. I). The principal effect of the salts dissolved in sea water is to decrease the amount of dissolved gases. It will be seen that I take Dittmar's "Challenger" figures as the standard. This I consider to be fully justified.*

So far we have only considered the two predominant gases of air, but, of course, air also contains carbon dioxide and argon in easily determinable quantities, besides traces of other gases. The cases of the two above-mentioned gases are worthy of consideration.

Carbon dioxide is very soluble in water; the following values show the amounts of the dry gas dissolved at a (dry) pressure of 760 mm. by 1 c.c. of water at varying temperatures (Bohr and Bock).¹⁴

TABLE IV.

	0°	5°	10°	15°	20°	25°	30°
c.c. CO ₂	1.713	1.424	1.194	1.019	0.878	0.759	0.665

One litre of water would therefore dissolve from air containing 0.03% CO₂ at:—

TABLE V.

	0°	5°	10°	15°	20°	25°	30°
c.c. CO ₂	0.514	0.427	0.358	0.306	0.264	0.228	0.199

but natural water usually contains carbonates of the alkali or alkaline-earth metals in solution as bicarbonates which yield part of their carbon dioxide on boiling, so that the case in nature is not quite simple. In addition, carbon dioxide is a product of the decay of organic matter in water. Argon is present in air to the extent of about 1%. Rayleigh and Ramsay said of it:²¹ "The gas seemed to rebel against the law of addition. It was thought that the cause lay probably in the solubility of the gas in water, a suspicion since confirmed." The absorption coefficient of this gas in water has been determined by Winkler, Estreicher,²³ and Andropoff.²⁴ Winkler's values are given below:—

TABLE VI.

1 c.c. water dissolves at	0°	10°	20°	30°	40°
c.c. argon	0.053	0.042	0.035	0.030	0.027

Estreicher's values are about 9% higher than Winkler's. Since air contains about 1% of argon, water in equilibrium with it should contain, per litre, the following amounts of argon:—

TABLE VII.

at	0°	10°	20°	30°	40°
	0.53	0.42	0.35	0.30	0.27 c.c. A.

The determination of the proportion of argon in the gases extracted from water might, in

*Dittmar's sea water "was prepared synthetically on a large scale from pure salts and distilled water, so as to represent about an average 'Challenger' water," probably containing 3.52% solids and 1.95% Cl.

certain cases, be of value in deciding the origin of the nitrogen, whether atmospheric or "chemical." Such a determination appears not to present insuperable difficulties, but would require very great care.

A curious fact about argon was observed by Kistiakowski.²² It diffuses through caoutchouc a hundred times as rapidly as carbon dioxide. This rapid diffusion may in part account for some of the discrepancies in the amounts of "nitrogen" extracted from water by different workers.

The other gases of the atmosphere are present in such small amounts that their presence in water would not be of great significance.

A consideration of the results graphically indicated on Fig. 1. which have been calculated, where necessary, from absorption coefficients or other expressions to a basis of 760 millimetres actual barometric reading, shows that, on the whole, the agreement is good, especially having regard to the variety of methods used by various workers. The greater discrepancy observable in the sea water figures may reasonably be attributed to varying salinity. Tornøe's results are lower than Dittmar's. The North Atlantic, which was the ocean specially examined by Tornøe, yielded Dittmar the greatest proportion of salts found by him in "The Challenger" water, viz., 37.37 parts per

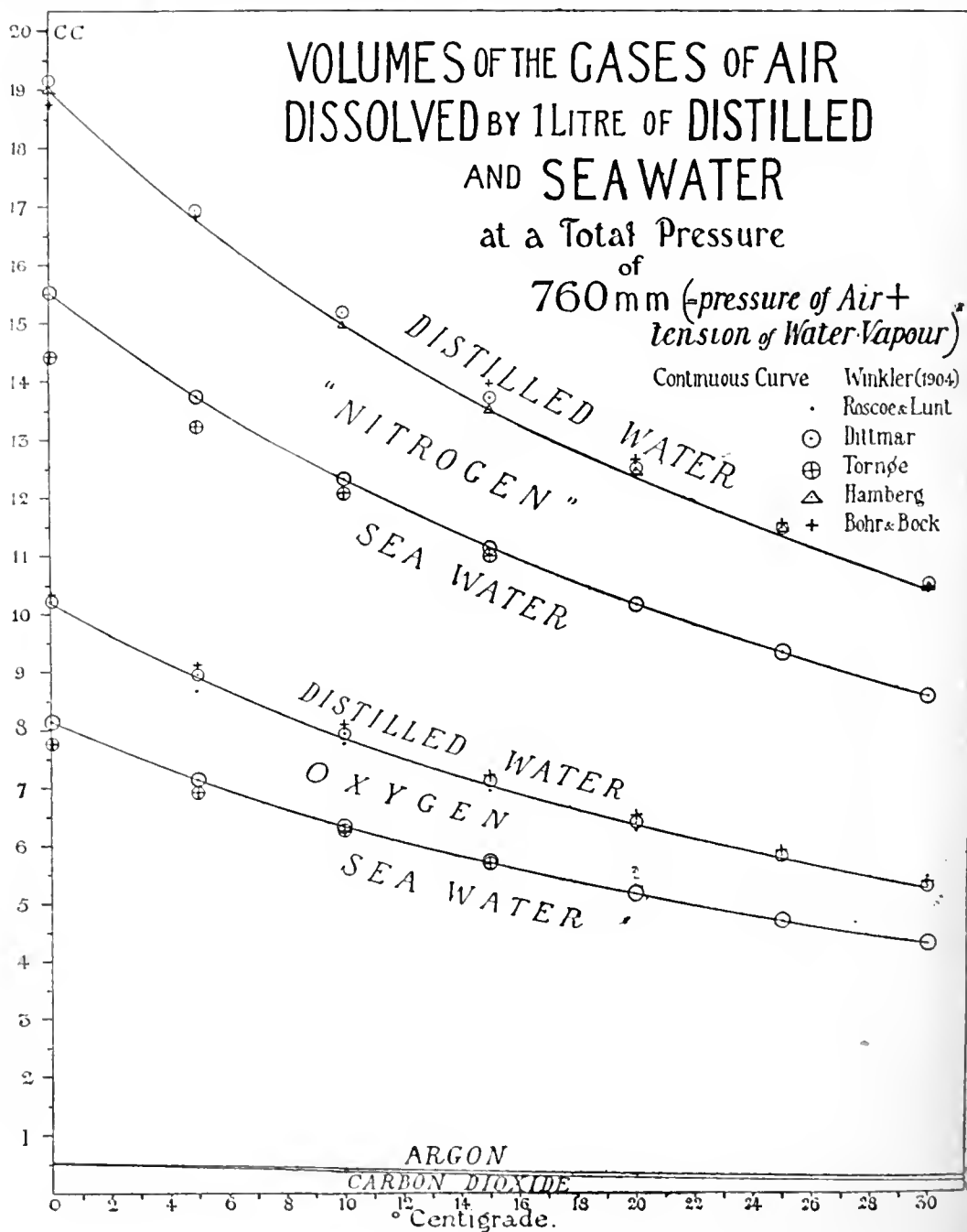


FIG. 1.

1000, whilst the lowest (33.01) was found in the Indian Ocean. Dittmar used a water of medium salinity for his experiments. Braun²³, whose values are not shown, as they are not comparable with the others, worked with pure nitrogen obtained by the interaction of sodium nitrite and ammonium sulphate. His absorption coefficients are given below as compared with those of other workers. They refer to the volume of pure nitrogen absorbed by 1 c.c. of water when the dry pressure of the pure gas (not air) is 760 mm.

TABLE VIII.
Absorption coefficients of nitrogen.

Temp. C°.	Winkler.	Bohr & Bock.	Braun.	Dittmar.
0	0.02421	0.02388		0.02440
5	0.02142	0.02153	0.02172	0.02162
10	0.01915	0.01956	0.02003	0.01943
15	0.01737	0.01786	0.01789	0.01765
20	0.01598	0.01639	0.01621	0.01619
25	0.01494	0.01504	—	

It is probable that the principal cause of discrepancies is the difficulty of obtaining satisfactory

indicate. The use of inverted commas—"nitrogen"—indicates, in this paper, that the gas under consideration is that mixture which before 1895 we all called nitrogen.

The CO₂ figures in Fig. 1. are based on 0.03 % CO₂ in the air. It seems to be agreed that the older figure 0.04 was too high.

II. Rate of absorption of atmospheric gases by water.—The amount of the two principal gases of air which can be dissolved by water of varying salinity has been shown to be on the whole well ascertained. Another point which is of importance is the rate at which de-aerated water will absorb those gases. Dittmar says (*loc. cit.*): "Supposing a certain portion of the ocean were separated from the rest, and after having somehow been deprived of its gaseous contents, exposed to the air at a constant temperature of t°. The three gases would stream into the water at a steadily diminishing rate until absorptiometric equilibrium was established, i.e., a point reached when, for instance, the number of molecules of oxygen dissolved in a given small time would be exactly compensated by the same number of previously dissolved oxygen molecules returned to the atmosphere." This was written several years before reactions of this class had been investigated,

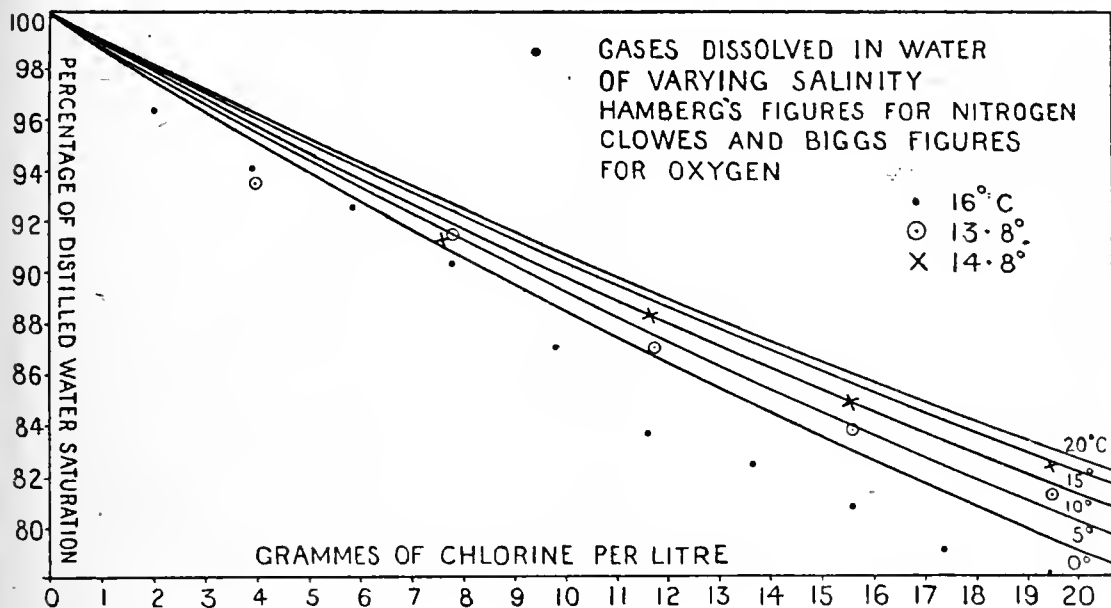


FIG. II.

equilibrium between water and the air or other gas above it. If the bubbling method of saturation is used, one is faced by the fact that the water is aerated at a pressure rather above atmospheric, owing to the height of the water column through which the bubbles have to pass. Winkler, who used this method for his direct experiments with air, took the pressure of saturation as equal to that of the atmosphere + half the water pressure; he points out the desirability of using shallow vessels for the water. Shaking appears to be a good method of saturation, but temperature variations may occur between the time of shaking and determination of gaseous content. The gaseous exchanges, as the point of saturation is reached from either side, are very slow.

The presence of the relatively soluble gas argon in air has no doubt had some effect on the nitrogen figures, although Braun's figures on chemical nitrogen do not differ from the others in the sense which the inferior solubility of this gas would

and is a distinct adumbration of Bohr's work on invasion and evasion coefficients.²⁵ As a matter of fact, many physical phenomena suggest such a course of events.

The first actual investigation of the rate of interaction between a gas and a liquid appears to have been undertaken by Knox,²⁶ who determined the rate of removal of carbon dioxide from water by means of a current of air. He concluded that "Der Verlauf der Entsättigung ist ein genähert logarithmischer." Perman²⁷ came to a similar conclusion in respect of carbon dioxide and some other gases, as also did Meyer²⁸ and Roth.²⁹ Duncan and Hoppe Seyler³⁰ investigated the absorption of the gases of air by water in connection with their classical work on fish life, but although their results follow the course indicated by Dittmar, they did not attempt to deduce any law regulating the rate of absorption. Dibdin³¹ made a series of experiments to clear up this point and drew a curve. He appears to have been the first to

attempt to estimate the rate of absorption of oxygen from the percentage saturation. His curve is not throughout its whole length exactly of the form which could be expressed by an exponential formula, but it fairly approximates to such a form. The work was never put directly before the scientific public, and has therefore received little attention. Roth (*loc. cit.*) quotes a paper by Raoult,³² in the course of which he found it necessary to determine the rate of absorption of air by water in order to apply a small correction to some of his work on molecular weight determinations. Roth shows that the equation—

$$(i) K = \frac{1}{t} \log_e \frac{c}{c-x}, \text{ which may be written}$$

$$(ii.) \frac{c-x}{c} = e^{-kt}, \text{ whence } \frac{dx}{dt} = k(c-x) \quad (iii)$$

where c = the saturation concentration, x the concentration at any time, t , and k is a constant, will express Raoult's results.

A large amount of work was done on this point by the Metropolitan Sewerage Commission of New York³³ in 1914, but here again there was no attempt to obtain a mathematical expression for the rate of re-aeration, and the actual results do not follow quite the course which an exponential formula would require. They will not stand the test of plotting logs, and time to get a straight line.

The absorption of a gas by a liquid is a heterogeneous reaction, very similar to the solution of a solid by a liquid. There is a definite boundary between the phases which is on the whole more easily defined and regulated than in the case of solids and liquids. Now this latter case has been investigated by Noyes and Whitney,³¹ and later by Brunner³⁵ under the guidance of Nernst.³⁶ These workers found that the velocity of such reaction could be expressed by the equation—

$$\frac{dx}{dt} = C(S-x) \quad (iv.).$$

x being the concentration of the solution at time t and S that of the saturated solution, C being a constant. This equation is identical with (iii.). Both groups of workers came to the conclusion that what they were measuring was really the rate of diffusion of the saturated solution of the solute in the solvent or in the bulk of the solution, there being no doubt in their minds that the solution at the boundary of the two phases, solid and liquid, was saturated, and that with rapid stirring the fall of concentration from saturation to that of the main bulk of the solution occurred in a layer of extreme thinness.

Brunner estimated this layer as varying in his experiments from 0.018 to 0.052 mm. Its thickness appeared to be proportional to the $\frac{2}{3}$ power of the rate of stirring. The above equation (iv.) is in agreement with the rate of diffusion as based on Fick's law of diffusion.

The difference—not very great—which is to be observed in the form of a curve calculated from, say, the half saturation point, by means of the exponential formula (ii.) from the actual curve, showing the rate of absorption of, say, oxygen (most of the experiments were conducted more from the point of view of public health than from that of physical chemistry) are, in my opinion, easily explained by the fact that still water only was experimented with. Hence, owing to slowness of diffusion downward, the aeration was much less rapid and regular than would have been the case if the liquid had been properly mixed. I have found that water stirred without breaking the surface absorbs air much more rapidly than still water under otherwise exactly similar conditions. I am aware that Adeney and Letts³⁷ have expressed very different views as to the

absorption of gases by water, based on Adeney's very careful, well designed, and interesting experiments. They say: "It is generally believed that the atmospheric gases as they are dissolved by de-aerated water, remain more or less concentrated in the layer of water exposed to the air, and are only slowly circulated through the water by thermal currents and diffusion. The results of the experiments show that this belief is not well founded. They afford strong evidence to the contrary, since it is evident from them that the gases as they are dissolved at the surface, pass through sea water with comparative rapidity. They also show that the slow rate of re-aeration is due to some retardation of the process of solution at the surface of the liquid exposed to the air."* The statement italicised seems to me to be directly contrary to the facts shown by practically all Adeney's experiments. In, I think, every case where he examined samples taken from different depths of a mass of water exposed at its surface to the air, the dissolved gas was less in amount in the deeper layers; that is, however fast the diffusion may have been, it could not keep pace with the rate of aeration at the surface. The experiments (*e.g.*, Nos. 8 and 9) with broken surfaces show the same thing; he obtained a high concentration—practically saturation—in the layer through which air was bubbled, but owing to the relative slowness of diffusion or the interesting phenomenon of "streaming" which he examined, there was a progressive falling off in the lower layers. I have prepared a diagram (Fig. III.) showing this for some of his experiments (Nos. 1, 8, and 9). Without discussing the matter

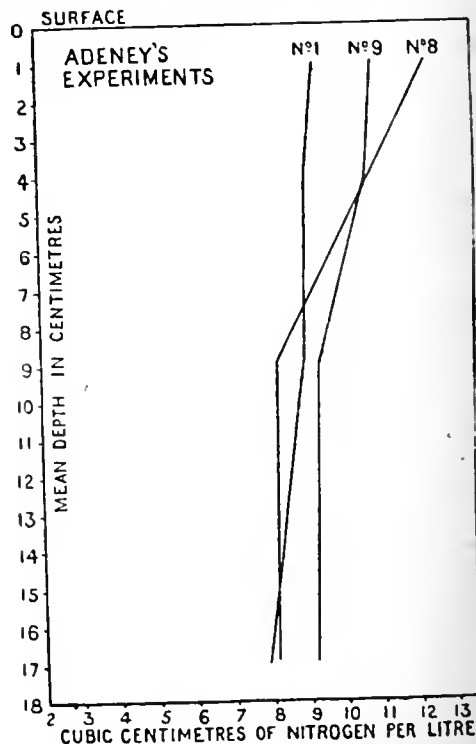


FIG. III.

at great length, one may say that Adeney's work shows conclusively that pure diffusion in still water, which appears to conform to Fick's law, is *very slow*, that some other phenomenon which he calls "streaming" undoubtedly comes into play when ordinary air is over ordinary sea water, and that in his words "the aeration of all aerated

* My italics.—J. H. C.

water, when protected from circulation of the surface layers* to the bottom by thermal currents requires long periods of time, extending to more than 30 days, for completion. But it is unlikely that conditions so unfavourable to re-aeration exist in nature." As Adeney did not carry out a series of experiments on the rate of absorption, he does not seem to have realised that the rate of absorption is a decreasing one; in fact, it is assumed in the report from which quotations have been made to be constant throughout an experiment lasting as long as 48 hours.

I consider it to be certain that, given motion of the water such as will occur in a tidal or fairly rapid river, the rate of absorption of gases from the air is directly proportional to the saturation difference, as Brunner calls it. A more convenient expression for this case is "co-aeration," i.e., the difference between 100 and the percentage saturation. In other words, the difference between 100 and the percentage saturation with, say, oxygen, is a direct measure of the rate at which the water is, at the time of experiment, absorbing oxygen as compared with the limiting rate.

NOTE.—I have been able to confirm Adeney's remarkable observation that gases dissolved in water can pass downwards with very much greater rapidity than they can travel horizontally or upwards, showing the great slowness of pure diffusion as compared with "streaming" (cf. also Hufner³⁸).

The experiments of Schleiermacher³⁹ and Marek⁴⁰ on the difference of density of water saturated with air and air-free water show such minute and uncertain differences as not to confirm Hufner's explanation of the phenomenon, which appears to be of the nature suggested by Adeney.

III. The gases in solution in natural water.—The proportion of atmospheric gases which water, either fresh or salt, can absorb, and the rate at which these gases are absorbed, has been defined. The question now arises what actually are the amounts of gas found in natural waters?

The simplest case would appear to be that of rain water, which one would expect to be in complete equilibrium with the air through which it had passed. Some old analyses from various sources are given below.

TABLE IX.
Gases dissolved in rain water.

	Baumert. 41	Pelagot. 41	McLeod. ⁴² (mean of 2)		Frankland 43	
	°	%	c.c.	%	c.c.	%
Oxygen ..	33.7	31.2	0.673	30.7	0.637	30.7
" Nitrogen "	64.5	66.4	1.382	63.1	1.308	63.1
Carbon-dioxide	1.8	2.4	0.135	6.2	0.128	6.2
	100.0	100.0	2.190 in 100 c.c.	100.0	2.073 in 100 c.c.	100.0

It will be noted that whereas the two former analyses contain proportions of CO₂ which correspond fairly with air containing 0.03% or thereabouts, the other two analyses contain much more CO₂, corresponding to about 0.1%. McLeod's rain water was collected at the old College of Chemistry on July 28th, 1869, between 10 a.m. and noon. The ratio of oxygen and "nitrogen" is in each case very close to the normal. It may be remarked that Rayleigh and Ramsay found the "nitrogen" extracted from rain water to contain about twice as much argon as air does.

It may be said generally that the water of rivers and seas which are uncontaminated with matters which absorb oxygen contains proportions of oxygen and nitrogen which approximate closely to the saturation amounts calculated for

* My italics.—J. H. C.

their temperature and saline contents. Some examples from various sources will illustrate this (Table X.).

TABLE X.
Gases from 100 c.c. water.

	Cumberland mountain stream. 43	Thames. 43	Jena water supply. 44	R. Mälar. 41
Oxygen	0.726	0.588	0.77	0.91
" Nitrogen "	1.424	1.325	1.76	1.87
Carbon-dioxide ..	0.281	4.021	2.47	—
Oxygen × 100	33.8	30.4	30.3	32.7
Oxygen + nitrogen				

Since the temperatures are not available, one can only remark that the actual amounts are in the neighbourhood of saturation at ordinary temperatures, whilst the ratios show only very slight divergencies—all on the low side—from the normal proportion of oxygen. The proportions of carbon dioxide are more variable. This is easily accounted for by the presence in most waters of bicarbonates as well as free CO₂.

Sea and river waters appear to differ but little in gaseous contents from surface to great depths. The following table from Tornoe illustrates this for nitrogen. The oxygen expressed as a percentage of oxygen plus nitrogen varied from 35.31 to 32.58.

TABLE XI.

Proportion of nitrogen in water of North Atlantic at various depths (Tornoe).

Depth, fathoms.	Temperature, ° C.	Nitrogen	
		Found.	Calculated.
0	6.4	13.07	12.93
0—100	2.7	13.98	13.78
100—300	1.0	14.14	14.17
300—600	− 0.68	14.54	14.54
600—1000	− 0.8	14.04	14.58
1000—1760	− 1.4	14.36	14.72

I have found the oxygen content of rivers to vary very slightly at different depths, even when appreciably different from the saturation figure. I consider the nitrogen much less likely to vary.

The gaseous content of water is likely to be divergent from the saturation figure, either above or below it, if the temperature of the water has varied rapidly. The phenomenon of super-saturation—at any rate with oxygen—is by no means a rare one. It is sometimes to be attributed to the above cause, but, I think, more often to its excretion from vegetation as a residual product of photosynthesis. Last summer I kept a small aquarium (19 litres) under observation; the oxygen content of the water always increased from morning to evening, and frequently was well above saturation. I have found natural water to contain as much as 180% of its saturation figure of oxygen with a normal nitrogen. The oxygen was reduced to near saturation by shaking. (See also C. A. Seyler⁴⁵.)

IV. The methods and apparatus employed for the determination of gases in water.—The gases dissolved in water can be extracted either (A) by boiling the water and evolving the gases with the steam (a consideration of the rapid decrease of the solubility with rise of temperature will show that this is an efficient method); (B) by pumping out and boiling at reduced pressure; or (C) by driving out with a current of some other gas. There are also several chemical methods for oxygen and for carbon dioxide.

(A.) Bunsen described⁴⁶ and used a boiling out apparatus with a collecting tube connected to it, which could be evacuated by boiling a small quantity of water contained in it and then sealing the upper end. Jacobson⁷⁴ modified and improved this. His apparatus was used by Buchanan (on "The Challenger") and others. Winkler⁴⁷ collected the gas in a rather similar upper tube, previously evacuated and sealed top and bottom, breaking the lower seal within a rubber tube connected to the boiling flask. Pettersson described, and he and Sonden used,¹¹ a very good boiling out and measuring apparatus combined.

(B.) McLeod⁴² in 1869 described a pumping out apparatus with a Sprengel pump. Dibdin⁴⁸ modified and simplified this. His apparatus was used for thousands of samples in 1893-4, and is very good. Roscoe and Lunt¹⁵ used a pumping out apparatus, as also did Dittmar,⁹ and Bohr and Bock,¹⁴ and Hoppe Seyler,⁷⁵ and Trueman.⁴⁹

(C.) Winkler⁵⁰ described a most convenient and simple apparatus for the determination of oxygen and nitrogen by driving out with CO_2 generated in the water by the action of hydrochloric acid on calcite, and subsequently analysing the gas (which is collected over 20% NaOH solution) over water. It gives good results, and can easily be used on board ship. It is on the whole the most practical apparatus, for general use, of any which I have seen described. Other apparatus are referred to in the bibliography. McLeod recognised the great difficulty in expelling the last traces of CO_2 from bicarbonate. Pettersson, and later Adeney,³⁷ who himself has described a good apparatus, found that the addition of sulphuric acid was necessary to complete the process. Pettersson called attention to the loss of oxygen when sulphuric acid was used in contact with mercury.

Of chemical processes for the determination of oxygen, Mohr's ferrous hydroxide process⁵¹, and Schützenberger's hyposulphite method, and Thresh's iodometric and nitrite process have all been found useful, but notwithstanding the improvements by Albert Levy, and Letts and Blake, by Roscoe and Lunt¹⁵, Adams,⁵⁶ and others, I heartily confirm the conclusion of Kisch,⁵⁷ that Winkler's manganous iodometric process is the best of all these chemical processes. Water analysts owe a great debt of gratitude to this worker for his many contributions to this branch of analytical chemistry.

Carbon dioxide can be titrated in the water by acidimetric processes or evolved by hydrogen.

V. *The significance of the gases dissolved in natural waters.*—Water, which is exposed freely to the air, should and does contain the proportion of gases of the air which are proper to its temperature and saline content, provided these have not changed recently. If, therefore, the examination of the water shows a deficiency of one or other of these gases there must be some abnormal cause at work.

Both argon and nitrogen are chemically rather inert. They are seldom considered apart, and a deficiency or excess of their sum, as compared with the saturation figure, is hardly likely to be greater in amount than could be accounted for by recent temperature changes. Greater differences could only be due to the influx of underground water. The Royal Commission on Pollution of Rivers, 1868,⁴³ of which the late Sir E. Frankland was a member, said: "It was at one time supposed that the proportion of oxygen in these gases was an important item in the history of the water, and it was believed to indicate if small the presence of putrescent organic matter; but the subsequent discovery that deep well waters (in which putrescent organic matter is certainly not present) contain little or no dissolved oxygen, deprived this analytical fact of much of its importance."

They gave the following figures:—

<i>Deep chalk well water.</i>	
" Nitrogen "	1.944
Oxygen	0.028
Carbon dioxide	5.520

7.492 c.c. in 100 c.c. water.

It seems to be rather straining a point to quote the case of a water which must have travelled a long way underground, and which may have had many opportunities of parting with its dissolved oxygen, as a proof of the inutility of a determination, the results of which should obviously be considered in relation to the contact of water with the air. It might be urged with reason that the large CO_2 content of the gases indicated a bad past history, since this gas, even although associated with lime, must have been, at least in part, organic in origin.

All the ascertained facts show that if water is found to contain very much less oxygen than the saturation figure for its temperature, a strong presumption is raised that there is matter in that water which requires a more or less considerable proportion of oxygen for its oxidation. Since, however, the water may have recently fallen in temperature, the point, in some cases, can only definitely be settled by determining the "nitrogen," the constituent which, so far as is known, is not taken up chemically by anything in the water. If the nitrogen is approximately twice the volume of the oxygen the deficient saturation must be due to the temperature having fallen at a higher rate than re-absorption can make up. Having regard to the slowness of absorption as saturation is neared, this is probably often the case. If the water under examination has not undergone any recent change of temperature, it may be assumed that a deficiency of oxygen indicates an appreciable demand for oxidation on the part of organic matter in the water. Provided the water is in fairly rapid motion, samples taken at different depths are not likely to differ much in oxygen content. In this case the percentage aeration subtracted from 100—the co-aeration—will give a direct measure of the extent to which the limit of absorption of the water, under its conditions of depth, movement, etc., is reached.

It appears that slow non-tidal streams will give rise to unpleasant symptoms at much higher aeration than deep streams with strong tidal currents. This is probably due to a variety of causes such as slowness of downward diffusion in the less rapid streams; the accumulation of undisturbed mud which, in fermenting, gives off gases which have little opportunity of being absorbed in their passage through shallow and still water. I think that matters which are dissolved in water, unless in simply enormous amounts, will be unlikely to give rise to offensive conditions in moving water, owing to the surface concentration of dissolved gases. It is probably only when gaseous products of putrefactive action reach such a tension as to disturb the concentration of oxygen at the surface that a water becomes offensive.

The proportion of carbon dioxide in water would doubtless be a valuable indication if either air did not contain carbon dioxide or water did not pass through or over rocks containing lime. As it is, the case is far too complicated for one to be able to make much of it.

The examination of the gases dissolved in water is complementary to the determination of the absorption of oxygen from permanganate or from aerated water which is not in contact with the air. The two latter determinations give an idea of how much oxidisable matter is present; the former tells us, not how much there is, but at what relative rate it is being oxidised, not *in vitro*, but *in fluvio*.

SUMMARY.

I. The conditions of equilibrium between water and the constituents of the air above it are well defined as depending on the actual solubility in water of the gases, the temperature of the water, and the atmospheric pressure. (The effect of the composition of the air is constant.)

II. The rate of approach to a state of equilibrium in either direction (*i.e.*, from supersaturation or from partial saturation) follows the normal course of a heterogeneous reaction, that is, it is proportional to the divergence from saturation.

III. Natural water in free contact with air, and not containing substances which will react chemically with the gases of the air, contains those gases in the same proportions and amounts as pure water, except in so far as the amounts, but not the proportions, are affected by other matters in solution (*e.g.*, NaCl).

IV. Convenient and trustworthy methods for the determination of the gases in water are available both for laboratory and field use.

V. The examination of the gases dissolved in water affords one of the most useful means of determining the probable behaviour *in loco* of the water.

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- ⁷⁵ Hoppe Seyler, F., Zeits. f. anal. Chem., 1892, 4, 367.
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Yorkshire Section.

Meeting held at Queen's Hotel, Leeds, on Monday, April 3rd, 1917.

PROF. J. W. COBB IN THE CHAIR.

A NOTE ON BOILER CORROSION.

BY BASIL G. McLELLAN.

This paper deals with a case of boiler corrosion which I think may be typical of many others, and with an attempt to discover the cause of this corrosion.

A range of Lancashire boilers were fed prior to 1910 with town water with a total hardness of 17 to 23 parts per 100,000, of which 13 to 17 was temporary and the remainder permanent. A certain amount of oil had access to the feed water from waste steam, etc. Under these conditions a thin layer of hard scale accumulated in the boilers and this had to be chipped off periodically. There was no corrosion. The source of the feed water was changed, and well water, having 71 parts per 100,000 total hardness, softened down by lime and soda treatment to 7 or 8 parts, was used. This water contained an excess of chemicals just sufficient to reduce the hardness to zero; precautions were also taken to eliminate all traces of oil from the feed water. The result was freedom from corrosion and from scale in the boilers, with a moderately soft scale in the pre-heaters and economisers. To eliminate this scale, it was decided to reduce the hardness by using a greater excess of chemicals. This was done, and the softener was run for three weeks, producing a water with a hardness of 3 to 4 parts per 100,000 with an excess of chemicals equal to 11 or 12 parts per 100,000. This naturally brought about an accumulation of alkalis in the boiler. The effect of this alteration, which was observed the next time the boilers were opened, was a reduction of scale in the pre-heaters and economisers, no scale in the boilers, and the first appearance of corrosion there in the form of pitting. Even though the softening conditions were readjusted so as to eliminate the excess of alkali, the effect was similar to that formerly observed, but corrosion continued in the boilers.

This corrosion was observed at every inspection for several years. Sometimes it had gone on only to a moderate extent, and sometimes fairly rapidly. It was usually found on the furnace tubes and on the shell near the tubes, and later it was found in the lower part of the upper drums of water-tube boilers which had been installed.

This corrosion was due to oxidation, and I am of the opinion that the period of strong causticity removed from the boiler shell a thin layer of oil residue which for years had acted as a protective coating; the surface of the plates was thus rendered clean, active, and open to attack.

The opinions of experts were evenly balanced as to the cause, and these were:—

1. Oxidation by dissolved oxygen in the feed water.

2. Electrolytic action.

Remedial measures were proposed, or suggested themselves to us, for overcoming either of these corrosive influences, but it was necessary to determine which was causing the trouble.

At that time I was of the opinion that dissolved oxygen was not the cause of the corrosion, and that opinion was based very largely on the work of Professor Cobb (see this J., 1914, 403). If I interpret his results aright, corrosion by dissolved oxygen would take place near where the air was first liberated from solution in the water, namely, in the pre-heater tubes, and would certainly not extend beyond the batteries of economisers, where ample provision is made for blowing off the air which collects in them.

It is obviously difficult to devise experiments on a plant scale to decide a point like this, so an eliminating experiment on a laboratory scale was suggested, namely, to remove all dissolved oxygen and try whether corrosion took place in its absence. The experiment was carried out as follows:—

A number of similar bars of metal were cut from the same piece of boiler plate; these were machined up and polished. Two of them were suspended by means of iron wires in a bell jar; the wires passed through a rubber stopper, through which a three-way stoppered tube passed. The electrolytes used were placed in a large evaporating basin and

boiled until free from dissolved oxygen, tests being made (by Winkler's method) from time to time as boiling proceeded. The bell jar was then supported over the boiling liquid and filled with hydrogen through the stoppered tube. It was then lowered so as to be sealed by the electrolyte and hydrogen was passed in until all the oxygen was removed. The bell jar was then lowered, allowing hydrogen to escape, until about one half of each electrode was immersed. In a few moments the boiling was stopped, and air was excluded from the surface of the electrolyte outside the bell jar by covering it with a layer of mineral oil. During cooling the level inside and outside the bell jar was kept constant by adjusting the volume of hydrogen gas inside. The terminals were connected up to a millivolt meter, by means of which the difference of potential could be noted. It was thus possible to operate in absence of free oxygen.

The trials lasted for some days. The electrolyte was heated during several days, but the greater part of the time it was cold.

Trials were made with softened water, with boiler water which had become concentrated, and with distilled water.

Softened water. The technical analysis of this was as follows (in parts per 100,000 expressed as CaCO_3):—Hardness 8.7; alkalinity, to methyl orange 12.7, to phenolphthalein 9.7; (O11) alkalinity after removing carbonates 3.6. The water still contained 0.32 c.c. of oxygen per litre. The potential difference between the two electrodes varied up to 18 millivolts, first one electrode and then the other being at the higher potential; slight vibration of either was sufficient to alter its polarity, tending to make it electro-negative.

The trial lasted eight days; a considerable amount of rust settled in the basin, and the bars showed distinct signs of corrosion.

The electrolyte, at the end of the trial, contained 3.0 c.c. of oxygen per litre, the increase having been produced electrolytically.

Concentrated boiler water. This was a very concentrated liquor, resulting from under-softened water. The following figures show its composition:

Parts per 100,000 as CaCO_3 .			
Total alkalinity	212.6	Total hardness	35.5
Chlorides	505.7	Lime hardness	23.3
Sulphates	1390.3	Magnesia hardness	12.2
		Alkalis (diff.)	2233.1
Total acids	1908.6	Total bases	2268.6

The water was entirely free from dissolved oxygen. The potential difference was greater on the average than with the softened water.

The trial lasted 26 days, and the corrosion was very marked. At the end of the trial the electrolyte contained 0.9 c.c. of dissolved oxygen.

Distilled water. This trial was run to ascertain the effect of a very soft water. The water contained 0.28 c.c. of oxygen per litre. The potential difference throughout the run of 15 days was small, not exceeding 5 millivolts. The plates indicated some corrosion, which was confirmed by the deposit of rust in the basin. At the end of the trial the electrolyte contained 2.6 c.c. of oxygen per litre.

The conclusion to be drawn from these tests is that even the absence of dissolved oxygen is no guarantee that corrosion of this order will not take place. That the corrosion referred to in the boilers was caused solely by electrolytic action is not definitely proved, but the evidence is fairly strong.

Some years ago Cumberland devised an electrical apparatus for overcoming electrolytic

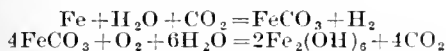
corrosion. Insulated iron rods are inserted into the boiler, heater, or whatever piece of plant is to be protected. Current, generated externally, sufficient to overcome any local potential differences is passed through the system so as to make these insulated rods the anodes. These corrode away, and are renewed from time to time. The electro-negative surfaces are kept free from scale and corrosion, and in cases where this plant has been installed in scaly boilers, the old scale has been removed, possibly by the formation of hydrogen below the scale.

The process has, I understand, been extensively installed on large ocean liners and also in factories. I have no direct experience of the process, but it seems to me to be sound. A reversal of current would be disastrous.

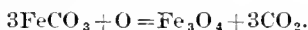
It is sometimes recommended to coat the inside of boilers with a protective paint as a cure for corrosion. Graphite in a volatile carrier is frequently used. If the corrosion is due solely to dissolved oxygen, this may be efficient, but unless the coating is absolutely perfect—which it never can be in practice—it is difficult to see how it can do otherwise than aid corrosion, graphite being electro-negative to iron.

Finally, we will look for a moment into certain conditions which have been observed to aid or retard boiler corrosion. It is frequently stated that small quantities of caustic soda in feed waters have little effect on the corrosive power, while similar quantities of sodium carbonate stimulate corrosion. This may be regarded as a rough-and-ready statement, but it is the experience of those who have to handle boilers. If we examine these statements in the light of the so-called and commonly accepted " CO_2 -theory" and from the point of view of electrolytic action, some light may be shed on them.

The " CO_2 -theory" is expressed as two equations:—



and shows the mode of action of water containing oxygen and CO_2 on iron. At boiler temperatures the latter equation might be:—



Now I think it is quite conceivable that an action of this kind can take place in a feed water which is devoid of free oxygen and carbon dioxide if it contains an excess of sodium carbonate. At the high temperatures in the boiler the sodium carbonate is partly dissociated and carbon dioxide is set free to form ferrous carbonate as in the first part of the CO_2 -theory. We have now to consider two electrodes, one of clean iron and the other of ferrous carbonate. I have no evidence to show which of these is electro-positive and which electro-negative, but there is almost certainly a considerable potential difference which will result in corrosion.

If there is sufficient excess of sodium hydroxide in the feed water, the dissociation will not be effective, and corrosion of this kind will not take place.

DISCUSSION.

The CHAIRMAN said that dissolved oxygen did cause corrosion and was often the principal cause. Corrosion by dissolved oxygen would show itself at the point where the water first came to be heated in contact with the iron plates. In plants where an economiser was used this corrosion would most likely be found in that portion of the plant. If there were no corrosion at that point, then dissolved oxygen as a cause fell out, but oxygen arising from chemical actions in the boiler was likely to play its part. Mr. McLellan was undoubtedly right in saying that corrosion was often electrolytic. He

(Prof. Cobb) had made experiments with regard to electrolytic corrosion, and his results agreed with those of Mr. McLellan. Local circuits were established between the pure iron and numberless particles of contained impurities. According to his experiments, it was nearly always the iron that passed into solution, while the impurities—silicates, phosphides, etc.—remained unattacked.

Mr. W. McD. MACKEY asked if the boiler was of steel. He also said that Mr. McLellan had not said much about the remedies tried. He asked if tannin had been tried.

Mr. F. W. RICHARDSON asked if Mr. McLellan's remarks applied to the action of soft waters on conduits: the conduits were not always full of water. He did not think it wise to allow any accumulation of caustic soda, as this was liable to produce priming. Tannic acid, together with the excess of caustic soda, gave an oxygen-absorbing liquid, and this would most likely put an end to corrosion by dissolved oxygen.

Mr. Lowson asked if the layer of oil as used in the experiment was sufficient to keep the oxygen of the air away from the electrolyte. He had found in certain cases that oxygen appeared to pass through paraffin with surprising speed.

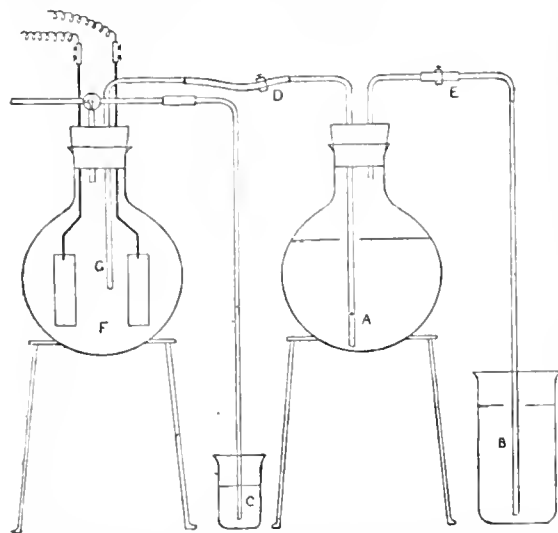
Mr. J. MILLER said that Lyons, of the United States Navy, had found that boiler corrosion increased with the alkali up to a certain point, when the corrosion stopped. His idea was to put in an excess of alkali and so eliminate all corrosion. In Mr. Miller's experience, oxygen passed through a layer of xylol very quickly, and he therefore doubted whether the electrolyte was free from dissolved oxygen at any time throughout the experiment.

In reply Mr. McLELLAN said that remedies of the type mentioned by Mr. Richardson might be effective for preventing corrosion by dissolved oxygen. The experiments described pointed to electrolytic corrosion, and other means must be adopted to prevent this. No remedial measures had been tried because for some unknown reason corrosion had now practically ceased. Many analyses of the hard and softened waters had been made; they contained no nitrates, and would be described as non-corrosive. The corrosion of conduit pipes was probably ordinary rusting caused by dissolved oxygen. When making the experiments he had been under the impression that the oil layer was a safeguard against atmospheric oxygen, and the point mentioned by Mr. Lowson and Mr. Miller was new to him. However, the fact that the millivoltmeter needle was immediately deflected the moment the electrodes were immersed in the liquor showed that, at any rate, the conclusions were correct.

ADDENDUM.

To make this quite clear, and to eliminate the use of hydrogen which might be regarded as metal, the experiment was repeated as follows (the diagram, p. 856, shows the apparatus at the commencement of the experiment). The electrolyte was placed in flask A and also in the beaker, B. A current of nitrogen was passed through the whole apparatus by way of the three-way tap until all the air was driven out. (The beaker, C, is useful for giving an idea of the speed at which nitrogen is passing.) The electrolyte in flask A was vigorously boiled, and the steam evolved caused the water in beaker B to boil. After boiling half an hour, the water in beaker B was tested and found to be absolutely free from oxygen. Clip D was then closed and the heating stopped; some water was thus allowed to run back from B into A, the quantity being controlled by the clip, E, which was finally closed. By applying suction to the tube in beaker C the electrolyte in A was drawn over into flask F until it reached the lower end of the tube, G. Pressures were then

adjusted by admitting nitrogen as before through the flasks, G, A, and beaker, B, opening the clips when the pressures were balanced.



One trial lasting 16 days was made with concentrated boiler water having the following composition.

Parts per 100,000 (as CaCO_3).

Total alkalinity	21.1	Total hardness	40.6
Chlorides	152.8	Lime hardness	26.9
Sulphates	1187.5	Magnesia hardness	13.7
		Alkalis (by diff.) ..	1371.3
Total acids	1361.4	Total bases	1411.9

As before the electrolyte was heated during several days. The potential differences observed were of a similar nature to those in the former experiments. Very considerable corrosion took place on both electrodes, which substantiated the conclusions arrived at in the paper.

Communication.

ESTIMATION OF NITROTOLUENES.

By E. DE W. S. COLVER AND E. B. R. PRIDEAUX.

In reply to Dr. Knecht's comments on our paper published in this Journal for 1917, page 480, we wish in the first place to disclaim any intention of undervaluing titanium chloride titrations as described in his book, "New Reduction Methods in Volumetric Analysis."

Our main object, as stated in the paper, was to investigate and define the limits of accuracy of the stannous chloride reduction method, to which perhaps full justice has not been done in previous descriptions. Having furnished sufficient experimental material for this object we do not take it upon ourselves to pass any general judgment on the relative applicability of the two methods.

Attention was, however, called incidentally to the necessity for sulphonation or the use of alcohol in the titanium reduction. ("New Reduction Methods," pp. 26-28.) With stannous chloride reduction sulphonation is not necessary in the case of mononitrotoluenes, nor is there any need to dissolve dinitrotoluenes in alcohol. In the case of mononitrotoluenes again, alcohol actually seems to inhibit the reduction. Hence it was put

forward as a mere probability, which we admit is based on indirect evidence, that alcohol is not likely to assist in the reduction of mononitro compounds with titanium chloride to such an extent as to render sulphonation unnecessary.

Possibly Dr. Knecht can show us wrong in this supposition, since it is based partly on his results.

We understand from the latter part of this note that the titanium method has undergone considerable development and that this is of such novelty that publication is undesirable, and can only regret if he is thereby debarred from making a full and illuminating reply.

We are glad to hear that titanium chloride of the grade of purity specified in his book can be obtained gratis. It would naturally be preferred on this account, since tin and stannous compounds cannot be obtained on such favourable terms.

In conclusion we can assure Dr. Knecht that we have no intention of discarding any useful method; least of all one which has been so carefully standardised as the reduction by titanium chloride.

Determination of Sugar in Baked Articles.

The following is the method for the determination of the amount of sugar in baked articles as settled at a Conference between the Government Chemist and representatives of the Society of Public Analysts and of Biscuit Manufacturers:—

1.—Preparation of sample.

A. *Biscuits and similar articles in a fairly dry condition.* The whole sample, or a thoroughly representative portion of it, is rapidly ground in a mortar or by passing through a mincing machine. The powder is mixed and used for analysis.

B. *Large cakes in a moist condition or with an outside crust.* A slice, not less than $\frac{1}{2}$ in. in thickness, is cut through the loaf, weighed, and dried at a moderately low temperature to a moisture content of about 10% when it can easily be ground. It is weighed again, ground, and mixed, and the powder used for analysis.

C. *Buns and small cakes in a moist condition.* Several buns or cakes are taken, weighed, broken into coarse pieces and dried at a low temperature to a moisture content of about 10%. The weight is again taken, the pieces ground, and the powder mixed, and used for analysis.

D. *Articles containing fruit (raisins, currants, dates, etc.) in which sugar naturally occurs.* A representative portion of the sample is weighed, broken rapidly on a sheet of paper, and the fruit removed and weighed. The drying of the cake from which the fruit has been removed is continued as under "B" or "C" and the fruit is reserved for the determination of the sugar.

II.—Analysis.

I. *Moisture.* A portion, about 5 grms., is weighed out from the prepared sample, and dried at 100°C . until the weight is constant. The loss in weight is corrected for the total loss in those cases in which preliminary drying previous to grinding has been carried out, and if fruit has been removed, to the original cake containing fruit.

II. *Sugars.* 10 grms. of the prepared sample is ground up with water in a mortar, and transferred to a 250 c.c. flask, using in all about 200 c.c. of cold water. The flask is shaken at intervals during 30 mins. The solution in the case of some articles, for example, certain kinds of biscuits, does not need a clearing agent. If it is necessary to use a clearing agent, basic lead acetate followed by sodium sulphate to remove excess of lead, or

alumina cream, or copper sulphate solution may be employed. The liquid in the flask is then made up to 250 c.c., filtered, and the sugars determined in the filtrate.

Fifty c.c. of the filtrate is measured into a 100 c.c. flask and inverted as follows:—5 c.c. of 38.8% hydrochloric acid is added and the flask placed in a water-bath maintained at 70° C. The solution should reach a temperature of 67° to 69° C. in 2½ to 3 minutes. It is maintained at 69° C. for 7 to 7½ minutes, the total period of heating being 10 minutes. It is then rapidly cooled, neutralised, made up to 100 c.c. and filtered.

The reducing sugar in the filtrate is determined either by gravimetric or volumetric means, the total copper-reducing power being calculated as cane sugar.

The quantity of "cane sugar" obtained is corrected to the original moisture of the sample and, if fruit has been removed, to the cake containing fruit. From the total quantity thus found, the sugar derived from added fruit in the case of fruit cakes is to be deducted.

This is estimated by determining the amount of sugar in the fruit removed from the cake, and the loss in sugar it has sustained, on the basis of the following average amounts of sugar in natural dried fruits, calculated on the *water-free* sample:—

	Total reducing sugars as sucrose.
Raisins	80
Currants	80
Figs	70
Dates (without stones)	70

A deduction of 3% (3 units) is made from the total amount obtained, for sugars naturally present in flour or derived from flour in course of baking.

To provide for variations in sampling, in methods of analysis, and in the amount of sugar in the different materials employed, an allowance of 2% (2 units) is made.

(Note.—In the case of samples which have been prepared from ingredients containing active malt flour or extract this method is not applicable.)

GOVERNMENT LABORATORY.

25th May, 1917.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each, to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.

United States.—1s. each, to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—

Patent number, date, name of patentee, and title of invention.

French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56, Rue Ferou 8. Paris (3e.)

Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

PATENTS.

Furnace heated by gaseous combustion. A. C. Ionides, jun., London. Eng. Pat. 106,546, June 21, 1916. (Appl. No. 8741 of 1916.)

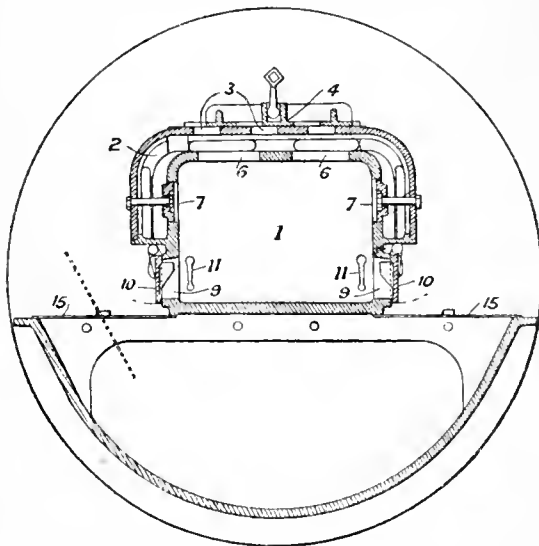
IN furnaces of the type in which a combustible gaseous mixture is injected tangentially into a combustion chamber at such a velocity that firing back is prevented, the injecting nozzle opens into a wider port in the furnace wall so that the mixture passes through the port as a self-contained jet without impinging on the walls. The nozzle is converging, and is made of refractory material surrounded by a metal sleeve which is also connected with the gaseous fuel supply. Firing back of the jet is prevented by its isolation from the heated furnace wall and by conduction of heat away from the nozzle by the metal sleeve as well as by the velocity of the jet itself.—W. F. F.

Furnaces [for liquid fuel]. C. Zulver, London, and L. E. Smith, South Shields. Eng. Pats. (A) 106,703, and (B) 106,704, June 30, 1916. (Appl. Nos. 9239 and 9240 of 1916.)

(A) In a furnace adapted for liquid fuel, the fuel-supply opening in the furnace front is provided with an outer dome-shaped perforated baffle which is enclosed by a cylindrical cover, the outer circular plate of which is adjustable to control the admission of air. The fuel burners pass through the cover and baffle. Large horizontal air-supply tubes extending into the ash-pit are controlled by sliding doors in the furnace front, and the air passes back over the tubes to an opening in the front of the furnace and is thereby preheated. When solid fuel is used, the liquid-fuel fittings, preheating tubes, and firebar covering are removed.

(B) A furnace front is provided with a fuel-supply opening, 1, having an air passage, 2, surrounding the upper part. The upper wall of the passage is provided with air inlets, 3, controlled by a slide, 4, operated by a handle on the exterior of the furnace front. The lower wall of the passage is provided with openings, 6, and adjustable openings, 7.

Additional openings, 9, are regulated by pivoted doors, 10, operated by levers, 11, and the air supply to the underside of the firebars is controlled by dampers, 15. The operating handles of the



dampers, 15, and slide, 4, may be interconnected. Liquid-fuel burners may be attached to the furnace door, in which case all the air inlets are opened, but when solid fuel is used, the side openings, 7 and 9, are closed. In a modification, the passage, 2, is extended down to the floor of the furnace so as to cover the openings, 9.—W. F. F.

Furnaces for steam generators. G. E. Heyl, London. Eng. Pat. 106,707, July 11, 1916. (Appl. No. 9763 of 1916.)

IN a furnace of the type in which low-grade fuel containing sulphur, such as shale oil, is burnt,

absorbents for sulphur such as lime, iron, ferrie oxide, copper, or compounds thereof are placed between the furnace and the flues of a steam generator. The absorbent is placed on shelves arranged to form a tortuous passage through which the furnace gases pass from top to bottom. —W. F. F.

Furnaces: Means for discharging material from mechanical—. Huntington, Heberlein and Co., Ltd., and H. C. Bingham, London. Eng. Pat. 107,185, Mar. 15, 1917. (Appl. No. 3792 of 1917.)

TREATED material such as roasted sulphur-bearing ore is discharged from the furnace through a passage containing an air lock, to avoid admission of air to the furnace. An inclined discharge passage is closed by a flap at its outer end adjacent to the furnace outer wall. A closed shoot extending downward surrounds the end of the passage and is closed at its outer end by a flap having an adjustable counterweight, so that it opens only with a greater pressure than the inner flap.

—W. F. F.

Furnace for pulverous fuel. K. H. V. von Porat, Stocksund, Sweden. U.S. Pat. 1,229,685, June 12, 1917. Date of appl., July 15, 1913.

PULVERISED fuel is injected into the upper end of a channel of refractory material sloping downward into the furnace, and is ignited at the beginning of the supply or at intervals. The hot burnt gases leaving the lower end of the channel are cooled by passing backward through passages formed by a hood over the admission channel, and then pass forward between this hood and the surrounding firebox to the boiler or the like.—W. F. F.

Drying fruit, vegetables, herbs, chemicals, powders, seeds, minerals, and the like; Apparatus for—. F. Hewett, Anerley, Kent. Eng. Pat. 106,549, July 3, 1916. (Appl. No. 9291 of 1916.)

REMOVABLE trays, each comprising a gauze base attached to side rails, are arranged one above the other in a casing so that a flue is formed at one end. Hot air is introduced into this flue and passes over, under, and through all the trays simultaneously to an outlet at the other end. The trays may be horizontal or inclined, or the perforated bottoms may be inclined. Removable deflecting boards are provided above each tray to prevent moisture rising from one tray into the next, and the boards may carry corrugated metal sheets to condense and carry away moisture. Two tiers of trays may be placed side by side in a casing, the common central passage acting either as an inlet or an outlet flue for the hot air. Removable boards may be provided to close the inlet flue at any height, so as to enable any desired number of trays to be used.—W. F. F.

Dryer for sand, gravel, etc. W. H. Dance, Assignor to The Dyar Supply Co., Cambridge, Mass. U.S. Pat. 1,230,981, June 19, 1917. Date of appl., Dec. 21, 1916.

A DRUM with open ends rotates on a slightly inclined axis and is provided with internal longitudinal wings to raise and release the loose material which is fed into the upper end of the drum. A fixed burner projects into the lower end of the drum below a fixed heat-conducting surface which is heated by the flame. The wings adjacent to the hot surface are bucket-shaped, so as to discharge the loose material on to the surface, which is inclined laterally to discharge the material on to the bottom of the drum. The upper end of the drum is provided with a suitable outlet, so that condensed vapour is prevented from running back on to the material.—W. F. F.

Combustion products; Method of and apparatus for generating—under pressure. W. B. Vanderlip, London. Eng. Pat. 106,579, Oct. 3, 1916. (Appl. No. 14,046 of 1916.)

ENERGY is stored in a suitable reservoir by the compressed gaseous combustion products of the explosion of successive cartridges of nitroglycerin or dynamite. The cartridges contained in a vertical magazine are fed by the reciprocation of two releasing slides at the bottom into a horizontal barrel attached to the side of the gas reservoir. A feeding ram provided with a concentric firing pin is inserted into the barrel to push the cartridge forward to the firing position, and the ram is then locked in position and the firing pin operated by a hammer by means of interconnected gearing. The outlet of the barrel is provided with a conical lift valve carried by a framework provided with springs which normally maintain the valve closed. At the moment of firing the valve is lifted mechanically and the opening is completed by the explosion gases. The valve is then allowed to close under the action of the springs and the gas pressure in the reservoir, and the cartridge is withdrawn and ejected by known mechanism. The storage reservoir is double walled and the jacket is partly exhausted to provide heat insulation. A thermostat within the reservoir may control the valve of an injector whereby water is sprayed into the reservoir to augment the pressure by the generation of steam. The compressed gas may be used in a suitable engine, or, when the steam is omitted, for smelting purposes.—W. F. F.

Power; Process of employing heat for the production of—. S. M. Lillie, Philadelphia, Pa. U.S. Pat. 1,230,417, June 19, 1917. Date of appl., Apr. 15, 1914. Renewed July 17, 1916.

LIQUID is heated by bringing it into intimate contact with hot gases from the combustion of fuel in a closed vessel, and the uncondensed gases are separated and conveyed to a suitable motor operating at a lower pressure than that in the closed vessel. The pressure of the heated liquid is reduced to a point below the pressure at which the liquid will boil at the higher temperature, and both the vapour formed and the residual liquid are used for the production of power in a suitable motor. The residual liquid is then reheated and used again as described above.—W. F. F.

Separators; Centrifugal— and methods of working same. W. J. Gee, London. Eng. Pat. 106,669, May 31, 1916. (Appl. No. 7727 of 1916.)

IN centrifugal separators of the type described in Eng. Pats. 4155 of 1907 (this J., 1908, 227), 21,421 of 1909 (this J., 1910, 1239), and 9365 of 1915 (this J., 1916, 1206), a draining device is provided to enable the liquid remaining in the basket after the feed has been stopped to drain away before the rotation of the basket is stopped.—W. H. C.

Producing cold by the liquefaction of gaseous fluids; Process and apparatus for—. E. A. W. Jefferies and F. E. Norton, Worcester, Mass., U.S.A. Eng. Pat. 106,675, June 1, 1916. (Appl. No. 7797 of 1916.)

THE pressure on the liquid produced by liquefaction of the gas is maintained or increased and the liquid is partly evaporated under such pressure by the heat given out by the gas undergoing liquefaction. The vapour produced is then circulated through a heat exchanger through which the gaseous fluid before liquefaction is also circulated in an opposite direction. A "heat transfer fluid" is circulated through heat exchange apparatus to act as a carrier between the liquid of which the pressure is raised and the gas undergoing liquefaction. —W. H. C.

Gases; Process and apparatus for separating mixed

— F. E. Norton, Worcester, Mass., U.S.A.
Eng. Pats. (A) 106,676 and (B) 106,677, June 1,
1916. (Appl. Nos. 7798 and 7799 of 1916.)
(See preceding abstract.)

(A) A MIXTURE of gases is partially liquefied in a heat interchanging apparatus, and the gaseous portion is withdrawn and passed through a refrigerating engine and then through a coil in the rectifying vessel. It is then mixed with a portion of the already condensed liquid and passed through a pump, whereby the pressure is increased, and delivered into the rectifying vessel. (B) A separate liquid is circulated through a coil and an expansion valve by a compressor to transfer the latent heat from the gas being liquefied to the high-pressure fluid being rectified.—W. H. C.

Refrigeration. G. James, London, Eng. Pat. 106,868, June 8, 1916. (Appl. No. 8146 of 1916.)

LIQUID ammonia or other refrigerating medium is passed through a heat interchanger comprising concentric pipe coils through which the ammonia and the air to be cooled pass in opposite directions. The outlet for the ammonia is connected to an inverted U-tube, the other end of which is connected to a suitable mechanical exhauster and condenser, so that the ammonia is vaporised as a saturated vapour in the U-tube, and then condensed, without change of temperature or pressure. The liquid ammonia passes through an oil separator and a cooling coil and thence back to the heat interchanger. The circulation of the air to be cooled may be facilitated by a blower or fan. The liquid-cooling coil and the oil separator may be omitted if desired. Air at varying temperatures may be drawn from different points of the coil of the heat interchanger.—W. F. F.

Refrigerating method and apparatus. W. T. Hoofnagle, Glen Ridge, N.J., Assignor to Electro-Chemical Products Co., New York. U.S. Pats. 1,230,482 and 1,230,483, June 19, 1917. Dates of appl., July 8 and Aug. 6, 1915.

WATER is admitted intermittently to a vessel and caused to flow backwards and forwards in it. A current of air is caused to flow between the surface of the liquid and a parallel rotating surface, close to it, to vaporise the liquid. Air and vapour are withdrawn by an exhauster, the vapour condensed, and the air returned to the vessel.

—W. F. F.

Water cooling towers; Water distributing arrangement for —. Dansk Jernbetonkonstruktions Co. Danalith Aktieselskab, Copenhagen, Eng. Pat. 106,933, Oct. 19, 1916. (Appl. No. 14,901 of 1916.) Under Int. Conv., June 20, 1916.

In a water cooling tower, water overflows from a vertical pipe on to the centre of a reinforced concrete plate having large openings, each with a flange of adjustable height projecting upward. The water overflows into small vertical pipes projecting upward through the plate to an adjustable distance and carrying splashing plates below their lower ends. The water then trickles over the usual arrangement of cooling bars or grids. The cooling air passes upward over the grids and through the large openings in the plate. The openings for water and air are distributed uniformly over the plate, so that in every circular belt, or sector, the ratio of water to air openings is constant.

—W. F. F.

Filter-press. H. A. Vallez, Bay City, Mich. U.S. Pat. 1,227,983, May 29, 1917. Date of appl., Mar. 6, 1915.

A FILTER-PRESS comprises a number of filtering elements mounted upon a shaft and rotated within a casing. The cake is removed from the filter

elements by jets of water in the upper part of the casing and a scraper bar attached to the peripheries of the filter elements so that it travels in close proximity to the interior of the casing. The cake falls into a trough which extends below the casing and is moved to a central discharge opening by oppositely working conveyors.—W. H. C.

Evaporator. A. W. Waern, Assignor to International Process Co., New York. U.S. Pat. 1,228,855, June 5, 1917. Date of appl., Aug. 11, 1916.

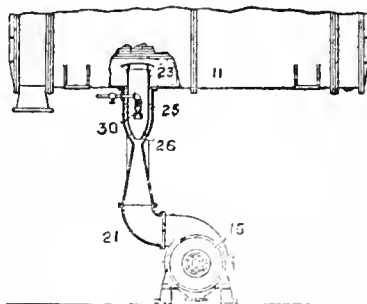
AN evaporator for recovering soda ash consists of a tank divided into two chambers by a longitudinal hollow partition open at each end, and furnace gases are passed through "baffle wheels" which dip into and are rotated in the liquid in each chamber. The discharge opening is in the bottom of the hollow partition and both it and the discharge pipe are provided with scrapers.—W. H. C.

Leaching apparatus. U. Wedge, Ardmore, Pa. U.S. Pat. 1,229,839, June 12, 1917. Date of appl., Mar. 1, 1915.

MATERIAL to be leached is fed by a rotating system of pipes on to a series of shallow superposed pans, each having a false bottom. Two discharge pipes are provided for each pan, connected respectively to the spaces above and below the perforated false bottom. Each set of similar pipes is connected by valved connections to a common discharge main.—W. F. F.

Condensing apparatus. J. J. Brown, Newark, N.J. U.S. Pat. 1,230,557, June 19, 1917. Date of appl., July 31, 1914.

THE non-condensable vapour from a surface condenser, 11, is discharged by the conduit, 23, extending into the condenser and restricted at the outer end, 26. The condensed liquid is discharged



by the annular conduit, 25, which is restricted at a point adjacent to the end of the inner conduit. Steam is injected by the nozzle, 30, to compress the non-condensable vapour in the restricted end of the conduit, 23, and the compressed vapour, condensed liquid, and condensed water are mixed in the conduit, 21, leading to an air and condensed liquid pump, 16.—W. F. F.

Mixer and pulveriser. R. W. Christian, Manchester, N.C. U.S. Pat. 1,230,672, June 19, 1917. Date of appl., Apr. 21, 1917.

A CASING having a base of semi-circular section is provided near one end with a slotted discharge opening. Near this opening the sides of the casing are connected by a transverse arch, forming with the base a circular opening, within which a stationary pulveriser is mounted on yielding supports. The portion of the casing between the arch and the opposite end forms a mixing chamber, within which is a mixer mounted on a rotating shaft. The pulveriser comprises a central plate, to which are secured segmental pulveriser plates with outstanding pulveriser arms. The material is forced through the pulveriser by the mixer.

Catalysts; Process of regenerating — N. Sulzberger, New York. Eng. Pat. 105,057, Sept. 13, 1916. (Appl. No. 12,990 of 1916.) Under Int. Conv., Mar. 20, 1916.

SEE U.S. Pat. 1,199,032 of 1916; this J., 1916, 1097.

Cooling air, liquids, vapours, gases, and the like; Apparatus for — E. Josse and W. Gensecke, Charlottenburg, Germany. U.S. Pat. 1,228,930, June 5, 1917. Date of appl., Oct. 28, 1911.

SEE Fr. Pat. 436,241 of 1911; this J., 1912, 479.

Purifying and separating finely-divided substances; Method of — B. Schwerin, Assignor to Ges. für Elektro-Osmose, Frankfurt, Germany. U.S. Pat. 1,229,203, June 5, 1917. Date of appl., Jan. 5, 1912.

SEE Fr. Pat. 438,183 of 1911; this J., 1912, 649.

Separation of finely-divided substances from coarse and foreign matters; Method for — B. Schwerin, Assignor to Elektro-Osmose A.-G. (Graf Schwerin Ges.), Frankfurt, Germany. U.S. Pat. 1,230,524, June 19, 1917. Date of appl., May 13, 1915.

SEE Eng. Pat. 7590 of 1915; this J., 1915, 729.

Gases under pressure; Storing of — A. Stephenson, Assignor to Acetylene Illuminating Co., Lambeth. U.S. Pat. 1,230,531, June 19, 1917. Date of appl., Nov. 7, 1916.

SEE Eng. Pat. 106,406 of 1916; this J., 1917, 701.

Steam generation. W. A. Bone and J. W. Wilson, Leeds, and C. D. McCourt, Assignors to Radiant Heating, Ltd., London. U.S. Pat. 1,230,990, June 26, 1917. Date of appl., June 23, 1911. Renewed Nov. 18, 1916.

SEE Eng. Pat. 2404 of 1911; this J., 1912, 110.

Combined furnaces and gas producers. Eng. Pat. 106,513. See IIA.

Feeding mechanism for shaft furnaces such as gas producers. Eng. Pat. 106,943. See IIA.

Compressing chlorine and other gases. Eng. Pat. 106,722. See VII.

Crucibles. Eng. Pat. 106,517. See VIII.

Dry kiln for drying lumber and other moisture-bearing substances. U.S. Pat. 1,228,989. See IX.

Apparatus and process for drying. U.S. Pat. 1,228,283. See XIXA.

Outlet or extraction pipes of filters. Eng. Pat. 106,512. See XIXB.

IIA.—FUEL; GAS; MINERAL OILS AND WAXES.

Coke; Conditions of formation of — G. Charpy and M. Godchot. Comptes rend., 1917, 164, 906—908.

A METHOD is described for studying the coking properties of coals quantitatively and also the influence of temperature on the coking process. The coal under test is powdered to pass a sieve of 120 meshes and exposed to an atmosphere saturated with water vapour and at 18°—20° C., so as to define the humidity of the sample. The powder, compressed under a pressure of 5 kilos. per sq. cm., is filled into a tube or fireclay which is securely closed at the ends with iron plates. The tube and contents are introduced into an electrically heated furnace of such dimensions that the temperature is not thereby appreciably depressed.

Heating is continued 1 hour. The coke is produced in the form of a cylinder 12 mm. in diameter and 20 mm. in height, which can readily be subjected to a compression test, the result of which is taken as a measure of the quality of the coke produced. The results of experiments on three kinds of coal at different temperatures are given. The compressive strengths in kilos. per sq. cm. are the mean values of six determinations, the extreme values of which are given in brackets:

Coking temperature.	St. Eloy coal.	Ferrières coal.	Noyant coal.
650° C.	19.85 (17, 22)	19.0 (17, 21)	100 (94, 105)
800° C.	32.9 (29, 36)	30.5 (21, 34)	93.6 (90, 98)
1000° C.	38.7 (35, 42)	45.0 (42, 49)	36.3 (33, 39)

The variations with temperature are thus much greater than the experimental error and are not, it is interesting to note, always in the same direction. On modifying the methods of heating, other changes are produced. Thus the Noyant coal, if heated for a time at 650° C. followed by a gradual rise of temperature to 1000° C., gives a coke having a compressive strength of 130 kilos. per sq. cm., while the coke from the St. Eloy coal is not appreciably improved by the same treatment. The authors advocate the determination for each coal of the thermal treatment which leads to the best results in the coke.—H. J. H.

Carbonising results with Glover-West vertical retorts at Macclesfield. J. E. Blundell. Gas J., 1917, 139, 106.

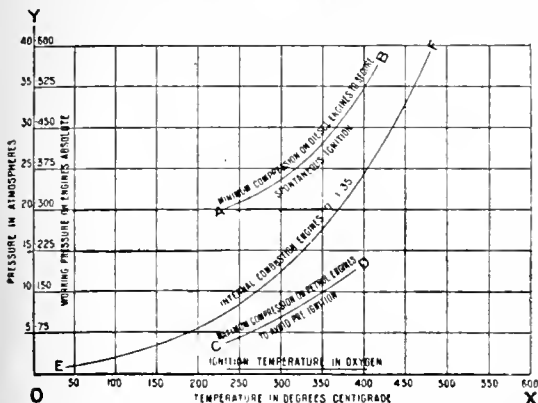
THE yield of gas from a Glover-West vertical gas retort plant has been increased by 25% by passing steam through the charge in the retort. In test runs with a mixture of Yorkshire, Derbyshire, and Staffordshire coals (volatile matter 37, ash 5%, yields of 15,500 cub. ft. and 15,200 cub. ft. of gas (tar-washed) of 510 and 508 B.Th.U. (gross) respectively were obtained, and during two months the yield of tar was 15.7 galls. and of ammoniacal liquor (10 oz.) 33.35 galls. The steam is supplied from boilers working at 100 lb. per sq. in. pressure and is reduced to 5—10 lb. pressure in the coke chambers, to each of which it is admitted through a nozzle of $\frac{1}{2}$ in. bore; the rate of discharge of the coke is reduced 10%. It is important that the heating of the retorts be so controlled that the highest temperature is towards the lower end of the carbonising portion of the retort, otherwise the carbon dioxide content of the gas is unduly high. Tests have indicated that by increasing the free space at the upper or outlet end of the retort, the content of heavy hydrocarbons in the gas is increased.

Cracking of petroleum in the liquid phase. R. Cross. Met. and Chem. Eng., 1917, 16, 643—645.

THE method recommended consists in applying heat to the petroleum in the liquid phase, maintaining a pressure of about 30 atmospheres and a temperature of not more than 400° C. The advantages of this method over cracking in the vapour phase are:—(1) greater yield and better quality of the product; (2) selective action on the heavy hydrocarbons with freedom from further cracking of the portion in the vapour phase; (3) the gasoline is removed from the reaction zone as fast as it is formed; (4) high heat economy; (5) carbon is deposited in the suspended condition and not on the walls of the tubes; (6) high oil capacity with small plant; (7) perfect temperature control; (8) rapid and complete absorption of heat from the furnace, and (9) convenient continuous or intermittent working of the process. The only serious disadvantage is the high pressure required with possible danger of explosive destruction of the apparatus.—W. H. P.

Liquid fuels; Spontaneous ignition temperatures of —. H. Moore. Engineer, 1917, 561.

THE spontaneous ignition temperature (this J., 1917, 109) can be used as a means of deciding the maximum and minimum engine compressions



suitable on petrol and Diesel engines respectively when burning any given liquid fuel. By plotting the calculated values of temperature and compression pressure, using the exponential, $\eta = 1.35$, a curve E F (see fig.) is obtained which shows the theoretical maximum compression practicable in a petrol engine, and which is also the minimum limit for the compression practicable in a Diesel engine, assuming that the temperatures represent the ignition points of the fuels. As several conditions cause interference with the working of this rule, the practical limits do not coincide with the curve E F. To obviate this difference the practical curves, C D and A B, applicable to engines operating on the constant volume and constant pressure cycles respectively, have been constructed from the results of engine trials on fuels of known ignition temperature. By the use of these curves the compression pressure of internal combustion engines can be directly ascertained by determining the ignition point of a fuel. Motor spirits of petroleum or shale origin do not vary in ignition point to any large extent. Benzol, alcohol, kerosene, and naphthalene possess widely varying ignition points which make adjustment of the engine compression advisable. Fuel oils derived from coal tar possess high ignition points, and mixtures are being marketed containing petroleum oils together with coal tar distillates. Such oils, if suitable as regards general chemical analysis, require examination as to ignition point; if the ignition temperature be high it will be necessary to make adjustment on Diesel engines, as otherwise in cold weather difficulty in starting will be experienced. By determining ignition points of mixtures of kerosene with tar oil and of Mexican fuel oil with tar oil, curves of ignition point against compression have been constructed. Mixtures containing half tar oil and half petroleum products have ignition points which are lower than the mean of the values for the two constituents. The admixture of a small quantity of either oil to the other causes the mixture to possess an ignition point differing widely from that of the main constituent.—F. W. A.

Cheap production of alcohol. Breckler. See XVIII.

PATENTS.

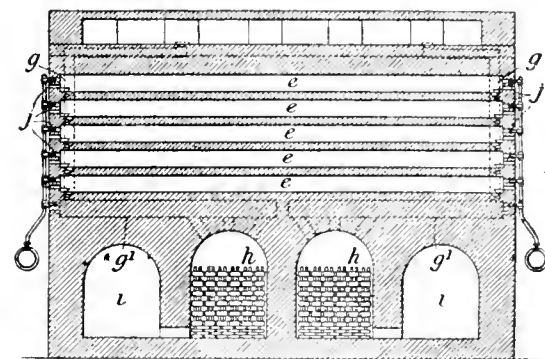
Waste products of coal and other fuels; Conversion of — into inflammable gas for consuming smoke in furnaces. A. E. Shill, S. Diggle, and G. B. Scott, London. Eng. Pat. 106,775, Nov. 24, 1916. (Appl. No. 16,854 of 1916.)

SMOKE, waste gases, and the like are withdrawn

from a flue by means of a steam jet operating in a pair of funnels arranged to act as an injector, and the mixture of steam and smoke is injected behind and above the fire along with superheated steam, producing an additional carbon monoxide flame of intense heat.—J. E. C.

Coke-ovens; Regenerative —. J. A. Roelofsen, Harrogate. Eng. Pat. 106,905, Aug. 10, 1916. (Appl. No. 11,318 of 1916.)

IN a regenerative coke-oven the coking chambers are arranged side by side and are heated by superposed horizontal flues, *c*, in the walls between them. Each flue is provided with gas supply



burner nozzles, *j*, at each end, which are used alternately. The air supply passes through an air chamber, *i*, to a regenerative chamber, *h*, of known form. The heated air passes through a horizontal flue, *g'*, to a vertical flue, *g*, which communicates with all the heating flues, *c*. The combustion gases are exhausted through the opposite flues, *g*, *g'*, and chambers, *h*, *i*, until these are heated to the required temperature. The air circulation is then reversed and the opposite set of burner nozzles, *j*, is used. When gas of low calorific value, such as generator or blast-furnace gas, is used, the regenerators, *h*, are placed above the chambers, *i*, and an additional pair is provided at each end through which the gas supply is passed to preheat it.—W. F. F.

Coke-ovens; Regenerative —. E. Hurez, Petit Couronne, France. Eng. Pat. 107,178, Jan. 26, 1917. (Appl. No. 1344 of 1917.)

IN a regenerative coke oven the walls are formed of flues, each adjoining pair of flues being traversed simultaneously, one by gases in intense combustion, the other by the burned gases, the direction of flow being periodically reversed. The flues are separated by partitions composed of hollow bricks enclosing a heat-insulating layer of air to concentrate the effective heat within the coking chamber.—J. E. C.

Retorts employed in the manufacture of illuminating gas from coal; Means for effecting the removal of the carbon deposit from —. W. T. Bark, Tenterden, Kent. Eng. Pat. 106,910, Aug. 21, 1916. (Appl. No. 11,830 of 1916.)

IN a retort for the manufacture of coal gas, the deposit of gas carbon is removed by burning. The bottom of the retort is provided with refractory bricks of flat, arch, channel or other shape, forming a longitudinal air conduit communicating with an opening in the door and extending nearly to the farther end of the retort. A current of air is drawn through the conduit into the retort to burn the carbon, and the combustion products are withdrawn at the charging end of the retort. A supplementary door may be provided having the

necessary air opening and a sight hole, or these may be formed in the ordinary door and closed when not in use.—W. F. F.

Vertical [gas retort] bench. P. Plantinga, Cleveland, Ohio. U.S. Pat. 1,228,175, June 5, 1917. Date of appl., July 12, 1915.

A VERTICAL retort bench comprises a gas producer, an oven beside the producer, and a recuperator below the producer and oven, the whole forming an integral masonry structure. Gas passes from the top of the producer to the bottom of the oven, and the products of combustion pass from the top of the oven downwards through the recuperator, in the opposite direction to the secondary air, which meets the gas supply at the bottom of the oven.—J. E. C.

Furnaces and gas producers; Combined—. R. F. Hislop, Paisley. Eng. Pat. 106,513, Mar. 24, 1916. (Appl. No. 4368 of 1916.)

A GAS producer forming part of a heating furnace for drying, annealing, or melting, heating galvanizing baths, enamelling muffles, or steam boilers, is provided with a special arrangement of secondary air-supply conduits. Air at 8—10 oz. pressure is preheated by passing from a supply main through branch pipes and conduits in the producer or furnace walls to the combustion chamber. In a modification, air may be induced into the conduits by a small jet of air or steam at 40—80 lb. pressure. Air at 8—10 oz. pressure may also be delivered directly to the combustion chamber.—W. F. F.

Shaft furnaces such as gas producers; Feeding mechanism for—. *Charging apparatus for gas producers.* The International Construction Co., Ltd., and A. Sahlin, London. Eng. Pats. (A) 106,943 and (B) 106,977, Nov. 19, 1916, and Mar. 19, 1917. (Appl. Nos. 16,125 of 1916 and 3988 of 1917.)

(A) IN feeding mechanism for shaft furnaces such as gas producers, of the type in which a rotating hopper is provided with an eccentric inclined distributing nozzle projecting into the furnace, the nozzle is made adjustable in length to compensate for the burning off of the extremity. For example, one or more bars resting on the lower wall of the nozzle and projecting beyond the outlet, may be moved forward to any desired distance, or completely withdrawn for renewal, by screwed rods operated from outside. The adjustment may be effected during the working of the apparatus. (B) The feeding apparatus described in (A) is combined with a horizontal rotating measuring drum for the fuel. A charge is deposited intermittently on the fuel bed, and the measuring drum and feeding mechanism are so geared that the charges are not fed in the same position during successive rotations of the feeding nozzle.—W. F. F.

Gas; Manufacture of—. J. Bueb, Dessau, Germany. U.S. Pat. 1,228,879, June 5, 1917. Date of appl., Oct. 11, 1913.

COAL is distilled in a vertical retort at a temperature approximating to the melting point of silica, and water vapour is admitted towards the end of the distillation, whereby water-gas is generated and reacts with the tar remaining in the coke.—J. E. C.

Gas producer. L. F. Burger, Beloit, Wis., Assignor to International Harvester Corporation. U.S. Pat. 1,230,558, June 9, 1917. Date of appl., June 30, 1913.

IN a gas producer a tuyère is arranged centrally on the top of a generating chamber. A fuel-charger is fitted within the tuyère and spaced

apart from the sides. An air and a steam pipe on the side of the tuyère communicate with the interior.—J. E. C.

Fuel gas; Method of producing—. M. Sklovsky, Assignor to Deere and Co., Moline, Ill. U.S. Pat. 1,229,338, June 12, 1917. Date of appl., Sept. 8, 1914.

AIR is preheated to a temperature high enough to vaporise fuel oil and is then passed through a vaporising chamber at a high velocity. Fuel oil is introduced into the stream of air, and the mixture, in correct proportion, passes to the combustion chamber at a velocity sufficient to prevent backfiring of the flame into the vaporiser.—J. E. C.

Hydrocarbon gases; Process for improving the quality and yield of—. J. G. Davidson and R. W. Ford, Vancouver, B.C. U.S. Pat. 1,229,042, June 5, 1917. Date of appl., Nov. 29, 1915.

THE gas is subjected to the action of a high-tension silent electric discharge so as to convert hydrocarbons of high molecular weight into those of lower molecular weight, and increase the percentage of fixed hydrocarbons and the final volume of the gas.—W. R. S.

Refining liquids and gases; Apparatus for—. J. N. Wingett, Assignor to W. A. Haggott, Denver, Colo. U.S. Pat. 1,229,189, June 5, 1917. Date of appl., June 21, 1915.

MATERIAL to be treated is fed through a combustion chamber to an inner concentric "treatment" chamber which contains a hydrometer. Heavy oil is automatically discharged through a valve in the bottom of the treating chamber, which is operated by electromagnetic means controlled by the vertical movement of the hydrometer as the density of the oil varies.—W. F. F.

Combustible fluids; Process of manufacturing—. J. R. Rose, Edgeworth, Pa. U.S. Pat. 1,230,226, June 19, 1917. Date of appl., Nov. 29, 1915.

A LIQUID or gaseous hydrocarbon is injected into a generator by a stream of hydrogen under pressure; a liquid hydrocarbon of a different series is also introduced into the generator, and the mixture of the three fluids is subjected in the generator to the action of highly heated refractory material. The resulting gaseous fuel is freed from carbon, scrubbed, and then enriched by conducting it through liquid hydrocarbon.—J. E. C.

Motor fuel for use in high-speed internal combustion engines. W. A. Hall, London. Eng. Pat. 106,876, June 16, 1916. (Appl. No. 8503 of 1916.)

A FUEL suitable for use in high-speed internal combustion engines consists of equal parts of an uncracked saturated hydrocarbon of the paraffin series boiling from 140° C. to 230° C., and a partly unsaturated hydrocarbon spirit produced by cracking as described in Eng. Pat. 24,491 of 1913 (this J., 1915, 216).—W. F. F.

Hydrocarbons; Treatment of—. H. Rostin and G. F. Forwood, London. Eng. Pat. 107,034, May 15, 1916. (Appl. No. 6926 of 1916.)

TO convert hydrocarbons of high boiling points into products of low boiling points, the heavy hydrocarbon, in the form of vapour, is mixed with hydrogen sulphide and brought into contact with a substance such as heated copper, capable of liberating the hydrogen of the hydrogen sulphide. The nascent hydrogen combines with the vapours of any unsaturated hydrocarbons produced. The copper sulphide produced may be treated with gases rich in hydrogen, forming hydrogen, sulphide and copper.—J. E. C.

Hydrocarbons; Synthetic production of—L. B. Cherry, Kansas City, Mo. U.S. Pat. 1,229,886. June 12, 1917. Date of appl., Feb. 21, 1916.

A HYDROCARBON of a relatively high gravity is produced from one of comparatively low gravity by subjecting the latter, in a hot vaporised state, to the silent discharge of a high frequency bipolar oscillating electric current in the presence of a heated and gaseous hydrogen-supplying agent.

—J. E. C.

[*Paraffin wax*] *candleslock*. R. Philip, Bofors, Sweden. U.S. Pat. 1,229,132, June 5, 1917. Date of appl., July 29, 1916.

THE material consists of paraffin wax and salicylic acid, with or without the addition of stearin.

—C. A. M.

Petrol and heavy oils; Process and apparatus for employing—in internal combustion engines. J. de Ferry, Paris. Eng. Pat. 106,963, Jan. 31, 1917. (Appl. No. 1573 of 1917.) Under Int. Conv., Nov. 14, 1916.

Coke oven; Method and apparatus for regulating the distribution of the heating gases among the heating flues of a regenerative—L. Wilputte, New Rochelle, N.Y., U.S.A. Eng. Pat. 106,953, Dec. 14, 1916. (Appl. No. 17,997 of 1916.)

SEE U.S. Pat. 1,212,866 of 1917; this J., 1917, 379.

Carbon monoxide and hydrogen; Manufacture of [a mixture of]—R. P. Pictet, Wilmersdorf, Germany. U.S. Pat. 1,228,818, June 5, 1917. Date of appl., July 1, 1912.

SEE Eng. Pat. 16,373 of 1911; this J., 1912, 805.

Hydrocarbons; Process and apparatus for the conversion of heavy—into lighter hydrocarbons. F. Lamplough, London. U.S. Pat. 1,229,098, June 5, 1917. Date of appl., Dec. 16, 1912.

SEE Eng. Pats. 19,702 and 28,101 of 1912; this J., 1913, 743.

Furnace heated by gaseous combustion. Eng. Pat. 106,546. See I.

Method and apparatus for generating combustion products under pressure. Eng. Pat. 106,579. See I.

Furnaces for steam generators. Eng. Pat. 106,707. See I.

Furnace for pulverous fuel. U.S. Pat. 1,229,685. See I.

Process of employing heat for the production of power. U.S. Pat. 1,230,417. See I.

Combined tar dehydration and ammonia distillation plant. Eng. Pat. 106,642. See III.

Manufacture of toluol. U.S. Pat. 1,230,087. See III.

Process for obtaining pigments, especially black pigments, from lignite. Ger. Pat. 297,111. See XIII.

Production of soot from hydrocarbons. Ger. Pat. 297,260. See XIII.

IIb.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

Chemistry of wood. Methods and results of analysis of some American species. Discussion of methods and results. Schorger. See V.

PATENTS.

Peat and the like; Preparing—for distillation. W. L. St. J. Prioleau, London. Eng. Pat. 106,636, Apr. 14, 1916. (Appl. No. 5512 of 1916.)

APPARATUS for obtaining volatile products from carbonaceous materials containing a considerable quantity of moisture, comprises an upper enclosed compartment acting as a preliminary drying and heating appliance, and a lower closed retort in which distillation is completed. The material traverses the upper section by means of a conveyor belt and scrapers and is then fed into the lower section along which it is transported by a screw conveyor. The vapours evolved are withdrawn at successive points in both sections and separately condensed.—J. E. C.

Filament; Ductile—O. M. Thowless, Assignor to A. J. Thowless, Newark, N.J. U.S. Pat. 1,226,925, May 22, 1917. Date of appl., Aug. 9, 1915.

A BODY of refractory metal powder is sintered at a high temperature in an atmosphere of hydrogen and the vapour of a halogen salt of tungsten, so that the metal contained in the halogen salt permeates and fills up the spaces between the particles of metal powder. The heating is continued until the whole mass is formed into a solid body, which is worked into a fibrous structure and reduced to a filament.—B. N.

Self-lighting gas mantles; Production of—J. G. Gotty, Jacksonville, Fla., Assignor to Gotty Gas Lighting Co. U.S. Pat. 1,227,259, May 22, 1917. Date of appl., Aug. 29, 1916.

A COMPOSITION containing platinum black and finely-divided particles of platinum as a catalytic agent, with a solvent comprising alcohol, glycerol, and dextrose, is used for making self-lighting gas mantles.—B. N.

Incandescence lamps; Method of making [electric]—W. D. Coolidge, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pat. 1,230,869, June 26, 1917. Date of appl., Nov. 7, 1910.

SEE Eng. Pat. 16,530 of 1907; this J., 1908, 496.

Neon-tube. G. Claude, Boulogne-sur-Seine, France. U.S. Pat. 1,231,494, June 26, 1917. Date of appl., June 16, 1915.

SEE Eng. Pat. 8312 of 1915; this J., 1915, 1005.

Furnace for making products electrically and means for facilitating discharge of the same. Furnace for electrically making products and means for heating discharged products. U.S. Pats. 1,227,068 and 1,227,069. See XI.

III.—TAR AND TAR PRODUCTS.

Phenol; Determination of—in crude carbolic acid and tar oils. J. M. Weiss and C. R. Downs. J. Ind. Eng. Chem., 1917, 9, 569—580.

THE oil, if dirty, should be distilled in a copper tar-still, and the weight of total distillate recorded. *Extraction of the acids*. A weight of oil containing 300 to 350 grms. of acids is shaken with about 300 c.c. of 20% sodium hydroxide solution, the mixture allowed to stand 15 to 30 mins., and the aqueous layer drawn off into another separating funnel. The residual oil is shaken successively with 3 more portions of 200 c.c. each of the alkali solution and the alkaline extracts are added to the first extract. In the case of crude acid 300 to 350 grms. is dissolved in 800 c.c. of the sodium hydroxide solution, which is then treated as above. Should the acids be tarry they must be distilled before being dissolved in the alkali solution. *Purification of the carbolate*. The united alkali

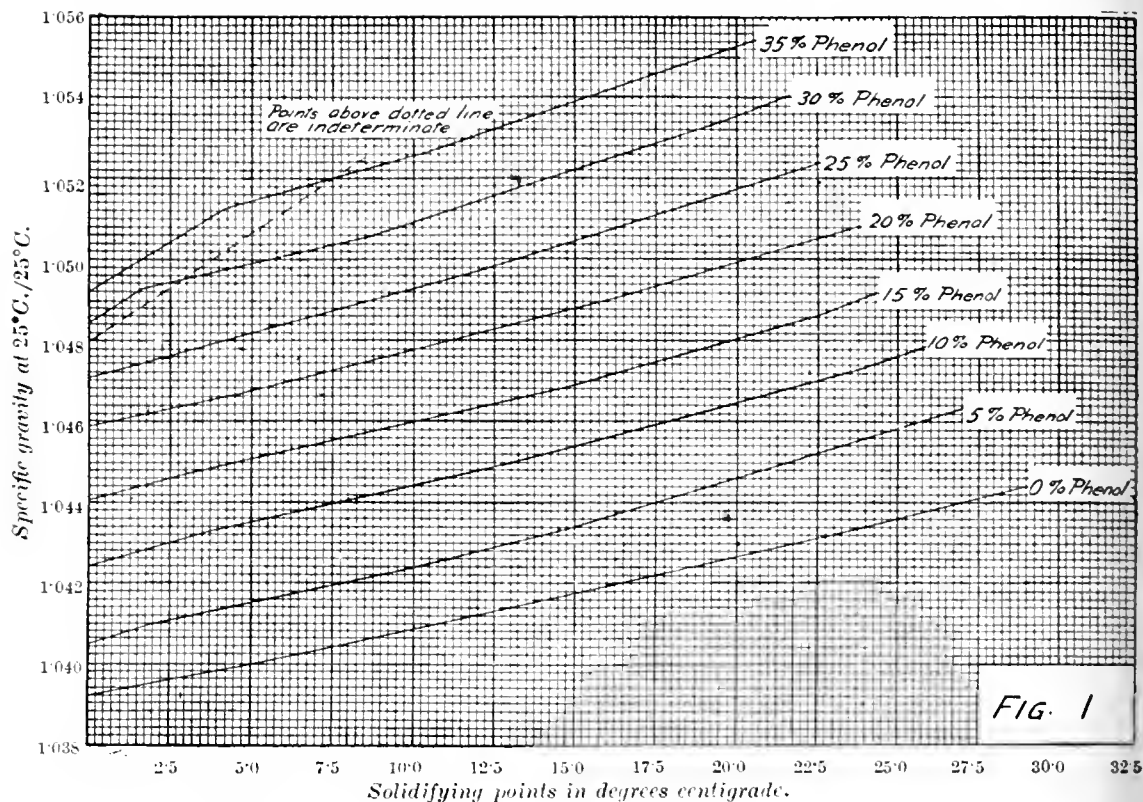


FIG. 1

extracts are extracted with five successive portions of 100 c.c. of pure benzene, the benzene extracts washed twice with 50 c.c. of water, and the washings added to the carbolate solution, which is then gently boiled until free from any odour of benzene. Any odour of creosote at this stage indicates insufficient washing of the solution. **Acidification.** The purified carbolate is treated in a separating funnel with 25% sulphuric acid (sp. gr. 1.21), the temperature being kept below 40° C. during the acidification, and care being taken to add not more than a slight excess (5 to 10 c.c.) of the acid. The funnel is allowed to stand until the lower layer of sodium sulphate solution is clear (3 to 4 hours), and this layer is then drawn off, and extracted three times with successive portions of 100 c.c. of pure benzene. The benzene extract is shaken with two or more portions of 25 c.c. each of 20% sodium hydroxide solution, the alkali extract heated to expel benzene, and rendered slightly acid with sulphuric acid, and the separated acids added to the main portion of acids. The weight of the total quantity of wet acids obtained is then recorded. **Fractional distillation.** This is effected in a 500 c.c. round-bottomed short-necked flask, which is connected with a standard 12-pear still head, and a Barrett trough type condenser with a 24-in. tube. The thermometer should be graduated from 170° to 225° C. in $\frac{1}{2}^{\circ}$ C. and should be accurate to $\frac{1}{2}^{\circ}$ C. when totally immersed. Its dimensions should be as follows:—Total length, less than 380 mm.; bulb length, 20 to 25 mm.; 170° mark to bottom of bulb, 70 to 80 mm.; scale length 170°—225° C., 270—280 mm.; stem diameter, 5 to 7 mm.; and bulb diameter, 4 to 5.5 mm. The flask is supported over a burner on $\frac{1}{4}$ in. asbestos board 6 in. square, with an opening 3.5 in. in diameter in the middle, and it is surrounded by a circular asbestos shield about 3½ in. high, whilst a piece of asbestos board with a hole cut for the neck of the flask forms the top of the screen. **Mode of distillation.**

The distillation is carried out at the rate of one drop per sec., the distillate being received in a separating funnel until the temperature has reached 170° C. The distillation is then interrupted, and sufficient salt is added to the contents of the separating funnel to cause any acids present to rise to the surface. These are separated and

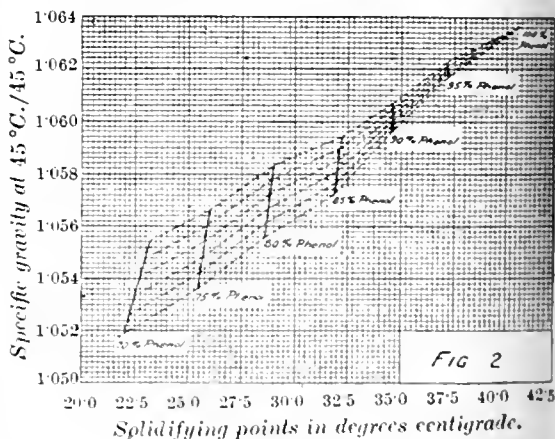


FIG. 2

returned to the distillation flask, which is then weighed so as to obtain the weight of dry acids. The distillation is now renewed, the first drops of acid and water being collected in a small separating funnel, and when the last drop of water has distilled, the distillate up to 190° C. is received in a small weighed flask, into which is also introduced the acid separated from the first drops of distillate. A second fraction (190° to 202° C.) is collected in a 250 c.c. flask, and at 202° C. the distillation flask is replaced by this flask. This fraction is now redistilled, after drying the condenser tube, and

the distillate is collected in the weighed flask containing the first fraction (to 190° C.). The distillation is continued up to 197° C., and the flask containing the combined fraction is weighed and kept well closed. *Testing the fraction.* The sp. gr. is determined by means of a Westphal balance, and the solidifying pt. as follows:—The fraction is poured into a test tube 5 to 6 in. long by 1 in. internal diameter so as to form a layer of 2 in. This tube is clamped vertically to a depth of 3 in. in a beaker containing 500 to 600 c.c. of water. A standard 0°–80° C. thermometer accurate to at least 0.1° C. is clamped with its bulb in the centre of the test-tube 0.5 in. from the bottom, and the liquid is stirred with a wire agitator surrounding the thermometer. The approximate solidifying pt. is taken, the contents of the tube remelted, the water in the beaker brought to a temperature 4.5° to 5.5° C. below the approximate solidifying pt., and a fresh determination is made with constant stirring until the maximum rise of temperature is obtained. Identical results should be obtained in duplicate tests. From the values obtained for the solidif. pt. and sp. gr., the phenol content may be ascertained by reference to the annexed curves. If they do not fall within the determination area it is best to mix the fraction with pure phenol (solidifying pt. at least 40.4° C.), so as to bring the tests within the range.—C. A. M.

Maplewood creosote; Toxic action of — and of some of its constituents and derivatives on a wood-destroying fungus. E. J. Pieper, S. F. Aree, and C. J. Humphrey. *J. Ind. Eng. Chem.*, 1917, 9, 566–569.

CULTURES of *Fomes annosus* were made on nutrient agar to which had been added measured quantities of maplewood creosote (this *J.*, 1917, 638) or of constituents thereof. It was found that the creosote had a high toxic coefficient, practically identical with that of beechwood creosote, which it also closely resembles in composition. The toxic action is due to the presence of carbocyclic compounds containing free hydroxyl groups or the corresponding methoxyl groups. The growth of the fungus was prevented by 0.05% of the alkalisoluble portion of the creosote, which is thus twice as toxic as the creosote itself, four times as toxic as the neutral oil, and seven times as toxic as coal-tar creosote. The lethal doses of the fractions distilling at 195° to 230° C. and 230° to 265° C. were practically the same as in the case of the creosote, but the fraction of higher b.pt. was somewhat more toxic than the fraction of lower b.pt. This was due to the greater proportion (80 to 85%) of phenols in the higher than in the lower fraction (65 to 70%). The higher fraction consists mainly of trihydric phenols, notably the dimethyl ether of pyrogallol and its homologues, whilst the lower fraction largely consists of mono- and di-hydric phenols, especially cresol, guaiacol, and creosol.

—C. A. M.

Condensations in the aromatic series by means of heat. H. Meyer and A. Hofmann. *Monatsh. Chem.*, 1916, 37, 681–722. *Z. angew. Chem.*, 1917, 30, Ref., 131–135.

THE vapours of the substances under investigation were heated to 700°–800° C. by an electrically heated platinum wire. Toluene yielded dibenzyl at a dull red heat, and, at a bright red heat, stilbene with some anthracene and a substance giving terephthalic acid on oxidation. At the lower temperature *p*-xylene gave *p*-dixyl and products oxidising to terephthalic and *p*-toluic acids, and gave *p*-dimethylstilbene at the higher temperature. Mesitylene and ethylbenzene yielded limesityl and stilbene respectively. Dibenzyl gave large quantities of anthracene, some stilbene,

very little toluene, and no phenanthrene. Fluorene was obtained from diphenylmethane, benzaldehyde and benzene from benzophenone, carbazole from diphenylamine, and naphthalene from α -dinaphthylamine. Naphthalene when heated at a dull red heat yielded principally $\beta\beta$ -dinaphthyl with a little of the $\alpha\alpha$ -isomer; at a higher temperature the yield of the latter was increased. Diphenyl yielded 4,4'-diphenylbiphenyl. The so-called "crackene" isolated from the red tarry substance obtained in the "cracking" process, is not identical with either benzerythrene or 4,4'-diphenylbiphenyl, but yields picene on purification. Pure benzerythrene and picene dissolve in concentrated sulphuric acid to colourless solutions; the green coloration used as a test is due to impurity.—F. C. T.

Phenyl- α -naphthylamine; Preparation of —. M. Katayama. *Kogyo-Kwaaku-Zasshi (J. Chem. Ind., Tokyo)*, 1917, 20, 353–365.

STREIFF's method of preparing phenyl- α -naphthylamine by combination of α -naphthylamine hydrochloride and aniline is tedious and gives a relatively poor yield. The author made experiments to ascertain the most suitable conditions for preparing the base by Friedländer's method of condensing aniline with α -naphthol in presence of a dehydrating agent. Under the following conditions a yield of 64% of the theoretical quantity of phenyl- α -naphthylamine (calculated on the α -naphthol used) is obtained. An intimate mixture of α -naphthol (1 mol.), aniline (2 mols.), and calcium chloride (1 mol.) is placed in an autoclave, which is heated for 10 hours at 300° C. The product is treated with boiling water to remove calcium chloride, with hydrochloric acid to remove uncombined aniline, and with caustic soda to remove uncombined α -naphthol, and is then distilled *in vacuo* in a current of carbon dioxide or hydrogen. After crystallising from alcohol, the phenyl- α -naphthylamine melts at 60° C.

Secondary arylamines from primary amines; Separation of —. J. Thomas. *Chem. Soc. Trans.*, 1917, 111, 562–572.

THE method is based on the observation that if a crude preparation of a secondary arylamine, *e.g.*, ethyl-*o*-toluidine, be heated with ethyl oxalate, no combination with the secondary amine takes place but that any primary amine present, *e.g.*, unchanged *o*-toluidine, readily reacts with the oxalic ester at the boiling point, giving a mixture of *o*-tolylloxamic ester and di-*o*-tolylloxamide in proportions depending on the duration of heating; the ethyltoluidine can then be readily separated by fractional distillation from the high-boiling products of the reaction of the toluidine with the oxalic ester. In practical use, the mixture of secondary and primary amines, distilled once to separate other impurities and containing about 13% of primary amine, is heated for 4–6 hours with 30% of its weight of oxalic ester, and the product fractionated. The fraction distilling up to 200° C. contains chiefly the excess of oxalic ester but contains also some of the base; the ethyltoluidine distilling at 200°–230° C. contains about 3% of the primary amine, which may be reduced to less than 1% by a second treatment with oxalic ester. In the case of secondary arylamines which are not readily separated from ethyl oxalate by distillation, owing to similarity of boiling points, butyl oxalate may be used with satisfactory results. The method has been employed also for the purification of ethylaniline, ethyl-*p*-toluidine, and monomethylaniline, in the last case with the use of butyl oxalate. It is likewise applicable for removing primary amines from tertiary bases.—J. F. B.

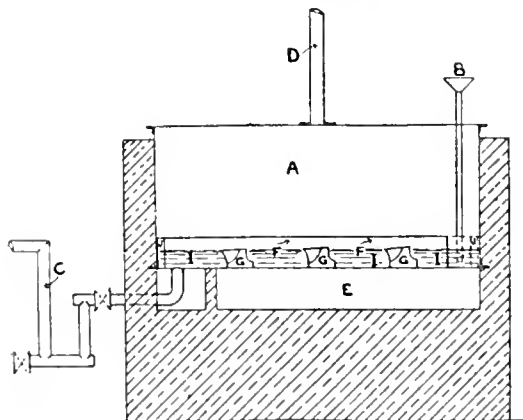
[*Anthraquinone derivatives*;] *Reduction [of —] in concentrated sulphuric acid solution by means of aluminium powder.* A. Eckert and R. Pollak. *Monatsh. Chem.*, 1917, **38**, 11—17. *J. Chem. Soc.*, 1917, **112**, i., 345—346.

THE authors have studied the reaction described in Ger. Pats. 190,656 and 201,512, by which anthraquinone derivatives are reduced in concentrated sulphuric acid solution by either copper or aluminium powder. In order to carry out the reduction, the substance is dissolved in 20—30 times its weight of concentrated sulphuric acid, and to the well-cooled mixture one-fifth of the weight of substance of aluminium powder is slowly added with continuous shaking and cooling. The end of the reaction is indicated by foaming. When the reduction is complete, the mixture is poured into cold water and the product extracted with a suitable solvent. In this way, anthraquinone has been reduced to anthraquinol and anthrone; benzophenone to β -benzopinacolin; benzoylbenzoic acid to the dilactone of dihydroxytetraphenylethanedicarboxylic acid. If the reduction is effected with the further addition of acetic acid or benzoic acid or their anhydrides, the products are either the diacetyl or dibenzoyl derivatives of the reduced substance. Acridone cannot be reduced by the above method. *p*-Chlorobenzoylbenzoic acid when reduced by aluminium powder yields the corresponding dilactone. When the dilactone of dihydroxytetraphenylethanedicarboxylic acid is heated with 20% fuming sulphuric acid for three hours at 180° C., it is converted into sulpho- β -anthraquinonecarboxylic acid.

PATENTS.

Tar dehydration and ammonia distillation plant; Combined —. F. L. Ball, Maidstone, and H. K. Hiller, Westminster. Eng. Pat. 106,642, May 16, 1916. (Appl. No. 6974 of 1916.)

AN apparatus for separating, dehydrating, or distilling emulsions, solutions, or mixtures of liquids of different specific gravity, such as tar, or debenzolising oil and other like fluids, or solutions of gases such as ammoniacal liquor, etc.



The still is heated by direct fire, and is designed so that priming or frothing is avoided. Vertical "staggered" deflector plates, F, form zigzag channels in the still, and the tops of hollow cast iron heat dispersers, G, placed in the channels, form tables on which the heated liquid, I, is spread in a thin film; the vapours escape by the pipe, D. The temperature of the liquid entering from B is progressively raised until it reaches the outlet, C, so that the vapours are liberated fractionally. The fire gases pass through flues, E, beneath the still.—F. W. A.

Distilling coal-tar on coal-tar pitch and products derived therefrom; Method of —. P. C. Reilly, Indianapolis, Ind. U.S. Pat. 1,230,782, June 19, 1917. Date of appl., Mar. 28, 1914.

COAL-TAR or coal-tar pitch is heated to about 1000° F. (about 540° C.) in a still, which is raised to an even temperature over its entire surface by a heated atmosphere. Dry coke is left as residue in the still, and the products of distillation comprise an orange-coloured mass waxy at 70° F. (21° C.) and a hard garnet-coloured product, brittle at 70° F. and of sp. gr. not less than 1.22.—F. W. A.

Toluol; Manufacture of —. O. B. Evans, Assignor to The United Gas Improvement Co., Philadelphia, Pa. U.S. Pat. 1,230,087, June 12, 1917. Date of appl., Feb. 24, 1915.

NAPHTHA "of gas-drip origin" is heated to a temperature sufficiently high to increase materially the percentage of toluene, in a chequer-brick chamber preheated by internal combustion of water-gas, and the toluol is recovered from the mixture of hydrocarbon gas and toluol vapour produced.—F. W. A.

Aromatic hydrocarbon hydroxy compounds; Cyclic process of making —. L. M. Dennis, Ithaca, N.Y. U.S. Pat. 1,227,894, May 29, 1917. Date of appl., July 14, 1916.

HYDROXY derivatives of aromatic compounds, e.g., phenol, are obtained by a cyclic process by the interaction of an aqueous solution of an aromatic sulphonic acid free from sulphuric acid, e.g., benzenesulphonic acid, with the alkali salt of a hydroxy compound, e.g., sodium phenoxide, thus producing the free hydroxy compound, e.g., phenol, and the alkali salt of the sulphonic acid; fusion of the latter with alkali hydroxide gives alkali phenoxide, which is used again as above described.—F. W. A.

Sulphonic acid from sulphuric acid; Method of separating aromatic — and of obtaining it in solid form. L. M. Dennis, Ithaca, N.Y. U.S. Pat. 1,228,111, June 5, 1917. Date of appl., Nov. 20, 1916.

THE sulphonic acid of an aromatic hydrocarbon, e.g., naphthalene- β -sulphonic acid, is separated from sulphuric acid and obtained in solid form by treating the mixture with a warm organic solvent, e.g., toluene, and cooling the separated solution of the sulphonic acid.—F. W. A.

Sulphonic acid of a hydrocarbon of the aromatic series; Method of separating a — from sulphuric acid and converting the sulphonic acid into a salt. L. M. Dennis, Ithaca, N.Y. U.S. Pat. 1,229,593, June 12, 1917. Date of appl., Nov. 6, 1916.

AN aromatic sulphonic acid, e.g., benzenesulphonic acid, is extracted from its mixture with sulphuric acid by means of an insoluble organic solvent, e.g., benzene, the solution is treated with water, and the aqueous solution is treated with a suitable compound to form a salt of the sulphonic acid.—F. W. A.

Treatment of hydrocarbons. Eng. Pat. 107,031. See IIA.

Synthetic production of hydrocarbons. U.S. Pat. 1,229,886. See IIA.

IV.—COLOURING MATTERS AND DYES.

Diazo-oxides (diazophenols); Constitution of —. H. G. T. Morgan and H. P. Tomlins. *Chem. Soc. Trans.*, 1917, **111**, 497—506. (See also this J., 1915, 653.)

THE sulphonic acids of the *o*-, *m*-, and *p*-amino-

phenols yield diazo-derivatives crystallising with 1 mol. of water. The *o*-diazo-derivative and its salts are yellow substances in which internal condensation has taken place between the phenolic and diazo-groups, leading to an *o*-diazo-oxide which may alternatively be represented as an *o*-quinonediazide. The diazo derivative of *p*-aminophenolsulphonic acid is a colourless internal diazonium sulphonate which gives yellow salts on the addition of 1 mol. of an alkali or organic base; these salts are *p*-diazo-oxide or *p*-diazo-quinone derivatives. The *m*-diazo-derivative is an internal diazonium sulphonate, colourless when pure, but far less stable than the *p*-derivative. On the addition of an alkali or organic base it shows no tendency to form salts of the *m*-diazo-oxide type, but decomposes rapidly with evolution of nitrogen, and the decomposition product (resorcinol-4-sulphonic acid) couples with the still undecomposed diazonium sulphonate to form an azo dyestuff.

—J. F. B.

PATENTS.

Soluble colour compound. W. Beckers and I. Dreyfus, Brooklyn, N.Y.. Assignors to W. Beckers Aniline and Chemical Works. U.S. Pat. 1,228,089, May 29, 1917. Date of appl., July 6, 1914.

A NEUTRAL alkali chromate is dissolved in glucose, heated until no chromic acid is present, and a solution of a mordant colour is added to obtain a compound of the mordant colour soluble in neutral, alkaline, and acidulated water.—F. W. A.

Acridine series; Cadmium compounds of the — and a process of making the same. P. Hüßy and M. Hartmann. Assignors to Soc. Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,228,926, June 5, 1917. Date of appl., Apr. 7, 1917.

AN acridine dyestuff alkylated at the acridine nitrogen is treated with a soluble cadmium salt in presence of a solvent. The cadmium compound of 2,7-dimethyl-3,6-diaminoacridine methylated at the acridine nitrogen is specially claimed.—F.W.A.

Silver compound of the acridine series [disinfectant] and process of making same. U.S. Pat. 1,227,624. See XIXB.

Manufacture of urcas and thiourcas of the naphthalene series. Eng. Pat. 20,192. See XX.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Wood; Chemistry of —. I. Methods and results of analysis of some American species.

II. Discussion of methods and results. A. W. Schorger. J. Ind. Eng. Chem., 1917, 9, 556—566.

THE following mean results were obtained in the analysis of seven kinds of American wood, four samples of each being taken:—

The water-soluble portion of the western larch consisted largely of a galactan, apparently $(C_6H_{10}O_5)_{50}$, which yielded only galactose on hydrolysis. Wood cellulose probably consists of definite compounds of hexosans with varying proportions of pentosans. In this paper cellulose is defined as the residue left after alternate treatment with chlorine and sodium sulphite up to the point where the chlorine-sulphite colour reaction ceases. Hard woods may be sharply differentiated from conifers by the pentosan content of the cellulose. Thus the amount of pentosans in the cellulose from conifer woods varied from 5 to 10%, and in that from hard woods from 24 to 28%. Douglas fir contained the largest amount of methylpentosans (42% of the total pentosans present). In general, conifers contain more methylpentosans than hard woods. Conifer wood offers much more resistance than the wood of broad-leaved trees to the action of chlorine. The following numbers of chlorinations were required to obtain cellulose free from lignin:—Douglas fir, 4 to 5; white spruce, 4 to 5; long leaf pine, 4; western larch, 5; yellow birch, 2 to 3; basswood, 2; and sugar maple, 2 to 3. In experiments to determine the effect of alkali on the yield of cellulose the following results were obtained with basswood, by two chlorinations of 30 mins. each.

Preliminary treatment.	Cellulose, %
Extracted with alcohol-benzene	62.92
Digested with 50 c.c. of 1% NaOH for 30 mins. in water-bath	59.78
Digested with 100 c.c. of 1% NaOH for 60 mins. in water-bath	58.25

The effect of the preliminary digestion with alkali in reducing the time of chlorination required to remove the lignin is considerable in the case of hard woods, but is less evident in the case of conifer woods. Digestion with alkali followed by acid, however, lowers the yield of cellulose from conifer wood (e.g., from 62.90 to 55.12%). The addition of alkali to the sodium sulphite solution in the removal of the lignin also reduces the yield of cellulose (e.g., by 5.69% after four treatments). The substitution of 2% sodium bisulphite solution for 2% sodium sulphite solution caused a pronounced reduction in the rate of removal of lignin from spruce wood, and the cellulose was pale yellow instead of dark greyish yellow. To render the method efficient it is essential that the liquid should be slightly alkaline. The amount of lignin removed is almost directly proportional to the rate at which the chlorine is introduced. For example, in the case of yellow birch wood the loss in weight was 15.31% when the chlorine bubbles were 44 to 45 per min., and 26.11% when they were 120 to 122 per min. It is advantageous to use a rapid stream of chlorine during

	Ash.	Soluble in cold water.	Soluble in hot water.	Soluble in ether.	Soluble in 1% NaOH.	Acetic acid by hydrolysis with 2.5% sulphuric acid.	Methoxy groups.	Pentosan.	Methylpentosan.	Cellulose.	Volatile oil.
	%	%	%	%	%	%	%	%	%	%	%
Longleaf pine (<i>Pinus palustris</i>)	0.37	6.20	7.15	6.32	22.36	0.76	5.05	7.46	3.60	58.48	1.30
Douglas fir (<i>Pseudotsuga taxifolia</i>)	0.38	3.54	6.50	1.02	16.11	1.04	4.95	6.02	4.41	61.47	—
Western larch (<i>Larix occidentalis</i>)	0.23	10.61	12.59	0.81	22.14	0.71	5.03	10.80	2.81	57.80	—
White spruce (<i>Picea canadensis</i>)	0.31	1.12	2.14	1.36	11.57	1.59	5.30	10.39	3.55	61.85	—
Basswood (<i>Tilia americana</i>)	0.86	2.12	4.07	1.96	23.76	5.79	6.00	19.93	3.73	61.24	—
Yellow birch (<i>Betula lutea</i>)	0.52	2.67	3.97	0.60	19.85	4.30	6.07	24.63	2.69	61.31	—
Sugar maple (<i>Acer saccharum</i>)	0.44	2.65	4.36	0.25	17.64	4.46	7.25	21.71	2.39	60.78	—

the first chlorination, but in subsequent chlorinations the rate should not exceed about 10 bubbles per min. The accuracy of the method depends upon the observance of exact details of procedure, and results obtained by different chemists using the same method may be regarded as satisfactory if they agree within 1%. The cellulose calculated upon the weight of wood free from substances soluble in ether and hot water is fairly uniform for different species. For example on this basis the amounts of cellulose in the conifer woods ranged from 63.79 to 67.20%, and in the hard woods from 63.43 to 64.97%. Exceptionally results considerably higher or lower than these figures are obtained. The strength of the sulphuric acid used in the acid hydrolysis has considerable influence on the yield of volatile acids. For example, yellow birch wood hydrolysed with 2.5% sulphuric acid yielded 3.99% of volatile acid, as compared with 4.53% when hydrolysed with 10% acid. Small amounts of free or loosely combined formic and acetic acids are present in certain woods, such as *guiso*, a Philippine wood, which has a corrosive action on metal, due to the presence of about 0.2% of acetic acid. The yields of methyl alcohol obtained by destructive distillation are much lower than would be expected from the methoxy values, as is shown by the following results:—

	Birch.	Maple.	Western Birch.
Methyl alcohol %	1.53	1.94	0.65
Methoxy group %	6.07	7.25	4.95

—C. A. M.

Sulphite-cellulose manufacture: Constitution and stability of the various lyes used in — and their specific action in the digestion process. I. T. Marusawa. Kogyo-Kwagaku-Zasshi (J. Chem. Ind., Tokyo), 1917, 20, 253—301.

The first stage of the ionisation of sulphurous acid ($\text{H}_2\text{SO}_3 \rightleftharpoons \text{H}^+ + \text{HSO}_3^-$) proceeds approximately in accordance with Ostwald's dilution law provided the concentration is not less than 0.05 gm.-mol. per litre, but the greater the dilution the more the acid behaves as a strong electrolyte. For concentrations between 0.01 and 0.8 gm.-mol. per litre, the ionisation constant, $K_1 = \frac{[\text{H}^+][\text{HSO}_3^-]}{[\text{H}_2\text{SO}_3]}$, is 1.62×10^{-2} — 1.96×10^{-2} at 18° C. At equal concentrations the degree of ionisation of sodium, potassium, and ammonium bisulphites is about the same. The ionisation constant of the second stage of the ionisation of sulphurous acid, $K_2 = \frac{[\text{H}^+][\text{SO}_3^{2-}]}{[\text{HSO}_3^-]}$, was estimated as 3.42×10^{-6} at 18° C. from measurements of the conductivity of potassium bisulphite solutions of concentrations between 0.0025 and 0.005 gm.-mol. per litre, and as 3.18×10^{-6} from colorimetric determination of the hydrogen ion concentration of potassium bisulphite solutions. For concentrations between 0.01 and 1 gm.-equivalent per litre, the equivalent conductivity of magnesium bisulphite at infinite dilution was found to be 88.2 at 18° C., and the degree of ionisation corresponds with the square of the value for potassium bisulphite for concentrations not exceeding 0.03. The solubility of normal magnesium sulphite is 5.01×10^{-2} gm.-mol. per litre at 18° C., and that of calcium sulphite 7.91×10^{-4} gm.-mol. per litre; the latter value differs considerably from the value hitherto accepted. Investigation of the equilibria in the systems, $\text{MgSO}_3 \cdot 6\text{H}_2\text{O} + \text{H}_2\text{SO}_3$ aq. and $\text{CaSO}_3 \cdot 2\text{H}_2\text{O} + \text{H}_2\text{SO}_3$ aq., showed: (1) that for concentrations between 0.02 and 0.5 gm.-mol. Ca per litre, it is impossible to prepare a solution,

saturated with $\text{CaSO}_3 \cdot 2\text{H}_2\text{O}$, of composition corresponding to either $x\text{CaSO}_3 + y\text{Ca}(\text{HSO}_3)_2$ or $x\text{Ca}(\text{HSO}_3)_2$; and (2) that the view that sulphite-cellulose digestion liquors have the composition $x\text{MSO}_3 + y\text{H}_2\text{SO}_3$, is incorrect.

Oxycellulose: Determination of —. G. Kita. Kogyo-Kwagaku-Zasshi (J. Chem. Ind., Tokyo), 1917, 20, 138—141.

The method of estimating oxycellulose suggested by Nishida, consisting in treatment with a known quantity of Methylene Blue solution and then titrating the excess of dyestuff, not fixed by the oxycellulose, with titanium chloride, is not trustworthy, because the quantity of dyestuff fixed is influenced by the degree of subdivision of the substance under examination and by other factors, and there is no proportionality between the quantity of oxycellulose and that of Methylene Blue absorbed. Though it may be conveniently used in certain special cases, this method is not applicable in the same way as Schwalbe's copper value for the determination of the damage caused by various treatments of cellulose.

Printed paper: Microscopical examination of —. M. Yano. Kogyo-Kwagaku-Zasshi (J. Chem. Ind., Tokyo), 1917, 20, 219—233.

VARIOUS kinds of paper were printed with an ink prepared by grinding lampblack with "medium" varnish coloured intensely scarlet with Naphthylamine Bordeaux, and the penetration of the coloured varnish was traced by microscopical examination of thin sections of the paper. The penetration varies with the fineness of the paper fibres; in wood pulp papers the varnish easily penetrates to the back side of the paper. If the printed paper is dried at too high a temperature the varnish penetrates quickly and the pigment separates on the surface and is easily rubbed off the drying temperature should not exceed 50° C. Drying may be carried out above 50° C., however if manganese borate be added to the printing ink. Rosin size, though effective in preventing penetration of writing ink in writing papers, does not prevent the penetration of printing ink varnish; indeed the varnish penetrates a paper containing 20% of rosin size more readily than it does unsized paper. Gelatin sizing prevents the penetration of the varnish and renders the paper unsuitable for printing. An excessive quantity of loading material must be avoided, otherwise the pores of the paper are filled and the penetration of the varnish prevented.

Practical method of determining the viscosity of starch for mill purposes. McNider. See XVII

Cheap production of alcohol. Breckler. See XVIII

PATENTS.

Fibrous materials: Separating impurities from waste —. Naamlooze Vennootschap Nec Cellulose Maatschappij, Rotterdam. Eng. Pat. 105,055, May 2, 1916. (Appl. No. 6270 of 1916 Under Int. Conv., Mar. 23, 1916. Addition to Eng. Pat. 21,057 of 1912 (this J., 1913, 1104).)

In cleansing waste fibrous materials by means of emulsifying and separating machines in conjunction with two immiscible liquids, e.g., a liquid hydrocarbon and water, a stable foam is produced on the surface of the heavier or of the lighter liquid in such a manner that the impurities are collected in the foam and thus separated from the fibrous material. For producing a stable foam, the lighter liquid may be replaced by a combination of a solid or semi-solid fatty material, such as vaseline or animal or vegetable fats, and substance, such as soap, which is capable of producing foam. The soap may be utilised as detergent in the preliminary treatment of the

material and as a foam producer in the later treatment; the quantity of soap may amount to 0.01 % of the weight of the fibrous material, and the quantity of fatty substance employed as a foam-tabiliser may amount to 0.02 %.—J. F. B.

Textile fabrics and other materials; Apparatus for impregnating or treating—. J. D. Taylor, London, and F. Shaw and Co., Ltd., Manchester. Eng. Pat. 106,805, Mar. 6, 1917. (Appl. No. 3326 of 1917.)

THE apparatus consists of a closed interconnected system of an impregnating chamber, a drying chamber, a condenser, and a vacuum pump. The impregnating chamber contains two spindles, an impregnating box connected with a supply of the solution, a scraper, and guide rolls. The horizontal drying chamber contains steam-chests or plates and guide rolls for leading the fabric in proximity to the heating surface. The roll of fabric is placed on the upper spindle in the impregnating chamber and the chamber closed; the fabric is led by tapes through the drying chamber and back again and subjected to heat and vacuum; it arrives again in the impregnating chamber dry and exhausted of air. Solution is admitted to the box and the fabric passes through the solution and is wound up on the lower spindle. The direction of the machine is reversed, the fabric is re-impregnated with solution, scraped, passed through the drying chamber, and re-wound on the upper spindle, while the volatile solvent is recovered in the condenser.—J. F. B.

Solvents; Apparatus for recovering—[from coated fabrics]. J. Lynah, Newburgh, N.Y., Assignor to E. I. du Pont de Nemours Powder Co., Wilmington, Del. U.S. Pat. 1,228,225, May 29, 1917. Date of appl., Oct. 16, 1912.

THE apparatus comprises a feeding chamber for a coating material, an evaporating chamber, means for supporting a coated web therein, a vapour-tight cover loosely supported over the feeding and evaporating chambers, with a liquid seal and an air pipe connected to the cover.—J. F. B.

Rubber; Process of impregnating fabrics with—. I. S. McGiehan, New York. U.S. Pat. 1,228,458, June 5, 1917. Date of appl., Dec. 17, 1915.

THE fabric is passed through a rubber solution so that it becomes thoroughly impregnated; it is then heated, and a coating of rubber is applied to the surface of the fabric; the coating is levelled by flexible scraping devices, and the fabric is finally passed between rollers having yielding surfaces so as to secure density and homogeneity.—J. F. B.

Fibrous materials; Machines and method for waterproofing—. A. O. Tate, Montreal, Canada, Assignor to Tate Electrolytic Waterproofing Co., Inc., New York. U.S. Pats. (A) 1,228,986, (B) 1,228,987, and (C) 1,228,988, June 5, 1917. Dates of appl., (A) Mar. 19, 1915, (B) and (C) Oct. 27, 1916.

(A) THE machine comprises pairs of electrodes of relatively large contacting surface area, connected with means for spraying or moistening the material with one or more electrolytic agents as it passes between the electrodes, together with source of electrical energy and connections for varying the direction of current flow through the successive pairs of electrodes. (B) The material impregnated with a solution of sodium palmitate and moistened with aluminium acetate to precipitate aluminium hydroxide and palmitate; is simultaneously subjected to the action of an electric current between aluminium electrodes to produce an excess of aluminium hydroxide and to drive the same into the fibres of the fabric.

(C) The machine comprises means for impregnating the fabric with a saponaceous solution and for pressing the solution into the interstices of the material. Spraying devices are provided to wet the material with a second reagent, in conjunction with means for conveying the fabric between a pair of roller electrodes, one of which is covered with an absorbent pad, the sprays being so directed that a precipitate is formed by the interaction of the two reagents simultaneously with the action of the electric current upon the material.

—J. F. B.

Broom; Manufacture of a textile fibre from—. E. K. Zeise-Gött, Freiburg, and R. Sütterlin, Mannheim-Neckarau. Ger. Pat. 297,138, Jan. 13, 1916.

BROOM is steamed and crushed as hot as possible, then boiled with sodium carbonate, hydro-extracted, dried, and passed through a breaking machine to eliminate the wood.—J. F. B.

Osier bark; Manufacture of yarns, particularly fine yarns, from—. T. Schiefner, Dresden. Ger. Pat. 297,569, Mar. 22, 1916.

THE bark is subjected to the usual boiling process and then to a washing process with a jolting or swirling motion. This motion agitates the material to and fro in the direction of the length of the fibres and facilitates complete separation of the spinning fibres from the bast tissues and epidermis.—J. F. B.

Plastic compositions; Process of making—. Process of making acetylcellulose plastic compounds. W. G. Lindsay, Caldwell, N.J., Assignor to The Celluloid Co., New York. U.S. Pats. (A) 1,229,485 and (B) 1,229,486, June 12, 1917. Date of appl., July 10, 1915.

(A) A PLASTIC material is made by gelatinising acetylcellulose (100 parts) with chloroform (100 parts) containing 10–20 parts of methyl or ethyl alcohol, adding an alkylated aromatic sulphonamide which is a solvent for acetylcellulose in the presence of chloroform and alcohol, allowing the excess of volatile solvent to evaporate, and manipulating the product. (B) A plastic material is made by gelatinising acetylcellulose with trichloroethylene and methyl alcohol in about equal proportions, adding a solid substance which is a solvent for acetylcellulose in the presence of trichloroethylene and methyl alcohol, allowing the excess of volatile solvent to evaporate, and manipulating the product.—F. Sp.

Acetyl cellulose; Solvent for—. W. G. Lindsay, Caldwell, N.J., Assignor to The Celluloid Co., New York. U.S. Pat. 1,229,487, June 12, 1917. Date of appl., June 6, 1916.

A MIXTURE of an arylacetamide (e.g., tetrachloroethylacetanilide), chloroform, and methyl or ethyl alcohol, is a solvent for acetylcellulose.—F. Sp.

Cellulose for fine, particularly photographic, papers; Process of treatment of—. O. Röhm, Darmstadt. Ger. Pat. 297,324, Nov. 14, 1915.

CELLULOSE previously boiled with water, with or without the addition of alkali, is treated with pancreatic or similar enzymes, with or without the addition of sodium carbonate or other alkaline salts. Wood cellulose contains up to 15% of impurities which are removed by this treatment and the cellulose is thereby rendered more suitable for use in photographic papers.—J. F. B.

Paper; Method of incorporating filling material in—. G. W. Miles, Belmont, Mass., Assignor to Ross Chemical Co., Boston, Mass. U.S. Pat. 1,228,580, June 5, 1917. Date of appl., Mar. 11, 1915.

THE fibre in the beater is mixed with an emulsion

of a waxy material, e.g., paraffin wax, containing a proportion of filler in excess of that which could be incorporated with the fibre in the absence of the emulsion.—J. F. B.

Paper; Manufacture of an opaque, non-stretching, water- and gas-proof—. G. H. C. Sachsenröder, Barmen-Unterbarmen. Ger. Pat. 297,515. June 29, 1915.

ABSORBENT paper is treated with cold sulphuric acid at a density of about 52 B. (sp. gr. F52), then washed, and dried. Several layers of such paper are pressed together between rolls after the webs have passed through the bath, and the product is used as a packing material for joints.—J. F. B.

Sulphite-cellulose waste liquor; Process for utilising—. M. Müller, Finkenwalde. Ger. Pat. 297,374. July 2, 1916.

SODIUM bisulphate is roasted in a furnace under reducing conditions with waste liquor from the digestion of sulphite pulp. The free sulphuric acid of the bisulphate is reduced to sulphurous acid which may be employed for the preparation of fresh sulphite liquor.—J. F. B.

Sulphite- and sulphate-cellulose waste liquors; Process for the evaporation of—. E. Mürbe, Grlitz. Ger. Pat. 297,440, Oct. 11, 1914. Addition to Ger. Pat. 293,394 (this J., 1916, 1106).

THE waste liquors are sprayed in contact with furnace gases with simultaneous admission of air, the temperature of the mixing chamber and of the saturated flue-gases being maintained above the boiling point of water, preferably at 110°–120° C. A fan is arranged for the introduction of air into the lower portion of the mixing chamber and a drying arrangement is provided beneath the mixing chamber to receive the aqueous lignin liquor discharged from the bottom of the mixing chamber.—J. F. B.

Artificial silk and other threads; Apparatus for treating—. M. Linfoot, Braintree, Assignor to Courtaulds, Ltd., London. U.S. Pat. 1,229,101, June 5, 1917. Date of appl., Aug. 10, 1915.

SEE Eng. Pat. 18,556 of 1914; this J., 1915, 957.

Artificial silk; Process for producing—. K. Kishi, Tokyo. U.S. Pat. 1,231,172, June 26, 1917. Date of appl., June 24, 1914.

SEE Fr. Pat. 473,986 of 1914; this J., 1915, 711.

Wood-pulp boiler. E. Morterud, Jeloén, Norway. U.S. Pat. 1,228,950, June 5, 1917. Date of appl., Aug. 6, 1914.

SEE Ger. Pat. 273,860 of 1913; this J., 1914, 746.

Paper and the like; Manufacture of—. C. W. Fish, Rawcliffe, Assignor to The Amber Size and Chemical Co., Ltd., London. U.S. Pat. 1,229,924, June 12, 1917. Date of appl., Dec. 28, 1916.

SEE Eng. Pat. 16,742 of 1915; this J., 1917, 132.

Manufacture of artificial graphite [from waste lyes from cellulose manufacture]. Ger. Pat. 297,075. See VII.

Manufacture of heat-resistant goods from rubber and rubber substitutes [from paper yarn]. Ger. Pat. 297,328. See XIV.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Determination of free chlorine in solutions of hypochlorites. Dienert and Wandenbulke. See VII.

PATENTS.

Textile materials; Treating—with dye and other liquors. W. C. Singleton, Manchester. Eng. Pat. 106,897, July 26, 1916. (Appl. No. 10,515 of 1916.)

AN apparatus for dyeing or treating cotton, wool, or other fibrous material, is provided with an inner cage fitted with a false bottom of grids or perforated plates hinged or pivoted at the ends or sides to open to allow the material to be easily discharged. The outer tank is provided with guides for the cage, and hinged, pivoted, or removable baffle-plates direct the liquor between the walls of the tank and the inner cage.—F. W. A.

Dyeing-machine. H. Higgs, Assignor to Klauder-Weldon Dyeing Machine Co., Amsterdam, N.Y. U.S. Pat. 1,229,612, June 12, 1917. Date of appl., Mar. 9, 1914.

A ROTARY cage consisting of a number of compartments to contain the material to be dyed, which are bounded by peripheral walls and longitudinal concavo-convex perforated walls, is placed in a vat so that the perforated walls are continuously submerged during its rotation.—F. W. A.

Dyeing, washing, and the like; Machine for—. J. H. Milnes, Huddersfield. U.S. Pat. 1,230,198, June 19, 1917. Date of appl., Dec. 7, 1916.

SEE Eng. Pat. 16,199 of 1915; this J., 1916, 1216.

Textile and other materials; Process for producing colours on—. J. Chester, Saltaire. U.S. Pat. 1,231,492, June 26, 1917. Date of appl., Nov. 24, 1915.

SEE Eng. Pat. 23,214 of 1914; this J., 1915, 1040.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Hypochlorites; Determination of free chlorine in solutions of—. F. Dienert and P. Wandenbulke. Comptes rend., 1917, 165, 28–29.

INCREASING quantities of ammonium sulphate were added to a series of solutions in which the iodine liberated from potassium iodide by hypochlorite was titrated by N/35.5 arsenious acid. It was found that by taking at least 150 parts of ammonium sulphate to one part of available chlorine present, the formation of iodate is prevented and the chlorine can be estimated in alkaline solution by arsenious acid. It is necessary to use dilute solutions of hypochlorite, as in concentrated solutions ammonia is partly decomposed, giving nitrogen and hydrochloric acid with consequent loss of free chlorine. The influence of the ammonium sulphate in the reaction is due to the formation of chloramine, and the sulphate can be replaced by chloride.—J. N. P.

Iodine; Action of—on alkalis. J. Bougault. Comptes rend., 1917, 164, 949–951.

WHEN iodine is added to caustic soda, the oxidising potential, as expressed in hypoiodite, falls off very rapidly, and in a few minutes almost the whole of the iodine is in the state of iodate. Similar reactions take place, though more slowly, with iodine and sodium carbonate, but with sodium bicarbonate neither the formation of iodate nor of hypoiodite is observed. On adding, however, sodium thiosulphate to the mixture, the amount required to decolorise the liquid, and the production of sodium bisulphate, appear to indicate the formation under these conditions of sodium bicarbonate. These mixtures of iodine with caustic soda, sodium carbonate, and bicarbonate, are recommended as oxidising media of variable intensity.—B. N.

Calcium oxide or hydroxide in the presence of some aluminates or silicates; Titration of —. W. E. Emley. Trans. Amer. Ceram. Soc., 1915, 17, 720—726.

By means of the following method, calcium oxide or hydroxide may readily be determined in the presence of mono- or di-calcium silicates, mono- or 5:3-calcium aluminates, calcium carbonate, calcium sulphate, and (with a little more skill in recognising the end-point) tricalcium silicate and magnesia. With tricalcium aluminate special precautions must be taken to ensure the absence of water, e.g., by re-distilling the alcohol over quicklime immediately before using. The finely powdered sample, in amount sufficient to give 0.1 gm. free lime, is added to 2 c.c. of glycerin and 10 c.c. of alcohol, then 5 drops of phenolphthalein is added, and the mixture is heated to boiling and kept nearly boiling whilst titrating with N/5 alcoholic ammonium acetate. The end-point is reached when the pink colour is discharged and does not return after boiling for one minute. The ammonium acetate may be standardised against pure calcium oxide. The method appears to be satisfactory with white lime-sand bricks, but not with coloured ones or with Portland cement, as the colour of the material obscures the end-point of the reaction.—A. B. S.

Potassium metasilicate-silica-water; The ternary system —. G. W. Morey and C. N. Fenner. J. Amer. Chem. Soc., 1917, 39, 1173—1228.

The equilibrium relations of this system have been studied over the range 200°—1000° C., with a view to investigating the conditions under which crystallisation of rock magmas may have occurred, here volatile as well as non-volatile components are probably been present. The method generally employed was to measure at various constant temperatures the change in the water content with the variation of the $\text{SiO}_2/\text{K}_2\text{O}$ ratio in the saturated solution. The mixture taken was heated in a suitably designed bomb (J. Amer. Chem. Soc., 1914, 36, 215) until equilibrium might be supposed to be attained, and then by rapidly cooling the bomb the equilibrium product was "frozen." The product, when suitably cooled, is in the same condition as regards crystalline or glassy character and chemical composition as when hot, and enables conclusions to be drawn as to the equilibrium conditions obtaining at the high temperature. The examination was both chemical and microscopical. The following compounds were identified in the melts: $\text{K}_2\text{O} \cdot 4\text{SiO}_2 \cdot \text{H}_2\text{O}$, $\text{K}_2\text{O} \cdot 2\text{SiO}_2 \cdot 0.2\text{SiO}_2 \cdot \text{H}_2\text{O}$, $\text{K}_2\text{O} \cdot \text{SiO}_2$, $\text{K}_2\text{O} \cdot \text{SiO}_2 \cdot 0.5\text{H}_2\text{O}$, $\text{O} \cdot \text{SiO}_2 \cdot \text{H}_2\text{O}$, and SiO_2 . The space model of the relationships between the various phases equilibrium was constructed.—H. J. H.

amide; Preparation of — from calcium cyanamide. I. Kitawaki and K. Kusano. Kogyo-Kwagaku-Zasshi (J. Chem. Ind., Tokyo), 1917, 20, 234—252.

The authors have found that for the preparation of cyanide from crude calcium cyanamide, the best yields are obtained under the following conditions. A mixture of 10 parts of crude calcium cyanamide (53.3% CaCN_2), 16—24 parts of calcium chloride (or 7—10 parts of anhydrous calcium carbonate), and 2 parts of charcoal is heated at 900°—950° C. (950°—1000° C. if sodium carbonate is used) for 10 mins., and the fused product is allowed to cool without coming in contact with air. In the authors' experiments the charge was heated in iron crucibles (14 grms. and 4—450 grms. capacity respectively) in an electric resistance furnace, and yields of more than 70% of the theoretical quantity of cyanide were obtained.

Ferric ferrieyanides; Colloidal —. R. Haller. Kolloid Zeits., 1917, 20, 76—81. J. Chem. Soc., 1917, 112, i., 324—325.

By the interaction of aqueous solutions of ferric chloride and potassium ferrieyanide, colloidal ferric ferrieyanide is formed. The freshly formed colloid is highly dispersed, but ultra-microscopic observations show that the particles undergo a gradual process of aggregation, and this leads ultimately to the separation of Prussian green. By the action of sodium hydrosulphite on the brown colloidal solution, a mixture of colloidal Prussian blue and Turnbull's blue is obtained. Further reduction yields colloidal Prussian white. The actual result of the action of potassium ferrieyanide on ferric chloride varies with the concentration of the aqueous solutions. If alcoholic solutions of ferric chloride and potassium ferrieyanide are mixed together, ferric ferrieyanide is obtained in the form of an unstable, gelatinous precipitate.

Bismuth acetate. E. Salkowski. Biochem.-Zeits., 1917, 79, 96—104. J. Chem. Soc., 1917, 112, i., 316.

The acetate was formed by dissolving the finely divided metal in a mixture of acetic acid and hydrogen peroxide, or by dissolving the hydroxide in acetic acid. A crystalline product, $\text{Bi}(\text{C}_2\text{H}_3\text{O}_2)_3$, was obtained, which is unstable and loses acetic acid on keeping in air, and more rapidly in a vacuum. If heated at 125° C., it loses acetic anhydride rapidly and yields bismuthyl acetate: $\text{Bi}(\text{C}_2\text{H}_3\text{O}_2)_3 = \text{BiOC}_2\text{H}_3\text{O}_2 + \text{C}_2\text{H}_6\text{O}_2$. The bismuthyl salt, unlike the salt $\text{Bi}(\text{C}_2\text{H}_3\text{O}_2)_3$, is insoluble in water.

Zirconyl sulphates. E. Chauvenet. Comptes rend., 1917, 164, 946—949.

SULPHATES described previously (this J., 1917, 711) are regarded as derivatives of the radical zirconyl, and the following formulæ are given to them: $\text{ZrOSO}_4 \cdot \text{SO}_3$; ZrOSO_4 ; $3\text{ZrOSO}_4 \cdot \text{ZrO}_2$; $2\text{ZrOSO}_4 \cdot \text{ZrO}_2$; $\text{ZrOSO}_4 \cdot \text{ZrO}_2$; and $5\text{ZrOSO}_4 \cdot \text{ZrO}_2$. The first compound is the acid sulphate, and may be prepared in the dehydrated state or combined with 1 or 4 mols. of water; the second, or neutral sulphate, may be obtained anhydrous, or with 1, 2, or 4 mols. of water; the remainder, or basic sulphates, may be obtained anhydrous or combined with water, the last compound combining with 12 mols., whilst the others combine with 8 mols. of water.—B. N.

Zirconyl; Acid sulphate of —. E. Chauvenet. Comptes rend., 1917, 165, 25—28.

In aqueous solution, zirconyl acid sulphate (see preceding abstract) appears to have the constitution $\left[\text{Zr} \begin{smallmatrix} \text{O} \\ \text{SO}_4 \end{smallmatrix} \right] \text{SO}_4$ and to hydrolyse according to the equation: $4(\text{ZrOSO}_4 \cdot \text{SO}_3) + \text{aq} = 5\text{H}_2\text{SO}_4 + 3\text{ZrOSO}_4 \cdot \text{ZrO}_2$. The curve showing the change of electrical resistance during gradual neutralisation of zirconyl acid sulphate by sodium hydroxide gives bends at the stages corresponding to the formation of zirconyl sulphate, ZrOSO_4 , and again with the formation of the basic sulphate, $\text{ZrOSO}_4 \cdot \text{ZrO}_2$, which is the most stable of these compounds and was found to be slowly formed at 30° C. by the reaction of the basic trisulphate with water. The zirconyl radical has a marked tendency to give compounds of the type $\text{ZrOA} \cdot \text{ZrO}_2$, where A is an acid radical such as Cl , Br , or SO_4 .—J. N. P.

Constitution and stability of the various lyes used in sulphite-cellulose manufacture, and their specific action in the digestion process. Marusawa. See V.

Microscopic investigations of some compounds noted in the systems soda-zinc oxide-silica, and soda-zinc oxide-titanic oxide-silica. Klein and Brown. See VIII.

Reaction of sulphur chloride with metals. Catalytic action of ether. Domanicki. See X.

Phenomena of electrolytic migration. Electrolysis of mixed solutions of alkali salts. Van Laer. See XI.

Action of solutions of ammonium sulphate on muscovite. Gardiner and Shorey. See XVI.

Compounds of calcium chloride and acetone. Bagster. See XX.

Use of molybdates, tungstates, and vanadates of cobalt-ammonium compounds in determination of cobalt. Carnot. See XXIII.

PATENTS.

Sulphuric acid in lead chambers; Production of —. T. C. Oliver, Charlotte, N.C. U.S. Pat. 1,229,316, June 12, 1917. Date of appl., Feb. 7, 1917.

A LEADEN chamber is surrounded and covered by a housing which forms separate air passages extending upwards along the outer surface of the walls of the chamber, and means are provided for allowing a natural or forced draught of air to flow along the air passages.—F. Sp.

Hydrochloric acid; Manufacture of —. A. H. Peter, Assignor to Royal Baking Powder Co., New York. U.S. Pat. 1,229,509, June 12, 1917. Date of appl., Apr. 12, 1912.

HYDROCHLORIC acid is produced by adding to chlorine sufficient water vapour to form a mixture showing practically no green colour against a white background (approximately 3 parts of chlorine to 7 parts of water vapour), and leading the mixture over carbon at a temperature between 100° C. and red heat.—F. Sp.

Drenching a material with a liquid and thereafter draining it therefrom; Process for periodically —. [Preparation of basic lead acetate.] A. T. Eyton, Nelson, B.C. Eng. Pat. 107,115, Sept. 2, 1916. (Appl. No. 12,461 of 1916.)

SEE U.S. Pat. 1,206,685 of 1916; this J., 1917, 75. The process may be applied to the production of basic lead acetate, metallic lead being periodically drenched with a solution of acetic acid and exposed to the air between successive drenchings.

Potassium salts; Process for recovering — from organic carbonaceous materials. F. C. Grimes, Idaho Falls, Idaho. U.S. Pat. 1,227,781, May 29, 1917. Date of appl., Aug. 19, 1916.

ORGANIC carbonaceous material is burnt in an open-top chamber under forced draught, and sulphur, or other material which liberates oxides of sulphur, is added. Potassium chloride in the organic material is thus converted into sulphate.—W. F. F.

Effervescent compound. M. D. Sohn, New York. U.S. Pat. 1,228,252, May 29, 1917. Date of appl., Sept. 9, 1915.

AN effervescing mixture containing sodium pyrosulphate.—W. F. F.

Bodies of extended discontinuously associated solid particles of [magnesium or] calcium carbonate; Method of producing — and the product thereof. W. R. Seigle, Assignor to H. W. Johns-Manville Co., New York. U.S. Pats. (A) 1,228,485 and (B) 1,228,486, June 5, 1917. Dates of appl., June 1, 1915, and June 28, 1916.

(A) A MIXTURE of powdered magnesium carbonate,

asbestos fibre, and cellulose fibre is mixed with a liquid containing an insoluble soap. The liquid is then removed, and the residual solid dried. (B) The magnesium carbonate in (A) is replaced by calcium carbonate, and in a modification, sulphite pulp fibre is substituted for asbestos and cellulose fibre.—W. F. F.

Lead arsenate; Method of making —. E. O. Barstow and J. A. Cavanagh, Assignors to Dow Chemical Co., Midland, Mich. U.S. Pat. 1,228,516, June 5, 1917. Date of appl., Aug. 2, 1916.

LEAD arsenate is produced by reaction between arsenic acid and sublimed lead monoxide in presence of water.—W. F. F.

Aluminium skimmings, screenings, slags, or analogous materials; Method of processing —. [Production of aluminium nitride.] P. R. Hershman, Milwaukee, Wis., Assignor to W. F. Jobbins, Inc., Aurora, Ill. U.S. Pat. 1,229,611, June 12, 1917. Date of appl., Nov. 14, 1912.

ALUMINIUM skimmings, etc., mixed with a reducing agent, such as a liquid hydrocarbon, are heated without access of nitrogen to a temperature (about 1200° C.) at which spontaneous heating would occur with formation of aluminium nitride on exposure to air, and the mixture is then exposed to air.—F. W. A.

Calcium cyanamide; Apparatus for manufacture of —. N. C. Tommasi, Assignor to Elektrizitätswerk Lonza, Basle, Switzerland. U.S. Pat. 1,230,343, June 19, 1917. Date of appl., Jan. 5, 1917. (See Fr. Pat. 476,294 of 1914; this J., 1916, 16.)

A ROTARY furnace is provided with a feeding device for calcium carbide, a discharging device for calcium cyanamide, and means for circulating nitrogen through external heating or cooling devices in order to regulate the temperature.—F. Sp.

Per-salts [perphosphates and perarsenates]; Production of —. S. Aschkenasi, Berlin. Ger. Pat. 296,796, July 26, 1914.

ALKALINE-EARTH peroxides can be dissolved in excess of concentrated phosphoric or arsenic acid forming hydrogen peroxide and the corresponding primary per-salt. The hydrogen peroxide does not decompose, and by evaporation under reduced pressure, with minimum elevation of temperature the primary perphosphate or perarsenate can be obtained. The corresponding alkali salts can be obtained by decomposing the alkaline-earth salt before evaporation with an alkali sulphate.—W. H. P.

Per-salts; Production of anhydrous — or mixtures of per-salts. S. Aschkenasi, Berlin. Ger. Pat. 296,888, Sept. 21, 1915. (See preceding abstract.)

PER-SALTS prepared *in vacuo* can be subsequently dried in air at 100° C., without evolution of oxygen. They soften and again dry giving off an appreciable quantity of water vapour. Drying in this way improves the stability of the per-salts.—W. H. P.

Chlorine and other gases; Compressing —. Società Italiana di Elettrochimica, and L. L. Bianchini Rome. Eng. Pat. 106,722, Aug. 7, 1916. (Appl. No. 11,122 of 1916.)

IS a compressing system for chlorine and the like using sulphuric acid for compressing the gas, strong sulphuric acid from a supply tank passes through a cooling coil to a rotary compressor (in which the gas is also supplied. Additional compressors in series may be used, with a cooling coil between each pair. The compressed gas passes

to a centrifugal diaphragm separator, and the acid passes to one of a pair of similar closed vessels. When full, the acid is diverted to the other vessel, and that in the first vessel is forced back to the supply tank by compressed air. Acid recovered from the centrifugal separator is also returned to the collecting vessels.—W. F. F.

Graphite; Manufacture of artificial — [from waste lyes from cellulose manufacture]. H. Messow, Berlin. Ger. Pat. 297,075, Aug. 8, 1915.

WASTE lyes from the manufacture of cellulose are mixed with oxides of heavy metals, e.g., ferric oxide, and with calcium phosphate, and the mixture is exposed to a high temperature and a very high pressure. The graphite so produced is converted into flake graphite by means of hot rolls.

Hydrogen; Manufacture of —. Badische Anilin und Soda Fabr. Ger. Pat. 297,258, Sept. 11, 1914. Addition to Ger. Pat. 292,615.

CONTACT masses prepared by saturating pumice with a solution of nickel or cobalt chloride and subsequently igniting (see Fr. Pat. 463,114 of 1913; this J., 1914, 313), have not proved satisfactory in the production of hydrogen from carbon monoxide and steam. Good yields of hydrogen are obtained, however, by using contact masses prepared by impregnating suitable materials with relatively small quantities of solutions of nickel salts free from halogens and sulphur.

Sodium chloride; Process for separating — from liquors containing it and sodium nitrate in solution. I. B. Hobsbaum, London, and J. L. Grigioni, Richmond. U.S. Pat. 1,230,162, June 19, 1917. Date of appl., May 20, 1915.

SEE Eng. Pat. 12,474 of 1914; this J., 1915, 715.

Sodium nitrate; Process of recovering — from liquors containing it and sodium chloride in solution. I. B. Hobsbaum, London, and J. L. Grigioni, Richmond. U.S. Pat. 1,230,163, June 19, 1917. Date of appl., May 20, 1915.

SEE Eng. Pat. 12,475 of 1914; this J., 1915, 799.

Evaporator. U.S. Pat. 1,228,855. See I.

Combined tar dehydration and ammonia distillation plant. Eng. Pat. 106,642. See III.

Gas generator. [Electrolysis of water.] U.S. Pat. 1,230,803. See XI.

VIII.—GLASS; CERAMICS.

Scientific glass-ware; Action of chemical and physical agents on some types of —. J. D. Cauwood, S. English, and W. E. S. Turner. Soc. Glass Technol., July 25, 1917.

THE method employed in the research was to subject Jena glass, five new British resistance glasses, and a few chemical glasses made in allied and neutral countries to the following series of tests:—Action of steam. Action of boiling water. Action of water under a pressure of 10 kilos. per sq. cm. Action of water at 20° C. and at 80° C. Action of N/10 and 2N sodium hydroxide, 2N sodium carbonate solution, 5% ammonium chloride solution, and 2N ammonia solution at 100° C. Action of hydrochloric acid fumes, boiling hydrochloric acid solution, and 2N sulphuric acid at 100° C. Cracking test. In addition each glass was analysed. From the results it was apparent that in every test applied the British glasses compared most favourably with Jena glass, in some of the tests even surpassing it.

Salt-cake and soda-ash in the glass industry. L. Springer. Keram. Rundsch., 1916, 24, 25, 159. J. Soc. Glass Technol., 1917, 1, Abstracts, 4—5.

IN discussing the substitution of other materials, chiefly salt-cake, for soda-ash in glass making, it is pointed out that salt-cake made in lead-lined pans contains only 0.01—0.03% of iron oxide, whereas that made in iron pans contains 0.07—0.13%. Salt-cake made by the Hargreaves process (treating common salt with sulphur dioxide, air, and steam in iron cylinders) is practically free from iron. For glass making salt-cake should not contain more than 0.02% of iron oxide, 1% of free sulphuric acid, 0.5% of undecomposed salt, and 0.5% of calcium sulphate. If the soda ash in a glass batch be replaced by an equivalent quantity of salt-cake (100 parts for 75 parts of soda-ash), and proper precautions be observed, the quality of the glass should be entirely unaffected. In a batch containing salt-cake a reducing agent (coal or anthracite) is necessary, and the lime should preferably be added as limestone, as the carbon dioxide then evolved facilitates the escape of the sulphur dioxide produced from the salt-cake.

Common salt is of little value as a substitute for soda-ash. Alkali metasilicates have also been suggested as substitutes for soda-ash. Their value in practice would depend upon the possibility of obtaining them sufficiently pure and at a low enough price.

It is suggested, as a possible development, that glass might be melted in very large quantities in certain centres and sold to individual manufacturers for re-melting, colouring, and working up into glass articles.

Barium peroxide as a substitute for nitre in glass batches. L. Springer. Sprechsaal, 1916, 49, 18 and 136. J. Soc. Glass Technol., 1917, 1, Abstracts, 3—4.

SOME commercial "saltpetre substitutes" were found to consist chiefly of barium peroxide, one preparation, for example, containing 77.3% of barium peroxide, 13.9% of barium carbonate, and 6.2% of barium oxide. Barium peroxide gives off oxygen when heated to 700—800° C., but to supply a given quantity of free oxygen to a glass batch four times as much barium peroxide would be required as of nitre, and the barium oxide so introduced would affect the quality of the glass, so that in a lead glass the proportion of lead and in a lime-soda glass the proportion of lime would have to be reduced to allow for the barium oxide added. In small quantities barium peroxide has no deleterious effect on glass.

Alumina; Influence of — on the fusibility of glasses. F. Singer. Keram. Rundsch., 1915, 5. J. Soc. Glass Technol., 1917, 1, Abstracts, 16—17.

THE alumina was added in the form of pegmatite, of which two samples were used, containing respectively: SiO₂, 75.95, 93.61; Al₂O₃, 13.01, 3.51; Fe₂O₃, 0.31, 0.20; CaO, 0.36, 0.44; MgO, 0.49, 0.33; (1) alkalis, 9.34; (2) K₂O 1.89; loss on ignition, 0.66, 0.27%. Two lime-soda batches were made up, corresponding to: (1) 0.1 CaO, 0.6 Na₂O, 2.6 SiO₂; (2) 0.5 CaO, 0.5 Na₂O, 2.6 SiO₂. Sufficient of the pegmatite No. 1 was added to give, in successive mixtures, 0.263, 0.2, 0.15, 0.10, and 0.05 mol. Al₂O₃, and batches were melted at 950°, 1150°, 1250°, and 1420° C. respectively. At 1420° C. melting was too rapid to observe the effect of the alumina. The batches with the larger proportions of alumina were less fusible than the alumina-free batches, but at 1150° C. mixtures with the smaller proportions of alumina (0.15, 0.10, and 0.05 Al₂O₃) were distinctly more fusible than the alumina-free mixtures. In another series of experiments it was found that the influence of alumina, in moderate quantities, on the melting point, depends on the relative proportions of lime

and soda and, in some cases, on the silica. Thus, with lime and soda in the proportion 0.4 CaO : 0.6 Na₂O, there was little difference between the melting points of alumina-containing and alumina-free batches, and the same was true for batches containing lime and soda in the proportion 0.5 CaO : 0.5 Na₂O with 2.5–2.75 SiO₂, but when the silica was increased to 3.0 SiO₂, alumina had a favourable effect in the case of the 0.5 CaO : 0.5 Na₂O batches. With lime and soda in the proportion 0.6 CaO : 0.4 Na₂O, alumina had a beneficial effect whether the proportion of silica was 2.5 SiO₂ or 3 SiO₂. These results show that when alumina is present, in addition to its beneficial effect on the properties of the glass, the proportions of lime and of silica may be increased and the alkali decreased. Alumina was found to diminish the tendency to devitrification.

Glass of the type RO, 3SiO₂; Variation in soda, lime, and magnesia content of a— C. C. Rand. Trans. Amer. Ceram. Soc., 1915, 17, 236–239.

Mixtures of magnesium carbonate, whiting, and soda ash in different proportions were prepared to correspond to a triaxial diagram the apices of which represent MgO.3SiO₂, CaO.3SiO₂, and Na₂O.3SiO₂ respectively, the increments being 1/15 equiv. RO. Each batch of 500 grms. was ground in a ball mill, then introduced into a crucible previously heated to 1000° C. The batch was melted, kept molten until free from air bubbles, and then poured out to an iron plate and rolled into a sheet 1/8 in. thick. The replacement of lime by magnesia reduced the amount of devitrification in the glass. In no case did devitrification occur in the lime-free glasses. The mixtures which contained less than 1/15 equiv. Na₂O.3SiO₂ were too viscous to pour. Most of those which contained less than 1/6 equiv. Na₂O.3SiO₂ devitrified after pouring. Many of the mixtures containing less than 1/3 equiv. Na₂O.3SiO₂ and 2/5 to 2/3 equiv. CaO.3SiO₂ devitrified after being heated to 800° C. in 6 hrs. and cooled in about 20 hrs. All the mixtures which contained more than 2/3 equiv. Na₂O.3SiO₂ produced glasses which were too soluble to be useful.—A. B. S.

"Seeds" in glass : Cause and differentiation of— R. L. Frink. Trans. Amer. Ceram. Soc., 1915, 17, 793–802.

"SEEDS" in glass are seen under the microscope to consist of minute blisters, which contain carbon monoxide or dioxide. The following varieties have been distinguished: (1) Seeds largely due to overworking the furnaces. (2) Seeds due to smoke or oil-vapour introduced when the pontil is inserted in the molten glass; these are bounded by a yellow zone and usually contain minute particles of ash or soot; they are not well distributed through the glass, but occur in local areas. (3) Seeds containing sulphur dioxide or volatilised sodium chloride, the crystals of the latter being recognisable under the microscope. (4) Seeds due to the production of gas formed on re-melting a devitrified cullet. (5) Seeds due to arsenic and containing crystals of arsenic trioxide. (6) Seeds caused by the occlusion of air, as when a jet of air plays on a crevice in the pot. (7) Seeds produced by incomplete melting of the glass and characteristically spherical. The author suggests that formation of seed may be prevented in most cases by not exceeding the proper output of the furnace and by studying its operation so as to secure homogeneity and freedom from gaseous occlusions.—A. B. S.

Glass; Red staining of—by means of copper compounds. L. Springer. Sprechsaal, 1916, 49, 50, 56, 61, 75, 80, 88. J. Soc. Glass Technol., 1917, 1, Abstracts. 18–20.

In the experiments described, small beakers were

used, made of a glass of the composition: SiO₂, 72; CaO, 9; Na₂O, 5.5; K₂O, 12.0%, corresponding to a batch mixture composed of: sand, 100; calcium carbonate, 22; sodium carbonate, 13, and potassium carbonate, 24 parts. The trial pieces were painted over with the colouring paste and fired three times in a muffle kiln. The first firing was under oxidising conditions, and part of the copper compound in the colouring paste was burnt into the glass, producing a yellowish- or bluish-green colour. After cooling, the residual paste was washed off, and the glass then fired under strongly reducing conditions, coal or lignite being placed in the muffle with the glass, and the air supply cut down as low as possible. The copper compounds in the glass were thus reduced, giving rise to a fine ruby-red colour. The trial pieces were subsequently fired a third time to burn away carbon, deposited on the glass during the second firing. The most successful colouring mixtures were:—(1) 100 parts of "yellow earth" (ochre), and 200 parts of crystallised copper sulphate, the copper being precipitated by caustic soda, and the product freed from sulphuric acid by calcining and from sodium salts and soluble sulphates by washing. (2) 100 parts of ochre and 66 parts of copper oxide ground together. (3) 100 parts of ochre and 200 parts of copper sulphate, calcined thoroughly to remove sulphuric acid. Pastes containing the copper as sulphate "strike" the glass at a much lower temperature than oxide pastes, but have an action on the glass itself, and the resulting ruby colour is irregular and inclined to be matt and streaky. Oxide pastes require a considerably higher temperature in the first firing, but the ruby tints obtained after reduction are much finer. To obtain a good ruby glass by this method, the colouring paste must be as finely ground and as intimately mixed as possible, and it must be applied evenly to the glass. The temperature in the first firing at which the best results are obtained must be ascertained for each particular kind of glass; it cannot be varied many degrees without unsatisfactory results. For the glass mentioned above, a temperature of about 600° C. was found suitable.

Glass; Silvering of— A. Silverman and P. D. Neckerman. Trans. Amer. Ceram. Soc., 1915, 17, 505–519.

A BRIEF historical summary with bibliography. The authors state that Brashear's process (in which silver nitrate is reduced by a mixture of loaf sugar, nitric acid, alcohol, and water) is the only one in which the subject is approached quantitatively. They have undertaken an extensive investigation on the precipitation of metals in the form of mirrors, and in the present paper describe some preliminary qualitative experiments.—A. B. S.

Kaolins : A comparison of some—in respect of size of grain. C. F. Binns. Trans. Amer. Ceram. Soc., 1915, 17, 356–371.

SEVERAL English, American, and German clays were deflocculated and then treated in a modified Schultze's elutriator consisting of a series of five cylinders of 5.0, 7.5, 13.5, 21.5, and 30 cm. diameter, respectively, through which a stream of water flows in succession with an upward velocity of 1.5, 0.7, 0.18, 0.08, and 0.04 mm. per sec., the finest particles being carried away by the water passing out of the last cylinder. With most kaolins, the amount left behind by a flow of 0.7 mm. per sec. is negligible. The third vessel, with a flow of 0.18 mm. per sec., is of the greatest importance in expressing the grain of a clay; the percentage of material retained in it varies from less than 5 to more than 25%. In the succeeding cylinder the variation with different clays is much less. English, German, and Georgian (U.S.A.) kaolins are very similar in grain. Some of the second-

class English china clays clearly show a large content of coarse grains, but this is most marked with North Carolina (U.S.A.) kaolins; these are particularly difficult to deflocculate.—A. B. S.

Clays; Use of deflocculating agents in washing—and the effect of the process on the colour. G. H. Brown and W. L. Howat. Trans. Amer. Ceram. Soc., 1915, 17, 81—90.

The addition of 0.05—0.25% of caustic soda to a clay slip effects the deflocculation of the clay and keeps it in suspension, whilst silica and other impurities settle out. The addition of aluminium chloride re-flocculates the clay. The colour of English china clays is not altered by this treatment, but that of several American clays is greatly improved. The treated clays have a lesser drying shrinkage and a greater burning shrinkage than the raw clays.—A. B. S.

Cracking clays; Effect of lime on certain—. N. B. Davis. Trans. Amer. Ceram. Soc., 1915, 17, 497—504.

CRACKING clays are of two types according as the gelatinous matter causing the excessive plasticity and shrinkage is of inorganic or organic nature. Clays which cracked when made into a paste with water and then allowed to dry, were mixed (dry) with 3, 4, 6, or 12% of lime and then tempered in the usual manner. The proportion of lime required varied with the nature of the clay, but in each case a sufficient quantity of lime prevented cracking. The cracking is attributed to the very finely divided colloidal gelatinous matter, which has a great affinity for water. On mixing the dry clay with lime, and then adding water, the conditions are favourable for the immediate formation of calcium silicates or for the destruction of the organic colloids by the lime. It is impossible to mix a wet plastic clay with lime; the clay should be dried, ground so that it will pass a 15-mesh sieve, mixed (dry) with the lime, and then tempered.

In the discussion, H. F. Staley pointed out that preheating the clay before use would, in most cases, serve the same purpose, and be cheaper and free from the objections to lime. He suggested that the addition of common salt is preferable to that of lime.—A. B. S.

Drying behaviour of some [American] clays; Effect of salts on—. H. F. Staley. Trans. Amer. Ceram. Soc., 1915, 17, 697—719.

THE addition of anhydrous sodium carbonate decreases the rate of drying, increases the tendency to crack, and lengthens the range of vitrification of the clays studied. Sodium chloride decreases the rate of drying and cracking, produces better coloured ware, and has a beneficial effect on vitrification, but usually increases shrinkage. The addition of $\frac{1}{4}$ to 2% of salt renders many tender Iowa clays workable. The addition of magnesium and calcium sulphates to clays is not recommended. The reduction of cracking by the addition of sodium chloride is due to its flocculating effect on the clay and the resulting production of a structure favourable to capillary action.

—A. B. S.

Castling [pottery]; Notes on—. A. V. Bleininger and M. R. Hornung. Trans. Amer. Ceram. Soc., 1915, 17, 330—355.

THE liquefying action of various alkaline salts on clay is due to their hydrolysis and to the action of the resultant negatively charged OH ions which repel the similarly charged clay particles and increase the state of dispersion in the system, breaking the larger particles into smaller ones. If there is an excessive concentration of OH ions a "stiffening" of the mass will occur and the

alkalinity will decrease. Organic colloids act similarly to alkaline salts, but also protect the particles and make the liquid less sensitive to the action of flocculating agents. The presence of salts such as sulphates or chlorides of calcium, magnesium, or aluminium in a clay may render the maximum liquefaction of the clay impossible. The viscosity of a clay slip is an extremely important factor in governing the rate of sedimentation; it is best determined by means of a simple efflux viscometer of the Marriotte flask type, no kinetic or temperature corrections being necessary in ordinary work. As a large volume of air is absorbed by clay slips, they must be thoroughly stirred or even subjected to a vacuum before determining their viscosity. The effect of this entrapped air is specially marked with some kaolins. Sodium silicate reduces the viscosity of a clay more effectively than sodium carbonate. Kaolins differ greatly in regard to the change effected in their viscosity by various reagents. Absorption of the reagents also has an important effect on the viscosity; sodium hydroxide is absorbed to a far greater extent than sodium carbonate. The addition of alkali sometimes increases the tensile strength of cast bodies. Mixtures containing a low concentration of alkali are more liable to change their viscosity with time than those of greater concentration. The viscosity of a mixture of several clays may differ from that which would be anticipated, on account of reactions which occur among the impurities present in the clays. Thus a mixture of 45% English china clay and 55% Georgia kaolin requires $2\frac{1}{2}$ times as long to flow out of the viscometer as would be expected from the viscosity of each of these clays taken separately. The changes effected by the addition of various amounts of different reagents to American kaolins and ball clays and to mixtures of these in various proportions are shown in 15 graphs.—A. B. S.

Plaster [pottery] moulds; Notes on the manufacture of—. G. A. Williams. Trans. Amer. Ceram. Soc., 1915, 17, 322—329.

THE breakage of moulds can be reduced by care in handling and drying the moulds and by mixing the plaster in such a manner as to produce the strongest possible mould. Moulds which are heated above 110° C. soon crumble. A very thin clay slip may crack the moulds by the internal expansion of the plaster whilst absorbing water. A mixture of plaster and water was poured into a tin pan, 14 in. × 9 in., and the rate of setting was noted by standing a thermometer in it and noting the time taken to reach the maximum temperature. The rise in temperature varied from 15° to 22°, and the time of setting from 11 to 54 mins. according to the accelerator added. The set plaster was sawn into blocks and slabs which were planed to bars (1) $3\frac{3}{4}$ in. × $\frac{13}{16}$ in. × $\frac{15}{16}$ in., (2) 6 in. × 3 in. × $\frac{15}{16}$ in. These bars were kept at 85° C. for 48 hrs. and then tested. The modulus of rupture ($S = \frac{1.5 pl}{bd^2}$ where S =modulus, p =load, l =distance

between supports, b =breadth and d =thickness of bar) varied from 230 to 705. The relative hardness was determined by applying a jet of water (delivery 3500 c.c. per min. at a pressure of 36 in. of mercury) to the plaster, the jet being 10 in. from the face of the slab. The time taken to wear a hole through the plaster varied from 5.5 to 28 mins. The weight of water absorbed when the plaster was immersed in a saturated solution of calcium sulphate at 20° C. varied from 31.3 to 50%. It was found that the best mixture is composed of $2\frac{1}{4}$ lb. of plaster to 1 quart of water. A larger proportion of plaster increased the strength, but reduced the porosity, lengthened the setting time, and raised the maximum temperature. With too little plaster, the rate of setting

is slow and the temperature attained is low. Each accelerator or retarder has its specific influence on the plaster. Thus, the addition of 10 c.c. of concentrated sulphuric acid gave a high temperature test in a shorter time and increased the porosity of the plaster, but reduced its strength to one-third. Common salt, alum, potassium sulphate, and potassium bichromate act similarly, potassium sulphate being the most active accelerator and sulphuric acid causing the greatest loss in strength. Gum tragacanth, dextrin, and sodium bicarbonate act as retarders, the last-named decreasing the porosity and seriously reducing the strength of the plaster.

The results of 25 experiments show that the use of accelerators and retarders increases the strength of the plaster, at the expense of the porosity, or *vice-versâ*.—A. B. S.

Fireclay, shale, and surface clay mixtures; Study of — with reference to their porosity-temperature relations. G. H. Brown. Trans. Amer. Ceram. Soc., 1915, 17, 450—457.

EIGHTEEN mixtures of No. 2 Killanning (Pa.) fireclay, Canton (Ohio) paving brick shale, and a surface clay from Groveport (Ohio) were made into small bricks, dried, and burned to various temperatures up to 1280° C. The addition of fireclay to a shale or surface clay does not prevent the tendency of the latter to overburn. The addition of 10–30% of fireclay to a surface clay or shale may improve the vitrification behaviour and decrease the porosity of the latter, though a higher firing temperature is necessary. Dissimilar clays cannot be satisfactorily blended, but retain their individual characteristics in the mixture.—A. B. S.

Fireclay mixture; Influence of varying water-content in a —. R. J. Montgomery and C. E. Fulton. Trans. Amer. Ceram. Soc., 1915, 17, 436—449.

THE variations in the proportion of water in a mixture of St. Louis fireclay and grog may be relatively large without materially affecting the physical structure of the mass during drying and burning. The property which is most affected is the shrinkage of the clay alone on drying, which is proportional to the amount of water used. A mixture of clay with 50% grog shows no marked variation.—A. B. S.

Grog; Effect of — in a fireclay body. C. E. Fulton and R. J. Montgomery. Trans. Amer. Ceram. Soc., 1915, 17, 409—420.

RAW St. Louis fireclay, ground so as to pass completely through a 20-mesh screen, was mixed with grog made by burning the same clay to about cone 6 and then crushing it to the desired size. *Effect of amount of grog.* The addition of grog reduces the amount of water required to develop plasticity, the drying and burning shrinkage, the strength of the unburned mixture, the tendency to over-fire at cones 15–20, and the strength up to the point of over-firing, and increases the apparent sp. gr. and apparent porosity. *Effect of size of grog.* Increasing the fineness of the grog increases the amount of water needed to develop plasticity; the drying and burning shrinkage, the latter especially at cones 15–20; the strength of the raw body; and, up to cone 15, the strength of the fired body. At cone 20 the change in the modulus of rupture clearly shows over-firing. The apparent sp. gr. is scarcely affected by the fineness of the grog below cone 20. The apparent porosity at cones 010 and 5 increases with the fineness of the grog; at cone 10 there is no effect, and at cones 15 and 20 the apparent porosity is reduced with increasing fineness of grog when the body is over-fired.—A. B. S.

Saturated sodium sulphate solution; Effect of — upon the structure of clay burned to different temperatures. W. L. Howat. Trans. Amer. Ceram. Soc., 1915, 17, 249—255.

BLOCKS of burned clay measuring 4 in. × 4 in. × 2½ in. were immersed in a cold saturated solution of Glauber's salt and then exposed to the air for a day to allow the salt to crystallise. The treatment was repeated as often as desired. A calcareous surface clay required to be heated to 1100° C. before it could withstand this treatment and it was then overburned. A shale became resistant at 1025° C. and a fireclay at 1100° C. The test appears to be sharp and decisive with clays which have not been burned sufficiently to reach their full strength, i.e., those with more than 8% porosity. It is much more severe than the freezing test.—A. B. S.

Porcelain mixture and shale; Electrical conductivity of — upon heating. C. S. Kinnison. Trans. Amer. Ceram. Soc., 1915, 17, 421—430.

A TYPICAL porcelain mixture and a Bedford (U.S.A.) shale were each made into cylinders, ¾ in. long and ¼ in. diam. Electrodes, consisting of platinum discs ¼ in. diam. to which were attached 4 in. of platinum wire, were embedded at each end of these cylinders and ¼ in. apart. The cylinders were then heated in an electric furnace, the temperature rising 1° C. per min. until vitrification occurred. The electrical conductivity was measured by a modified Wheatstone bridge with alternating current attachment, and a telephone. The conduction is probably of two kinds—corresponding to electron conduction through a copper bar and ionic or electrolytic conduction through a salt solution. The former predominates at low temperatures and the latter at a red heat or above. If a graph of the electrical conductivity and the temperature is plotted, the intersection of the two parts of the curve indicates the transition from the solid to the liquid phase of the material, the degree of sharpness varying with the abruptness of the melting point. The expression: $\log R = \frac{v}{T} + C$, where R = the specific

resistance, T = the absolute temperature, and v and C are constants depending on the material, may be deduced from van't Hoff's well-known formula. If $\log R$ is plotted as the ordinate and $\frac{1}{T}$ as the abscissa, the resulting graph shows two marked changes in direction. With a raw porcelain mixture the first change occurs at 980°–1000° C., and probably represents the beginning of sintering due to the active fluxes present as impurities in the clay. The second point, at 1125°–1135° C., probably indicates the commencement of the action of feldspar. A properly burned porcelain gives a perfectly smooth curve, indicating that no chemical changes occur below the softening point of the porcelain. With the shale, the first point, at 875° C., probably represents the fusing point of the most fusible eutectic, and that at 1080°–1100° C. the softening point of the principal eutectic. The author concludes that these materials (silicates) do not behave like alloys, but as electrolytes, and represent dissociated solutions. The large differences in the conductivity are due less to a change in the concentration of the ions than to their rate of motion, this depending on the viscosity.—A. B. S.

Dental porcelains. A. S. Watts. Trans. Amer. Ceram. Soc., 1915, 17, 190—199.

PORCELAINS used for the production of artificial teeth correspond in composition to the following mixtures:—

	A.	B.	C.	D.	E.
Felspar	81	80	89.5	61.06	12.02
Clay substance..	4	—	—	—	—
Flint	15	—	3.8	29.07	60.49
Quartz	—	20	—	—	—
Bone ash	—	5	—	—	—
Sodium carbonate	—	—	4.0	1.86	7.90
Calcium carbonate	—	—	2.7	4.21	1.43
Potassium carbon-	—	—	—	—	—
ate	—	—	—	1.98	7.21
Borax	—	—	—	0.83	10.45

The use of true porcelains for dental inlays has been almost completely replaced by that of porcelain (silicate) cements which consist of a powder composed of (i.) basic calcium and aluminium silicates, with or without beryllium nitrate, (ii.) zinc oxide, (iii.) calcined alumina, and a liquid which is a "modified" solution of phosphoric acid. An analysis of a commercial silicate cement showed the powder to consist of SiO_2 37.0, Al_2O_3 32.2, CaO 7.5, Na_2O 10.1, P_2O_5 1.9, F 9.3, and loss on ign. 2.0%, and the liquid to consist of Na_2O 6.0, P_2O_5 35.5, and water 58.5%.

In making true dental porcelains at York, Pa., the felspar is crushed, hand-picked, then ground in drag mills, 2 ft. 6 in. diameter, and mixed with kaolin, quartz, and a little starch and gum. The mixture is tinted with iron, titanium, cobalt, chromium, copper, manganese, gold, and other oxides. The teeth are made in bronze moulds, paste of the requisite colours being applied to the various parts of the mould. The mould with its contents is heated under pressure so as to bake the mixture lightly. The teeth are then removed, dressed, and burned in a gas-fired muffle on trays made of fused silica. The shortest possible heating is necessary to secure external fusion without warping. The teeth are then annealed in a separate furnace. The metal pins used to attach the teeth to the plate are preferably of platinum and are inserted before burning the teeth. If pins of base metal are used, they are generally soldered to platinum tips in the teeth. Attempts to produce dental porcelains at a temperature permitting base metal pins to be burned in the teeth have proved unsuccessful.—A. B. S.

Potash, lime, alumina, and silica; Study of the most fusible mixtures of —. H. H. Hanna. Trans. Amer. Ceram. Soc., 1915, 17, 672—690.

THE mixture of Canadian felspar, Florida kaolin, Ohio silica flint, and whiting which has the lowest deformation point (cone 3, 1140°C .) has a composition corresponding to silica 65.27, alumina 16.98, lime 5.04, and potash 12.71%. This mixture deforms 25°C . below the most fusible mixture described by Seger (cone 4). By replacing part of the potash by soda (microcline by albite), it was found that a mixture corresponding to 0.358 Na_2O , 0.142 K_2O , 0.500 CaO , 0.748 Al_2O_3 , 4.71 SiO_2 deforms at cone 2—3 (1120°C — 1140°C .). Other corresponding components and eutectics are: pure felspar, cone 6 (1200°C .); 8% kaolin and 92% felspar, cone 7 (1230°C .); 8% Tennessee ball clay and 92% felspar, cone 6 (1200°C .); 4% flint and 96% felspar, cone 7 (1230°C .). A mixture of lime 23.25, alumina 14.75, and silica 62.0% is the melting point eutectic and the deformation eutectic of the ternary CaO - Al_2O_3 - SiO_2 system; it is completely deformed at cone 6 (1200°C .).—A. B. S.

Colour of bricks; Experiments to overcome "scumming" [efflorescence] and improve the —. A. E. Williams. Trans. Amer. Ceram. Soc., 1915, 17, 764—770.

A SOLUTION of 0.7N ferric chloride (113 grms. Fe_2O_3 per litre) was sprayed on to a column of clay as it issued from an extrusion (wire-cut) brick

machine, the bricks being afterwards burned under commercial conditions. It was found that the colour of the bricks was improved, though with ferrous sulphate the results were unsatisfactory. A further set of experiments on a commercial scale, in which a 20% solution was applied to the clay by means of a roller covered with lamb's wool, produced a fairly good result, but weaker solutions were useless.—A. B. S.

Dryer "scum" on bricks; Use of barium fluoride for the prevention of —. H. F. Staley. Trans. Amer. Ceram. Soc., 1915, 17, 200—201.

BARIUM fluoride possesses the following advantages over other salts used to prevent the formation of efflorescence on bricks: (1) It is cheaper; (2) it is more soluble than barium carbonate; (3) smaller amounts are required; (4) there is no deleterious effect on the colour of the bricks; (5) the use of an excess does not produce a efflorescence, and (6) it promotes vitrification.—A. B. S.

Floor-tiles; Classification of — as related to degree of vitrification. F. K. Pence. Trans. Amer. Ceram. Soc., 1915, 17, 485—492.

THE author suggests that floor tiles shall be classified according to the average percentage (by weight) of water which they absorb when immersed in boiling water for one hour and then soaked in the same water for 24 hrs. Three classes are proposed, viz., vitreous, 0—2% absorption; semi-vitreous, 2—10%; plain unglazed, 10% or more absorption.—A. B. S.

Earthenware glazes free from boric acid. E. Berdel. Sprechsaal, 1916, 49, 346—347, 353—354. Z. angew. Chem., 1917, 30, Ref., 139.

GLAZES consisting of potassium, calcium, and lead mixtures, poor in silica, and free from boric acid, may be prepared which when fired are suitable for glaze-firing both at Seger cones 1—4 and at Seger cones 07—01. The mixtures suitable for higher temperatures are of the type 0.1—0.25 K_2O , 0.2—0.45 CaO , 0.4—0.7 PbO , 0.1—0.2 Al_2O_3 , 1.8—2.5 SiO_2 . The substitution of soda for potash was found to be unfavourable; it caused crazing. An increase in the lime caused matt results. For lower temperatures of firing, glazes of the type 0.15—0.3 K_2O , 0.05—0.2 CaO , 0.5—0.8 PbO , 0.05—0.07 Al_2O_3 , 1.5—2.2 SiO_2 are suitable. The glazes are not indifferent to underglaze colours containing chromium oxide; they produce a yellow zone of lead chromate. As regards the solubility of the lead in 4% acetic acid they conform to the legal specifications. Lead-free mixtures with such a low melting point and suitable glazing properties can hardly be prepared.—J. F. B.

Glazes; Lead oxide versus lead carbonate in —. A. S. Watts. Trans. Amer. Ceram. Soc., 1915, 17, 474—483.

A NOTABLE reduction in the cost of a glaze may sometimes be effected by substituting another lead compound for the one at present employed. The three available materials are litharge (PbO), minium or red lead (Pb_3O_4), and white lead ($2\text{PbCO}_3 \cdot \text{PbO} \cdot \text{H}_2\text{O}$). A number of commercial glazes, prepared with the lead in each of these three forms, showed that those containing litharge form a dense coating on drying, with no tendency to dust. Those containing red or white lead dust readily. White lead tends to produce a slight opacity; litharge gives a clearer and more liquid glaze which may have a faint yellow tint. The lowest lead oxide content and highest glossiness in the glaze are possible when the lead is introduced as litharge.—A. B. S.

Galena and lead-bearing waste materials as glaze ingredients. J. Miller. Trans. Amer. Ceram. Soc., 1915, 17, 779—792.

EXPERIMENTS have shown that the substitution of equivalent amounts of such plumbiferous waste products as "flue dust" or "baghouse dust" from lead smelters, or of cheap sources of lead, such as galena and lead sulphate, for the purer lead pigments is satisfactory for glazing bricks, sewer-pipes, drain tiles, and other common wares. The disadvantages accompanying the use of these materials are: galena introduces sulphur into the glaze and may cause semi-opacity; lead sulphate can only be used economically when purchased in a dry calcined form, but is quite satisfactory at cones 02—2 (1060—1120° C.) in shale and fire-clay bodies; the "flue dust" and "baghouse dust" give better results than either of the foregoing, but are liable to produce a red colour (possibly due to antimony oxysulphide) or slight opacity; they also introduce carbon, sulphur, and volatile impurities, and the glazes containing them require very careful firing.—A. B. S.

Pinholing of glazes: An unusual case of —. H. J. Knollman. Trans. Amer. Ceram. Soc., 1915, 17, 165—172.

WHILE there are undoubtedly several causes of "pinholes" in glazes, the main one is the action of sulphur during the water-smoking period of burning. The moisture evolved during this period combines with the sulphur dioxide and trioxide in the fire-gases, forming sulphuric acid which is deposited as a dew on the glaze, particularly on goods placed in the cooler parts of the kiln. This explains why pinholes are more frequent in a closely set kiln than in a more open one. The appearance of pinholes also coincides with glazes of excessive viscosity. The remedy consists in adding a flux to the glaze or in employing a "softer RO content" so as to increase its fusibility. A slight increase in the proportion of alumina or silica in the glaze will sometimes cause pinholing. Re-firing the glazed goods will sometimes remove the pinholes. A sharp quick fire at the finish of the burning increases the fluidity of the glaze and lessens the loss by volatilisation and so prevents the formation of pinholes.—A. B. S.

White terra-cotta glazes at cones 6 and 7. E. C. Hill. Trans. Amer. Ceram. Soc., 1915, 17, 380—408.

TIN oxide and barium oxide were added to terra-cotta glazes of the Bristol type, consisting of felspar, whiting, zinc oxide, ball clay, and flint. The replacement of lime by tin oxide reduces the gloss, but with baryta no change occurs. The opacity and whiteness of these glazes are increased by keeping the alumina low and by adding either tin oxide or baryta, but the former is much more effective. With a low proportion of zinc oxide, tin oxide tends to produce a pink colour, whilst a high zinc oxide content prevents the pink discoloration and increases the glossiness, but tends to form blisters on account of its volatilisation. Glossiness is also reduced by an increase of alumina or clay or by a reduction of felspar. Notwithstanding the greater complexity of the glazes used due to the added tin oxide and baryta, the results agree with previously published results on Bristol and terra-cotta glazes with one exception, viz., Purdy (this J., 1903, 1017) found that a considerable proportion of clay must be added to Bristol glazes to obtain the maximum fusibility, whereas the author found that any increase in the proportion of clay had precisely the opposite effect.

—A. B. S.

Chrome-tin red glazes between cones 2 and 8. B. S. Radcliffe and C. L. Walduck. Trans. Amer. Ceram. Soc., 1915, 17, 278—289.

A MIXTURE of tin oxide 622.4, flint 247.6, whiting 930.0, and lead chromate 200.0 parts was calcined in a sagger to cone 8 in 28 hrs. It was then washed well and dried. This formed the stain used for colouring various glazes composed of felspar, whiting, barium carbonate, white lead, clay, flint, and boric oxide.

Of the glazes in Group A (constant RO, varying Al_2O_3 : SiO_2 ratio; cones 6—8, 1200—1250° C.) the best result was obtained with a mixture corresponding to 0.095 K_2O , 0.620 CaO , 0.188 BaO , 0.097 PbO , 0.281 Al_2O_3 , 0.0088 Cr_2O_3 , 2.00 SiO_2 , 0.118 SnO_2 .

In Group B (0.281 Al_2O_3 , 2.00 SiO_2 ; varying RO and boric acid), the best glaze at cone 8 is composed of (0.189 K_2O , 0.716 CaO , 0.071 PbO , 0.021 BaO , 0.284 Al_2O_3 , 0.0088 Cr_2O_3 , 0.118 B_2O_3 , 2.00 SiO_2 , 0.118 SnO_2). This glaze is of a dark raspberry red colour, opaque, and does not craze or crawl. At cone 4, the best glaze in Group B is composed of (0.189 K_2O , 0.621 CaO , 0.166 PbO , 0.021 BaO , 0.281 Al_2O_3 , 0.0088 Cr_2O_3 , 0.188 B_2O_3 , 2.00 SiO_2 , 0.118 SnO_2), and has a colour between raspberry and cherry red. A better colour—blood red—though inferior in gloss, corresponds to (0.189 K_2O , 0.527 CaO , 0.024 BaO , 0.260 PbO , 0.281 Al_2O_3 , 0.118 B_2O_3 , 0.0088 Cr_2O_3 , 2.0 SiO_2 , 0.118 SnO_2). At cone 2 the best glaze in Group B is opaque and shows no defects; it corresponds to (0.189 K_2O , 0.621 CaO , 0.142 PbO , 0.048 BaO , 0.284 Al_2O_3 , 0.237 B_2O_3 , 0.0088 Cr_2O_3 , 2.00 SiO_2 , 0.118 SnO_2). Hence, good colours can be made using chrome-tin stain, and these burn well between cones 2 and 8 provided the glaze matures properly at the selected temperature. In such glazes the addition of boric oxide changes the colour from raspberry to cherry red, but if over-burning occurs a green glaze is produced. The partial replacement of lime (1) by calcium fluoride has no effect on the colour but makes the glaze dull, (2) by magnesia produces mottled glazes, (3) by baryta produces a brownish red, and (4) by bismuth oxide produces a softer mottled green and red glaze. Hence the composition of the RO portion of a chrome-tin glaze has a marked effect on its colour.—A. B. S.

Zinc compounds in a chrome green glaze: Influence of some unusual —. R. H. Minton. Trans. Amer. Ceram. Soc., 1915, 17, 667—671.

BROWN and pink colours are produced by the formation of zinc chromates in glazes containing chromium and zinc oxides, the tint depending on the conditions of heating and on the compound of zinc used. Zinc chromate produces the strongest brown and zinc phosphate the strongest pink. No greens were produced in any of the mixtures containing zinc, as the green colour due to chromic oxide is destroyed by the zinc salts.—A. B. S.

Soda-zinc oxide-silica and soda-zinc oxide-titanic oxide-silica: Microscopic investigations of some compounds noted in the systems —. A. A. Klein and G. H. Brown. Trans. Amer. Ceram. Soc., 1915, 17, 745—759.

IN molten mixtures of the soda-zinc oxide-silica system within the following molecular percentage limits: SiO_2 90%, ZnO 10%; ZnO 10%, Na_2O 50%, SiO_2 40%; and ZnO 60%, SiO_2 40%, glassy, matt, and crystalline structures occur. In the matt and crystalline products, with one exception (ZnO 10%, Na_2O 10%, SiO_2 80%), prismatic needle crystals of hexagonal cross section and consisting of zinc orthosilicate separate out and resemble the mineral willenite. The maximum indices of the glassy structure follow the Lorentz-Lorenz law of specific refractivities (Wied,

Annalen, 1880, 9, 641; 2, 70). In the soda-zinc oxide-titanic oxide-silica system, glassy, matt, and crystalline structures also occur. Two types of crystal are found: one is zinc orthosilicate containing a little titanic oxide; the composition of the other is unknown, but its high refraction and double refraction suggest either zinc titanate or titanium dioxide.—A. B. S.

Enamels; Antimony compounds as opacifiers in —. H. F. Staley. Trans. Amer. Ceram. Soc., 1915, 17, 173-189.

THE use of antimony compounds as opacifiers in enamels is beset with difficulties which have hindered their general use, but with careful attention to the following precautions, satisfactory results may be obtained. For a good gloss, the enamels should be one of the following types: (i.) High boric oxide, leadless enamel as A; (ii.) medium boric oxide, leadless enamel as B; (iii.) low boric oxide, plumbiferous enamel as C.

	A.	B.	C.
Felspar	425	425	425
Borax	500	325	200
Soda ash	—	57	57
Sodium nitrate	27	27	27
Barium carbonate	—	90	90
Whiting	—	27	27
Fluorspar	—	100	85
Cryolite	100	—	—
Zinc oxide	125	100	80
Red lead	—	—	102
Antimony oxide	75	75	75

Enamels containing antimony compounds yield three colours: (i.) a tan, due to sulphur, which fades as the melting proceeds; (ii.) a persistent yellow due to lead oxide; and (iii.) a blue due to a combination of antimony oxide, boric oxide, calcium, and fluorine. Opaque white enamels are the result of balancing the yellow and blue colours by adjusting the proportion of lead and cobalt oxides, and by appropriate heating. The dark specks in enamels containing antimony oxide are due to dirt introduced after melting the enamel. They do not occur in carefully conducted laboratory experiments.—A. B. S.

Ferric iron; Role of chlorides in the volatilisation of — [from enamels]. G. A. Bole and R. M. Howe. Trans. Amer. Ceram. Soc., 1915, 17, 125-129.

To an enamel with the following formula (0.2 K₂O, 0.3 CaO, 0.5 PbO) (0.25 Al₂O₃, 0.08 Fe₂O₃), (2.8 SiO₂, 0.15 SnO₂), and thus containing 2.5% Fe, about 5% of a chloride was added. The mixture was fused completely at cone 04 (1020° C.) and was kept at this temperature for 5 hrs. The power of barium chloride to cause volatilisation of the iron was nil, and the chlorides of sodium, potassium, and magnesium were all feeble in this respect. The best results were obtained by the addition of lithium chloride, lead chloride, silver chloride, and stannous chloride. As the prices of tin oxide and chloride are equivalent to the metallic content, the use of tin chloride in enamels is preferable, inasmuch as it effects a partial volatilisation of the iron present.—A. B. S.

Enamel; Relative action of acids on —. E. P. Poste. Trans. Amer. Ceram. Soc., 1915, 17, 136-149; 1916, 18, 762-766.

Two grms. of finely powdered enamel was placed in a 400 c.c. beaker, 100 c.c. of the acid added and mixed by stirring. The beaker and contents were then allowed to stand for 24 hours, after which the liquid was passed through a weighed Gooch crucible with asbestos filter, and the residue

(in the crucible) dried and weighed. With the exception of acetic acid, the loss of weight increases with the concentration of the acid with solutions below 10%, but then diminishes rapidly to a minimum solubility of 0.015 gm. The effect of time is to increase the solubility, and the ratio of the surface area of the enamel to the volume of the acid is important.

In a second set of experiments, the enamel was ground and sifted, the particles (a) passing an 80-mesh and retained on a 100-mesh sieve, or (b) passing a 100-mesh and retained on a 150-mesh sieve, being used for testing as follows:—2 grms. of the selected portion of the enamel was immersed in 100 c.c. of 11.8% hydrochloric acid for 24 hrs. at 21° C. (70° F.). The loss in weight was found to be constant for any given size of particles. In another series of tests 2 grms. of the sample was heated with 13.6% hydrochloric acid under a reflux condenser. The loss in weight was proportional to the rise in temperature of the acid up to 50° C., but after this it remained almost constant. In the discussion, H. F. Staley pointed out that the solubility of the enamel corresponded very closely with the electrical conductivity of the acid solution at various strengths.—A. B. S.

The ternary system potassium metasilicate-silica-water. Morey and Fenner. See VII.

PATENTS.

Crucibles [for glass melting or annealing]. J. Gray, London. Eng. Pat. 106,547, June 26, 1916. (Appl. No. 8970 of 1916.)

A CRUCIBLE particularly suitable for melting or annealing glass without contamination by the material of the crucible, is made from plates or staves of tungsten, tantalum, or other refractory material held together by detachable bands in the same manner as in a barrel. The joints may also be soldered with fused tungsten or other suitable fused metal. In a modification the staves are clamped at the top by a water-cooled electrically-conducting clamp, and the bottom dips into a water-cooled mercury receptacle. The crucible is heated by a current passing longitudinally through it.—W. F. F.

Silica [quartz]; Process for treating [fusing] —. I. Rosenblum, Swampscott, Mass., U.S. Pat. 1,229,324, June 12, 1917. Date of appl. Mar. 31, 1917.

QUARTZ is heated in a graphite crucible in an electric furnace at 1400°-1700° C., in an atmosphere of nitrogen. A protective layer is formed on the crucible by the interaction of a part of the quartz with the crucible lining, and the temperature is then raised to fuse the quartz.—W. F. F.

China clay; Treatment of —. W. Feldenheimer, London. Eng. Pat. 106,890, July 10, 1916. (Appl. No. 9726 of 1916.)

To remove "mica" from china clay or other clay, the clay is washed in the usual way over "mica drags," using washing water containing a minimum of 0.06% of sodium carbonate for a 5% suspension of clay. A larger proportion of "mica" is thus deposited. The clay is then passed to a settling tank for further deposition of "mica," and finally to a tank where a weak solution of alum is added to neutralise the solution and cause the deposition of the clay.—W. F. F.

Refractory materials; Production of —. P. R. Hershman, Assignor to Armour Fertilizer Works, Chicago, Ill. U.S. Pat. 1,227,909, May 29, 1917. Date of appl. Oct. 21, 1916.

A MIXTURE of alumina and carbon is heated to sintering temperature (1800°-1900° C.) in an atmosphere containing an excess of reducing gas.

The product is pulverised, mixed with carbon and a suitable binder, moulded, and heated to about 1950° C. in a reducing atmosphere.—W. F. F.

Argillaceous composition and process of making the same. L. H. Minton, Metuchen, N.J., Assignor to A. W. Herbst, Philadelphia, Pa. U.S. Pat. 1,228,465, June 5, 1917. Date of appl. Nov. 29, 1916.

TERRA-COTTA is made from a mixture of stoneware clay 30%, low-grade fireclay 30%, and subdivided acid furnace slag substantially free from metallic iron, poor in lime, and rich in silica, 10%. The mixture is moulded, dried, and heated to a temperature sufficient to destroy the plasticity of the clay but below sintering temperature.—W. F. F.

Glass-melting pots; Manufacture of—G. M. Bowen, Birmingham. Eng. Pat. 106,871, June 13, 1916. (Appl. No. 8318 of 1916.)

IX.—BUILDING MATERIALS.

Sand-lime bricks; Silica bond in—W. E. Emley, A. A. Klein, and E. M. Sanborn. Trans. Amer. Ceram. Soc., 1915, 17, 471—473.

A CRITICISM of the work of Parr and Ernest (Illinois State Geolog. Survey Bull. 18; Trans. Amer. Ceram. Soc., 1911, 13, 648; this J., 1911, 1387) showing that their conclusions are largely erroneous for the following reasons:—(1) No method has yet been found for isolating the free lime in a mixture of calcium silicates and lime; (2) there is no justification for supposing that $2\text{CaO} \cdot \text{SiO}_2$ and $\text{CaO} \cdot 2\text{SiO}_2$ occur in sand-lime bricks; (3) the evidence to show that calcium silicate forms no definite hydrate is inconclusive; (4) in their petrographic examinations Parr and Ernest used only thin sections, whereas it has repeatedly been shown that the only reliable method is to use immersed grains; and (5) the grains which Parr and Ernest believed to be zeolites have been identified as calcium carbonate by the authors of the present paper.—A. B. S.

Estrich [flooring] plaster; Note on—R. K. Hursh. Trans. Amer. Ceram. Soc., 1915, 17, 549—556.

ESTRICH plaster is made commercially by heating gypsum at 900°—1000° C. The author finds that flooring plaster of maximum tensile strength is produced by heating gypsum to only 700° C., or 200°—300° C. lower than commercial practice, but adds that the higher temperature may be requisite to obtain constancy of volume during the setting of the plaster—a property of great importance. The full strength of Estrich plaster requires several weeks to develop, but is then comparable with that of Portland cement.—A. B. S.

Wood; Impregnation of—with mercuric chloride solution. R. Nowotny. Elektrotechnik, 1916, No. 39, 1. Z. angew. Chem., 1917, 30, Ref., 136.

THE amount of mercuric chloride absorbed by wood immersed for some days in a solution of the salt, is in excess of the amount corresponding to the volume and concentration of the saturating liquid. The excess increases with increasing volume of solution, is proportional to the initial concentration, and is independent of the quantity of solution absorbed by the wood. There is no definite relation between the normal absorption and the excess.—F. C. T.

Toxic action of maplewood creosote and of some of its constituents and derivatives on a wood-destroying fungus. Pieper and others. See III.

Titration of calcium oxide or hydroxide in presence of some aluminates or silicates. Emley. See VII.

Notes on manufacture of plaster moulds. Williams. See VIII.

PATENTS.

Paving material; Process of producing—G. C. Glynn, Kansas City, Kans. U.S. Pat. 1,227,903, May 29, 1917. Date of appl. Dec. 20, 1916.

Soil containing colloidal matter is mixed with a deflocculating agent and water, heated, and liquid bitumen added. The material is dried in air and then melted.—W. F. F.

Lumber and other moisture-bearing substances; Dry-kiln for drying—H. D. Tiemann, Madison, Wis. U.S. Pat. 1,228,989, June 5, 1917. Date of appl., Dec. 18, 1915.

THE kiln consists of a closed chamber containing heating pipes arranged so as to produce an ascending column of heated air along one side of the pile of lumber, which is so arranged that the heated air may pass freely downward through the pile in cooling, and a space is left on the opposite side of the pile through which the cooled air may descend; a vertical flue near the bottom of the pile into which the cooled descending column of air may enter; a spray of water in this flue; means for regulating the temperature of the spray of water; baffle-plates near the bottom of the flue for separating the mist from the air.—J. F. B.

Porous blocks; Method of treating [impregnating]—C. E. Fuller, Kansas City, Mo. U.S. Pat. 1,229,439, June 12, 1917. Date of appl., Oct. 20, 1916.

POROUS blocks are impregnated with melted bitumen at a pressure above atmospheric, and then subjected to a vacuum before the liquid solidifies, and subsequently to pressure during solidification of the liquid.—W. F. F.

Heat-insulating material and process of producing same. H. A. Ashenhurst, Assignor to J. J. Reynolds, Chicago, Ill. U.S. Pat. 1,230,085, June 12, 1917. Date of appl., Oct. 30, 1916.

A COMPOSITION of cellular structure with a specific gravity less than 1 consists mainly of finely divided asbestos together with aluminium hydroxide and a substance such as calcium sulphate which sets hydraulically after the reaction by which the cellular structure is formed.—F.W.A.

Concrete structures; Method of and means for preventing the disintegration of—H. P. Brown, Montclair, N.J. U.S. Pat. 1,230,373, June 19, 1917. Date of appl., June 8, 1912.

TO prevent disintegration of reinforced concrete structures by electrolytic action, the reinforcing elements are coated with a dense waterproof concrete by "jetting" at a pressure of 30—60 lb. per sq. in., and the coated elements are then embedded in concrete in the usual way.—W. F. F.

Furnace lining and method of making same. G. W. Patnoe, Maple Grove, Ohio, Assignor to The Dolomite Products Co., Cleveland, Ohio. U.S. Pat. 1,230,430, June 19, 1917. Date of appl., Nov. 16, 1915.

A REFRACTORY material for furnace linings and the like is made by mixing magnesian limestone with 2—5% of "argillaceous matter in the form of silica, alumina, and iron oxide," grinding the mixture till substantially all of it passes through a 100-mesh sieve, and then calcining it at 2600°—3000° F. (1430°—1650° C.) until it is converted into a dense sintered mass impervious to air and moisture.—W. F. F.

Magnesia cement; Process for the manufacture of — A. Reich. Budapest. Ger. Pat. 297,431. Mar. 21, 1915. Under-Int. Conv., Mar. 21, 1914.

BURNT or unburnt magnesite is mixed with solutions of acid sulphates; if desired, free sulphuric acid may be added to the mixture. Magnesium oxide mixed with sodium bisulphate forms a double salt $\text{MgSO}_4 \cdot \text{Na}_2\text{SO}_4$ which gives with magnesium oxide a fluid and easy setting cement. —J. F. B.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Titaniferous iron ores; Electric smelting of — A. Stansfield. Canadian Geol. Survey, Bull. 92. Eng. and Min. J., 1917. 103, 1020.

A DEPOSIT of titaniferous magnetite estimated to contain 1,000,000—5,000,000 tons occurs near St. Charles, Quebec. Electric power may be obtained close by from the Saguenay River, and supplies of charcoal and limestone are also available. The ore contains iron 50.53, titanium 10.55, sulphur 0.02, and phosphorus 0.03%, and yields a magnetic concentrate assaying iron 56.2 and titanium 8.3%. It is estimated that 1.75 tons of concentrate smelted in a Swedish furnace would yield 1 ton of pig iron with 0.4% of titanium, and 0.7 ton of slag containing titanium 34 and silica 14%. The electric power required would approximate 0.55 H.-P.-year per ton of metal; the total cost of production would be \$17.93 per ton.—W. R. S.

Ferrosilicon; Metallurgy of — R. J. Anderson. Eng. and Min. J., 1917. 103, 1095—1098.

FERROSILICON is second in importance only to ferromanganese as regards tonnage consumed, in the metallurgy of iron and steel. Analyses of ferrosilicon used in steel manufacture either as deoxidisers or in the production of silicon steels show a content of silicon ranging from 8% (English blast furnace) to 94.8% (electric furnace). The structure is finely or coarsely crystalline depending on the silicon content; distinct crystallisation is absent in high-grade alloys containing over 50% Si, the fracture being fine, and of a bluish colour. The number of iron-silicon compounds is open to dispute; at least three exist, namely, Fe_2Si , FeSi , and FeSi_2 . Tammann and Guertler's researches indicate the existence of two eutectics, the first containing 21.6% Si, and composed of Fe_2Si and FeSi , the second one containing 60% Si and composed of FeSi and Si. Impurities present in electric furnace ferrosilicon are chiefly due to the raw materials charged: manganese is generally low, 0.10% to 0.40%; phosphorus from 0.01% to 0.05%; sulphur from 0.01% to 0.05%, and carbon from nil to 0.30%. In general the higher the silicon content the lower the impurities. In the blast-furnace product manganese ranges from 1.25% to 2.5%, phosphorus is usually less than 0.06%, sulphur less than 0.05%, and carbon varies from 1 to 2%. In the 25% grade calcium may be about 0.5% and increases up to 1% in the 90% grade; aluminium averages about 0.1% in most grades. Ferrosilicon-aluminium is an alloy containing about 45% Si, 12 to 15% Al, and the remainder iron; it is used as a deoxidiser for steel made in the electric furnace. It is more effective than aluminium, and is usually added to the ladle before teeming. Ferrosilico-manganese is of two grades, 60% to 70% Mn, 20 to 25% Si, and 3 to 4% Fe; and 50 to 60% Mn, 22 to 25% Si, and about 19% Fe; in both the carbon is about 0.35% and sulphur and phosphorus low. The alloys are used at times for adding silicon and manganese to steel. Ferrosilico-manganese-alumin-

ium is made in two grades containing 18 to 20 or 9 to 11% Si, 18 to 22 or 9 to 11% Mn, and 9 to 12 or 4.5 to 6% Al. Ferrosilico-calcium-aluminium has an average composition of 50 to 55% Mn, 18 to 22% Ca, 12 to 15% Fe, 4 to 5% Al, and about 1% C; this alloy is a deoxidiser and desulphuriser; its use is limited to high-grade steels. Silico-spiegel contains 22 to 24% Si and 35 to 40% Mn, and is made by melting together ferrosilicon, flint, manganese ore, and carbon. Ferrosilicon is made either in the blast furnace or the electric furnace and is also produced from two different charges; first by reducing silica and iron ore with carbon, and second by the reduction of silica with carbon, iron being added in the form of turnings. Experiments with iron-silicon slags indicate that their use is not practicable commercially. The blast furnace product does not contain more than 20% Si, the higher grades being produced in the electric furnace; even in making 15% alloy in the blast furnace, fuel consumption is high. Iron oxide, silicious iron ore, and coke are used in blast-furnace charges, and the most suitable slags are high in alumina and low in lime. In the electric furnace, two kinds of charges are used, quartz or sand, and charcoal, coke, or coal with either wrought iron, steel, or cast iron turnings or silicious iron ore; using turnings instead of iron ore power consumption is less, furnace operation steadier, and less slag is formed; purity of materials is necessary as most of the phosphorus and sulphur appears in the metal. The liquid metal is highly corrosive towards iron and is therefore tapped out into sand or carbon-lined cars or sand moulds. The electric furnace product is in four grades, 25 to 30%, 45 to 55%, 75 to 80%, and 90 to 95% Si and higher. Packing and transport, particularly of grades 30 to 65% Si, is important, cases of poisoning having been traced to the disintegration of the alloys; the gases evolved were hydrogen phosphide and arsenide. The tendency to decomposition is not so marked in alloys containing less than 30% Si; the richer alloys, over 65% Si, are also less liable to spontaneous disintegration. Silicon promotes soundness in ingot iron but should not exceed 0.15% in metal which has to be rolled; about 0.30% promotes soundness in steel castings; it is probable that carbon is detrimental to silicon steel. Usually the 25 to 30% alloy is used for making fixed additions of silicon, the 45 to 50% grade for deoxidising purposes. Though the addition of silicon to iron increases its elastic limit and tenacity, a loss in ductility is caused, but in well-annealed material this is not marked until the silicon reaches 3%; above this amount, ductility loss increases rapidly.—T. H. B.

Carbon steels; Mechanism of the hardening of — P. Chevenard. Comptes rend., 1917. 165, 59—62.

THE rate of cooling, in an inert atmosphere, of a steel wire, after heating to a red heat by an electric current, varies largely with the nature of the gas. Hydrogen generally produces hardening, while in nitrogen, annealing usually occurs, and with a mixture of the two gases, a whole range of intermediate conditions can be obtained. By means of a registering differential dilatometer, the curve, which is traced photographically, of the thermal dilatation during cooling records transformations in the metal with great sensitiveness, and the method is almost independent of the rate of cooling. In the curve which is traced, the ordinate gives the difference of expansion of the wire which is being studied and a standard wire of "baros" alloy which is maintained at the same temperature. The temperature is recorded by the expansion of the standard which traverses the abscissa axis of the curve. The two wires of 0.23 mm. diameter are held close together in a gas-tight case and connected with an adjustable electric circuit by which the current through the

two filaments is regulated so as to give equality of temperature, which is judged optically. After any particular thermal treatment a microscopical and mechanical examination is made of the metal. With a given steel and identical conditions of cooling, the nature of the transformation was found to depend on the temperature reached during the heating. When the initial temperature of the metal was gradually raised, the transformation corresponding to the formation of pearlite of minimum hardness, which normally occurs at 600° – 650° C., is gradually lowered. Above a certain temperature of initial heating θ_0 , the transformation occurs in two stages, one reverting to a temperature of 200° – 300° C. With further increase of temperature the proportion which reverts increases, and at a certain temperature, θ_1 , reversion is complete. On increasing the rate of cooling, the temperatures, θ_0 and θ_1 , are rapidly lowered, approach each other, and finally coincide. The transformation which reverts to the lower temperature corresponds to the formation of martensite, i.e., to the condition of maximum hardness. The phenomena are more complex in the cases in which the transformation occurs in two stages, but it was found possible to obtain products which microscopic examination showed to contain both troostite and martensite. The speed of cooling with very fine wires is probably greater than can be obtained with more massive samples; in the latter case, the internal pressure produced during the contraction tends to oppose the passage from the γ to the α state.—J. N. P.

Steel: Anomalous dilatation due to cementite in carbon—. P. Chevenard. Comptes rend., 1917, 164, 1005–1008.

A NUMBER of samples of steel of high purity were prepared by melting Swedish iron with electrode graphite in an electric furnace. Measurements of dilatation during regulated heating were made by a registering differential dilatometer with bars of metal 10 cm. long in a gauge in which carbon-free electrolytic iron was used as a standard of comparison. The differential curves obtained showed that with all samples an anomalous negative dilatation occurs which is reversible and similar to the negative dilatation shown by ferro-nickel alloys. The departure from the value for pure iron varied with the content of carbon and at 15° C. could be expressed by the value 3.3×10^{-4} C., where C is the percentage of carbon. The curves representing the differential of the expansion showed a bend at 210° C., which coincides with the temperature at which a sudden fall in magnetisation has been found to occur with cementite. Beyond 300° C. the curves became almost rectilinear, denoting a constant difference in the dilatation of iron and the steels. The amplitude of the curves varies with the content of carbon and the previous heat treatment and enables the changes in carbide formation to be followed comparatively with those indicated by micrographical examination. The identity of constitution of pearlite and sorbite was thus revealed, and measurements made with partially hardened steels containing troostite and martensite showed that troostite is a complex of the phases ferrite and cementite which are stable at ordinary temperatures.—J. N. P.

Manganese steels. A. Portevin. Comptes rend., 1917, 165, 62–65.

PEARLITE in laminated form, together with martensite, can be produced in steels containing 7% manganese and 0.5%–1% carbon, by reheating to 1300° C., followed by very slow cooling (extending over 75 hours). The clusters of pearlite possess a rounded and nodular form which are often considered to be limited to troostite in a medium of martensite or austenite. In the present instance

the laminated crystals of pearlite in the clusters have a stellated or fan-shaped form. By reheating to 1000° C., and cooling in 5 hours, these steels return to the austenite condition with a correlated variation of the mechanical and physical properties. For example, a steel containing 8.6% Mn and 0.08% C had a Brinell hardness of 435 and specific resistance 51.1 microhms per centimetre cube after the very slow cooling, whereas after reheating to 1000° C., and cooling in 5 hours, the hardness was 217 and the resistance 63.1 microhms. A measurement of the differential expansion of the hardened steel during the cooling showed a marked transformation point at 640° C. With a steel containing about 12% Mn and 1% C it has been possible by very slow cooling to obtain laminated pearlite and austenite separated by a narrow border of troostite. The clusters of pearlite present in some cases the external morphological character which is customary to troostite. By ordinary reheating and cooling the whole changes to austenite, while by cooling very slowly from a temperature of 1300° C., a partial transformation at a high temperature to pearlite and troostite can be obtained in manganese steels which are originally austenite, the residual austenite remaining unchanged or undergoing a transformation at a low temperature leading to martensite. Micrographical examination of nickel and tungsten steels gave results which are difficult to interpret and seem to indicate a new constituent.—J. N. P.

Iron-nickel alloys: Changes in the dilatations of — under the influence of various thermal and mechanical treatments. C. E. Guillaume. Comptes rend., 1917, 164, 904–906. (See also this J., 1917, 31.)

THE experiments previously recorded on "invar" have been extended to other iron-nickel alloys. Eight alloys, with nickel content varying from 27.5% to 69.0%, were examined ("invar" contains 36%). The alloys were quenched, annealed, annealed in a porcelain kiln at 1000° C., followed by slow cooling lasting three or four days, also quenched and drawn so as to produce an extension of 50%. Two alloys with nickel content 27.5% and 27.6% showed an increased coefficient of expansion as a result of any form of treatment applied. One alloy (Ni 28.7%) showed a decreased dilatation in all cases. The other samples (Ni, 42.0, 43.0, 49.8, 55.8, 69.0% respectively) behaved like invar, but the changes produced were much smaller.—H. J. H.

Alloys to replace platinum; New—. F. A. Fahrenwald. J. Ind. Eng. Chem., 1917, 9, 590–597. (See also this J., 1916, 543; 1917, 81, 460, 670.)

ALLOYS of gold and palladium, as the chief constituents, were prepared, and gave results which for many purposes were quite equal to those given by platinum. The name "rhotanium" has been given to this series of alloys, which contain from 90 to 60% of gold, according to the purposes for which they are required. For certain electrical and other uses the addition of a small proportion of rhodium is essential, but this is not necessary in the case of material for chemical ware. A small amount of silver may also be introduced into alloys which are not intended for chemical purposes. In the preparation of rhotanium alloys great care is required to obviate the affinity of palladium for gases and solids ordinarily met with in manufacturing processes, and also to regulate the heat so as to prevent segregation of the constituents. The slightest want of homogeneity makes the alloy worthless for many purposes, and especially for chemical requirements. Comparative tests with boiling acids, alkali and alkali

sulphide solutions, and by fusion with potassium bisulphate showed that, excepting for use with nitric acid, an alloy may be chosen which will give results equal to or better than those given by platinum. The loss by volatilisation in 10 hours at temperatures of 1050° to 1400° C. was lower than for platinum in the case of some of the alloys. At 1400° C. the crystalline structure was clearly shown, but no brittleness was produced. Some of the alloys are practically indistinguishable from platinum in colour, and are equally malleable and ductile. They melt at temperatures up to 1450° C., and have an electrical conductivity and tensile strength equal or superior to those properties of platinum. The sp. gr. varies from 18.5 to about 16.0 (platinum 21.5), and the temperature coefficient is much lower than that of platinum. These alloys may be welded readily at white heat without the use of a flux, and may be made into any shape while either cold or hot. Rhotanium has been found suitable for contact terminals in automatic-electric devices, and in most other cases where it has been found necessary to use a platinum alloy containing a large proportion of iridium, but it has not given uniformly satisfactory results in magnetos. For dental work it has proved as useful as platinum for most purposes. It cannot be used in chemical work, as an anode in electrolytic analysis, or when exposed to the action of strong nitric acid, but is a satisfactory material for cathodes. It is superior to platinum for jewellery, being harder, stronger, and taking a better finish. It may be "sweated" or otherwise treated as platinum without darkening or oxidising, and the finished articles cannot be distinguished by ordinary means from those of platinum.—C. A. M.

Copper ores; Leaching of low-grade——. J. Irving. Eng. and Min. J., 1917, 103, 932—933.

Two new plants for leaching oxidised ores are being erected, by the New Cornelia Copper Co., at Ajo, Ariz., and by the Utah Copper Co., at Bingham, Utah. At the latter plant it is proposed to treat the ore without a preliminary roast, tests having shown that a fair proportion of the gold and silver can be recovered with the copper in this way. It has been demonstrated that the waste liquors left after precipitation of the copper by iron can be used advantageously for leaching, after aeration, the ores being first treated with regenerated liquor, followed by sulphuric acid. A great saving of acid is thus effected in the case of ores rich in alumina and lime. Mixed oxide-sulphide ores may be crushed and concentrated with regenerated liquor and the mill solution treated for the recovery of the dissolved metal. Experimental leaching of large heaps of poor ores without using any other plant than a prepared floor has given very promising results at the Copper Queen Mine, Bisbee, Arizona. A recovery of 80% after two years' leaching may be expected. —W. R. S.

Copper; Purity of "selected"——made in converters. H. F. Collins. Bull. 153, Inst. Min. and Met. [Advance copy.] 3 pages.

AFTER the outbreak of the war, the Huelva Copper Co. adopted the "bottom" process (this J., 1915, 618) to save part of the gold contents and obtain a product which could be sold locally. The copper is sold at £1-£2 less than "Best Selected" and is suitable for alloy-making as regards freedom from impurities, though too brittle for rolling on account of a slight excess of oxygen. To remove the latter, the metal must be re-melted in a reverberatory furnace, and poled. This process is carried out in an Australian works. The following figures indicate the purity of the metal produced:—

	Spain.		Australian copper.
	Selected copper.	Bottom copper.	
Copper	99.41	97.97	99.62
Silver	0.1060	0.1724	—
Gold	0.0010	0.0206	—
Ni + Co	0.1222	0.2410	0.2800
Iron	0.0353	0.5600	0.0030
Sulphur	0.0364	0.7770	trace
O + loss	0.2348	0.1302	0.0890

—W. R. S.

Copper-nickel sulphide ores; Smelting of——[in the electric furnace]. A. von Zeerleder. Metall. u. Erz. 1916, 13, 453—462, 473—481, 494—505. Z. angew. Chem., 1917, 30, Ref., 130.

SMELTING experiments were made in an electric shaft furnace on a copper-nickel sulphide ore from the Black Forest, which contained 1.3% Ni, 0.44% Cu, 14.7% Fe, 4.5% S, and 45% SiO₂, and has hitherto been neglected mainly on account of the low nickel content. The furnace product gave, on solidification, a nickel-copper matte, below which was a layer of a heavy compound of iron, nickel, and silicon containing only a very small quantity of sulphur and copper. Experiments made on a larger scale in a Girod electric furnace of 300 kilos. capacity gave a matte with 4.9% Ni, 4.1% Cu, 30.5% S, and 60% Fe, and a ferro-nickel with 13.8% Ni, 0.72% Cu, 8.37% Si, 1.32% S, and 75% Fe. A recovery of 91.3% of the total nickel and 77.4% of the total copper in the original ore smelted was made in these separate products. Refining of the ferro-nickel to a degree sufficient to allow of its use in the manufacture of nickel-steel can be carried out without difficulty. The addition of 5% of iron scale and an equal quantity of lime suffices to reduce the sulphur contents to a harmless amount.—J. N. P.

Zinc ore; Hydrometallurgical and electrolytic treatment of——. E. E. Watts. Met. and Chem. Eng., 1917, 16, 645—647.

THE author has made tests to ascertain how metallic zinc can be obtained continuously by electrolysis of a zinc sulphate solution with the addition of high-grade zinc products at the anode. Sulphurous acid or zinc sulphite prevents successful electrolysis, so that the product from sulphurous acid leaching of a zinc ore cannot be used without first being roasted. Any of the various forms of zinc oxide may be used successfully if added in separate anode compartments. The anodes were lead or antimony lead, the cathodes copper or aluminium, the current density from 2.5 to 4.5 amps. per sq. dem., and the voltage 3.5 to 6 volts. The process was operated on a small commercial scale with canvas diaphragms, and although it did not show a satisfactory profit, it appears to be workable if the diaphragm material can be satisfactorily improved.—W. H. P.

Condenser tube corrosion. W. Ramsay. Engineering, 1917, 104, 41—46.

THE corrosion of brass is due to local electrolytic action through non-homogeneity, which occurs in all alloys, e.g., at the junction of the crystals. In condenser tubes, corrosion is usually accompanied by the solution of the zinc, leaving the copper or material rich in copper as a coherent film, the original dimensions of the tube being nearly preserved. In the case of alloys of 60% Cu and 40% Zn, the action takes place between the α and β constituents and may proceed to completion, leaving a product which, on microscopical examination, is seen to consist of a material of the appearance of copper, which preserves the form of the α constituent, the space previously occupied

by the β being more or less filled by a corrosion product or possibly empty. With tubes of brass containing 70% Cu and 30% Zn, and Admiralty alloy, the corrosion appears to be accompanied by the formation of a more or less continuous film of copper on the surface; electrolysis then takes place between the copper and the underlying adjacent brass, resulting in a gradual concentration of copper. With these tubes the removal of zinc is as a rule superficial, the more compact nature of the residual copper sealing off the metal underneath from further action. The higher resistance of lead brass is also probably due to formation of a more insoluble corrosion product on the porous copper residue. There is evidence that the removal of zinc is accompanied by the solution of copper, which is re-deposited on the brass, an equivalent amount of zinc going into solution. Most copper compounds are capable of depositing metallic copper on brass. On painting tubes with basic chlorides of zinc and immersing them in warm sea water, a distinct copper-coloured stain results after some time. Defects sometimes appear on the inside of tubes in the form of laminations, which may often be traced for a number of feet; these arise from fissures or spills formed during the casting and elongated during the drawing. On opening up, these defects, which may occur as mere surface folds or may penetrate the wall of the tube to some extent, are seen to be coated with copper oxide which on immersion in sea water is gradually reduced to the metallic state, and this is probably the initial stage of electrolytic corrosion. In other cases, the interiors of tubes become pitted along the bottom through the settling of particles of iron which set up a local galvanic action accompanied by the deposition of ferric hydroxide along the tube. Metals which are electro-positive to brass, such as iron, zinc and lead, and carbon were found to initiate corrosion, probably through secondary action due to copper being re-deposited on the foreign metal. A corrosion which attacks the inlet ends for a few inches immediately beyond the tube plate was traced to the deposition of dissolved gases from the circulating cold water at the point where it becomes warm. This defect occurs where a smaller volume of steam is used, and owing to reduced circulation, the friction of the water is insufficient to sweep away the deposited gases; it is more marked when use is made of contaminated water, containing large amounts of carbon dioxide and ammonia. The extreme ends of the tubes are in some cases eaten away on account of the changed physical condition produced by crushing or distortion in the ferrule. Tubes which have been grooved corrode frequently in the locality of the furrows through overstrain during the grooving, and this defect could probably be remedied by annealing after finishing. The direction of the flow of current between hard and soft brass in an electrolyte varies in a very erratic manner, which is apparently due to polarisation and the condition of the electrode surface. The difference of potential in the cold is usually about 2.5 to 5 millivolts, and is increased by bubbling air or carbon dioxide through the electrolyte, but unless fresh electrolyte is continuously supplied the current falls off very rapidly. The small currents involved cannot immediately have a corrosive effect, but when the conditions are favourable, as in a condenser, where the galvanic elements are in close metallic continuity and the resistance and polarisation low, the time factor becomes important. The E.M.F. from copper-brass is appreciably higher and becomes of significance in the consideration of electrolysis between brass and metal from which zinc has been dissolved. For some unknown reason, tubes, after several years of service, have been found practically unaffected except for dirt and slight oxidation, though such tubes respond to artificial corrosion

tests as readily as normal tubes. Tinning the metal, if well carried out, seems to increase the life in some cases, while in others it appears to accelerate the breakdown. Zinc and iron protectors have a slightly favourable influence on the life of the tubes. The corrosion of brass is more marked the higher the content of zinc and would appear to be best obviated by the substitution of more resistant alloys, such as cupro-nickel, for the manufacture of condenser tubes.—J. N. P.

Metal colouring. I. "Shakudo." II. New kind of "shakudo," and "shibuichi." S. Miyasawa. *Kogyo-Kwagaku-Zasshi* (J. Chem. Inds. Tokyo), 1917, 20, 109—134, 365—384.

SHAKUDO is an alloy consisting essentially of copper and gold, which is used in Japan for the manufacture of objects of art and is coloured by treatment with aqueous solutions containing copper sulphate and acetate. The author's experiments show that the coloration is due to the production of a layer of cupric oxide, the tint being determined by the thickness of the layer. The colouring solution contains hydrogen ions owing to hydrolysis of the copper salt, and when the alloy is introduced a local electrical circuit is formed between the gold and copper, the latter being dissolved as cupric ion and hydrogen ions being discharged, thus disturbing the equilibrium. In consequence of this, hydrolysis proceeds further, and the process goes on, with progressive increase of the concentration of cupric and hydroxyl ions, until the solubility product of cupric hydroxide is exceeded. The precipitated hydroxide is rapidly converted into the oxide, which is deposited on the surface of the alloy. An analogous coloration can be obtained on alloys containing palladium, platinum, and silver, respectively, in place of gold.

In confirmation of these views as to the mechanism of the coloration of shakudo, it is shown that a similar effect is produced by mere contact of copper with platinum, palladium, or gold in the solution used, and that an electric current is produced when a copper electrode is connected by a copper wire with a platinum or palladium electrode immersed in acid or in the salt solution used for colouring shakudo. The colouring of "shibuichi," an alloy of 25% of silver and 75% of copper, used for purposes similar to those mentioned for shakudo, is due to an analogous cause.

Iodimetry; Differential—, IV. Analysis of pyrolusite and other oxidised manganese ores. O. L. Barnebey and G. M. Bishop. *J. Amer. Chem. Soc.*, 1917, 39, 1235—1238.

THE method described previously (this J., 1917, 571) is not generally applicable because certain ores are decomposed only with difficulty by treatment with phosphoric acid and potassium iodide. Another method is now described based on the facts that whereas both ferric iron and manganese dioxide liberate iodine from potassium iodide in presence of hydrochloric acid, yet if the resulting solution be subsequently neutralised, only the ferrous iron is oxidised by the iodine, the manganese remaining in the divalent condition. To determine the available oxygen in pyrolusite (which practically always contains ferric iron), 0.2 gm. of the sample, powdered to pass a 200-mesh sieve and dried at 110° C., is treated with 10 c.c. of N/1 sodium iodide and 5 c.c. of concentrated hydrochloric acid, and the mixture allowed to stand, with frequent shaking, in a covered flask. When the reaction is complete, 0.2—0.5 gm. of sodium tartrate (to prevent hydrolysis of the iron salt) is added, the solution is diluted to 150 c.c., neutralised with sodium bicarbonate, and excess of the bicarbonate added.

The free iodine (equivalent to the manganese dioxide present in the sample) is titrated with arsenite solution, using starch as indicator.

Mercury; [*Laboratory*] apparatus for the purification of—. H. E. Patten and G. H. Mains. J. Ind. Eng. Chem., 1917, 9, 600—603.

THE apparatus combines the spraying of the mercury through a column of dilute nitric acid, with the automatic return and circulation of the mercury, electrolytic purification, and the automatic renewal of the nitric acid to remove products of the electrolysis and prevent impurities from being redissolved. The impure mercury flows from a main reservoir, through a stopcock, into a spraying chamber, and falls on to a piece of bolting silk stretched across the lower end of the chamber. The mercury passes through this, and is broken up into a fine spray as it enters the column of nitric acid. A platinum wire is fused through the side of the spraying chamber into a mercury contact cup, and this wire extends down to the mercury on the silk, which thus becomes the anode. The spraying chamber is fitted into the ground glass neck of a fall tube, a slot being provided in the neck for the introduction of the cathode wire into the tube. Just below the level of the electrode is an overflow tube through which the products of the electrolysis are withdrawn by means of a stream of dilute (2%) acid, which is introduced into the lower end of the fall tube from an acid reservoir at the rate of about 1000 c.c. during a run of 7 hours. Connected with the bottom of the fall tube is an injector constructed on the principle of the Sprengel pump, whereby the mercury is raised in small globules in a current of air through a tube of small bore to an auxiliary reservoir at the top of the apparatus. The inner tube of this device is connected with the laboratory vacuum system, whilst the tube through which the mercury is raised is surrounded by a heating coil to promote the oxidation of foreign metals in the mercury. The mercury then flows back into the main reservoir through a tube provided with a stopcock. The flow of mercury through the apparatus is regulated at about 30 c.c. per min., and during a period of 7 hours the metal circulates about 100 times through the acid. After circulating about 300 times it is drawn off through an outlet at the bottom of the fall tube. Mercury thus purified has given satisfactory results in thermo-regulators and in calomel half-cells. Any trace of nitric acid may be removed by distilling the mercury once with air bubbling through it as in Hulett's method (Phys. Rev., 1905, 21, 388), and then redistilling it *in vacuo*. About 7% of the mercury is lost by solution in the nitric acid, but upwards of 75% of this dissolved mercury may be recovered as calomel.—C. A. M.

Cerium-iron alloys. R. Vogel. Z. anorg. Chem., 1917, 99, 25—49. J. Chem. Soc., 1917, 112, ii, 259.

THE alloys were prepared in quantities of 20 grms in special porcelain tubes, the cerium used containing 95.6% Ce, with lanthanum and traces of iron, but free from neodymium and praseodymium. Nitrogen was used to protect against oxidation. Cerium of this degree of purity solidifies at 775° C. The solidif. point curve falls to a eutectic point at 335° C. and 5% of iron. The rising branch of the curve corresponds to the separation of a compound, $CeFe_2$, which is changed at 773° C. to the compound Ce_2Fe_3 . There is a second break in the curve at 1085° C., where Ce_2Fe_3 breaks up into liquid and a solid solution rich in iron. This solid solution contains up to 15% of cerium at 1085° C., diminishing on cooling to about 11% at 850° C. and lower temperatures. It undergoes two polymorphic changes due to those of iron, at

810° C., determined thermally, and again at 795° C., recognised by the appearance of magnetic properties on cooling. The change in saturation of the solid solution at these points, if any, is too small to be observed. Cerium, $CeFe_2$, and Ce_2Fe_3 do not form solid solutions. The reactions in the solid state take place slowly, and there is difficulty in obtaining equilibrium. The compound $CeFe_2$ is magnetic at the ordinary temperature, but becomes non-magnetic at 116° C. It is uncertain how far the second compound is magnetic, as the alloys contain the magnetic solid solution, which becomes non-magnetic at 795° C. The hardness is a maximum at 60% of cerium. The saturated solid solution is more resistant to oxidation than pure iron. The compounds are readily oxidisable, especially $CeFe_2$. The pyrophoric properties reach a maximum at 70% of cerium, and depend on the presence of one or other of the compounds. Pyrophoric cerium alloys usually consist of a hard compound embedded in a softer, readily oxidisable ground-mass.

Metallic coatings prepared by the spraying method: Structure of—. H. Arnold. Z. anorg. Chem., 1917, 99, 67—72. J. Chem. Soc., 1917, 112, ii, 260.

COATINGS prepared by Schoop's method of melting the end of a rod of metal and converting the molten drops immediately into spray by the action of a blast of air have been examined microscopically. Such coatings may be obtained in an adherent form even on paper or celluloid. The molten drops are elongated during their flight through the air, so that each has a long tail. The coatings have a fine waved or laminated structure, which is characteristic, and enables them to be distinguished from coatings obtained electrolytically or by other methods. The laminae are due to the flattening out of the drops on reaching the surface. The union of the particles is a mechanical one, the fibres being felted together, and the evidence does not point to the formation of a true weld. Thus, successive spraying with zinc and copper leaves the two metals separate, and brass is not formed.

Silicon-coated metal. W. E. Vawter. J. Ind. Eng. Chem., 1917, 9, 580—581.

SAMPLES of iron wire were heated at temperatures ranging from 500° to 700° C. in a current of dry silicon hydride for varying periods up to 7 hours. In some cases a homogeneous coating of silicon was obtained, but, at best, only a thin fragile layer was deposited, which had a tendency to scale off. Preliminary treatment of the iron by pickling in acid and exposure to the air before heating gave no better results. In the case of other metals, including copper, nickel, and aluminium, no coating of any kind was obtained.

—C. A. M.

Sulphur chloride: Reaction of— with metals. Catalytic action of ether. N. Domanicki. J. Russ. Phys.-Chem. Soc., 1916, 48, 1721—1727.

PREVIOUS investigators have shown that some metals do not react with sulphur chloride either in the cold or on heating, whilst others react only on heating, and in a few cases the reaction begins at the ordinary temperature: the products of the reaction are sulphur and chlorides of the metals, with small proportions of sulphur compounds. The author finds that the reaction may be brought about or greatly accelerated by the agency of dry ether, with which the metallic chlorides form complexes and so enhance the thermal effect of the reaction. Under these conditions, magnesium, zinc, aluminium, tin, antimony, bismuth, molybdenum, iron, mercury, and gold are readily converted into their chlorides or etherates of the latter. On the other hand, the alkali metals,

calcium, cadmium, thallium, lead, tungsten, chromium, manganese, cobalt, nickel, copper, silver, and platinum, react either not at all or with extreme slowness. The metals which do react either (1) give chlorides which readily form etherates, as is the case with zinc, aluminium, tin, and bismuth, or (2) give chlorides which are readily fusible and volatile and approximate in their properties to the chloro-anhydrides; in correspondence with the latter, the higher chlorides are mostly formed, for instance, $ZnCl_2$, $FeCl_3$, $HgCl_2$. Univalent metals do not react and divalent metals—excepting mercury—if at all, react with far greater difficulty than trivalent and quadrivalent metals. It is probable that other metals, giving volatile higher chlorides, such as titanium, germanium, vanadium, and the like, would also react readily with sulphur chloride and ether.—T. H. P.

Galena and lead-bearing waste materials as glaze ingredients. Miller. See V111.

The hydration of ions, and metal overvoltage. Newbery. See X1.

PATENTS.

Cast-iron; Production of—S. Wallis, Darlaston, Staffs., J. S. Cudlip, Beeston, Notts., A. Parr, West Bridgford, Notts., and J. B. Cudlip, London. Eng. Pat. 106,196, Aug. 2, 1916. (Appl. No. 10,926 of 1916.)

CAST-IRON containing about 1.88% of silicon, 2.25% of graphitic and 0.67% of combined carbon, is produced by melting a mixture of 1 part of hot-blast pig iron, 3 of cold-blast pig iron low in silicon, 2 of the same of medium silicon content, and 4 of scrap iron. Mild steel (7 lb.) and aluminium (3 lb. per 10 cwt. of cast-iron) may also be added. —W. R. S.

[Cobalt-chromium] steel. P. R. Kuehnrich, Sheffield. Eng. Pat. 106,187, July 25, 1916. (Appl. No. 10,433 of 1916.)

THE steel contains carbon 1—3.5, chromium 6—20, and cobalt 1—6%. Small quantities (up to 1%) of nickel, molybdenum, tantalum, or vanadium may be added. The steel possesses the characteristic properties of high-speed steels, but melts at a lower temperature than tungsten high-speed steel, and can be hardened at a much lower temperature than is necessary with ordinary high-speed steels. —W. R. S.

Steel; Method and means for annealing — J. G. R. Munday, Kingston-upon-Hull. Eng. Pat. 106,624, Aug. 17, 1916. (Appl. No. 2365 of 1916.)

THE steel is heated, e.g., to 600°—700° C. for high-speed or air-hardened steel, and is then placed in a liquid annealing mixture of turpentine (1 gall.) and resin (1 lb.); common salt (2 lb.) and sulphur (1½ lb.) may be added to the mixture.—W. R. S.

[Steel] casting process and apparatus therefor. J. C. Davis, Hinsdale, Ill., U.S.A. Eng. Pat. 106,678, June 1, 1916. (Appl. No. 7805 of 1916.)

THE casting is made by mixing a modifying element (such as manganese) in suitable proportion with a uniform column of molten metal immediately prior to its entry into the mould. The flow of molten metal is controlled by a "choke device," and the modifying element is forced into the stream of metal between the "choke device" and the mould; valves connected for simultaneous operation control the flow of the two metals. The mould may be rotated, and the metal and modifying element brought together in gradually changing

proportions so as to produce a casting of varying composition from the periphery of the casting inwards.—W. R. S.

Manganese-steel; Manufacture of — for railway wheels. R. Schwarz, Vienna. Ger. Pat. 297,509, Oct. 5, 1915.

STEEL with about 1% carbon and 17% or more of manganese can be so tempered that it is equal in tensile properties and resistance to shock and wear to the well-known steels with about 1% carbon and 12% manganese, but in addition has a greater resistance at higher temperatures and so is particularly suited for railway wheels where heating occurs through impact and the action of brakes. Tempering is effected by heating to about 1000°—1100° C., and cooling by an air current or by a cooling liquid at a speed greater than that of ordinary air cooling but less than that produced by quenching in the usual way.—J. N. P.

Decaridation of mild steel, steel, or copper. H. König, Crefeld. Ger. Pat. 297,411, May 12, 1916. Addition to Ger. Pat. 290,309 (this J., 1916, 511).

THE process described in the chief patent (*loc. cit.*) is modified in that the carbon anode is made to dip into the bath of molten metal, whilst the cathode, which may be of carbon or other suitable material, is not in contact with the bath so that an arc is struck between it and the surface of the molten metal.—J. N. P.

Ores; Process for separation of — [by flotation]. E. Primosigh, Also-Szalank, Hungary. Eng. Pat. 29,340, Dec. 19, 1913.

AFTER crushing, the material is sifted with a sieve containing 130 meshes per linear inch. The fine portion is subjected to an intermittent flotation process in which the metallic particles are removed with the foam from a water, acid, and oil mixture flowing continuously away from the apparatus, accompanied by the minimum amount of liquid (see Eng. Pat. 10,087 of 1914; this J., 1917, 721). A duration of 3 to 4 hours may be required for the operation. The granular portion of the ore can be satisfactorily treated by a continuous flotation process.—J. N. P.

Flotation of minerals. H. P. Corliss, Pittsburgh, Pa., Assignor to Metals Recovery Co., New York. U.S. Pats. (A) 1,228,183 and (B) 1,228,184, May 29, 1917. Date of appl., Mar. 21, 1917.

THE pulp is subjected to a flotation process in presence of a small amount of (A) α -naphthylamine or (B) nitronaphthalene, with or without addition of an oil.—W. R. S.

Ore concentrator or separator. W. H. Munroe, Assignor to G. A. Mattison and A. B. Conklin, Ashland, Ala. U.S. Pat. 1,230,081, June 12, 1917. Date of appl., Oct. 10, 1916.

AN open tank for the concentration of ores by flotation has curved walls elongated at the base so as to form a V-shaped trough. By means of a curved plate a stream of liquid is caused to flow across and in line with the upper surface of the liquid in the tank, and the ore is fed, in a thin layer, into the path of the entering liquid. The feed of liquid causes the body of liquid in the tank to rotate in a direction opposite to that of the hands of a clock.—J. N. P.

Mixer [for flotation process]. G. A. Williams, Lark, Utah. U.S. Pat. 1,230,638, June 19, 1917. Date of appl., May 23, 1916.

A TALL cylindrical vessel with a conical base is fitted inside with a smaller concentric vessel of the same form. The two vessels communicate at the

top and the space between them contains an oil and water flotation medium which is admitted to a definite height. An inlet pipe is connected with the base of the outer cylinder, and a separate outlet pipe with the base of the inner cylinder. Streams of air are admitted to the liquid in the outer space by means of jets near the base, and the inner vessel is provided with a series of agitators which are arranged to rotate on the same vertical shaft below fixed conical deflectors. A circulation of the liquid upwards from the outer to the inner vessel, carrying with it the material under treatment by flotation action, takes place through the lower specific gravity of the aerated liquid.—J. N. P.

Zinc; Production of metallic—A. J. F. de Bavay, Kew, Victoria, Australia. Eng. Pat. 102,142, Oct. 17, 1916. (Appl. No. 14,760 of 1916.) Under Int. Conv., Nov. 6, 1915.

Zinc is distilled from ore in a suitable furnace and the vapour, after passing through a flue filled with incandescent coke, or the like, to reduce any zinc oxide, passes into a condenser consisting of a long chamber divided into a number of compartments by cross-baffles or bridges projecting upwards from the bottom and sub-divided by other baffles depending from the top. A bath of molten zinc is maintained in the separate compartments, and by means of the depending baffles which extend below the surface of the zinc, the fumes caused to pass through a layer of the molten metal in its passage from one division to the other. The bridges are formed with a groove, the near side lip being made slightly lower than the far side lip, and the groove is connected to a pipe which projects downwards and dips into a vessel containing a body of molten zinc of sufficient depth to counterbalance the pressure in the condenser. A constant level of the bath of molten zinc is thus maintained within the compartments, the surplus zinc being withdrawn from time to time. Each compartment is further provided with a well having a plugged outlet by which the molten zinc may be tapped at the end of the operation. The last compartment is provided with an outlet flue leading to a chamber, to which an exhaust fan is connected. The separate compartments are heated and the temperature of the chambers falls progressively throughout the series. Lead and the least volatile impurities in the fume are thus condensed in the first chamber while cadmium and more volatile metals escape uncondensed with the exit gases from the last compartment which collects the purest zinc. For the refining of spelter the first compartment of the condenser may be adapted for the distillation of the zinc by admitting the metal in molten form from a suitable crucible. For this purpose, the first compartment is maintained at 900° C., the second at about 650°, and the third at about 450° C.

—J. N. P.

Furnace; Zinc smelting—J. W. and H. Hegeler, Assignors to The Hegeler Zinc Co., Danville, Ill. U.S. Pat. 1,227,050, May 22, 1917. Date of appl., Nov. 17, 1913.

NE of the walls of the furnace is provided with a framework, comprising metal supports and transverse metal bars supported by and extending between the supports, and is practically non-retractible by heat, whilst the other wall, of clay, contracts excessively and permanently under heat. The roof is formed from sections supported by the framework and by the fire-ay wall, and is in tilting and sliding engagement respectively with these walls.—B. N.

etal; Stirring molten—[in electric furnaces, etc.], E. Stassano, Turin, Italy. Eng. Pat. 106,313, May 15, 1916. (Appl. No. 6496 of 1916.)

IRRING is effected by imparting rotational move-

ment to the molten metal by means of a rotary magnetic field, electromagnetic cores being arranged on or in the casing of the chamber containing the molten metal and excited by a current controlled by a commutator, by means of which the current is periodically interrupted and the direction of rotation of the magnetic field reversed. The electromagnetic cores may be mounted on a support independent of the chamber containing the molten metal, and the chamber introduced within the support when stirring is required.

—J. N. P.

Open hearth regenerative furnaces, The Clyde Furnace Co. (A), Ltd., and W. Dixon, Glasgow. Eng. Pat. 106,376, Aug. 17, 1916. (Appl. No. 11,644 of 1916.)

THE lining is repaired whilst the furnace is in operation, by fitting at the damaged part a metal plate or fireclay slab and filling in plastic refractory material at the back thereof. The repairing material solidifies before the plate or slab is burnt away.—W. R. S.

Crucible or melting furnaces fired by solid fuel. I. Hall, Birmingham, Eng. Pat. 106,896, July 18, 1916. (Appl. No. 10,057 of 1916.)

IN a crucible furnace for use with solid fuel, the outer furnace casing is enlarged at the lower part so as to form, in conjunction with the lining, an annular blast or air chamber, into which air, under a pressure of, for instance, 6 inches of water, is introduced. The fuel is supported on a grate below the crucible, the grate preferably being constructed in halves. Air from the annular blast chamber is supplied through ducts to the space below the grate, and also, through another series of ducts, to the interior of the furnace above the grate. Inspection holes are formed in the outer casing opposite this second series of ducts and are provided with sliding covers.—J. N. P.

Furnace; Heat-treating—T. F. Bailly and F. T. Cope, Assignors to The Electric Furnace Co., Alliance, Ohio. U.S. Pat. 1,227,027, May 22, 1917. Date of appl., May 13, 1915.

THE furnace is provided with a heating chamber, having inlet and outlet openings on opposite sides and doors arranged normally to cover the openings, mechanical means being arranged to pass the material to be treated through the chamber, and similar means for opening and closing the doors. A thermally-controlled device, for measuring the temperature of the furnace, is located within the heating chamber, and an electrical controlling means is provided to form an operative connection between the temperature-measuring device and both the mechanical means.—B. N.

Metal-melting furnace, D. S. Marfield, Assignor to The Buckeye Products Co., Cincinnati, Ohio. U.S. Pat. 1,229,494, June 12, 1917. Date of appl., Jan. 2, 1917.

A ROTATING cylindrical furnace, lined with refractory material, is mounted horizontally on bearings. A horizontal blowpipe with ports for gas and air passes through one of the bearings, and a charging and pouring port for the metal leads through the wall of the chamber at right angles to the axis of rotation. The charging port at its inner end has an annulus projecting for a short distance inside the chamber and adapted to baffle the combustible gases as they sweep along the wall of the chamber towards the port.—J. N. P.

Aluminium; Process for obtaining by a cold process a galvanic deposit of—E. L. Lalbin, Paris. Eng. Pat. 106,400, Sept. 23, 1916. (Appl. No. 13,523 of 1916.)

ALUMINIUM chloride, dissolved in a liquid hydro-

carbon such as toluene, etc., is electrolysed, the liquid being rendered conductive by the addition of "potassium bitfluoride."—B. N.

Aluminium-soldering flux. H. V. Burt, Rock Island, Ill. U.S. Pat. 1,225,761, May 15, 1917. Date of appl., Mar. 2, 1916.

THE flux contains: oleic acid 90, and spirit of ammonia 8 parts.—W. R. S.

Aluminium alloy, and articles made therefrom. A. W. Morris, Springfield, Mass. U.S. Pat. 1,227,174, May 22, 1917. Date of appl., Nov. 26, 1915.

THE alloy contains not less than 70% of aluminium, together with 1—6% of iron, and one or more other hardening metals such as nickel.—J. N. P.

Aluminium skimmings, screenings, dross, slags, or analogous aluminous materials; Process for treating —. S. W. Lawrie, Milwaukee, Wis. Assignor to W. F. Jobbins, Inc., Aurora, Ill. U.S. Pat. 1,228,119, May 29, 1917. Date of appl., Sept. 8, 1913.

THE material is treated with a solution of alkali so as to produce an aluminate solution from which zinc, copper, and other impurities are precipitated as sulphides. The metals may be extracted from the sulphide precipitate.—J. N. P.

"Bronzing" or colouring of metallic surfaces [; Electrolytic] —. Q. Sestini and T. Rondelli, Bergamo, Italy. Eng. Pat. 106,774, Nov. 18, 1916. (Appl. No. 16,582 of 1916.)

A COLOURED protective layer is formed on a metallic surface by covering it with a deposit of electrolytic iron or copper which is subsequently oxidised. The article to be coated is, without preliminary cleaning, arranged as cathode in a strongly alkaline solution, heated to 120°—140° C., while the anode consists of iron or copper, and a current of about 5 amps. per sq. dm. is passed for 1 to 2 mins., when the surface is at the same time cleaned and coated with metal. The current is then passed in the reverse direction for 6 to 8 mins., when the metallic deposit previously formed is oxidised, the completion of the oxidation being shown by the change of voltage, which rises from about 0.6 to between 1.8 to 2 volts. The alternate deposition and oxidation may be repeated several times, ending finally with an oxidation, by arranging the article as anode. The deposit is strengthened and rendered more adhesive by subsequently immersing for a few minutes in a solution of sodium hydroxide of sp. gr. 1.1 and containing 10—20% of sodium nitrate, nitrophenol, or nitronaphthol, and heated to about 140° C. After drying, the article is immersed for 10 mins. in a bath of olive oil heated to 150—180° C. The colour and brightness of the deposit are determined by the electrolyte employed and the number of alternations of the electrolysis.—J. N. P.

Electric heating and tempering [of metals]; Apparatus for —. The Sneed and Co. Iron Works, Jersey City, N.J., U.S.A., Assignees of H. P. Macdonald, Montclair, N.J., and E. M. Huggins, New York. Eng. Pat. 106,940, Nov. 3, 1916. (Appl. No. 15,733 of 1916.) Under Int. Conv., June 14, 1916.

METAL tubes or the like to be tempered or annealed are held vertically by two pairs of jaws which make contact at the two ends and serve as terminals for the passage of an electric current through the tube. The lower pair of jaws is mounted on a movable support, which is forced downwards as the tube expands on heating. After a predetermined degree of expansion,

corresponding to the desired temperature, has been reached, a trip lever is released by the movable support which permits a counterweight to open a switch cutting off the supply of current and at the same time opening the supporting jaws and allowing the metal to fall into a quenching liquid.—J. N. P.

Cementation compound. J. M. Allen, J. C. Christen, and O. S. Miller, St. Louis, Mo. U.S. Pat. 1,226,739, May 22, 1917. Date of appl., Sep. 15, 1916.

A FINELY-DIVIDED mixture of equal weights (30—32%) of anthracite coal, bones, and carbonaceous matter, together with from 4—10% by weight of manganese.—J. N. P.

Carburising agent. L. Dankmeyer, Königsberg, Ger. Pat. 297,244, May 5, 1915.

THE claim is for coating materials used for carburising iron with a mixture of lime, gypsum, sodium silicate, or the like. On adding the material to molten iron, the covering layer melts, forming a slag which protects the carbon against oxidation and causes its solution in the metal to proceed slowly.—J. N. P.

Ores; Apparatus for roasting —. G. L. Tanzer, Seattle, Wash. U.S. Pat. 1,226,923, May 22, 1917. Date of appl., Mar. 25, 1915.

A ROTARY furnace is provided with hollow trunnions, and with a pump for moving fluid to and fro from end to end of the furnace, means being arranged to operate the pump and rotate the furnace simultaneously. The pump is composed of a cylinder with a solid piston reciprocating between its ends, and each end of the cylinder is connected by means of a pipe and swivel with one of the hollow trunnions.—B. N.

Metal-bearing substances; Process of reducing —. G. L. Fogler, Pittsburgh, Pa. U.S. Pat. 1,227,127, May 22, 1917. Date of appl., Mar. 30, 1912.

A CHARGE containing a metal (iron-) bearing substance is subjected to partial reduction in a furnace in the presence of felspar and insufficient carbon to complete the reduction, whereby a spongy mass is obtained by the solution in the molten slag of the partially reduced iron oxide. The product is then transferred to a second furnace together with carbon, when complete reduction is brought about and the iron separates in the fused condition from the slag.—J. N. P.

Dehydrator [for ore pulp]. C. Robinson, Mount Vernon, N.Y., Assignor to Metallurgical Engineering and Process Corporation, U.S. Pat. 1,227,491, May 22, 1917. Date of appl., July 21, 1913. Renewed Oct. 10, 1916.

A FILTERING drum into which the ore pulp to be dehydrated can be admitted is enclosed by a containing vessel and arranged to rotate in a vertical plane. The liquid collecting in the container can be raised from gutters at either side and fed directly on to the surface of the drum.—J. N. P.

German-silver alloy products and manufacture of same. R. Beck, Assignor to Dürener Metallwerke Akt.-Ges., Düren, Germany. U.S. Pat. 1,227,569, May 29, 1917. Date of appl., June 27, 1914.

THE alloy consists of zinc 40—50, nickel 5—15%, and at least one of the following: cobalt, manganese, iron, aluminium, tin, magnesium, or lead, the nickel predominating among these metals and the remainder consisting mainly of copper. The alloy is heated to redness, and rolled, drawn, extruded, stamped, or forged, while hot.—W. R. S.

Casings; Method of making —. W. A. Bole, Pittsburgh, Pa. U.S. Pat. 1,227,573, May 29, 1917. Date of appl., Sept. 25, 1912. Renewed, Apr. 12, 1917.

ABSORPTION of oxygen by the molten metal during casting is prevented by filling the mould with and submerging the pouring hole in an atmosphere of heavy inert dry gaseous products of combustion while pouring the molten metal.—W. R. S.

Copper-lead [manganese] alloy. E. D. Gleason, Asbury Park, N.J., Assignor to Neu-Metals and Process Co., Brooklyn, N.Y. U.S. Pat. 1,228,017, May 29, 1917. Date of appl., May 17, 1915.

A COPPER-LEAD-MANGANESE alloy is prepared by adding to a molten bath of equal weights of lead and copper, a mixture of 3% of cryolite and 2% of manganese oxide, together with some carbon.—J. N. P.

Precious metals; Apparatus for recovering —. C. R. Rawdon and F. McCoole, St. Louis, Mo. U.S. Pat. 1,228,133, May 29, 1917. Date of appl., Dec. 18, 1916.

A TANK is provided at one end of the base with an inlet pipe, and at a higher level on the opposite side, with a discharge pipe. A perforated screen or diaphragm is disposed horizontally in a plane between the inlet and discharge. An endless belt fitted with buckets of porous fabric travels over the surface of the liquid circulating through the tank, so that the buckets dip slightly below the surface of the liquid and gather or skim the metal values. On emerging from the tank the liquid in the buckets is forced through the fabric by the application of pressure and the residue deposited at the head of the tank.—J. N. P.

Composite metal article. F. A. Fahrenwald, Cleveland, Ohio. (Dedicated to the public.) U.S. Pat. 1,228,194, May 29, 1917. Date of appl., May 31, 1916.

TUBES and other articles for use at temperatures up to 1000° C., which are ductile, mechanically strong, and resilient, are made of tungsten or molybdenum coated with a surface layer of gold or gold-palladium alloy.—J. N. P.

Manganese alloys; Making low carbon —. E. Humbert, Niagara Falls, N.Y. U.S. Pat. 1,228,925, June 5, 1917. Date of appl., Mar. 6, 1914.

COMMERCIAL ferro-manganese which contains about 6% of carbon is heated in contact with manganese oxide in an electric furnace to a temperature above 1700° C., until the carbon content is reduced to about 1% or less.—J. N. P.

Alloy. H. S. Cooper, Assignor to The Electro Metals Products Co., Cleveland, Ohio. U.S. Pat. 1,229,037, June 5, 1917. Date of appl., Aug. 14, 1915.

AN alloy for electrical contact purposes is composed of silver 70, palladium 25, and cobalt 5%.—W. R. S.

Welding process; Electric —. C. B. Auel, Wilkinsburg, Pa., Assignor to Westinghouse Electric and Manufacturing Co. U.S. Pat. 1,229,700, June 2, 1917. Date of appl., Dec. 10, 1914.

A THIN sheet or ribbon of oxidisable metal is prepared for welding, by forming a large number of relatively small indentations on one side over substantially the area to be welded, and thus producing a like number of relatively sharp projections upon its other side. The surface coating of oxide is thus broken up, without distorting or weakening the sheet or ribbon, and the treated surface is placed against another metal surface, and electric current and pressure applied.—B. N.

Metal article, and process of making same. C. H. Humphries, Kearney, N.J., Assignor to The Commercial Research Co., Long Island City, N.Y. U.S. Pat. 1,229,960, June 12, 1917. Date of appl., Sept. 28, 1914.

FINELY divided tungsten is agglomerated into a solid massive form by the use of a small amount of nickel as a binding material for the particles of tungsten. The resulting metal is dense, hard, and non-ductile, but sufficiently malleable to allow of swaging hot or cold.—J. N. P.

Ores or metal-bearing products; Process for treating —. F. A. Eustis, Milton, Mass. U.S. Pat. 1,230,143, June 19, 1917. Date of appl., May 8, 1916.

OXIDISED iron ore which contains one or more of the metals, nickel, cobalt, aluminium, or manganese, is heated in the dry condition in an atmosphere of sulphur dioxide so as to bring about intimate contact between the material and the gas. By this treatment a relatively small amount of iron and a relatively large amount of the other metals are rendered soluble. The ore is then leached with a suitable solvent heated to boiling, and the iron precipitated from the solution by continued boiling.—J. N. P.

Copper; Process for extraction of — from its ores. H. B. Slater, Los Angeles, Cal. U.S. Pat. 1,230,078, June 12, 1917. Date of appl., July 28, 1915.

ORE containing native copper together with calcite is leached with a solution of ferric chloride and either sodium or calcium chloride, whereby copper is dissolved and a portion of the iron is precipitated. The solution is separated from the ore, the copper precipitated by the addition of metallic iron, and the solution is then regenerated by free chlorine, and used for a further extraction.—J. N. P.

Bearing metals; Manufacture of white —. Maschinenbau-Anstalt Humboldt, Cöln-Kalk. Ger. Pat. 297,210, Oct. 10, 1915.

ABOUT 3% of calcium is alloyed with lead by introducing it below the surface of the molten metal, and small quantities (1–3%) of cadmium and of bismuth are subsequently added to the melt. The resulting alloy is claimed to be equal in value to the best white metal alloys of high tin content.

Bearing metals; Manufacture of white —. C. Hassler, Aalen. Ger. Pat. (A) 297,290, Feb. 2, 1916, and (B) 297,291, Mar. 14, 1916.

(A) AN alloy is first prepared from 56–62 parts of antimony, 40–32 parts of copper, and 4–6 parts of 30% silico-copper, and from this a second alloy is prepared containing 15–35% of the first alloy, the remainder consisting of equal parts of antimony and tin. The final alloy is prepared by melting together 85–65 parts of lead and 15–35 parts of the second alloy. (B) An alloy is prepared by melting together 70–80 parts of zinc, 2–6 parts of copper, and 18–24 parts of a tin alloy composed of Sn 84–80, Sb 11–12, and Cu 5–8 parts. From this first alloy a second alloy is prepared by fusing 7–12 parts of it with 55–65 parts of lead and 23–33 parts of the tin alloy mentioned above. This second alloy is used in the preparation of alloys containing more than 17% Pb for the production of white metal bearings.

Platinum; Separation of — by a dry process. H. Haedicke, Schladerm. Ger. Pat. 297,211, July 28, 1916.

POWDERED ore containing platinum, or platinumiferous sand, is passed between the discharge poles of a high-tension electric circuit, when the heating action of the sparks causes the platinum grains to fuse on to the metal of one of the pole pieces.

After acquiring a certain concentration of platinum the pole plate is removed and the platinum recovered by melting off the base metal.—J. N. P.

Ores; Drying of moist —. W. Buddäus, Charlottenburg, Ger. Pat. 297,380, June 25, 1916.

A METHOD particularly suited for the drying of finely divided ores consists in mixing the material with a calculated amount of low-grade fuel such as lignite, peat, or sawdust, and placing it on two superimposed grates in a furnace. The material on the upper grate is partially dried by the hot gases rising from the lower layer, which is dried by the heat produced by combustion of its contained fuel. The partially dried material is transferred from the upper to the lower grate. Ores already containing combustible matter, such as bituminous ores, are dried by combustion of the organic matter without addition of fuel.—J. N. P.

Crucible furnaces for melting brass and other metal; Coverings of —. P. J. Weston, Birmingham, Eng. Pat. 106,781, Dec. 5, 1916. (Appl. No. 17,157 of 1916.)

Castling metal; Means for —. I. Hall, Birmingham, Eng. Pat. 106,850, June 2, 1916. (Appl. No. 7830 of 1916.)

Ores; Treatment of —. A. H. Higgins, Assignor to Minerals Separation, Ltd., London, U.S. Pat. 1,227,615, May 29, 1917. Date of appl., Nov. 11, 1913.

SEE Eng. Pat. 27,323 of 1912; this J., 1914, 204.

Ores; Art of fusing —. R. P. Pietet, Paris, U.S. Pat. 1,230,431, June 19, 1917. Date of appl., Oct. 29, 1913. Renewed May 12, 1917.

SEE Fr. Pat. 461,895 of 1912; this J., 1914, 201.

Zinc; Process of producing pure —. H. Specketer, Griesheim, Germany, U.S. Pat. 1,231,083, June 26, 1917. Date of appl., Sept. 2, 1913.

SEE Fr. Pat. 461,905 of 1913; this J., 1914, 205.

Zinc and other similar metals; Apparatus for producing —. H. Specketer, Griesheim, Germany, U.S. Pat. 1,231,084, June 26, 1917. Date of appl., Jan. 29, 1915.

SEE Ger. Pat. 290,643 of 1914; this J., 1916, 611.

Means for discharging material from mechanical furnaces. Eng. Pat. 107,185. See I.

Combined furnaces and gas producers. Eng. Pat. 106,513. See 11A.

Ductile filament. U.S. Pat. 1,226,925. See 11B.

Method of processing aluminium skimmings, screenings, slags, or analogous materials. U.S. Pat. 1,229,611. See VII.

XI.—ELECTRO-CHEMISTRY.

Electrolytic migration; Phenomena of —. *Electrolysis of mixed solutions of alkali salts.* M. Van Laer, J. Chim. Phys., 1917, 15, 151—163.

THE insertion of a diaphragm between the walls of a vessel containing a liquid undergoing electrolysis with electrodes which are not attacked, causes notable changes of concentration in the two compartments. A solution of potassium or sodium hydroxide thus becomes more concentrated at the negative pole, and more dilute at the positive pole, while the converse relationship is obtained with an acid. The change in the concentration is determined by the transport numbers or the relation between the migration velocities of anion and cation, and also by diffusion and electrical endosmosis, which favour the migration of certain ions and retard those with an opposite electrical charge. The transport numbers are

again affected by temperature, and the diffusion and cataphoresis effects vary with the potential and with the current density. With sodium hydroxide, cataphoresis and increase of temperature both hinder the migration of the hydroxyl ion relatively to the sodium ion, thus increasing the concentration in the catholyte. The current yield in regard to this concentration increases with the current density up to a certain limiting value, when further increase of current density gives a relatively lower yield. The most favourable intensity of current varies with the concentration of the electrolyte. With 2.5 amps., at 15 volts potential between the electrodes, in 865 c.c. of 0.775 N sodium hydroxide solution, and a temperature of 17.5° C., after passing 10 amp.-hrs., an increase of concentration corresponding to a current yield of 35.7% was obtained. With an anolyte of sodium carbonate and a catholyte of sodium hydroxide a similar concentration of sodium hydroxide occurs at the cathode, while bicarbonate is formed at the anode and finally precipitates, and the resistance of the cell gradually increases and finally stops the electrolysis. By adding to the anolyte a soluble oxy-salt such as nitrate, sulphate, chlorate, or perchlorate, the increase of resistance can be avoided, while the migration of sodium ions to the catholyte is not hindered. In this way, at a temperature of 52° C., starting with an anode liquor of 3.3 N sodium hydroxide and a cathode liquor of saturated sodium carbonate, together with 100 grms. of sodium nitrate per litre, and a current of 10 amps. for 13 hours, a concentration of 11.3 N sodium hydroxide was obtained with a current yield of 42.6%. This method of electrolytic concentration also enables pure baryta to be prepared from witherite (BaCO₃), used in conjunction with barium nitrate.—J. N. P.

Overvoltage; The hydration of ions and metal —. E. Newbery, Chem. Soc. Trans., 1917, 111, 170—189.

THE overvoltages, cathodic and anodic, of a number of metals during deposition have been measured under varying conditions of time and current density, and also in the presence of colloids. Under these conditions, cathodic overvoltages are generally very low, less than 0.5 volt, but with iron, nickel, and cobalt they are very high. Anodic overvoltages are low, unless passivity occurs, and passivity, during metal deposition, has been observed with iron, nickel, and thallium. Metal overvoltages are due to the formation of hydrides, higher oxides, etc., on the electrode surfaces, and the cathodic compounds form solid solutions in the deposited metal, which are very dilute except in the cases of iron, nickel, and cobalt. The single potentials of iron, nickel, and cobalt have been re-determined, but accurate and reproducible values are obtained only in the absence of free hydrogen and metallic hydrides. The single potentials of these metals are changed by 0.06 to 0.13 volt by rapid motion of the metal electrode relative to the electrolyte, but those of other metals are affected to a much smaller degree by similar treatment. The ions H, OH, Fe, Ni, and Co are hydrated in aqueous solutions: the ions Cu, Ag, Zn, Cd, Hg, Tl, Pb, Sn, NH₄, Na, K, Cl, NO₃, and SO₄ are non-hydrated. Colloids are carried into a metal surface only by hydrated ions, and have no effect on overvoltage, and little or none on the nature of the deposited metal unless such ions take part in carrying the current. Previous determinations of the degree of hydration of ions, by observations of the change of concentration of a non-electrolyte present, have given incorrect values due to the transport of the non-electrolyte by the ions present, and also by the action of electrical endosmosis. (See also this J., 1916, 1265; 1917, 38, 145.)—B. N.

Electrical conductivity of porcelain mixtures and shale upon heating. Kinnison. See VIII.

PATENTS.

Furnaces; Electric —. T. H. Watson and Co., H. A. Greaves, and H. Etchells, Sheffield. Eng. Pat. 106,626, Mar. 1, 1916. (Appl. No. 3067 of 1916.)

THREE-PHASE currents are distributed so that the supply phases have balanced loads, by grouping three transformer secondary windings in "star" fashion, so that the two windings connected to the two upper electrodes or groups of electrodes of the furnace are identical in output and voltage. The voltage of the winding connected to the lower electrode, embedded in the hearth of the furnace as a resistor, is less than either of the other two, and is proportioned according to the resistance of the lower electrode, the voltage in this winding being varied to balance the loads on the supply phases when the currents through the upper electrodes are equal. In an alternative arrangement, with two-phase currents, both supply phases are loaded when either electrode carries current, the two upper electrodes being connected to the opposite ends of the transformer secondary winding supplied by one phase of the two-phase supply, whilst the lower electrode is connected to one terminal of the transformer secondary winding supplied by the other phase, the other terminal being connected to the middle point of the first-named transformer secondary winding. The secondary voltage between the terminals connected to the upper electrodes is twice (or less than twice if resistance be interposed in the bottom electrode) the voltage between the terminals in the other transformer secondary winding, whereby the loads on the two phases of primary supply are balanced when equal currents pass through each of the top electrodes.—B. N.

Furnace; Electric induction —. J. Funck, Charlottenburg, Germany. Assignor to The Gröndal Kjellin Co., Ltd., London. U.S. Pat. 1,226,764, May 22, 1917. Date of appl., Feb. 2, 1916.

THE hearth of an electric induction furnace is lined by placing the lining material around a templet, comprising several hollow metallic elements, with suitable reinforcements, arranged at the furnace hearth, so that the templet closely fits and entirely covers the inner surface of the lining material. The templet, which is provided with an enveloping sheath of asbestos, or similar material, is utilised for heating and consolidating the material to form the lining *in situ*, and finally the templet is fused to form the metal bath of the furnace.—B. N.

Discharge of molten products from a furnace or other apparatus; Means for [electrically] promoting the —. Furnace for making products electrically and means for facilitating discharge of the same. Furnace for electrically making products and means for heating discharged products. J. H. Reid, Newark, N.J., Assignor to Patents Process Co. U.S. Pats. (A) 1,227,067, (B) 1,227,068, and (C) 1,227,069, May 22, 1917. Dates of appl., (A) Dec. 28, 1914, (B) and (C) Aug. 12, 1915.

(A) A DISCHARGE duct, forming the tap-hole of the furnace, is arranged in line with a trough extending from the duct, and the molten material flowing from the tap-hole through the trough completes an electrical circuit between one electrode arranged entirely within the furnace, and a second electrode situated in the trough outside the furnace wall. (B) A closed receptacle, attached to a condenser, is provided with electrodes, and the means for bringing the electrodes and the receptacle into an electrical circuit. The resistance between the electrodes is altered by means con-

trolled by an arrangement actuated electrically, so that products having varying volatilising points can be recovered by uniformly inducing and maintaining selective temperatures in substances of progressively varying resistance. Suitable means are provided for supplying the material to be acted upon, and for separating and recovering the desired product during the operation. The fore-hearth is heated by an electric arc produced by an induced or secondary current between opposite electrodes, independently of the discharge opening, in order to maintain the product in a fluid condition at the point of discharge. (C) The apparatus described in the preceding abstract (B) is claimed for producing fluid products from solid carbonaceous substances.—B. N.

Electrodes; Manufacture of —. E. H. Becker, Washington, D.C., Assignor to Kinetic Electric Co., Norfolk, Va. U.S. Pat. 1,228,169, May 29, 1917. Date of appl., Sept. 27, 1916.

A SLURRY of finely-ground copper oxide is made with water containing a small amount of a temporary binder, and the slurry is vibrated in a mould until it forms a compact body with the particles interlocked. The clear liquid is separated and the vibration continued to unite the particles.—B. N.

Manganese depolarising compound; Non-hydrated moisture-containing —. C. Ellis, Montclair, N.J., Assignor to National Carbon Co., Long Island City, N.Y. U.S. Pat. 1,228,359, May 29, 1917. Date of appl., Oct. 23, 1915.

AN intimate mixture of graphite and artificial manganese dioxide free from acid and containing occluded moisture, is used as a depolarising agent for Leclanché batteries, the proportion of graphite being substantially less than that of the manganese dioxide.—B. N.

Storage battery plates; Wood separator for —. Separator for storage-battery plates. W. Morrison, Chicago, Ill., Assignor to Vesta Accumulator Co. U.S. Pats. (A) 1,228,368 and (B) 1,228,369, May 29, 1917. Dates of appl., (A) Nov. 11, 1916, and (B) Apr. 2, 1917.

(A) WOOD separators are treated with a solution of barium hydroxide, which is then converted into barium sulphate in the pores of the wood. (B) Strontium hydroxide is converted into sulphate in the pores of the separators.—B. N.

Storage-battery plates; Paste for — and process of making the same. Process of making pasted storage-battery plates. L. H. Flanders, Jenkintown, Pa. U.S. Pats. (A) 1,228,516 and (B) 1,228,547, June 5, 1917. Date of appl., Oct. 20, 1913.

(A) A NON-SETTING storage battery paste, of any desired lead content per unit volume, is made from "varying oxides of lead" by mixing with water to form a paste, and then mixing with sulphuric acid of strength adapted to preserve the required consistency of the paste; sufficient acid is used to produce lead sulphate in appropriate quantity for increasing the volume of the water paste to give a predetermined lead content per unit volume, whilst leaving sufficient oxide to react with sulphating material in order chemically to set the paste. (B) The paste, having a definite weight of lead per unit volume, is prepared from lead oxides of a definite density and known lead content, a portion of the oxide being converted into a quantity of lead sulphate appropriate to the ascertained density and lead content of the oxides used, and to the capacity required. The paste is applied to a grid and whilst still wet is sulphated to set it and then charged to produce material of the desired porosity.—B. N.

Storage-batteries; Negative-pole plate for — and process of making the same. W. G. S. Grant, Hamilton, Ontario, and L. H. Flanders, Jenkintown, Pa., Assignors to The Electric Storage Battery Co., Philadelphia, Pa. U.S. Pat. 1,228,551, June 5, 1917. Date of appl. Oct. 8, 1913.

THE plate, whilst the paste is still wet from the process of manufacture, is subjected to a prolonged soaking in dilute sulphuric acid, then reduced, and dried in a non-oxidising atmosphere. Coherent active material of pure lead is obtained, free from cracks and ready for discharge.—B. N.

Insulating material; Making — from basic magnesium carbonate and fibrous substances. K. Schmid, Assignor to "Lipsia" Chem. Fabr. A.-G., Muehl, Germany. U.S. Pat. 1,228,609, June 5, 1917. Date of appl. Nov. 9, 1916.

NORMAL magnesium carbonate is precipitated on a mass of fibrous substances suspended in a liquid containing magnesium hydroxide, by the action of ammonium carbonate. The liquid is filtered off, the mass dried and heated to convert the magnesium into basic magnesium carbonate; or a pasty mass of basic carbonate may be first formed and then added to the fibrous substances.—B. N.

Gas generator [electrolysis of water]. L. P. Seville, Providence, R.I. U.S. Pat. 1,230,803, June 19, 1917. Date of appl. Aug. 28, 1916.

HYDROGEN and oxygen are generated electrolytically, then cooled as they pass from the generator into separate containers, the condensed moisture being led back into the generator. A diaphragm is so arranged, containing chambers through which the gases pass on their way to their respective containers, that a predetermined difference of pressure on one side of the system causes the diaphragm to close the gas entrance to the opposite container, until a balancing pressure has again been raised on that side. By means of a body of water, the gases are automatically compressed to a pressure higher than that originally generated.—B. N.

Electric furnaces. J. W. Moffat, Toronto, Canada. Eng. Pat. 106,760, Oct. 11, 1916. (Appl. No. 14,466 of 1916.)

SEE U.S. Pat. 1,208,817 of 1916; this J., 1917, 224.

Process for improving the quality and yield of hydrocarbon gases. U.S. Pat. 1,229,042. See II.A.

Synthetic production of hydrocarbons. U.S. Pat. 1,229,886. See II.A.

Machines and method for waterproofing fibrous materials. U.S. Pats. 1,228,986—1,228,988. See V.

Electric insulating material resembling vulcanite. Eng. Pat. 107,122. See XIV.

[Electrical resistance] thermometer unit. U.S. Pat. 1,230,598. See XXIII.

XII.—FATS; OILS; WAXES.

Menhaden oil fatty acids; Composition of —. E. Twitchell. J. Ind. Eng. Chem., 1917, 9, 581—584.

FURTHER determinations by the melting point method previously described (this J., 1914, 797) have shown that the solid fatty acids of menhaden oil contain myristic acid and stearic acid, but not arachidic acid. The latter was present in the products of the hydrogenation of the total fatty acids, having been produced by the addition of hydrogen to an unsaturated fatty acid with 20 atoms of carbon. The menhaden oil fatty acids

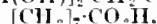
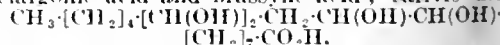
had therefore the following composition:—Palmitic acid, 22.7; myristic acid, 9.2; stearic acid, 1.8; unsaturated fatty acids with 16 carbon atoms, none; unsaturated fatty acids with 18 carbon atoms, 24.9; with 20 carbon atoms, 22.2; and with 22 carbon atoms, 20.2%. Fusion of the fatty acids with potassium hydroxide did not yield arachidic acid, and hence the fatty acid with 22 carbon atoms was not erucic acid, although, like that acid, it yielded behenic acid on hydrogenation. It is probably a more unsaturated acid, which is converted in the fusion into stearic or palmitic acid. This was confirmed by the depression of the m.p. of this fraction when melted with pure stearic and palmitic acids.—C. A. M.

Fats used in medicine; Oxidation values of —. G. Issoglio. Annali Chim. Appl., 1917, 7, 187—199.

THE method previously described (this J., 1916, 808) has been applied to the principal fats used in medicine, including olive, almond, and castor oils, lard, and cod liver oil, and to ointments, etc., containing fats. The general conclusion drawn is that oils for medicinal purposes, and benzoated lard should not have an oxidation value exceeding 10. In the case of expressed castor oils of different origin, free from alcohol, the acid values ranged from 7.52 to 18.23, and the oxidisability values from 0.85 to 3.18. Under the conditions of the determination 1 mgrm. of alcohol would reduce 1.738 c.c. of N/100 potassium permanganate solution. Although castor oil may show a high acid value it does not undergo the same decomposition as ordinary types of oil, and hence, even when old, may only contain a small quantity of the volatile aldehydic and ketonic products found in other oils. Codliver oil which is of a reddish or brownish-yellow colour ought not to be used for medicinal purposes, since it has almost invariably undergone some decomposition, as is shown by the high oxidation value. A high oxidation value of the fat in mercury ointment points to the use of a rancid fat in the preparation, whilst an abnormally high value indicates the presence of oil of turpentine.—C. A. M.

Fatty acids; Course of the reaction which takes place when higher unsaturated — are fused with potassium hydroxide. A. Eckert. Monatsh. Chem., 1917, 38, 1—10. J. Chem. Soc., 1917, 112, i, 317.

THE author has examined the action of molten potassium hydroxide on several dihydroxy- and monohydroxy-fatty acids with the following results: Dihydroxystearic acid when fused with 6 times its weight of potassium hydroxide, 3 times its weight of water, and 3/5ths its weight of potassium chlorate at 200°—220° C., for ten to twelve hours, yields pelargonic acid and azelaic acid. In the same way, dihydroxybehenic acid yields pelargonic acid and brassylic acid; sativic acid



yields azelaic acid, acetic acid, and hexoic acid. β -keto-stearic acid is practically unacted on. From these results the author draws the conclusion that dihydroxy-acids and monohydroxy-acids are not intermediate products in the decomposition of higher unsaturated fatty acids, and that the probable course of the reaction is to be regarded as the direct shifting of the double linking to the end of the chain.

Lipase; Activation of pancreatic — by cholate. J. A. de Jonge. Arch. Néerland. Physiol., 1917, 1, 182—197. J. Chem. Soc., 1917, 112, i, 36.

THE extent of activation of pancreatic lipase by sodium cholate depends on the age of the pancreatic extract and appears to vary rhythmically

as the age of the extract increases. A pancreatic extract, the activity of which is increased by the addition of sodium cholate, may at the end of a week have entirely lost the capacity for being thus activated. If this extract is kept for another week, the addition of cholate again begins to exert an activating action, and at the end of the second week the activation produced by the cholate may be greater than that observable with the original extract. At the end of the third week the activating capacity may have again vanished, and so on. The addition of gum arabic to the pancreatic extract produces an activating effect owing to its emulsifying action on the substrate, and this action is independent of the age of the pancreatic extract. The specific action of sodium cholate is therefore different from that of gum arabic; it is not concerned with the emulsification of the substrate, but with a true activation of the lipase.

Fuller's earth and its valuation for the oil industry.
T. G. Richert. J. Ind. Eng. Chem., 1917, 9, 599—600.

As it is not possible to determine the absolute bleaching power and absorptive capacity of fuller's earth, it is necessary to compare the results obtained with an unknown earth with those given under the same conditions by a sample already tested. From the results of laboratory determinations of loss of oil by absorption, and a knowledge of the loss by absorption in practice in the case of a particular earth, it is possible to calculate the presumptive loss with other earths under the same conditions. Assuming an earth will bleach an oil to a certain extent, the bleaching cost may be calculated by means of the formula—

$$V = \frac{x(100P + AO)}{100} \text{ cents,}$$

where x is the necessary % of earth, A the presumptive loss, and P and O the price in dollars for 100 lb. of earth and oil respectively. In practice the bleaching usually costs 25 to 50% less than is indicated by the calculation, since the effect is intensified by the close contact of the earth and oil under pressure.—C. A. M.

Glycerin analysis: Modified bichromate method for
— E. Little and B. C. Fenner. J. Amer. Leather Chem. Assoc., 1917, 12, 254—257.

A MODIFICATION of the bichromate method for rapid work is described. Five solutions are necessary: (1) basic lead acetate, made by dissolving 236 grms. of lead acetate in 1 litre of water, heating to boiling, adding 165 grms. of litharge whilst stirring, and continuing to boil for 15 mins., subsequently filtering and making up to 1 litre; (2) a cold, saturated solution of silver acetate; (3) 15% sulphuric acid; (4) $N/5$ or $N/10$ sodium thiosulphate solution; and (5) 10% potassium iodide solution. A sample containing 0.1—1.0 gm. of glycerin is washed into a beaker with 100 c.c. of water. Basic lead acetate solution is added slowly and in small quantities whilst stirring, until precipitation is complete. The precipitate should be allowed to settle after each addition. After filtering into a 250 c.c. flask, 12 c.c. of silver acetate solution is added to remove chlorides, and then sulphuric acid to remove lead and silver. The solution is made up to $\frac{1}{16}$ in. above the mark, and filtered (after shaking) into a glass stoppered flask. From the approximate strength of the original sample, the amount of bichromate is calculated which is necessary to oxidise the glycerin in 25 c.c. of the prepared solution. A quantity of bichromate 0.2—0.3 gm. in excess of this amount is weighed into a 1000 c.c. conical flask, and 25 c.c. each of glycerin solution, water, and concentrated sulphuric acid successively added, the last whilst gently shaking. If the solution turns blue more bichromate is needed and a fresh start should be made. The contents of the flask are heated for

30 mins. on the steam bath, cooled, diluted to 500 c.c., and immediately titrated with thio-sulphate solution, after adding 25 c.c. of hydrochloric acid (1:1) and 10 c.c. of potassium iodide solution. Starch paste is used as indicator. 1 gm. of bichromate used in the oxidation is equivalent to 0.1341 gm. of glycerol. The results are in excellent agreement with those obtained by the standard bichromate method.—F. C. T.

PATENTS.

Glycerin; Production of— G. J. Lemmens, Wateringbury, and P. J. Fryer, Tonbridge, Kent. Eng. Pat. 106,598, Feb. 21, 1917. (Appl. No. 2527 of 1917.)

OILS or fats are heated in an autoclave under pressure in the presence of water and zinc oxide or zinc hydroxide, and the glycerin is recovered from the liquor in the usual way. The mixture of fatty acids and zinc soaps is treated with boiling dilute sulphuric acid, the solution of zinc sulphate is separated, the zinc precipitated as hydroxide by the addition of sodium or potassium hydroxide or ammonia, and the zinc hydroxide used in the treatment of a further quantity of oil or fat.
—W. P. S.

Oils, fats, and greases; Apparatus for the extraction of— and of gelatin. H. Engel, London. Eng. Pat. 106,895, July 17, 1916. (Appl. No. 10,018 of 1916.)

THE material is extracted in one compartment of the apparatus by means of a solvent, which, with the extracted oil, etc., then passes into another chamber, where it is evaporated by means of heating coils or the like. A condenser is connected with this chamber and the solvent condensed therein is returned to the extraction chamber. Means are provided for hermetically separating the two chambers, and valves for controlling the communication of each with the condenser.—C. A. M.

Oils and fats; Preparing— for hydrogenation.
C. Dreymann, Baltimore, Md. U.S. Pat. 1,228,888, June 5, 1917. Date of appl., Dec. 6, 1915.

THE free fatty acids in the oil are converted into neutral esters by heating the oil with alcohol, a catalyst, and a dehydrating agent; the esters are left in the oil, and any remaining free fatty acids are neutralised. The glycerin may be separated from the fatty acids prior to their conversion into neutral esters.—C. A. M.

Soap and the like, and the manufacture thereof. W. Feldenheimer, London. Eng. Pat. 107,036, May 19, 1916. (Appl. No. 7194 of 1916.)

A "WATER-SOLUBLE" soap, of the character in which the lyes would ordinarily be salted out, is prepared by boiling the soap, retaining the lyes in the soap, adding china-clay or ball-clay when the soap is neutral or slightly alkaline, and running the whole direct into the crutcher and thence straight to the soap-frames, without any separation of the lyes. The clay is preferably freed from grit by the process described in Eng. Pat. 106,890 of 1916 (see page 879).—E. W. L.

Emulsifiable liquid or solid solution and method of making it. R. Vidal, Paris. U.S. Pat. 1,229,681, June 12, 1917. Date of appl., July 3, 1912.

SEE Fr. Pat. 445,053 of 1911; this J., 1912, 1190.

Paraffin, wax, fats and resins, naphtha and mineral oils; Process for obtaining from— products dissoluble in water or forming with it colloidal solutions. G. Petroff, Petrograd. U.S. Pat. 1,230,599, June 19, 1917. Date of appl., July 31, 1915.

SEE Fr. Pat. 452,054 of 1912; this J., 1913, 665.

Candle stock. U.S. Pat. 1,229,132. See IIa.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Sandarac; Detection of — in resins, lacrs, and partially manufactured materials. J. F. Sacher. *Farben-Zeit.*, 1916, 22, 188—189. *Z. angew. Chem.*, 1917, 30, Ref., 117.

THE dried material is extracted with ether, and the solution is filtered, concentrated, treated with ethereal sulphuric acid until reddish brown in colour, and finally diluted with half its volume of water. A characteristic smell is then produced which forms a very delicate test for sandarac from *Callitris quadrivalvis*. The test is not reliable for sandarac from *Callitris verrucosa* which contains pinene.—W. H. P.

Colloidal ferric ferricyanides. Haller. See VII.

PATENTS.

Paint composition. W. E. Wright, Cleveland, Ohio. U.S. Pat. 1,226,934, May 22, 1917. Date of appl., Aug. 26, 1916.

A FLAT-FINISH paint composition composed of a lead pigment together with not more than one-tenth of its weight of a mixture of about 3 parts of linseed oil, 2 parts of a semi-drying vegetable oil, and one part of tung oil.—J. N. P.

Paint for metallic surfaces subject to high temperatures. G. E. Rieck, Bremerton, Wash. U.S. Pat. 1,227,071, May 22, 1917. Date of appl., Apr. 7, 1915.

THE paint is composed of the products resulting from the reaction of japan, powdered aluminium, and "clabber" resulting from soured milk.—J. N. P.

Paint composition. O. H. Shultz, Windsor, Ontario. Assignor to F. M. Bill and R. M. Foster, Edmonton, Alberta, and L. R. Benson, Windsor, Ontario. U.S. Pat. 1,229,337, June 12, 1917. Date of appl., Mar. 14, 1916.

A PAINT composition contains the reaction products of litharge, 8; sodium silicate, 16; methylated spirit, 40; common salt, 8; alum, 8; lead acetate, 16; zinc sulphate, 32; potassium acetate, $1\frac{1}{2}$; gum arabic, 8; common rosin, 24; oxalic acid, 4; caustic soda, 32; and water, 6400 oz.—E. W. L.

Pigments; Process for obtaining —, especially black pigments, from lignite. C. Grossheim, Coln-Nippes. Ger. Pat. 297,411, Dec. 10, 1915.

COMPRESSED or briquetted lignite is raised to a white heat, complete combustion being avoided, and then quenched in water. The residue, powdered and suitably prepared, is a deep black pigment of great covering power and intensity, suitable for use as an oil or water colour. Paints prepared with it dry rapidly.—W. H. P.

Lampblack; Production of — from hydrocarbons. B. Thieme, Berlin. Ger. Pat. 297,266, Nov. 21, 1914.

GASEOUS hydrocarbon (usually acetylene) and a high-boiling liquid hydrocarbon (from coal tar or petroleum) are subjected in the same metal vessel to the action of an electric arc with a voltage of less than 1000. The arc is started without altering the position of the carbons, by means of an igniting current of higher tension from an induction coil. The lampblack remains in the liquid and sinks to the bottom, while the gaseous decomposition products (mainly methane and ethylene) mix with the acetylene in the gaseous phase. Air is now added, thus causing decomposition of the acetylene, and at the same time some of the hydrocarbons in the gaseous phase decompose further into carbon and hydrogen.—W. H. P.

Ink, and process for producing same. R. Hochstetter, Assignor to Ault and Wiborg Co., Cincinnati, Ohio. U.S. Pat. 1,226,884, May 22, 1917. Date of appl., Nov. 11, 1911.

A PIGMENT, sulphonated oil, and glycerin are thoroughly ground and mixed with about 5% of a gum varnish to form an ink, for mimeographs and the like.—J. N. P.

Varnish-bases; Process of making —. C. Ellis and L. Rabinovitz, Montclair, N.J., Assignors to Ellis-Poster Co., New Jersey, and to Indestructible Paint Co., Ltd., London. U.S. Pat. 1,226,760, May 22, 1917. Date of appl., Dec. 29, 1914.

ROSIN is dehydrated by heating and treatment with carbon dioxide, and the resulting rosin anhydride is treated at atmospheric pressure with an organic hydroxy compound, such as glycerin, to obtain a rosin ester.—J. N. P.

Varnish-removing composition. C. Ellis, Montclair, N.J., Assignor to Chadeloid Chemical Co., New York. U.S. Pat. 1,229,217, June 12, 1917. Date of appl., Mar. 21, 1917.

A PAINT and varnish remover comprises a mixture of coal-tar hydrocarbon solvents (mainly solvent naphtha), having a relatively low solvent action (less than that of benzol) on waxy material; a wax precipitant such as denatured alcohol; a wax such as paraffin wax, the purpose of which is to retard evaporation; and a relatively small quantity of carbon bisulphide, adjusted so as to ensure with the wax good film-formation.—E. W. L.

Moulding material, and process of making the same. J. P. A. McCoy, Wilkesburg, Pa., Assignor to Westinghouse Electric and Manufacturing Co. U.S. Pat. 1,227,465, May 22, 1917. Date of appl., July 3, 1914.

SHELLAC is precipitated in admixture with sodium or potassium tannate.—J. N. P.

Composition of matter [artificial resin]. B. B. Goldsmith, New York. U.S. Pat. 1,228,428, June 5, 1917. Date of appl., Aug. 4, 1915. (See also U.S. Pat. 1,168,626; this J., 1916, 317.)

A COMPOUND soluble in acetone and having the physical characters of a resin is obtained by heating together a phenol or a fusible phenol resin and a definite compound of formaldehyde and an amine (e.g., anhydroformaldehyde-aniline). The product of the interaction is readily fusible at first, and is transformed by heat into a hard, homogeneous substance without forming any readily volatile by-product.—C. A. M.

Resin; Artificial— and process of making the same. B. B. Goldsmith, New York, Assignor to Redmanol Chemical Products Co., Chicago, Ill. U.S. Pat. 1,230,829, June 19, 1917. Date of appl., July 27, 1910.

SEE Eng. Pat. 6363 of 1912; this J., 1913, 436. The reacting substances are mixed in such proportions as to furnish at least one phenolic group of the aromatic hydroxy compound to each methylene group of the hexamethylenetetramine.

Carbonate of lead [white lead]; Process for the production of —. G. Bevilacqua, Genoa, Italy. U.S. Pat. 1,231,476, June 26, 1917. Date of appl., Feb. 16, 1915.

SEE Eng. Pat. 9201 of 1915; this J., 1916, 932.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Hevea rubber of the Amazon district, Brazil; Comparative studies on different varieties of —. F. Heim. *Bull. de l'Office Colonial*, Melun, 1916, 9, 511—516. *Bull. Agric. Intell.*, 1917, 8, 600—601.

FROM the results obtained on chemical and

physical examination of 6 samples of "Borracha fina" from different parts of the Amazon district—Fina das Ihas, F. de Caviana, F. de Amapu, F. de Cajarv, F. de Xingu, F. de Tapajoz—the author concludes that the differential properties of the *Hevea* rubber trees indigenous to the various Brazilian districts are not sufficiently marked to justify preference for seed from one particular district in the formation of new plantations. The samples studied had the characteristics of a fine medium soft Para.—E. W. L.

PATENTS.

Rubber compound. E. von Vargyas, Washington, D.C., U.S.A. Eng. Pat. 107,107, Aug. 5, 1916. (Appl. No. 11,086 of 1916.)

A RUBBER compound having a high degree of wearing quality, and suitable for pneumatic tyre outer covers, is obtained by incorporating dry cork flour, 13 to 37, and granulated iron slag, 122½ to 215, with rubber, 120 parts, and vulcanising in the ordinary way.—E. W. L.

Insulating material resembling vulcanite; Electric —. T. S. Chivers and C. Marter, Stoke Newington. Eng. Pat. 107,122, Sept. 7, 1916. (Appl. No. 12,685 of 1916.)

SPENT tan, 5 oz., is finely ground and mixed with coal ash, 1½; soot, 2½; dry black pigment, 2; and sulphur, 3 oz., and the whole is then incorporated with rubber, 2 oz., in solution. The solvent is evaporated in a current of air, and the resultant mass vulcanised in the ordinary way.—E. W. L.

Indiarubber and rubber substitutes [from paper yarn]; Manufacture of heat-resistant goods from —. H. Kramer, Dresden. Ger. Pat. 297,328, Feb. 29, 1916.

FABRICS of paper pulp yarn are formed into packing rings, hose pipes, etc., and coated first with a layer of lacquer composition and then with a solution of rubber or rubber substitute. A suitable composition is made from pitch dissolved in benzene, or other similar material, which adheres well to paper yarn and combines with the rubber solution.—J. F. B.

Caoutchouc or rubber and the like; Non-skid composition of —. C. Pacchetti, Milan, Italy. U.S. Pat. 1,230,597, June 19, 1917. Date of appl., Nov. 14, 1916.

SEE Eng. Pat. 105,026 of 1916; this J., 1917, 558.

Process of impregnating fabrics with rubber. U.S. Pat. 1,228,458. See V.

XV.—LEATHER; BONE; HORN; GLUE.

Tannery wastes; Disinfection of —. D. D. Jackson and A. M. Buswell. J. Amer. Leather Chem. Assoc., 1917, 12, 229–253.

AN account of anthrax and the means by which it is spread is followed by an account of previous work on the disinfection of tannery effluents, particularly with regard to the killing of anthrax spores. The work of the authors was undertaken in consequence of an epidemic of anthrax. Experiments showed chlorine to be the most effective disinfectant: 3 parts per 1,000,000 reduced the count of a water suspension of anthrax spores from 700 per c.c. to 0 in 45 mins. 300 parts of chlorine per million had no effect on spores suspended in a peptone solution, owing no doubt to combination of chlorine and protein. Tests were carried out on the entire effluent from a tannery during 14 months. 50 parts of chlorine per 1,000,000 was used, and only coarse suspended matter was

removed from the effluent. Anthrax, though found six times in the raw sewage, has never been found after treatment, and no further outbreaks have occurred among the cattle of the district.—F. C. T.

Tannase of Aspergillus oryzae. Kita. See XVIII.

PATENTS.

Chromium oxide; Preparing compounds of — [for tanning]. E. Voetter, Krefeld, Germany. U.S. Pat. 1,228,622, June 5, 1917. Date of appl., July 2, 1914.

ORGANIC chromium compounds are prepared by reducing chromic acid or its salts in absence of free acid other than chromic acid, with glucose, either alone or mixed with thiosulphate. The compounds are specially adapted for tanning purposes.—J. H. J.

Leather; Process of treating — for gloves. A. Aaron and G. M. Jones, Gloversville, N.Y. Assignors to L. Meyers and Son, New York. U.S. Pat. 1,230,358, June 19, 1917. Date of appl., Aug. 30, 1916.

THE grain, and the surface on the flesh side of tanned, dry leather, are removed by an abrasive wheel or other means, after which the leather is coloured.—F. C. T.

Leather; Process for the manufacture of —. O. Carr, New York. U.S. Pat. 1,230,667, June 19, 1917. Date of appl., Nov. 6, 1915.

HIDES are treated with heated circulating tanning liquor, under reduced pressure, in a specially constructed chamber. The leather fabric so produced may be acidified or waterproofed while still wet and hot. Alkaline liquors may be used for tanning.—F. C. T.

Tanning hides; Process for —. Ges. f. Chem. Ind. in Basel. Ger. Pats. (A) 297,187 and (B) 297,188, Apr. 21, 1915.

(A) HIDES or skins are tanned with soluble aromatic compounds containing two or more sulphamino groups together with a sulphonic group, but no hydroxyl or free amino groups. The lined and bated skins are immersed or shaken in a 2–5% faintly acid solution of one of these compounds, and are tanned in one or more days according to their thickness. The leather is not coloured, and is very similar to vegetable-tanned leather. (B) Hides or skins are tanned with acidified solutions of arylsulphaminobenzyldisulphonic acids.—F. C. T.

Leather substitute; Preparation of — from tanned films of bacteria or proteins. H. Siebold, Berlin-Wilmersdorf. Ger. Pat. 297,189, Apr. 7, 1914.

BACTERIAL cultures or protein substances are incorporated before tannage with leather powder (not more than 60% of the total matter), or with treated oils e.g., factis or latices of tropical plants. Too much leather powder gives a brittle product, whilst when properly prepared, the substitute is pliable and resistant to mechanical action.—F. C. T.

Adhesive; Process for obtaining a neutral, non-drying — [from waste products of breweries]. H. Kühle, Darmstadt. Ger. Pat. 297,186, Sept. 15, 1915.

AN improvement on Ger. Pat. 264,291 (this J., 1913, 1079). During or after concentration of the brewery waste, molasses is added. The alkaline salts of the molasses react with the acid substances of the yeast, etc., and a neutral non-drying adhesive is obtained.—W. H. P.

Tanning and impregnating materials by means of electricity; Process for —. B. Schwerin. Frankfurt, Assignor to Elektro-Osmose A.-G. (Graf Schwerin Ges.). Berlin, Germany. U.S. Pat. 1,229,150, June 5, 1917. Date of appl. Sept. 8, 1914.

SEE Eng. Pat. 19,819 of 1914; this J., 1915, 1020.

Tanning fish-skins or the like; Process for —. K. Bendixen. Assignor to Skindfabriken Unicum, K. Bendixen. P. Bendixen & Co., Copenhagen, U.S. Pat. 1,230,266, June 19, 1917. Date of appl. Feb. 19, 1912.

SEE Fr. Pat. 140,092 of 1912; this J., 1912, 738.

Apparatus for the extraction of oils, fats, and greases and of gelatine. Eng. Pat. 106,895. See X11.

XVI.—SOILS; FERTILISERS.

Muscovite; Action of solutions of ammonium sulphate on —. R. F. Gardiner and E. C. Shorey. J. Ind. Eng. Chem., 1917, 9, 589—590.

MUSCOVITE is of common occurrence in soils, and is usually regarded as one of the most stable of soil constituents. The finely ground mineral (0.15 to 0.6 gm.) was treated with 10 c.c. of solutions of ammonium sulphate of from 0.5 to 1.5% strength for 24 hours at temperatures of 20° to 80° C. The amount of potassium oxide extracted ranged from 1.65 to 3.73% (25.5 to 57.65% of the total amount present). Increase in the concentration of the salt solution caused but slight differences in the proportion of potassium oxide extracted, nor was the influence of temperature very pronounced, although the extraction was greater at temperatures above 20° C. In parallel experiments in which the muscovite was heated for 1 hour in an autoclave at 160° C. with water only, and with a 4% solution of ammonium sulphate, the amounts of potassium oxide made soluble were 4.32%, and 47.3% of the total quantity respectively. Orthoclase treated with 1.5% ammonium sulphate solution at 65° C. yielded 0.08 to 0.25% of soluble potassium oxide, corresponding to 1.03 to 3.23% of the total quantity present.—C. A. M.

Soil; Influence of crop, season, and water on the bacterial activities of —. J. E. Greaves, R. Stewart, and C. T. Hirst. J. Agric. Res., 1917, 9, 293—311.

SAMPLES of soil were taken in foot sections from each plot of the experimental field and were analysed. The field was divided into five sets of plots, the first of which was left fallow, whilst the others were planted with alfalfa (lucerne), corn (maize), potatoes, and oats. A maximum, medium, and minimum application of water was made to three of each of the sets respectively whilst one was left unwatered. Samples of the soil were taken in April, July, and October–November and were analysed and examined bacteriologically. It was found that the amount of nitric nitrogen in the top 6 ft. of alfalfa soil was relatively low throughout the period, but was higher in autumn than in spring or summer. The amount rose with the increase in the water applied, but reached its maximum per acre-inch of water when only 15 in. of water was applied. In the case of the plots containing potatoes, oats, and maize, and also of the fallow ground, the amount of nitric nitrogen in the surface 6 ft. of soil decreased with increase of water, but the quantity formed in the soils containing the crops was greatest when most water was applied. The maximum per acre-inch of water was reached when only 15 in. of water was applied. The disappearance of large quantities of nitric nitrogen from the fallow soil during the summer months was attributed to the bacterial conversion of this nitrogen into proteins, and not

to denitrification. Larger applications of water (37 and 25 in.) conveyed much of the nitric nitrogen beyond the reach of the plant, and this explains the decreased yields of crops frequently observed on soils which have been excessively irrigated. The application of water to the soil reduced the number of micro-organisms capable of growing upon an agar medium, in the case of soils containing alfalfa, oats, and potatoes, but increased them in the fallow soil. The results obtained with the maize soil were irregular. The application of water to the soils increased the capacity for producing ammonia, except in the case of alfalfa soil, and the nitrifying power, except in the case of the oat soil. The temperature to a depth of 4 ft. was 2° F. higher in the unwatered than in the watered soils. The number of micro-organisms was higher in the soils on which crops were grown than in the fallow soil, this being probably due to plant residues left in the soil in the case of the former. The ammonia-producing capacities of the soils were in the following ascending order:—Alfalfa, oats, maize, potato, and fallow soils. Arranging them in increasing nitrifying powers they were:—Fallow, maize, oats, alfalfa, and potato soils. Alfalfa not only consumed more nitric nitrogen from the soil than the other crops, but also increased the nitrifying power of the soil. Hence it would deplete the soil of nitrogen more rapidly than the other crops, if the whole of the crop were removed. Irrigation increases the bacterial activity of the soil, and thus renders the nitrogen soluble, but if excessive quantities of water are used much of this nitrogen is washed from the soil, which then gives a reduced yield.—C. A. M.

Soil; Effect of decomposing organic matter on the solubility of certain inorganic constituents of —. C. A. Jensen. J. Agric. Res., 1917, 9, 253—298.

IX experiments to determine the extent to which the beneficial action of decomposing organic mulches is due to solution of mineral constituents in the soil, aqueous extracts were made of alfalfa (lucerne) hay, sweet clover, and barley hay. In each case 70 grms. of the finely chopped material was saturated with distilled water in a bottle and allowed to ferment for 14 days, and then thoroughly shaken with 1500 c.c. of water, and the extract filtered first through muslin and then through a Chamberland filter. The insoluble matter was again treated in the same way, and further extracts obtained. These extracts were added to the soils in the proportion of 250 grms. of soil to 500 c.c. of extract. Two types of soil, a clay loam and a sandy loam, were used. It was found that these aqueous extracts removed from the soil from two to five times as much calcium as was added to the soil with the extract. As a rule they also removed more magnesium than they introduced, the increase ranging from a trace to about 80%, but the amount of iron and phosphoric acid removed was less than that added to the soil by the extracts. At the same time, the amount of iron dissolved from the soil was from 1.7 to 5.4 times the amount dissolved by water. The solvent action of the various preparations, whether derived from leguminous or non-leguminous plants, was closely similar. Extracts prepared in the same way from cow manure removed less calcium from the soil than the vegetable extracts, but had much the same solvent action upon the other mineral constituents. Both the inorganic and organic salts in the aqueous extracts appeared to play a part in dissolving the mineral substances in the soil. Green manures kept moist until thoroughly decomposed yielded extracts which dissolved much more calcium from the soil than they introduced, and also removed considerably more magnesium, phosphoric acid, and iron than was dissolved by water alone. These aqueous extracts were not alkaline to phenolphthalein, nor acid to methyl orange. By mixing soil

with 3% of green manure and stable manure and allowing partial decomposition to take place, the solubility of the calcium and phosphoric acid in the soil was increased by 30 to 100%. The effect of the organic constituents of the extracts was shown by experiments in which green manures and sugar were hydrolysed with strong acid, and then washed free from acid, and extracted with ammonia. These extracts when freed from ammonia represented artificial humus solutions free from calcium, magnesium, iron, and phosphoric acid. When added to the soil they increased the solubility of the calcium by amounts ranging from a few parts to 240 parts per million of soil, as compared with the solubility in water. They also caused a slight increase in the solubility of magnesium, phosphoric acid, and iron.—C. A. M.

Peat soils, waste and cultivated: Micro-organisms of —. T. Arnd. Centr. Bakt., 1916, 45, 554—574. Bull. Agr. Intell., 1916, 7, 1744—1745.

PRELIMINARY trials at the Bremen Experiment Station to ascertain the effect of drainage, liming, and tillage on the bacterial life of peat soils, gave the following general results. Ammonifying organisms were present in all samples, but were far more active in surface soils than in subsoils, and in cultivated than waste land. The breaking up of waste land only affected the bacterial life to a depth of about 8 ins. of soil. No nitrifying organisms were found in waste land or cultivated land, except such as received a dressing of more than $\frac{1}{2}$ ton of lime per acre; more than 1 ton per acre would appear to be necessary to produce active development of the nitrifying organisms in the peat itself. All the samples tested were able to reduce nitrates; the surface soil of waste land was not much more active than the subsoil, but the surface soil of cultivated land showed much more activity, especially where tillage had been accompanied by liming. Similar relations were observed in respect of the power of decomposing cellulose. As with ammonification and nitrification, the maximum decomposition of cellulose occurred when the soil had previously received a dressing of dung. In no sample of soil was *Azotobacter* present. Surface soils and cultivated soils fermented mannitol more readily than subsoils and waste land, the maximum effect again being obtained with a dunged plot.—J. H. L.

Plant food in the leaves of forest trees. P. Serex-jun. J. Amer. Chem. Soc., 1917, 39, 1286—1296.

ANALYSES of maple, chestnut, and oak leaves showed that the quantities of phosphoric acid, nitrogen, and potash contained in the leaves varied with the species of tree, the portion of the tree from which the leaves were obtained, and the kind of soil on which the trees were growing. Briefly, the autumn leaves contained from 1.3 to 3.0% of nitrogen, 0.5 to 1.4% of P_2O_5 , and 0.7 to 1.4% of ζ_2O (all calculated on the dry substance); slightly higher amount of these constituents were present in the leaves during the early summer months. The cost of collecting and handling the leaves would probably be greater than their manurial value.
—W. P. S.

Mineral phosphates and superphosphates: Solubility of — in dilute mineral and organic acids. A. Aita. Annali Chim. Appl., 1917, 9, 200—210. (See this J., 1916, 974, 1074.)

Each determination 2.5 grms. of the phosphate was digested for 30 mins. at 14° to 15° C., with 50 c.c. of the dilute sulphuric, hydrochloric, formic, acetic, oxalic, tartaric, or citric acid solution, the mixture being frequently stirred. The mineral acids were used in strengths of $\frac{1}{16}$ to $\frac{1}{10}$ gm.-equivalent per litre and the

organic acids in $\frac{1}{2}$ or 1 gm.-equivalent per litre. It was found that in the case of the inorganic acids the solubility of the phosphoric anhydride in superphosphate was comparable with that obtained with the mineral phosphates, after making allowances for such factors as fineness, friability, and proportion of lime. In the case of the organic acids, mineral phosphates behaved in the same way as when treated with inorganic acids, except that there was a slighter dissociation, and that the influence of other constituents was more pronounced. Superphosphates, however, behaved in the same way as mineral phosphates towards oxalic acid, but yielded a high proportion of phosphoric anhydride to the other solutions. For example, the following amounts of the total phosphoric anhydride were extracted:—With formic acid, 73.28; acetic acid, 62.61; oxalic acid, 24.44; tartaric acid, 66.43; and citric acid, 77.87%. The formation of complex citrophosphates in combination with aluminium and ferric iron has been shown (this J., 1916, 1074) to be the cause of the high citric solubility of phosphoric acid, and it would seem that similar complex compounds are formed with organic acids containing atoms of hydrogen not in combination in carboxyl or hydroxyl groups. The solubility of the phosphoric anhydride in superphosphates is somewhat less than that of mineral phosphates in dilute mineral acids, but the solubility of the phosphoric anhydride is almost equal in both cases in organic acids which have the property of forming compounds with phosphoric acid, aluminium, and ferric iron.

—C. A. M.

"Tetraphosphate": Fertiliser trials with — in Piedmont rice fields, Italy. Marcarelli and Novelli. Giorn. Riscoltura, 1916, 6, 321—327. Bull. Agric. Intell., 1917, 8, 230—231.

EXPERIMENTS were made in an extremely acid soil, very poor in lime, growing rice. The field was in a fertile condition at the commencement of the experiments, having received a dressing of mineral superphosphate and farmyard manure during the previous winter. Three equal areas of the field were sown with paddy rice and manured with 500 kilos. per hectare of tetraphosphate, the same amount of ground phosphorite, and 930 kilos. of superphosphate. The amount of marketable grain obtained from the tetraphosphate plot was 6330 kilos., from the ground phosphorite plot 5730—5906 kilos., and from the superphosphate plot 5690 kilos. The tetraphosphate contained 2% of citrate-soluble, 7.8% of citric acid soluble, and 28.3% total P_2O_5 .—J. H. J.

Phosphoric acid in mixed fertilisers containing superphosphates: Factors influencing the solubility of —. E. V. Flack. S. African J. Sci., Dec., 1916.

No appreciable loss of soluble phosphoric acid takes place within three weeks when superphosphate is mixed with potassium sulphate or kainit, and an actual increase may occur when the fertiliser is mixed with ammonium sulphate. Admixture of superphosphate with guano results in a decrease of the soluble phosphoric acid to the extent of 7% within 3 hours, whilst in a mixture of superphosphate and bone-meal the loss of soluble phosphoric acid may amount to 14.5% in fourteen days.
—W. P. S.

Cane molasses [and vinasses]: Utilisation of the fertiliser constituents contained in —. W. E. Cross and W. G. Harris. Rev. Ind. y Agric. de Tucuman, 1916, 7, 95—103. Intern. Sugar J., 1917, 19, 281—283.

THE ash obtained by the incineration of Tucuman cane molasses is particularly rich in potash, nitrogen, and phosphoric acid, the amount of the former constituent being 45—50% as K_2O , corres-

ponding to 66–73% K_2CO_3 . Hence this material might well at the present time be sold as such as a fertiliser, or it might be further purified by fractional crystallisation. Vinasses especially would repay utilisation in this way, and the authors have observed that after acidifying the partially evaporated product with sulphuric acid, it can be evaporated completely to dryness, yielding a black dry powder suitable for transport in bags or barrels, whereas by concentration in the ordinary way a pasty hygroscopic substance results. Deerr and Peck have proposed to separate the nitrogenous bodies from cane molasses by heating with lime, utilising the precipitate separated in a filter-press as a fertiliser; but the authors have found in the case of Tucuman molasses that only a small proportion of the nitrogen can be eliminated by this process.—J. P. O.

Metabolism of nitrogenous substances in plants; rôle of ammonia in the —. D. N. Prianchnikov. Collected Papers of Agronom. Inst. of Moscow, 1916, 10, 1–24. Bull. Agric. Intell., 1917, 8, 204–211.

IN the life of the higher plants, ammonia plays an important part as the starting point for the synthesis of protein and as an end product in the oxidation of nitrogenous substances. It does not however accumulate as such, but is converted into asparagine. Plants may be divided into three types according to the facility with which they accomplish this synthesis of asparagine: (a) Plants which readily absorb ammonia from solution and convert it into asparagine. *Hordeum sativum* (barley), *Zea mays* (maize), and *Cucurbita pepo* (pumpkin) belong to this group. (b) Plants in which the absorption of ammonia is very feeble and in which the presence of ammonia in the culture solution retards the oxidation of nitrogenous substances. The absorption of ammonia can be increased by adding calcium carbonate to the culture solution. *Pisum sativum* (pea) and *Vicia sativa* (vetch) are plants of this type. (c) Plants in which the presence of ammonia in the culture solution prevents the conversion of ammonia into asparagine. The addition of calcium carbonate has no effect in these cases. The yellow lupin (*Lupinus luteus*) is an example of this type.—J. H. J.

Calcium; Function of — in the nutrition of garden pea seedlings with ammonium salts. V. A. Morosov. Papers from Laboratory of Prof. Prianchnikov, Moscow Institute of Agriculture, 1916, 10, 391–395. Bull. Agric. Intell., 1917, 8, 214–216.

IN the assimilation of ammonium salts by plants the base is absorbed and the acid left; this acid requires to be neutralised if continued assimilation is to go on. Experiments were made with sprouted seeds of the garden pea grown in solutions of ammonium sulphate alone, ammonium sulphate and calcium carbonate, and ammonium sulphate and ferric hydroxide. The best development of the seedlings occurred with the solution containing calcium carbonate, the second best with ferric hydroxide, whilst that with ammonium sulphate alone was poorer than with distilled water. The greatest accumulation of total nitrogen and asparagine nitrogen in the seedling also occurred with calcium carbonate followed by ferric hydroxide, whilst the ammoniacal nitrogen was least with calcium carbonate. Thus calcium carbonate does not act merely as a neutralising agent, but the calcium present also exerts its own specific nutritive influence.—J. H. J.

Plants; Biochemistry of —. A. Stutzer. Biochem. Zeits., 1917, 80, 163–151.

IT has been shown that the heart-rot and dry-rot

diseases of sugar beet and certain parasitic diseases of oats are in all probability due to the presence of alkaline substances in the soil in which they are grown. A garden soil which affected *Syringa vulgaris* (filix) was found to contain 0.88 gm. of water-soluble alkali per kilo. of dry soil. Roses grown in the same soil were greatly damaged by blight, although other plants (*Lathyrus odoratus*, *Roseda*, *Traprobium*, etc.) grew well. The affected roses recovered completely when peat dressing containing 16.6 grms. of acid (as H_2SO_4) per kilo. of air-dry material was applied. In a vineyard in which *Oidium* and *Peronospora* were very troublesome, the dried soil was found to contain 0.5 gm. of soluble alkali per kilo. On the other hand, the field thistle (*Cirsium arvense*) grew abundantly and vigorously in a soil containing 0.98 gm. of soluble alkali per kilo., and it is known that some plants grow best in acid soils. Investigations on the effect of the reaction of the soil on the growth of different species of plants and on plant parasites are urgently needed. The method used by the author for determining acid or alkaline substances in soils (see this J., 1915, 1064) consists in treating an aqueous extract of the soil with a solution of potassium iodide and iodate and titrating the liberated iodine with thiosulphate. If the extract is alkaline it is first treated with a known excess of standardised sulphuric acid; 1 c.c. of N/100 thiosulphate represents 0.00049 gm. of alkali, i.e., the mean of the equivalents of sodium and potassium hydroxides.

Constitution of cyanamide. Colson. See XX.

PATENTS.

Fertilisers [from molasses]. The Molassine Co., Ltd., East Greenwich, J. J. A. and H. C. S. de Whalley, Lee, Kent. Eng. Pat. 106,858, June 5, 1916. (Appl. No. 7954 of 1916.)

MOLASSES, or waste sugar material, diluted if desired, is mixed with chalk or other alkaline-earth carbonate, and then inoculated with fertile soil or with a culture of azotobacter. The inoculated solution is allowed to stand for a few days at 24° C., and is then mixed with peat or other absorbent material to convert it into a fertiliser.—J. H. J.

Soil; Amelioration of —. H. P. Hayden, Perth Amboy, N.J., Assignor to The Barber Asphalt Paving Co., Philadelphia, Pa. U.S. Pat. 1,228,361, May 29, 1917. Date of appl., Nov. 16, 1915.

THE infiltration of an emulsion of colloid matter, such as clay, with oil and water, into soil, is claimed to render it more suitable for vegetable growth.—J. H. J.

Fertiliser and the manufacture thereof. F. J. Nash, Brooklyn, N.Y. U.S. Pat. 1,228,587, June 5, 1917. Date of appl., Feb. 24, 1916.

A STACK is formed of alternate layers of ripened peat and fresh sea vegetation, still moist with its deliquescent potash, and is allowed to stand until the peat has absorbed the drainage from the sea vegetation. The result is a humus-forming mixture of green manure with potash-impregnated peat.—J. H. J.

Phosphate fertiliser; Process for the preparation of a —. V. Volpato, Milan, Italy. U.S. Pat. 1,229,684, June 12, 1917. Date of appl., Oct. 27, 1916.

SEE Fr. Pat. 480,697 of 1916; this J., 1917, 152. Special claim is made for a product obtained by roasting, at about 750° C., a mixture of 100 parts of phosphoric (60% $Ca_3(PO_4)_2$) and 6 parts of a mixture of 40% of dolomite, 25% of sodium carbonate, and 35% of sodium sulphate, and treating the calcined mass with water.

Phosphates ; Method of treating — C. G. Memminger, Asheville, N.C., U.S.A. Eng. Pat. 107,082, June 28, 1916. (Appl. No. 9092 of 1916.)

SEE U.S. Pat. 1,192,545 of 1916 ; this J., 1916, 937.

Apparatus for manufacture of calcium cyanamide. U.S. Pat. 1,230,343. See VII.

XVII.—SUGARS ; STARCHES ; GUMS.

Sugar cane ; After-ripening of — *Chemical changes taking place after cutting.* J. H. Barnes. Agric. J. India, 1917, 12, 200—215.

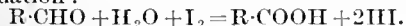
IN the Gurdaspur District, India, the stripped cane is allowed to remain in heaps for a day or so before crushing, it being thought by the peasant farmers that the *gur* obtained is lighter in colour and drier than that resulting from cane crushed immediately. Results obtained from numerous experiments with Katha or Chin and other local varieties showed that storing the cane in this way tends to further ripening with increase of the sucrose content ; but that, on the other hand, there is a danger of loss of sugar by inversion and decomposition if more than a certain time, depending upon the temperature of the air and the condition of the cane, be exceeded. The system used in Java of covering cut cane with damp "trash" in the event of the breakdown of the milling plant, is applicable only so long as the cell protoplasm is alive and the ordinary chemical processes of the cell can continue. When the cane is dead, chemical reactions of hydrolysis and oxidation by enzymes get beyond control, and the rate of sugar decomposition becomes very high.—J. P. O.

Masseccutes and after-products ; "Frothy fermentation" of second jet — in beet sugar factories. R. Gillet. Intern. Sugar J., 1917, 19, 264—269.

EXPERIMENTS are described tending to prove that the "frothy fermentation" of beet masseccutes and after-products may be caused by the agency of a thermophilic micro-organism, having its optimum temperature at about 70° C., which produces evolution of carbon dioxide. It may be cultivated in a medium containing invert sugar, neutral or slightly acid to phenolphthalein, but its growth is inhibited by alkalinity, especially at higher temperatures. Referring to the chemical theory advanced by Lafar, that the phenomenon is due to the combination of invert sugar with the amino-acids of the organic non-sugar present, causing a considerable evolution of carbon dioxide, the author states that he has observed a case of frothy fermentation in a beet after-product containing nitrogen in quantity much too small to cause appreciable evolution of carbon dioxide by such a reaction.—J. P. O.

Aldoses ; Determination of — J. Bougault. Comptes rend., 1917, 164, 1008—1011.

ALDOSES can be estimated by measuring the quantity of iodine required for their oxidation, in presence of sodium carbonate, in accordance with the equation :—



The reaction is not instantaneous but takes place with a velocity depending on the excess of iodine present and on the alkalinity, and is retarded by the presence of bicarbonate. A secondary reaction also takes place but much more slowly. The estimation of the aldoses (dextrose, mannose, galactose, arabinose, lactose, and maltose) is effected by adding an excess of iodine, and titrating samples of the solution at regular measured intervals until the loss of iodine reaches a low constant value which occurs within half an hour (90 mins. in the case of mannose) and indicates

completion of the chief reaction. The correction for the reduction of iodine, due to the secondary reaction, can then be estimated and applied. Ketoses and sucrose are oxidised by the iodine very slowly, so that their presence is usually without appreciable influence on the determination of the aldoses. In the absence of other oxidisable organic compounds, the quantity of aldose present with sucrose in a proportion as low as one part in a thousand can be satisfactorily estimated by iodine, by comparing the reduction with that given in the same time by pure sucrose. The method can also be used for determining the molecular weight of an aldose, or as a criterion of its purity when the molecular weight is known. (Compare Bland and Lloyd ; this J., 1914, 948.)—J. N. P.

Arabinose ; Kinetics of furfural formation from — R. Kremann and H. Klein. Monatsb. Chem., 1917, 38, 63—75. J. Chem. Soc., 1917, 112, ii., 251—252.

THE authors have studied the kinetics of the formation of furfural from arabinose by the action of sulphuric acid and hydrochloric acid at 95° C. The results are expressed in dx/dt curves, where dx represents the amount of furfural semioxamizide formed at the time dt . The results fall on to two different curves, the one being an S-shaped curve, the other a slowly rising curve. There is no apparent reason why the results should fall on one curve rather than on the other. The author concludes that at 95° a high concentration of hydrogen ions can produce in arabinose solutions, in the course of the reaction, either a positive catalyst *A*, which accelerates the furfural formation autocatalytically, or a catalyst *B*, which accelerates the subsidiary reaction, so that in the latter case only one-third of the quantity of the furfural expected appears to be formed. With decreasing acid concentration the two curves come closer together, and eventually coincide to represent a reaction of the first order. The S-shaped curve is represented by the typical equation for an auto-catalytic reaction.

Starch ; Practical method for determining the viscosity of — for mill purposes. G. M. MacNider. J. Ind. Eng. Chem., 1917, 9, 597—599.

TO ascertain the viscosity of starch solutions after being boiled with steam for an hour, as is done in the preparation of warp sizing, etc., in the mill, a miniature kettle of about 1½ galls. capacity, similar in every respect to the large kettles used in the mill, was employed. The amount of starch to be taken varies with the grade of the starch. For thick-boiling maize, potato, and similar starches 0.5 lb. per gall. of water is used ; for medium thin-boiling starch, 1 lb. ; and for very thin maize starch and other chemically treated starches 2 to 2.5 lb. per gall. The weighed quantity of starch is added to 1 gall. of cold water in the kettle, and the agitators are run for 10 to 15 mins. until a smooth cream is obtained, when steam is admitted and the solution is boiled for 1 hour after the boiling point has been reached. Some of the solution is then rapidly transferred to the cup of a Scott viscometer, and 50 c.c. is run out into a graduated vessel. The number of seconds required to deliver 50 c.c. of the solution, divided by the number of seconds required to deliver 50 c.c. of boiling water, gives the viscosity (this J., 1912, 680). Tested in this way, various grades of thick-boiling starch (0.5 lb.) showed a viscosity of 2.89 to 4.58, whilst thin-boiling starches (1 to 2 lb.) gave a viscosity of 1.27 to 2.45. A maize starch solution (4 lb. per gall.) had a viscosity of 3.51, which was reduced to 2.63 by the addition of 2 oz. of potassium hydroxide. The effect of the addition of the chlorides of calcium, magnesium, zinc, etc., upon the thickness of the starch may be determined in the same way.—C. A. M.

Utilisation of the fertiliser constituents contained in cane molasses [and vinasses]. Cross and Harris. See XVI.

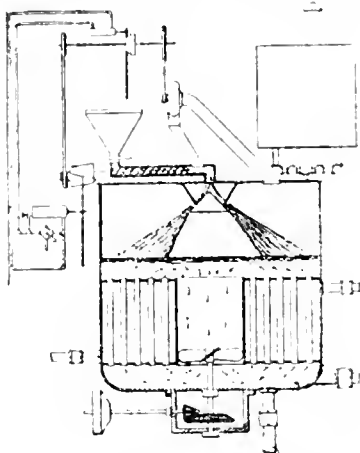
Cheap production of alcohol. Breckler. See XVIII.

Proportion of levulose in apple juice. Edff. See XIXA.

PATENTS.

Sugar: Process of precipitating — A. M. Dupern. Oxnard. Cal. U.S. Pat. 1,229,190, June 5, 1917. Date of appl. May 20, 1911.

For the "precipitation of sugar from impure aqueous solutions," the liquid, contained in a cylindrical tank (see fig.) provided with means for



cooling, is so maintained in circulation that it flows from the periphery towards the centre of the tank at the surface, and a stream of finely divided lime is directed downwards on the peripheral parts of the liquid surface.—J. H. L.

Sugar and other crystalline substances: Process for the manufacture of dry crystals of — J. C. Grière, Padua, Italy. U.S. Pat. 1,228,910, June 5, 1917. Date of appl. Jan. 5, 1916.

See Eng. Pat. 13,361 of 1911; this J., 1915, 1066.

Fertilisers [from molasses]. Eng. Pat. 106,858. See XVI.

XVIII.—FERMENTATION INDUSTRIES.

[*Brewing:*] *Saccharification of raw cereal mash* [in —]. G. Thevenot. Communications U.S. Master Brewers' Assoc. Brewers' J., 1917, 53, 250—253.

IN employing raw cereals as brewing adjuncts it has hitherto been the practice to cook them before use, to liquefy the starch. The author states that equally satisfactory results, as regards yield of extract and quality of worts, may be obtained without the preliminary cooking, if the adjuncts are finely ground, not necessarily to flour, but to fine meal which still feels gritty to the touch. It is only necessary to allow a longer period than usual for saccharification, and in some cases to carry out this process at temperatures above 70° C. Comparative laboratory mashings were made with 60% of malt and 40% of raw grits (maize), the latter being used in the cooked state and also after simply being passed several times through a two-roller *Rehle* mill set as close as possible. The mashings were held for 30 mins. at 15° C., and then slowly (in 25 mins.) raised to 70° C. for saccharification. In the mash containing uncooked adjunct, saccharification occupied 25 mins. as

compared with 9 mins. in the other case; the wort from the former mash was quite as satisfactory as the other as regards composition, filtration, colour, odour, flavour, and break, and the yield of extract from the uncooked grits was slightly higher than from the cooked grits. Similar trials were made with other raw adjuncts, viz., refined grits, rice, and barley. To obtain the maximum yield of extract it was found necessary, however, to raise the temperature of saccharification to 72.5°—73.7° C. for the refined grits and to 75° C. for the rice; saccharification was then complete in 45 mins. in both cases. With barley as adjunct the ordinary temperature, 70° C., was employed, and saccharification occupied only 5 mins. In all these cases yields were obtained equal to or slightly higher than those given by the same adjuncts previously cooked, and the worts produced were entirely satisfactory. Mashings with malt and uncooked raw grits were carried out on a larger scale (12-barrel brews), with similar results. In laboratory mashings of the finely ground uncooked adjuncts alone, *i.e.*, without malt, under the same conditions as for the combined mashings, the following yields of extract (referred to dry substance) were obtained:—69.18% from raw grits, 9.92% from refined grits, 8.62% from rice, and 44.85% from barley, so that, contrary to published statements, some of these raw adjuncts must contain considerable amounts of liquefying diastase.

—J. H. L.

Beers and ales: A study of American — L. M. Tolman and J. G. Riley. U.S. Dept. of Agr., Bureau of Chem., Bull. No. 493, Mar. 21, 1917. Reprinted in J. Inst. Brew., 1917, 23, 298—322.

THE course of manufacture of typical malt products was observed from beginning to end in three American breweries, and the results of analysis of the worts, before and after fermentation, and in some cases after storage, are given in a series of tables. These data relate to (1) all-malt beers, (2) beers made from malt and rice or malt and maize, (3) porters made from malt, cerealine, and sugars, and (4) ales made from malt and cerealine with or without sugars. The average value of the ratio of extract loss to alcohol produced during fermentation was practically the same, 2.12, for the bottom-fermentation products (beers) and the top-fermentation products (ales, porters, stouts). Whilst in the case of beers, however, the extract loss was practically identical with the sugar loss, in the case of top-fermentation the former value exceeded the latter by amounts ranging from 1.47 to 2.65 grms. per 100 c.c., these differences no doubt representing dextrin fermented. There was found to be no appreciable development of volatile acidity during fermentation and only a slight increase in fixed acidity, averaging 0.049% in the case of beers and 0.103% in the case of ales. The average losses of protein, ash, and phosphoric acid during fermentation, for the different classes of products, showed only small variations, viz., 0.168—0.275 grm. of protein, 0.014—0.045 grm. of ash and 0.013—0.019 grm. of phosphoric acid (P_2O_5) per 100 c.c., and there was practically no further loss during storage in the cases investigated. The results of analysis of a large number of American beers, besides those referred to above, are given in tables. The conclusion is drawn that American all-malt beverages can be distinguished from those made with the use of adjuncts, by means of their contents of protein, ash, and phosphoric acid, if for comparative purposes these values are calculated on a uniform basis of original gravity. The all-malt beers analysed contained 0.230—0.336% of ash, 0.701—1.079% of protein ($N \times 6.25$), and 0.087—0.143% of phosphoric acid, calculated to a uniform original wort gravity of 15%, whilst beers and ales made from malt and 20% or more of rice, maize, cerealine, or sugar, in

no case contained more than 0.223% of ash, 0.59% of protein, and 0.076% of phosphoric acid. The marked difference in the protein-content of the two classes of products, which is not observed with European beers, is a consequence of the relatively high nitrogen-content of American brewing barleys. Analysis of 72 samples of present-day American beers of various origin showed an average alcohol-content of 3.52% by weight, and an average original wort gravity of 12.5%; these values are respectively 1.11 and 2.23% lower than corresponding ones published 30 years ago.—J. H. L.

Beers; Iron-content of brewing materials in relation to sedimentation in bottled —. A. Fischer. Amer. Soc. Brew. Technol., Chicago Section. Feb. 21, 1917. Western Brewer, 1917, 46, 164—167.

It is well known that contact of beer with certain metals, notably tin, may give rise to turbidity and deposit, and iron has also been regarded as detrimental in this respect. In order to ascertain whether the small quantities of iron contained in brewing materials may affect injuriously the beer produced, the author determined the iron-content of brewing materials and products. Malt was found to contain 0.005—0.02% of iron (calculated as ferric oxide), rice 0.0034—0.0051%, maize products 0.00017—0.01%, and hops 0.042—0.118%, whilst beer contained only 0.00003—0.00019%. Nearly the whole of the iron contained in brewing materials remains in the spent grains and hops, only about 1% passing into the beer. The traces of iron sometimes present in sugars used as *krausen* do not pass into the beer, but either remain undissolved or are again eliminated by the yeast.—J. H. L.

Malt amylase; Modification of the amylolytic activities of — and their behaviour on keeping in presence of different reagents. T. Chrzaszcz and A. Joscht. Biochem. Zeits., 1917, 80, 211—241.

AMYLASE preparations were made from ground barley malt, using as extracting media water and a large number of other substances in the form of aqueous solutions, and the extracts (5% or 8% concentration) were tested in regard to their starch-liquefying power (modified Lintner-Solleid method; this J., 1910, 583), saccharifying power (reducing sugars determined by Bertrand's method; this J., 1907, 60), and dextrin-forming power (colour reaction with iodine solution), tests being made immediately after preparation and after keeping for different periods, up to 2½ years in some cases. The results are tabulated. They show clearly that there is no definite relation between the liquefying and saccharifying powers of the amylase, the ratio varying widely according to the experimental conditions, and it is concluded that these powers are due to separate enzymes (see this J., 1912, 1089). The results are not conclusive in regard to the dextrin-forming power, which varies mostly in accordance with the liquefying power, but sometimes with the saccharifying power. Probably the dextrin-forming power is a separate function of the amylase in causal connection with the liquefying and saccharifying powers, but it may be a resultant of the two last-named functions under conditions which have not yet been determined. An amylase preparation cannot be adequately characterised by determinations of any one of its functional activities, but only by methods in which at least three of its four functions (the starch-precipitating power has been disregarded in the present investigation) are taken into consideration. The results obtained show that the media commonly used for the preparation of amylase, viz., water, alcohols, acetone, and chloroform, are not the most suitable for the

purpose. Glycerin at concentrations of from 20 to 90%, but preferably 50%, pyridine solution (3% or 6%), and quinoline water are much more effective in preventing growth of micro-organisms and maintaining intact the amylolytic power of amylase preparations over long periods. Bases, both inorganic and organic, act favourably on the liquefying and dextrin-forming powers of amylase, but unfavourably on the saccharifying power. Alcohols, on the other hand, act more injuriously on the liquefying and dextrin-forming powers and only to a lesser extent on the saccharifying power. Ammonium sulphate, urea, and asparagine have a favourable effect on the enzymic activity of the amylase, but are not capable of preventing the growth of micro-organisms.

Diaslase; Independence of the optimum temperature of a — of the concentration of substrate and enzyme. A. Compton. Ann. Inst. Pasteur, 1916, 30, 496—502. Bull. Agr. Intell., 1916, 7, 1755.

IX experiments on the action of takadiastase on maltose solutions of concentrations ranging from M/30 to M/5, the optimum temperature of hydrolysis, 47° C., was found to be independent of the concentrations of substrate and enzyme. (Cp. this J., 1914, 977.)—J. H. L.

Tannase of Aspergillus oryzae. G. Kita. Kogyo-Kwagaku-Zasshi (J. Chem. Ind., Tokyo), 1917, 20, 131—138.

FERNBACH and Pottévin (this J., 1901, 137) found that *Aspergillus oryzae* secreted tannase when it was grown in a medium containing tannin, and Yanagisawa has recently patented a process for utilising the tannase technically in distilleries using raw materials containing tannin. Experiments by the author showed that *Aspergillus oryzae* grows well in a medium containing tannin (e.g., 2 grms. of tannin in 250 c.c. of 7.5% starch solution), but the growth is somewhat impaired if the tannin content be unduly high, e.g., in a medium containing 20% of bran. *A. oryzae* secretes tannase even when grown in a medium free from tannin, whereas, according to Fernbach, this is not the case with *A. niger*. The tannase-activity increases with the tannin-content of the culture medium. There is a relation between the starch-saccharifying power of koji and the growth of *A. oryzae*, and hence there exists an optimum for the saccharification of tannin-containing material with bran-koji containing tannin.

Enzymes; Formation of —. II. M. Jacoby. Biochem. Zeits., 1917, 80, 357—363. (See this J., 1917, 663.)

UREASE-SECRETING bacteria were grown in a broth medium, from which sub-cultures were grown in Uchinski's solution (8 c.c. of glycerol, 1.2 grms. of sodium chloride and of ammonium lactate, 0.8 gm. of sodium asparaginate, 0.5 gm. of dipotassium phosphate, 0.08 gm. of magnesium sulphate, and 0.02 gm. of calcium chloride dissolved in 200 c.c. of water), and in the same solution with the addition of 8 c.c. of a 1% solution of ferrous sulphate. In the two last-named media growth practically ceased after the second generation, but commenced again on addition of even a small quantity of the broth medium; the same holds good in regard to the formation of urease by the bacteria.

Teslitupin; New substance. —. prepared from beer yeast. E. Moufang and A. Mayer. Allgem. Z. Bierbrau., u. Malzfabr., 1917, 45, 19. Woch. Brau., 1917, 34, 46.

THE authors, who have previously drawn attention to the decolorising and reducing properties of dead yeast (see this J., 1913, 303; 1915, 1159), claim to have extracted from beer yeast, by a

method not described, a substance, testilupin, which accelerates fermentation by living or dead yeast, and possesses strong reducing powers. It reduces Fehling's solution in the cold, potassium permanganate and phenylhydrazine, and decomposes hydrogen peroxide. It is capable of reducing aqueous solutions of "methylene blue" and does not lose its decolorising power on continued use.

—J. H. L.

Wine yeasts. E. Kaiser. Rev. Viticulture, 1916, 45, 149—155, 165—170. Bull. Agr. Intell., 1917, 8, 118—152.

THE author investigated the influence of addition of 1% (or in some cases 1.7%) of nitrogen, in the form of ammonium sulphate, asparagine, and ammonium phosphate, on the formation of esters during the fermentation of sterilised grape must by various wine yeasts from the Laboratory of the Agronomic Institute, viz., yeasts 7 (St. Emilion), 32 (Langdale, Gard), 88 (Chambertin), 94 (Musigny), 255 (pointed Burgundy yeast), 101 (*Folle blanche* Cognac yeast), and 42 (Sauterne). In most cases the added nitrogen increased the production of esters, especially non-volatile esters, but the yeasts showed marked individual differences which preclude generalisations. Ammonium sulphate had usually less effect than the other forms of nitrogen. In ammonium phosphate both the nitrogen and phosphorus were obviously effective, and powerfully stimulated yeast development and fermentation; in some cases this salt doubled or trebled the production of non-volatile esters.

—J. H. L.

Cider spirits; Composition of —. E. Kayser. Bull. Soc. Agric. France, 1916, 262—265. Bull. Agr. Intell., 1916, 7, 1838—1840. (See also this J., 1917, 608.)

APPLE must was fermented by *Saccharomyces mali Risleri* (yeast 153 of the Laboratory of the Agronomic Institute), alone and together with an apiculated ferment (yeast 158), and the distillates from the fermented liquids were analysed. Fermentation was started at 26° C. and completed, in some cases at 26° C. and in others at room temperature. The distillates differed considerably from ordinary cider spirits in composition, their ester-content being markedly lower than their content of higher alcohols and not very different from their aldehyde-content. The sum of acids, aldehydes, furfural, esters, and higher alcohols in the distillates ranged from 375 to 618 mgrms. per 100 c.c. of alcohol; the higher values were the result of fermentation at 26° C., the lower and fluctuating room temperature favouring only the formation of acids. Addition of phosphates before fermentation increased the production of all the volatile impurities at 26° C., and the production of aldehydes at room temperature to a very marked extent. The effect of the apiculated yeast varied with the temperature of fermentation, but was favourable to

Maximum cost per lb. of hexose, cents	1.0
Minimum cost per proof gall. of alcohol, cents	9.6

the formation of esters and aldehydes, and unfavourable to the formation of higher alcohols.

—J. H. L.

Alcohol; Cheap production of —. A. M. Breckler. J. Ind. Eng. Chem., 1917, 9, 612—615.

THE total quantity of alcohol produced in 1914 in U.S.A. was 182,000,000 proof galls., which was equivalent to about 5% of the total consumption of petroleum spirit. The bulk of this alcohol was derived from grain, and it is estimated that to produce sufficient alcohol to replace petroleum spirit as a motor fuel, 16% of the total cereal production or about 26% of the maize production (U.S.A.) would be necessary. The average price,

during the past 5 years, of alcohol from maize has been 17.5 cents per proof gall., and this year the cost will be about 25 cents per proof gall., or 45 cents per gall. of 90% alcohol. This cost could not be materially reduced. The production of alcohol on the farm is only practicable in exceptional cases, since cattle fed upon the distillery slop produce meat which becomes flabby when kept, and must therefore be used for immediate consumption. In 1912 the Minnesota Agricultural Exper. Station tried the experiment on a large scale under favourable conditions, and found that they were unable to produce alcohol as cheaply as they could buy it. Another source of alcohol is "black strap" molasses, which 5 years ago was sold at 2 cents per gall. at the sugar house, but now costs 12 to 14 cents per gall., whilst it now contains less sugar and yields a much lower proportion of alcohol. From black strap molasses of good quality at 5 cents, alcohol could be produced at about 10 cents per proof gall., but it is estimated that the total raw material available in U.S.A. and Cuba would produce only 162,000,000 galls. of alcohol or 5% of the total requirements for motor fuel. Two plants are engaged on the production of alcohol from sawdust in U.S.A., but it is questionable whether they would continue to work if it were not for the present high price of alcohol. Sulphite liquors from pulp mills are a cheap source of alcohol, and at the present time about 3 plants in America are producing alcohol in this way. None of the present processes, however, is entirely satisfactory. Important factors in the production of alcohol from low-grade material are fuel and water supply. In the case of sulphite liquor, which, as concentrated for fermentation, usually contains 4% of hexose sugar, the resulting solution will contain theoretically 2.61% of alcohol, but in practice about 2.2%. The theoretical heat of distillation per lb. of 80% (by vol.) alcohol from such a solution is 4000 B.Th.U., or about 180,000 B.Th.U. per gall.; and for this purpose about 10 to 14 lb. of a good coal would be required, which at a cost of \$3.00 per ton, would make the cost of distillation 1.5 to 2.4 cents per gall. In like manner the cost of distilling 80% alcohol from sorghum juice, containing 15% of hexose, would be 0.4 to 0.6 cent per gall., with coal at the same price. Should the mash require cooking, as, e.g., when starch is present, the B.Th.U. as calculated for the distillation may be multiplied by the factor 2.5, whilst the fuel required for pumping, etc., in a grain distillery is about 50% of the total quantity used. The amount of water required to condense 100 galls. of 80% alcohol and to cool it to 85° F. (29° C.) will be from 900 galls. at 55° F. (13° C.) to 1250 galls. at 80° F. (27° C.). Assuming the liquid as prepared for fermentation to contain 10% of fermentable matter, the following table shows the maximum permissible cost per lb. of fermentable matter for producing alcohol of any given cost per proof gall., allowing a yield of 85%:—

1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0
11.2	12.6	14.2	15.7	17.2	18.7	20.2	21.8	23.3	24.4

—C. A. M.

Utilisation of the fertiliser constituents contained in cane molasses [and vinasses]. Cross and Harris. See XVI.

Experiments on the preparation of home-made rennet. Todd and Cornish. See XIXa.

Experiments with pepsin to replace rennet. Stuart. See XIXa.

Proportion of levulose in apple juice. Eoff. See XIXa.

Constitution of amygdalin. Bau. See XX.

Identification of alcohols. Reid. See XX.

PATENTS.

Yeast; Process for the treatment of —. J. A. Stevenson. Burton-on-Trent. Eng. Pat. 106,531. May 25, 1916. (Appl. No. 7465 of 1916.)

YEAST, particularly brewers' yeast, is mixed in fine suspension with a large volume of water; any free acid is neutralised by the addition of sodium carbonate or bicarbonate. The liquid mixture is strained and treated with sodium chloride in order to increase the density of the liquid and facilitate the separation of the heavy impurities from the yeast. When the solids have settled, the supernatant liquid is drawn off in such a way as to avoid disturbing the sediment, *e.g.*, by arranging a discharge pipe a certain distance above the bottom of the vat. The process of stratification may be repeated in two or three successive receptacles. In one of the latter a solution of formaldehyde and calcium carbonate may be added to precipitate the tannin and eliminate or reduce the colouring matter. In another receptacle the liquid is treated with oxygen either by electrolysis or otherwise and the yeast is finally separated from the suspension. A yeast suitable for bakers' use may be prepared by blending 35–40% of treated brewers' yeast with 65–60% of distillers' yeast.—J. F. B.

Beer, etc.; Manufacture of dry extracts of —. H. Heuser. Chicago, Ill. U.S. Pat. 1,228,917. June 5, 1917. Date of appl., Dec. 20, 1916.

EXTRACTS which can be converted into beverages of low alcohol-content by dilution with water, are claimed, containing dry extract of a fermented beverage, dry fermentable carbohydrates, and dry living yeast.—J. H. L.

Yoghurt beer; Process of producing —. W. Henneberg. Berlin. U.S. Pat. 1,228,916, June 5, 1917. Date of appl., Apr. 27, 1914.

SEE Fr. Pat. 472,483 of 1911; this J., 1915, 505.

Process for obtaining a neutral non-drying adhesive [from waste products of breweries]. Ger. Pat. 297,186. See XV.

XIXa.—FOODS.

Rennet; Experiments on the preparation of home-made —. A. Todd and E. C. V. Cornish. J. Board Agric., 1917, 24, 307–312.

By slightly varying the conditions of preparation given previously (this J., 1916, 1077), rennet extracts may be prepared having a strength approximating to that of the usual commercial extract. Fifteen split and washed vells are placed in one gall. of brine containing 2 oz. of boric acid; after about 10 days the liquid is separated, the mucous membrane is scraped off the vells and returned to the liquid, whilst the vells are placed in 0.5 gall. of fresh brine. The first steep is tested from time to time until it attains a suitable strength, then filtered and stored in a dark place. The second steep yields a weaker extract. The strength of the extract frequently increases during storage, whilst the number of lactose-fermenting organisms present decreases.—W. P. S.

Pepsin; Experiments with — to replace rennet. D. W. Steuart. J. Board Agric., 1917, 24, 313–315.

FURTHER experiments (see this J., 1917, 664) with pepsin as a substitute for rennet showed that pepsin is much more sensitive to slight differences in the ripeness of the milk than is rennet. One oz. of soluble pepsin powder (1 to 3000) will coagulate 300 galls. of well-ripened milk, but only 75 galls. of fresh milk.—W. P. S.

Plums; Conserving surplus — by drying. J. V. Eyre and S. T. Parkinson. J. Board Agric., 1917, 24, 275–287.

ALL large plums may be dried successfully at 70° to 80° C., either in a current of hot air or in a vacuum apparatus; about 25 hours is required for the drying in hot air and 18 hours in the vacuum process. Preliminary treatments, such as steaming, pricking, and exposure to chloroform vapour, decrease the time of drying, but the plums require subsequent treatment in order to improve their texture. The best results are obtained by treating the plums with chloroform vapour, then drying them, and heating them in a closed vessel with a limited quantity of steam for a few hours. No appreciable advantage is gained by immersing the plums in 1% sodium carbonate solution before drying.—W. P. S.

Lavulose in apple juice; Proportion of —. J. R. Eoff, jun. J. Ind. Eng. Ch. m., 1917, 9, 587–588.

THE juice was expressed from 15 varieties of American and five varieties of French apples ripe for market. The juice from the American apples contained from 7.9 to 12.0% of sugars, comprising from 7.6 to 31.2% of sucrose, 52.5 to 74.7% of lavulose, and 5.0 to 37.6% of dextrose. In the case of the French apples the juice contained from 9.1 to 13.8% of sugars, consisting of sucrose 2.1 to 29.5%; lavulose 58.2 to 74.2%; and dextrose 12.3 to 23.7%. In every instance the amount of lavulose exceeded the combined amounts of the other sugars present.—C. A. M.

Fish; New freezing process for preserving —. E. Kallert. Z. Fleisch und Milchhygiene. Berlin, 1916, 26, 353–355. Bull. Agric. Intell. 1917, 8, 627–628.

THE fish are first refrigerated in ice-cold water, and are then transferred to a salt solution which is far from being saturated at the temperature (–15° C.) at which the process is carried out. Such a solution cannot lose salt to the fish, but will rather absorb more salt. A minimum quantity of salt thus penetrates the skin and subjacent flesh, which were found to contain 0.24 to 0.42% NaCl as against 0.1% of natural salt content. In a basin of 2 cub. metres capacity 197 cwt. of fish can be frozen in 24 hrs. The fish should be kept at –7° C. until required for use.—E. W. L.

Kinetics of the formation of furfural from arabinose. Kremann and Klein. See XVII.

PATENTS.

Bread; Manufacture of —. W. J. Mellersh-Jackson. London. From Ward Baking Co., New York. Eng. Pat. 106,726, Aug. 9, 1916. (Appl. No. 11,269 of 1916.)

DOUGH is placed in a mixer with revolving arms and adapted to withstand high pressure. Compressed oxygen is pumped in at a pressure of 80 lb. per sq. in. for 3 mins., or compressed air (80 lb. per sq. in.) for 10 mins., or air at a pressure of 20 lb. for 20 mins. Subsequently the dough is fermented. The bread obtained is improved in whiteness. Only 50% of the usual amount of yeast is required, and there is a saving of sugar amounting to 1% of the weight of the flour in the dough.—J. H. J.

Drying [fruits and vegetables]; Apparatus and process for —. O. Q. Beckworth and O. J. Hobson. Seattle, Wash. U.S. Pat. 1,228,283. May 29, 1917. Date of appl., May 11, 1915.

THE material is placed on supports in a chamber and is heated to a temperature below that at which harmful chemical change takes place, by circulating a moist drying medium around the

supports. The heating is continued by radiation from radiators fixed at various points on the walls of the chamber and heated from outside. A current of air is circulated through the materials, and the moisture air is removed from the upper part of the chamber.—W. H. C.

Coffee product and method of making the same. W. J. Ewing, Roland Park, Md., Assignor to The Coffee Products Co. U.S. Pat. 1,229,052, June 5, 1917. Date of appl., Dec. 22, 1916.

ROASTED pulverised coffee is treated with superheated water in a closed vessel to form a liquid extract, which is concentrated to a syrup. A small percentage of water-soluble tapioca starch is added, and the mixture is dried.—J. H. J.

Creamery sewage: Separation of casein and albumin from —. G. Ebrill, Blackrock, and T. Kiersey, Assignor to Ebrill's Process, Ltd., Dublin, Ireland. U.S. Pat. 1,229,919, June 12, 1917. Date of appl., Dec. 4, 1916.

SEE Eng. Pat. 18,923 of 1915; this J., 1917, 160.

Apparatus for drying fruit, vegetables, herbs, chemicals, powders, seeds, minerals, and the like. Eng. Pat. 106,549. See I.

Process for the treatment of yeast. Eng. Pat. 106,531. See XVIII.

XIXB.—WATER PURIFICATION; SANITATION.

Nitrates [in water]: Determination of — in the presence of chlorides. W. F. Gericke. J. Ind. Eng. Chem., 1917, 9, 585—586.

THE loss of nitrates caused by the presence of chlorides in the colorimetric method with phenoldisulphonic acid, occurs when the reagent is added to the residue from the evaporated solution. Complete evaporation of the solution may be obviated by adding sulphuric acid to the aqueous solution. About 50 c.c. of the solution (containing 1 to 5 parts of nitrate per million) is treated with 1.5 c.c. of strong sulphuric acid, with constant stirring, and then with 2 c.c. of the phenoldisulphonic acid reagent, and the liquid is concentrated first on the water-bath and finally at a temperature not exceeding 70° C. to a quantity of 6 or 7 to 12 or 14 c.c., according to the amount of nitrate present. When concentrated to the necessary degree the liquid will be of a pale yellow colour; it should not be dark in colour or turbid. It is then diluted with about 50 c.c. of water, neutralised with alkali (care being taken to avoid an excessive rise of temperature), and the colour compared with that of a standard solution, which may have been made either by the old method of total evaporation to dryness before the addition of the reagents, or by the modified method described above.—C. A. M.

Nitrates in waters rich in magnesium salts: Determination of — by the phenolsulphonic acid method. M. S. Nichols. J. Ind. Eng. Chem., 1917, 9, 586—587.

ON neutralising the excess of phenolsulphonic acid, hydroxides of iron and magnesium are precipitated, and must be separated by filtration before the colorimetric comparison can be made. In the absence of iron hydroxide filtration may be obviated by adding a sufficient quantity of an ammonium salt to keep the magnesium in solution. If ammonia has been used for the neutralisation, 5 c.c. of a saturated solution of ammonium chloride will keep in solution the amount of magnesium present in 20 to 50 c.c. of most waters, but if sodium or potassium hydroxide has been used, a larger quantity of the ammonium salt will be

required, according to the amount of alkali used in excess. The ammonium salt is added after the neutralisation and before the final dilution.—C. A. M.

Strontium and lithium: Determination of — in water. S. D. Averitt. J. Ind. Eng. Chem., 1917, 9, 584—585.

STRONTIUM.—The weighed oxides of calcium and strontium, as obtained in the official method of the Assoc. Off. Agric. Chemists (U.S.A.), are dissolved in hydrochloric acid, and reprecipitated as oxalates. The precipitate is separated, washed with 0.5% ammonium oxalate solution, and finally with three successive portions of 5 c.c. of cold water, and titrated with N/10 potassium permanganate solution. The amount of oxides taken for the titration should not exceed about 0.03 grm. The amount of strontium oxide may then be calculated by means of the equation: $W - \text{CaO equivalent of permanganate titration multiplied by } 2.179 = \text{SrO}$, where W = weight of CaO and SrO.

LITHIUM.—The weighed chlorides of sodium, potassium, and lithium, as obtained in the official (Gooch) method, are dissolved in water, and aliquot portions are used for the determination of the potassium (and hence of the KCl), and of the total chlorine. The weight of LiCl may then be found as follows:—NaCl equivalent of total chlorine—Cl in KCl—(total weight of mixed chlorides—KCl) multiplied by 2.64 = LiCl. Accurate results were obtained in the determination of strontium and lithium in test solutions by these methods.—C. A. M.

Sterilisation of liquids in thin layers. H. Stassano. Comptes rend., 1917, 165, 41—43.

THE liquid is forced by the uniform pressure of a compressed inert gas, such as nitrogen, through a heating vat formed by two plane metallic surfaces separated by a paper frame at a distance of about 0.01 mm. In this way the liquid is raised to the desired temperature as rapidly and regularly as possible, and after a very short interval of heating is rapidly cooled. The short period of exposure to the heat enables bactericidal changes to be brought about in milk or in serums and toxins, without causing chemical decomposition of the main organic constituents.—J. N. P.

Disinfection of tannery wastes. Jackson and Buswell. See XV.

PATENTS.

[Water] filters; Outlet or extraction pipes of —. J. J. Lassen and V. F. Hjort, London. Eng. Pat. 106,512, Mar. 21 and May 12, 1916. (Appl. Nos. 4183 and 6797 of 1916.)

IN extraction or outlet pipes for filters, a hemispherical cup is mounted on the pipe in the filtering chamber and communicates with it through an opening in the bottom. The cup carries radial arms projecting outwards level with the top, and a perforated metal disc larger than the cup is laid on the top. The whole is covered by a conical hood so that sand or other filtering medium is diverted away from the perforated disc, and the discharged liquid passes upward through the annular part of the perforated disc, and then downward through the central part and through the cup into the extraction pipe. In a modification, the cup may be replaced by a trough and the hood may project over one or both sides, or two separate hoods may be used meeting at the centre. In another modification, the troughs may be formed by ridges projecting upward from the bottom of the filtering chamber.—W. F. F.

Water; Apparatus for the softening and purification of—. [Cleansing filtering material.] J. J. Lassen and V. F. Hjort, London. Eng. Pat. 106,514, Mar 30 and May 12, 1916. (Appl. Nos. 4694 and 6798 of 1916.)

FILTERING material which has been used for filtering water after this has been softened by treatment with lime, etc., is cleansed by increasing the flow of water through the material and agitating by a current of air or steam, or both. Various arrangements are described for carrying out the process.—W. P. S.

Sterilisation of liquids by ozone; Apparatus for—. J. Steynis, Bay Shore, N.Y.. Assignor to Steynis Ozone Co. U.S. Pat. 1,228,712, June 5, 1917. Date of appl., Nov. 24, 1914.

THE apparatus consists of a mixing tank into which liquid is injected with a rotatory movement. Gas is also supplied to the injector, and a safety reservoir is provided to prevent liquid from entering the gas supply in case of a failure in the means for supplying the liquid.—J. H. J.

Silver compound of the acridin series [disinfectant] and a process of making same. P. Hüsey and M. Hartmann, Assignors to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,227,624, May 29, 1917. Date of appl., Jan. 23, 1917.

COMPOUNDS of value as disinfectants are obtained by the action of a soluble silver salt, in presence of a solvent, on acridine dyestuffs which may be alkylated at the acridine nitrogen. Special claim is made for the silver compound of 2·7-dimethyl-3·6-diamino-acridine, methylated at the acridine nitrogen. It is a brownish-red powder, forming coloured solutions in water, alcohol, acetone, ethyl acetate, acetic acid, and sulphuric acid. It acts as a disinfectant in solutions of great dilution, strongly checking the growth of bacteria, especially streptococci and splenitis bacilli.—J. H. J.

Water, sewage and the like; Treatment of—. S. H. Menzies, London. Eng. Pat. 106,914, Sept. 1, 1916. (Appl. No. 12,401 of 1916.)

CHLORINE gas under pressure is allowed to diffuse through plates of spongy carborundum into the liquid flowing along a pipe. The excess of chlorine is removed farther along the pipe by sulphur dioxide gas diffusing into the liquid, in a similar manner. To oxygenate the liquid and to remove excess of sulphur dioxide, the liquid is passed through a filter containing manganese zeolite, activation of the zeolite being effected by the sulphur dioxide present.—J. H. J.

Water, sewage, and the like; Treatment of—. S. H. Menzies, London. U.S. Pat. 1,229,305, June 12, 1917. Date of appl., Sept. 27, 1916.

SEE Eng. Pat. 106,914 of 1916; preceding.

Sterilising liquids; Process of—. J. Mérie, Paris. U.S. Pat. 1,230,751, June 19, 1917. Date of appl., Apr. 17, 1914.

SEE Eng. Pat. 9495 of 1914; this J., 1915, 448.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Amygdalin; Constitution of—. A. Bau. Biochem. Zeits., 1917, 80, 159—162.

EXPERIMENTS on the decomposition of amygdalin by *Saccharomyces Ludwigii* Hansen, which does not secrete maltase, were undertaken to gain an insight into the nature of the sugar component of amygdalin. Tests by Kluijver's method (Biochem. Suikerbepalingen, Leyden, 1914), in which the dextrose is estimated from the volume of carbon

dioxide formed by fermentation, indicated that in 3% solution the amount of dextrose formed corresponds to the decomposition of over 54% of the glucoside. In experiments with larger quantities of the glucoside, also in 3% solution, the formation of hydrocyanic acid was demonstrated in quantity equivalent to the decomposition of a little over 2% of the glucoside into hydrocyanic acid, benzaldehyde, and dextrose. These results indicate that the yeast contains another enzyme, amygdalase, in addition to emulsin (see Caldwell and Courtauld, this J., 1907, 885), and that amygdalin does not contain a maltose group (compare Fischer, this J., 1895, 877) but another disaccharide which yields 2 mols. of dextrose (see Auld, this J., 1907, 437).

Silver salt-proteins compound. Changes in the physical condition of colloids. XXI. W. Pauli and J. Matula. Biochem. Zeits., 1917, 80, 187—210.

SOLUTIONS of glutin (purified gelatin) and albumin were treated with silver nitrate and the amount of silver fixed by the protein was determined by electrometric and electrical conductivity measurements. In both cases the amount of silver fixed increased with the concentration of the silver nitrate (at first rapidly and then slowly in the case of glutin) until a constant value was attained: the maximum quantity of silver combined with 1 gm. of the protein was about $2·3 \times 10^{-4}$ gm.-equivalent for glutin and 5×10^{-4} for albumin. Similar results were obtained when casein was suspended in silver nitrate solution. The silver-salt glutin compound yields unaltered glutin when subjected to prolonged dialysis, and both it and the albumin compound migrate to the anode under the influence of an electric current, whilst compounds of proteins with salts of heavy metals such as iron, chromium, etc., migrate to the cathode. The silver can be partially displaced from the complexes by treatment with alkali or alkaline-earth salts, an equilibrium being established. Comparison with previous results indicates that in the compounds of proteins with alkali, alkaline-earth, and silver salts, the anion and cation of the salt are fixed in equivalent quantities. The coagulation of albumin by heat is retarded or inhibited in presence of silver nitrate.

Alpinia nutans, Roscoe; Volatile constituents of leaves of—. K. Kafuku. Kogyo-Kwagaku-Zasshi (J. Chem. Ind., Tokyo), 1917, 20, 319—353.

THE leaves of *Alpinia nutans*, Roscoe, contain 0·053% of a volatile oil of sp. gr. 0·9301 at 19° C., $n_D^{20} = 1·4750$, $n_D^{25} = 1·4750$, $n_D^{30} = 1·4750$, $n_D^{35} = 1·4750$, $n_D^{40} = 1·4750$, $n_D^{45} = 1·4750$, $n_D^{50} = 1·4750$, $n_D^{55} = 1·4750$, $n_D^{60} = 1·4750$, $n_D^{65} = 1·4750$, $n_D^{70} = 1·4750$, $n_D^{75} = 1·4750$, $n_D^{80} = 1·4750$, $n_D^{85} = 1·4750$, $n_D^{90} = 1·4750$, $n_D^{95} = 1·4750$, $n_D^{100} = 1·4750$. Saponification value 9·88, saponification value after acetylation 36·1. The chief constituents of the oil are *d*-camphor (more than 30%) and *d*-camphane (17%). Other constituents are cineol and an ester of cinnamic acid, and probably limonene, a sesquiterpene, and a high-boiling phenol.

Oil of wine; Heave—. R. Kremann. Monatsh. Chem., 1917, 38, 53—62. J. Chem. Soc., 1917, 112, i, 314.

WHEN 2·5 parts of concentrated sulphuric acid and 1 part of ethyl alcohol are distilled on a sand-bath, a product is obtained which settles into two layers. The lower layer is a yellow, oily liquid, formerly termed heavy oil of wine. This consists mainly of ethyl sulphate, but contains a small quantity (5%) of unsaturated hydrocarbons of the olefine series. On shaking with warm water, the whole of the ethyl sulphate is hydrolysed to ethyl hydrogen sulphate, which passes into solution, whereas the hydrocarbons remain undissolved. The hydrocarbon oil, after drying, boiled at 286° C. and had sp. gr. 0·921. On keeping, a solid, crystalline substance separated, of sp. gr. 0·980.

m. pt. 100° C., b. pt. 260° C.; this also is an olefine. Molecular weight determinations by the cryoscopic method (in acetic acid) and by the ebullioscopic method (in ether) showed that the liquid hydrocarbon has a mean molecular weight of 221, corresponding to $C_{16}H_{32}$. Experiments on the hydrolysis of the crude ethyl sulphate in aqueous, acid, and alkaline solutions, led to the conclusion that the crude ethyl sulphate prepared as above is not a mixture of ethyl sulphate and unsaturated hydrocarbons, but rather a mixture of ethyl sulphate and a compound of ethyl sulphate with the unsaturated hydrocarbons.

Acetone: Compounds of calcium chloride and —.
L. S. Bagster. Chem. Soc. Trans., 1917, 111, 491—497.

ACETONE, dried by several successive quantities of dehydrated calcium chloride, has been shown to combine with the latter substance, forming $CaCl_2 \cdot 2C_3H_6O$, and by placing this in an exhausted vessel connected to a pump, the compound $CaCl_2 \cdot C_3H_6O$ is formed. Analyses and determinations of the vapour pressures have confirmed the existence of these substances as definite compounds, which are stable up to 130° C.—B. N.

Calcium glycerophosphate. J. F. Conch. Amer. J. Pharm., 1917, 89, 243—251.

COMMERCIAL calcium glycerophosphate is essentially a mixture of isomeric α - and β -calcium glycerophosphates, the isomerism being that of substituted propyl and isopropyl groups. The solubility of the compound in water at 25° C. is 1 in 31.6 parts, but is decreased by the presence of alcohol, glycerol, or sodium glycerophosphate, the solubility in 12% alcohol being 1 in 66.6. Lactic, citric, and phosphoric acids, and sodium citrate increase the solubility even in the presence of alcohol or glycerol, but the compound undergoes hydrolysis by the action of the acids. Alcohol and glycerol retard the hydrolysis, but the use of acids in order to increase the solubility of the compound is undesirable. Many compound mixtures of glycerophosphates contain quinine, and weak organic acids produce an intramolecular change in the quinine with the production of quinotoxine, a highly poisonous ketone.—W. P. S.

Cyanamide: Constitution of —. E. Colson. Chem. Soc. Trans., 1917, 111, 554—561.

Two possible structural formulae have been suggested for cyanamide: the normal formula $N:C:NH_2$ and the carbodi-imide formula $NH(C:NH)$. The constitution of the dialkyl-amides has been clearly established and the author has studied the refractometric constants of cyanamide in comparison with those of its dialkyl derivatives on the one hand and of carbodi-propylimide on the other. The values obtained for the CN_2 group in cyanamide and three of its alkyl derivatives were found to agree very well with the calculations made from Eisenlohr's atomic refractivities, and since the dialkyl cyanamides are known to have the constitution $N:C:NR_2$, it follows that cyanamide possesses a similar structure.—J. F. B.

Alcohols: Identification of —. E. E. Reid. J. Amer. Chem. Soc., 1917, 39, 1219—1255.

WHEN alcohols are heated with phthalic anhydride the corresponding acid phthalic esters are obtained and the sodium salts of these esters, on heating with *p*-nitrobenzyl bromide, give mixed phthalic esters which may be used for the identification of the alcohols, since they have definite melting points. About 1 gm. of the alcohol is heated for 1 hour with 1 gm. of phthalic anhydride, primary alcohols being heated in a sealed tube at 100° C., and secondary alcohols in an open tube at 140° C.; the mixture is then diluted with

water, rendered alkaline with sodium hydroxide, and shaken with ether. The aqueous layer is separated, evaporated to dryness, and the residue is boiled for 1 hour under a reflux condenser with 5 c.c. of water, 10 c.c. of 95% alcohol, and 1 gm. of *p*-nitrobenzyl bromide; the product obtained is recrystallised from 63% alcohol, and its m. pt. determined. The following mixed phthalates have been prepared and their m. pts. are given:—Methyl *p*-nitrobenzyl phthalate, 105.7° C.; ethyl *p*-nitrobenzyl phthalate, 80° C.; propyl *p*-nitrobenzyl phthalate, 53.0° C.; isopropyl *p*-nitrobenzyl phthalate, 74° C.; allyl *p*-nitrobenzyl phthalate, 61.5° C.; *n*-butyl *p*-nitrobenzyl phthalate, 62.0° C.; *n*-octyl *p*-nitrobenzyl phthalate, 41.0° C.; benzyl *p*-nitrobenzylphthalate, 83.0° C.; phenylethyl *p*-nitrobenzyl phthalate, 84.3° C.; bornyl *p*-nitrobenzyl phthalate, 100° C.; isobornyl *p*-nitrobenzyl phthalate, 87° C. The method may be used for the detection of methyl alcohol in the presence of ethyl alcohol, ethyl alcohol in admixture with ethyl benzoate or menthol, and borneol in camphor.—W. P. S.

Bismuth acetate. Salkowski. See VII.

Oxidisibility values of fats used in medicine. Issoglio. See XII.

Course of the reaction which takes place when higher unsaturated fatty acids are fused with potassium hydroxide. Eckert. See XII.

PATENTS.

Ureas or thioureas of the naphthalene series; Manufacture of —. P. A. Newton, London. From Farbenfabr. vorm. F. Bayer und Co., Leverkusen, Germany. Eng. Pat. 20,192, Sept. 25, 1914.

UREAS and thioureas are prepared from:—(1) 1,8-aminonaphtholsulphonic acids by the action of nitroacyclic carboxylic acid chlorides, chlorides of nitroxyl fatty acids, nitronaphthoyl chlorides, or nitronaphthalene sulphochlorides, and, after reduction of the nitro-group, treatment with phosgene for the introduction of the carbonyl group; (2) from naphthylaminesulphonic acids by the action of aromatic nitroacydihalogenides, completing the process as before; and (3) from naphthylaminesulphonic acids or aminonaphthol sulphonic acids by the action of aromatic nitroacydihalogenides, completing the process by reduction of the nitro-group and introduction of the CS group from thiophosgene. The new compounds have a germicidal action on blood parasites, although harmless to the body containing them. They may be used for the production of substantive cotton dyestuffs.—J. H. J.

Di[hydr]pyridiaminoarsenobenzene; Metallic derivatives of —. J. Danysz, Sèvres, France. Eng. Pat. 104,196, July 10, 1916. (Appl. No. 9677 of 1916.) Under Int. Conv., Feb. 29, 1916.

THE compounds obtained from 4,4'-dihydroxy-3,3'-diaminoarsenobenzene and mercury salts are difficult to use therapeutically, since they are only slightly soluble in dilute acids, and decompose when soda is added. If, however, they are treated with antimony compounds, antimonyl derivatives are obtained which are more soluble, stable in alkaline solution, more active, and less toxic. *Example.*—10 grms. of 4,4'-dihydroxy-3,3'-diaminoarsenobenzene in 100 c.c. of methyl alcohol, is mixed with 4 grms. of antimony chloride in 4 c.c. of methyl alcohol and 1 gm. of mercuric iodide in 90 c.c. of methyl alcohol. A clear cherry-red solution is produced from which ether precipitates a yellowish-red powder containing the antimonyl group, easily soluble in water and in dilute soda. The soluble sodium compound is precipitated from the solution in caustic soda by adding ether.—F. Sp.

Oxydianilinoarsenobenzene; *Metallic derivatives of* —. J. Danysz, Sèvres, France. Eng. Pat. 104,497, July 10, 1916. (Appl. No. 9678 of 1916.) Under Int. Conv., Feb. 29, 1916.

ONE mol. of 4,4'-dihydroxy-3,3'-diaminoarsenobenzene hydrochloride is treated in aqueous solution with 1 mol. of a freshly prepared silver halide, and 1 mol. of antimony trichloride is dissolved in the solution by heating; to the resulting solution is added a concentrated solution of citric acid; dilute sulphuric acid is then added to precipitate the base. The silver salt may be replaced by the salts of gold, platinum, or copper. The stable products obtained are much more antiseptic and relatively less toxic than the parent substance. —F. W. A.

Salicylic acid vapour; *Condensation of* —. R. J. Pugh, Southall, Middlesex. Eng. Pat. 106,516, Apr. 20, 1916. (Appl. No. 5789 of 1916.)

FOR the condensation of salicylic acid vapour when mixed with steam, the mixed vapours are passed into a condensing chamber having a wall, part or the whole of which is pierced by capillary interstices permeable to the steam, so that condensation of the salicylic acid and its separation from the steam occur on the inner permeable wall of the chamber and the acid falls down in a powdery condition. The condensing chamber is preferably constructed with a wooden framework, without iron or other metals, and a woven material, such as woollen canvas, is stretched over the framework to form a permeable wall on which the crystals of salicylic acid are condensed and deposited. —J. F. B.

Lyxyllic acid or its compounds; *Process of making* —. M. Vaygouny, Berkeley, Cal., Assignor to Royal Baking Powder Co. U.S. Pat. 1,227,706, May 29, 1917. Date of appl., July 23, 1910. EE Fr. Pat. 456,156 of 1912; this J., 1913, 959.

Iodo-2,3-dihydroxypropane and process of making same. R. Lüders, Steglitz, Assignor to Farb. vorm. Meister, Lucius, u. Brünig, Höchst, Germany. U.S. Pat. 1,230,185, June 19, 1917. Date of appl., June 15, 1915.

EE Eng. Pat. 8488 of 1915; this J., 1916, 489.

Formaldehyde; *Process for the manufacture of crystalline polymerisation products of* —. F. Pollak, Vienna. U.S. Pat. 1,230,600, June 19, 1917. Date of appl., Nov. 21, 1913.

EE Eng. Pat. 25,830 of 1913; this J., 1914, 218.

Ever compound of the acridine series [disinfectant] and process of making same. U.S. Pat. 1,227,624. See XIXB.

XI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

PATENTS.

Photographic printing paper and transfer process. F. W. Kent, London. U.S. Pat. 1,228,680, June 5, 1917. Date of appl., Dec. 13, 1913.

EE Eng. Pat. 29,616 of 1912; this J., 1914, 221.

Process of treatment of cellulose for fine, particularly photographic papers. Ger. Pat. 297,324. See V.

XXII.—EXPLOSIVES; MATCHES.

Nitrocellulose; *A product of the deflagration of* —. E. Trapani. Atti R. Accad. Lincei. 1917, 26, I., 332—334.

WHEN a few centigrams of a nitrocellulose powder (cellulite, cordite, etc.) was heated in a test-tube until deflagration occurred, a pungent odour, resembling that of formaldehyde, was observed, and on adding water and sodium carbonate to the

contents of the tube and applying Rimini's test with phenylhydrazine hydrochloride and sodium nitroprusside (this J., 1898, 697), an intense coloration was obtained, indicating the presence of a notable quantity of formaldehyde.

PATENTS.

Smokeless powder; *Process of manufacture of* —. Westfälisch-Anhaltische Sprengstoff-A.G., Berlin. Ger. Pat. 296,591, Mar. 16, 1913.

IN order to increase the stability and plasticity of the powder, anilides of organic acids are added in which the imide hydrogen is replaced by a radicle, with the exception of ethyl or methylacetanilide. These anilides are particularly suitable as camphor substitutes, and owing to their lower volatility have a favourable effect on the stability of the powder. —J. F. B.

Impregnating solids with liquids of very low boiling point [e.g., liquid oxygen]; *Apparatus for* —. L. Sieder, Munich. Ger. Pat. 297,225, June 9, 1915. Addition to Ger. Pat. 295,270 (this J., 1917, 238).

THE steeping vessel, closed either at the bottom or the top and insulated against heat, is arranged inside the reservoir for the liquid, which is closed at the top and likewise insulated, and taps are situated in the reservoir or in both vessels whereby pressure may be applied to drive the liquid into or out of the steeping vessel. A cartridge holder is provided in which the cartridges are arranged one above the other and which can be put in or taken out when required. —J. F. B.

XXIII.—ANALYSIS.

Nichrome-constantan thermocouple; *Notes on the* —. R. W. Woodward and T. R. Harrison. U.S. Bureau of Standards. Met. and Chem. Eng., 1917, 16, 647—648.

THE thermocouple No. 18 nichrome—No. 12 constantan can be used in air up to 1000° C. even when only partly protected, and retains its constancy to within 10° C. until the constantan is nearly completely oxidised. The E.M.F. of the couple is quite high (63·8 millivolts at 1000° C.). —W. H. P.

Crystals; *The drainage of* —. N. F. Hall, J. Amer. Chem. Soc., 1917, 39, 1118—1152.

WHERE substances are being separated by crystallisation, the mother liquor may be drained off the crystals by simple gravitational drainage, or more efficiently, by means of a centrifugal machine. By means of one centrifugal draining a degree of separation may be attained which would otherwise require a number of recrystallisations. The author has calculated the equivalence of these two methods of drainage on certain assumptions. A table is given of the number of crystallisations with gravitational drainage such that one-fourth of the mother liquor remains adhering to the crystals, which will be necessary to secure the same degree of purity as one crystallisation followed by centrifuging where all but 0·008 of the mother liquor is removed. It includes values corresponding to the whole range of conditions of solubility of the dissolved bodies. —H. J. H.

Precipitates; *Contamination of* — *in gravimetric analysis. Solid solution and adsorption versus higher order compounds*. G. McP. Smith. J. Amer. Chem. Soc., 1917, 39, 1152—1173.

THE author seeks to show that the contamination of precipitates by soluble salts, during analytical operations, is due to the formation of complex insoluble salts and not of solid solutions or of adsorption products. As an example the retention of iron by barium sulphate precipitated from solutions containing iron under various conditions

of precipitation is considered. The iron was introduced in the form of disulphato-ferrie acid (ferri-sulphuric acid), $\text{Fe}_2(\text{SO}_4)_3 \cdot 11\text{H}_2\text{SO}_4 \cdot 5\text{H}_2\text{O}$, which in solution in water behaves as a mixture of sulphuric acid and ferric sulphate. On the addition of barium chloride, the barium salt, $\text{Ba}[\text{Fe}(\text{SO}_4)_2]_2 \cdot n\text{H}_2\text{O}$ is held to be formed and carried down with the precipitate. On standing this complex is slowly dissociated with the liberation of barium sulphate. As this will probably be of an extremely fine-grained character it will cause the development of a slimy and impervious type of precipitate often found in the determination of barium sulphate.—H. J. H.

Molybdates, tungstates, and vanadates of cobalt-ammonium compounds; Use of— in determination of cobalt. A. Carnot. *Comptes rend.*, 1917, 164, 897—902. (See also Schoeller and Powell, this J., 1917, 720.)

THE complex cobalt-ammonium compounds have been studied in connection with the analytical separation and determination of cobalt. To a solution of cobalt containing ammonium chloride, ammonia and then hydrogen peroxide is added. The solution passes through a series of colour changes, becoming dark brown and then, with the evolution of oxygen, purple, red, or pink. In the cold, this requires 1 hour with concentrated solutions and much longer with dilute. A few minutes suffices if gentle heating be applied, but the solution must not be boiled or decomposition to the luteo-compound with precipitation of cobalt will occur. In this way a solution of purpureo-cobaltamine chloride $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ is produced. The cobalt is then precipitated as the corresponding molybdate by just neutralising the ammonia and adding a slight excess of 5% ammonium molybdate solution. After settling for some time the precipitate is filtered through a tared filter and washed with water. The precipitate is insoluble in water but soluble in ammonia, and dilute acids; hence the need for careful neutralisation. The precipitate is weighed after drying at 110°C . and then has the composition $\text{Co}_2\text{CO}_3 \cdot 10\text{NH}_3 \cdot 6\text{MoO}_4$. The corresponding tungstate and vanadate are similarly prepared but are not so suitable for analytical purposes. Cobalt may be separated from nickel by precipitation as described, but a reprecipitation of the molybdate is necessary if the nickel predominates in the mixture treated. The nickel is then estimated by known methods. The reaction may be used in separating cobalt from zinc, cadmium, or copper, but is only to be recommended where the cobalt alone is to be estimated, as the presence of molybdate introduces complications in the determination of the other metals.—H. J. H.

Arsenic; New method of destroying organic matter preparatory to the detection of—. A. Gautier and P. Clausmann. *Comptes rend.*, 1917, 165, 11—16.

THE method of destroying animal or vegetable organic matter by means of nitric and sulphuric acids is tedious, and it is necessary to precipitate the arsenic as sulphide and again bring it into solution before introducing it into the Marsh apparatus. The following method requires much less time, and experiments have shown that quantitative results are obtained even with minute quantities of arsenic. The substance is heated at about 300°C . until it swells and becomes friable. It is then ground in a porcelain mortar with 2—3% of pure quicklime (from marble or calcium nitrate), which is slaked with a small quantity of water; the mixture is placed in a shallow porcelain capsule which is introduced into a small muffle furnace, and the furnace is heated to dull redness; the mixture swells somewhat at first and then burns slowly like tinder. After cooling, the residue is powdered, treated with

water, a slight excess of sulphuric acid added, and the solution heated to boiling and filtered. The insoluble residue is washed, and the filtrate and washings are concentrated until white fumes appear, then diluted with 8—10 times its volume of water, and introduced into the Marsh apparatus (see this J., 1902, 1472; 1903, 903).

Conditions of formation of coke. Charpy and Godehot. See IIA.

Determination of phenol in crude carbolic acid and tar oils. Weiss and Downs. See III.

Determination of oxycellulose. Kita. See V.

Determination of free chlorine in solutions of hypochlorites. Dienert and Wandenbulke. See VII.

Titration of calcium oxide or hydroxide in presence of some aluminates or silicates. Emley. See VII.

New alloys to replace platinum. Fahrenwald. See X.

Differential iodimetry. Analysis of pyrolusite and other oxidised manganese ores. Barnebey and Bishop. See X.

[Laboratory] apparatus for the purification of mercury. Patten and Mains. See X.

Modified bichromate method for glycerin analysis. Little and Fenner. See XII.

Detection of sandarac in resins, lacs, and partially manufactured materials. Sacher. See XIII.

Determination of aldoses. Bougault. See XVII.

Practical method for determining the viscosity of starch for mill purposes. McNider. See XVII.

Determination of nitrates [in water] in presence of chlorides. Gericke. See XIXB.

Determination of nitrates in waters rich in magnesium salts by the phenoldisulphonic acid method. Nichols. See XIXB.

Determination of strontium and lithium in water. Averitt. See XIXB.

Identification of alcohols. Reid. See XX.

PATENTS.

[Electrical resistance] thermometer unit. H. N. Packard. Assignor to Cutler-Hammer Mfg. Co., Milwaukee, Wis. U.S. Pat. 1,230,598, June 19, 1917. Date of appl., Nov. 30, 1914.

THE thermometer consists of a frame having an inwardly projecting flange, on which are clips holding the bends of a continuous length of flexible metallic tubing, which is strung to and fro across the frame. The resistance wire is within the flexible tubing and is insulated from it.—F. Sp.

Refractometer. G. W. Moflitt. St. Louis County, Mo. U.S. Pat. 1,230,754, June 19, 1917. Date of appl., July 7, 1916.

THE refractometer consists of a combination of lenses similar to a compound microscope, but having one lens composed of the liquid of which the refractive index is to be measured. The system is adjusted so that the variation in the position of the focus is directly proportional to the variation in the refractive index of the material forming the liquid lens.—F. Sp.

Gases; Instrument for recording percentage volumes of constituent—. W. W. Crossweller, Manchester. U.S. Pat. 1,229,587, June 12, 1917. Date of appl., Mar. 27, 1916.

SEE Eng. Pat. 5041 of 1915; this J., 1916, 387.

Journal of the Society of Chemical Industry.

No. 16, Vol. XXXVI.

AUGUST 31, 1917.

No 16, Vol. XXXVI.

Official Notices.

PROHIBITED EXPORTS.

An Order-of-Council, dated 14th August, 1917, orders that the Schedule to the Proclamation, dated 10th May, 1917, as amended by the Orders-of-Council of 22nd June and 13th July, prohibiting the exportation from the United Kingdom of certain articles to certain or all destinations,* should be amended, as follows:—

The following headings are deleted:—(A) Zinc oxide; (B) Zinc sulphide; (A) Cylinders, metal, such as can be used for containing compressed gas; (A) Tanning extracts, and substances for use in tanning.

The following headings are added:—(A) Ethylic alcohol, mixtures and preparations containing (not otherwise prohibited); (A) Zinc oxide, and mixtures containing zinc oxide; (A) Zinc sulphide, and mixtures containing zinc sulphide; (A) Cylinders, metal, capable of use for the storage of gases or liquids under pressure; (A) Oil, shark, and mixtures containing such oil; (A) Colza or rape seed oil and articles and mixtures containing such oils; (A) Tanning extracts and substances for use in tanning, including cutch.

EXPORTS TO SWITZERLAND.

An Order-of-Council, dated 10th August, 1917, orders that the Schedule to the Proclamation, dated 13th March, 1917, prohibiting the exportation from the United Kingdom of certain articles, and any articles composed wholly or partially of those articles, to any destination in Switzerland, should be amended as follows:—

The following headings are deleted:—Bitumen. Curriers' crystalline grease. Glucose, solid. Naphtha; naphthylamine (alpha and beta naphthylamine); naphthol (alpha and beta naphthol) and similar products; naphthalene and its compounds. Platinum. Steel, special, containing nickel, chrome, molybdenum, vanadium, tungsten, titanium and other alloys, including tools (except watchmakers' tools), machine parts and all articles in special steel; scrap, filings and waste of special steel; edge tools in ordinary steel. Turpentine. Varnishes, gum.

The following headings are added:—Benzonaphthol. Bitumen and bituminous compositions. Cardboard, asphalted. Cassava root. Celluloid wares. Citrate of lime. Curriers' grease. Degras. Felts, asphalted. Glucose. Glucose, solid, for the manufacture of artificial silk. Insulating materials. Liqueur wines containing a higher percentage of alcohol than that indicated in the Swiss Tariff. Mosses, Iceland, Irish (Carrageen), and Sphagnum. Naphtha; naphthol; naphthalene; naphthylamine and similar products. Paper, Japanese, and similar paper. Platinum in all forms, including manufactures (except platinum jewellery). Salophene. Steel, special, containing

0.5% of nickel, chrome, or tungsten, 0.2% of molybdenum, 0.1% of vanadium or titanium, 9% of manganese, 0.5% of cobalt (stellite), including tools (except watchmakers' tools), machine parts and all articles in special steel; scrap, filings and waste of special steel; edge tools in ordinary steel. Tin wares, including alloys. Turkey red oil, and other sulphuric acidates. Turpentine and mixtures containing turpentine. Varnishes of all kinds. Waxed and oiled cloth. Wines in casks, or otherwise than in bottles. Wood spirit.

EXPORTS FROM THE UNITED STATES.

A Proclamation has been issued by the President of the United States providing for the control by licence of exports from that country, and it is notified in the 23rd July issue of the official "Commerce Reports" (Washington) that the Exports Council has authorised the publication of the following list comprising articles determined to be included under the general headings mentioned in the Proclamation referred to. Additions may be made to this list if it is determined that other articles are properly included in the general headings given in the Proclamation. Export licences are, therefore, required at present for any article included in the following list:—Coal. Coke. Fuel oils—Lubricating oil; benzol; head lantern oil; toluol; naphtha; benzine; red oil. Kerosene and gasoline, including bunkers. Oil cakes and oil-cake meal. Malt. Cottonseed oil. Corn oil. Copra. Coconuts, desiccated. Grease, inedible or edible, of animal or vegetable origin. Linseed oil. Lard. Tinned milk. Peanut oil and butter. Rapeseed oil. Tallow. Tallow candles. Stearic acid. Pig iron. Steel billets:—Steel sheet bars; steel blooms; steel slabs. Scrap iron and scrap steel. Ferro-manganese. Cattle manure, shredded. Nitrate of soda. Poudrette. Potato manure. Potassium salts. Land plaster. Potash. Cyanamide. Phosphoric acid. Phosphate rock. Superphosphate. Chlorate of potash. Bone meal. Bone flour. Ground bone. Dried blood. Ammonia and ammonia salts. Acid phosphate. Guano. Humus. Hardwood ashes. Soot. Sheep manure, pulverised. Anhydrous ammonia. Nitrate of potash. Resin. Sulphur. Saltpetre. Turpentine.

SUPERPHOSPHATE PRICES.

The Minister of Munitions has made an Order as follows, under date 20th August:—

1. As on and from the day following the date of this Order the maximum prices for superphosphate shall be as follows:—

(a) In the case of sales or purchases for delivery in railway trucks at purchaser's or consumer's siding or nearest railway station or on barge or ship at purchaser's or consumer's wharf or in the case of sales or purchases for shipment to the Channel Islands, f.o.b. at port of shipment, the prices specified in the Schedule hereto, but less a discount or deduction of 2s. 6d. per ton on sales of two tons and upwards by makers or producers to manure mixers, agricultural merchants and dealers, and co-operative societies registered under the Friendly Societies Acts.

(b) In the case of sales or purchases for delivery at maker's or producer's works free into purchaser's or consumer's carts or wagons for conveyance direct by road to consumer's premises, the prices

* The prohibition of exports is as follows:—

Goods marked (A), to all destinations;
Goods marked (B), to all ports and destinations abroad other than ports and destinations in British Possessions and Protectorates;

Goods marked (C), to all destinations in foreign countries in Europe and on the Mediterranean and Black Seas, other than France and French Possessions, Russia, Italy and Italian Possessions, Spain and Portugal, and to all ports in any such foreign countries, and to all Russian Baltic ports.

specified in the Schedule hereto, less 10s. per ton.

(c) In the case of sales or purchases for delivery ex vendor's store or shop or ex warehouse, railway goods yard or public wharf, the prices specified in the Schedule hereto with the addition of the following amounts according to the quantity of superphosphate included in the sale or purchase, namely:—

Quantity sold and purchased.	Additional price authorised.
4 tons and over	5s. per ton.
1 ton and over but less than 4 tons	10s. "
2 cwt. and over but less than 1 ton	1s. per cwt.
Less than 2 cwt.	2s. "

Provided that such additional prices shall not be charged or paid in the case of sales or purchases of more than one ton for delivery ex railway goods yard or public wharf.

(d) In the case of sales or purchases for delivery by road at consumer's premises from vendor's store or shop or from warehouse, railway goods yard or public wharf, the maximum prices authorised under paragraph (c) above plus cost of or local rates for cartage or haulage.

2. The maximum prices fixed by paragraphs (a) and (b) of clause 1 of this Order shall not apply to any sale or purchase by or from a maker or producer for delivery as mentioned in those paragraphs where the quantity of superphosphate included in the sale or purchase is less than two tons; and none of the provisions of clause 1 hereof shall apply to any sale of superphosphate for export from the United Kingdom. But save as aforesaid no person shall as on and from the day following the date of this Order until further notice effect or offer to effect any sale or purchase of superphosphate except for delivery in accordance with the terms specified in one or other of subparagraphs (a), (b), (c) and (d) of clause 1 of this Order and at a price not exceeding that prescribed by the said clause and the Schedule hereto as the maximum price (having regard to quantity, quality and date for and terms of delivery) for such sale or purchase.

3. The maximum prices fixed by clause 1 of this Order are *net* prompt prices for superphosphate in maker's or vendor's bags. Where credit is given to the purchaser a reasonable extra charge may be made provided that a price for net prompt cash is quoted on the invoice and does not exceed the maximum price authorised. If purchaser's bags are used, a reasonable allowance shall be made.

4. All persons engaged in producing, manufacturing, selling, distributing or storing superphosphate, or in any manufacture in which the same is used, shall make such returns with regard to their businesses as shall from time to time be required by or under the authority of the Minister of Munitions.

5. All provisions of the Fertilisers and Feeding Stuffs Act, 1906, and the regulations made by the Board of Agriculture and Fisheries in pursuance of the provisions of that Act, shall apply *mutatis mutandis* to this Order.

For the purposes of this Order, superphosphate shall mean superphosphate of lime manufactured from mineral phosphate, but shall not include basic superphosphate, bone superphosphate, dissolved bones, bone meal or bone compound, guanos or compound manures.

NOTE.—All applications in reference to this Order should be addressed to the Director of Acid Supplies, Ministry of Munitions, Department of Explosives Supply, Storey's Gate, Westminster, London, S.W.1, and marked "Fertilisers."

The Schedule.

Maximum prices for superphosphate referred to in clause 1 of the above Order:—

Percentage of tribasic phosphate of lime rendered soluble in water:—15% or over but less than

16%, £4 12s. 6d.; 16—17%, £4 15s.; 17—18%, £4 17s. 6d.; 18—19%, £5; 19—20%, £5 2s. 6d.; 20—21%, £5 5s.; 21—22%, £5 7s. 6d.; 22—23%, £5 10s.; 23—24%, £5 12s. 6d.; 24—25%, £5 15s.; 25—26%, £5 17s. 6d.; 26—27%, £6; 27—28%, £6 2s. 6d.; 28—29%, £6 5s.; 29—30%, £6 7s. 6d.; 30—31%, £6 10s.; 31—32%, £6 14s.; 32—33%, £6 18s.; 33—34%, £7 2s.; 34—35%, £7 6s.; 35—36%, £7 10s.; 36—37%, £7 14s.; 37—38%, £7 18s.; 38—39%, £8 2s.; 39—40%, £8 6s.; 40—41%, £8 10s.; 41—42%, £8 14s.; 42—43%, £8 18s.; 43—44%, £9 2s.; 44% or over but less than 45%, £9 6s. per ton.

The above prices for all qualities are for orders placed for delivery during December, 1917. In the case of orders placed for delivery during other months, the above prices are in each case to be reduced or increased 1s. per ton per month according as the month for delivery precedes or is subsequent to December, 1917, but with a maximum increase of 5s. per ton, e.g., the prices for October, 1917, deliveries will be 2s. less per ton, while the prices for May and June, 1918, deliveries will be 5s. more per ton than the prices set out above.

Yorkshire Section.

Meeting held at Queen's Hotel, Leeds, on Monday, March 12th, 1917.

PROFESSOR J. W. COBB IN THE CHAIR.

DISCUSSION ON THE SOFTENING OF WATER.

Mr. G. H. FRANK opened the discussion with a short paper in which he enumerated the chief methods of softening water, by the use of lime, sodium carbonate or caustic soda, permuto, or combinations of these, and gave brief descriptions of some types of softening plant, including those of Archbutt and Deeley, Paterson, Collet, Wilson, and Lassen and Hjort. The paper was illustrated by a number of photographs.

The CHAIRMAN referred to various problems that arose in connection with water-softening plants, and the distribution of softened water from them. The modern tendency was to automatic addition of the chemicals required, but it was obviously necessary to secure accuracy, and such difficulties as the clogging of measuring-buckets, and the irregularities in the content of suspensions, and the alteration in diameter of measuring apertures had to be faced. Moreover when water supplies were liable to serious fluctuations in composition, the applicability of any automatic appliance became questionable and the softening of large volumes in tanks of the Archbutt-Deeley type more practicable. In connection with the permuto process arose the liability of a perfectly softened water to initiate or aggravate corrosion of service-pipes and boilers, and also the tendency to "priming" in the boiler of a water heavily laden with sodium salts. It was sometimes debatable as to whether in a large establishment central softenings followed by distribution through pipes was better or worse than the use of separate plants for particular installations. "Furring" of the pipes undoubtedly occurred at times and it was debated as to how far carbonating of the softened water to prevent this was convenient and effective. The disposal of the mud of lime salts from a softening plant was sometimes a problem.

Mr. F. W. RICHARDSON said that the permuto process worked well under certain given conditions, and it was very desirable that waters to be treated

should be free from iron. A preliminary treatment with lime and soda ash did not remove iron from all waters. It was, indeed, suggested that the iron in waters should be passed through manganese-permutite, which always oxidised any ferrous salt, and completely removed the per-salts so formed. One objection to the use of permutite with waters containing much calcium carbonate was the production of an alkaline effluent which affected certain light shades in dyeing, and some firms had been obliged to resort to neutralisation—a rather delicate matter. The use of barium carbonate had been suggested. If this salt were effective, in conjunction with magnesium and calcium sulphates, it would form insoluble barium sulphate and also the relatively insoluble calcium and magnesium carbonates, whereas in the lime and soda process much sodium sulphate was left in solution, and after concentration in the boiler had to be blown off from time to time.

Mr. B. G. McLELLAN emphasised the need for proper chemical control of water-softening plant, and quoted figures to show that the softeners did not take their full share of the softening process, and that, in some cases, a large excess of chemicals was entering the boilers. He had had experience with a water softener in which the softening medium used was milk of lime and sodium carbonate. Troubles due to uneven solution of the lime and to the presence of gritty particles were overcome by breaking up these particles in the chemical preparation tank. It was found to be advantageous to agitate the water after the addition of chemicals, before sending it to the main tank for settling. A baffled trough ("Salmon-ladder") was provided, which was later increased in length with beneficial results. The removal of the precipitated matter presented many difficulties; a large proportion of this settled in the main tank, and was sludged away at intervals, the remainder being caught in the wood-wool filter in the upper part of the tank. With the water in question, the filter soon filled up, and required frequent flushing and periodical removal for cleaning. He had frequently noticed that the softening was not so complete for some time following the packing of the filter with new wood-wool. Experiments had been made to elucidate this, the results of which showed that the intimate contact of the water with the precipitate on the wood-wool caused the reactions to proceed to a point nearer completion. The water was softened from 31 grains to 5 or 6 grains per gallon. No scale formed in the boilers, but the economisers had to be cleaned periodically. As was to be expected the feed water contained a large quantity of sodium sulphate and precautions had to be taken to prevent the water in the boiler becoming too concentrated.

Mr. P. E. KING said that he had had considerable experience with the Lassen and Hjort automatic softening machine, and also with the permutite process. The permutite process in his opinion dealt for softening crude water and the quantity of solids left in solution was not so objectionable as in water previously softened with lime or lime and soda, which contained free lime and was a source of constant annoyance in filling up pipes, valves, etc. This deposit in pipes was due to a secondary reaction between the free lime and the residual temporary hardness and was accelerated by heat. Permutite was used for softening town's water. There was one installation softening 50,000 galls. per day of 20° hardness to zero and then mixing with an equal quantity of hard water, thus bringing the hardness down to 10°. The sodium bicarbonate produced exerted no action on the remaining hardness. Manganese permutite was largely used for sterilising water, and calcium permutite could be used for the removal of free lime to some extent. He preferred the

milk of lime and soda process to clear saturated lime water, the former being more adjustable to range of speed of softening. Unfortunately permutite was proved to be spoilt by passing water of too great alkalinity through it, and this happened when a previous softening of the water with lime or lime and soda took place and the resultant water was very alkaline. The deterioration of the permutite in this case was slow and did not occur in all cases of alkaline water. In his opinion, a great deal more should be known with regard to the action of various waters on permutite. At the present time permutite plants were being installed to remove the remaining hardness after the lime and soda treatment. This was the ideal system, both from initial cost standpoint and from results obtained.

Mr. A. PENDLEBURY said that he had designed an apparatus for keeping milk of lime in suspension by agitation and lifting it to the softening plant. The apparatus consisted of two tanks driven by belts for mixing the milk of lime; a centrifugal pump connected to the two tanks lifted the milk of lime to the top tank on the softening plant which was designed with a semicircular bottom. The end of the delivery pipe was fan shaped, causing a rapid flow along the bottom of the top tank. About two to three times the quantity of lime picked up by the plant and necessary for softening the water was pumped and the surplus fell back to the mixing tank.

Dr. H. INGLE said that he had had experience with several plants, including the Archbutt-Deeley, and Watson and Birkett, but he always found difficulties owing to the variation on the water from day to day if it came from a stream and the variation of the composition of the lime caused by the exposure to air and other causes. To overcome these troubles each tank ought to be tested, and all lime should be kept in airtight receptacles and analysed. The preparation of a constant "milk of lime", was difficult, and he approved of Mr. Pendlebury's appliance. The use of colloids in the boiler to prevent the formation of scale was very old. Tannin refuse, potatoes, and other substances of a colloidal character had been used. Their effect was to render the deposition of crystalline substances impossible, and to produce an amorphous deposit, and they had been found effective. Complaints had been made in Leeds that during the last twelve months a great increase of boiler scale from the River Aire water had resulted. A considerable amount of soap was present in the water and this was probably the cause of the varnish-like surface of the total solids. Sulphates were high, due no doubt to the use of nitre cake in place of sulphuric acid in the neutralisation of scouring liquors, and also to the effluent from munition works.

Mr. B. A. BURKELL did not think it desirable completely to soften waters that were intended for a town's supply, or for boiler purposes; if for the former, there would probably be an outbreak of plumbism, and for the latter purpose he had had several of these completely softened waters which had attacked boiler plates rather badly owing no doubt to the water containing much carbon dioxide which had not been removed by treatment.

Mr. W. HARRISON stated that sand did not act catalytically but chemically in a similar manner to permutite, although to a much less extent. He suggested that the effect of tannins in preventing boiler scale was due to colloids other than tannic acid, which are always present in vegetable tannins.

Mr. H. G. BENNETT speaking from a tanner's point of view, indicated that the excess of alkali remaining in water softened by the permutite process was a fatal defect when tan liquors were to be made with the softened water. One of the great difficulties with aill processes yet suggested

was that the reactions were incomplete, and that the later stages of softening took place after the water had left the softener—in pipes, tanks, and boilers. This difficulty seemed to be greater when larger proportions of magnesia were present, and in some cases it would appear that the magnesia remained in colloidal solution. He supported Dr. Ingle's suggestion that variations in the quality of the lime were another cause of difficulty, and he had found that the only way to obtain satisfactory results was to have the softened water tested, at least once each day, and also to make tests of water actually taken from the boilers. He suggested that it was desirable that chemists not only had better agreement in the methods of testing, but also in the method of reporting results. It was high time that such terms as "degrees of hardness" and "grains per gallon" made a final disappearance. With regard to a recent paper by Kay and Newlands on the "Determination of Hardness of Natural Waters, and the use of methyl red as indicator" (this J., 1916, 415), he pointed out that the methods were not altogether new. He had himself used methyl red for temporary hardness determinations for some years, and had published the method (Collegium 1915, 237, Lon. Edition; see this J., 1915, 1028). He had found it an exceedingly satisfactory indicator. With reference to the use of organic matter in boilers, he supported Mr. Harrison's suggestion that the extractive matters rather than the tannins were the useful ingredients, and mentioned that some tanners ran their spent tan liquors into the boilers.

Mr. THORP WHITAKER mentioned that the permute process of softening was taking place naturally around Bradford. Natural zeolites occurred in certain districts and water obtained from such strata was very soft and contained a certain amount of alkalinity, which for instance in Bradford was very constant in composition, and greatly appreciated for wool-scouring purposes. Instances had been known in well sinking in the Bradford district where the water was first struck it was exceedingly hard, and on sinking lower through the strata natural zeolites were found and the water from below this was exceedingly soft and contained large quantities of sodium carbonate.

Mr. S. EVANS said that his experience of a large number of waters, used for boilers in connection with turbo-generator sets, was that is no single instance was the water properly softened. He also knew of a large well which delivered water alkaline to phenolphthalein. He agreed that the best method was to soften the water to 5 or 6 degrees, and then use an organic boiler compound in the boiler. His theory of the action of these organic boiler compounds was that they increased to a very great extent the surface tension of the water, and thus prevented deposited matter from interlocking to form an incrustation. The suggestion to use barium carbonate to give two insoluble compounds by double decomposition was excellent, except for the fact that barium carbonate was insoluble, and therefore the reaction would be inefficient; the grains of barium carbonate would become covered with a coating of sulphate, which would prevent further action. He had had experience of similar material becoming coated with calcium sulphate and had been able to dissolve out the soluble interior, leaving the thin shell of calcium sulphate intact. He agreed that the best method of keeping lime was to slack it to a pug. Lime was never properly burnt, and when allowed to air-slake or slaked with a minimum of water, the heap contained somewhere about 40% of free lime. One speaker had referred to the action of "baffle plate" and "salmon ladder" mixers for promoting the reactions. In his opinion this was exactly the action of sand, wool-wool, and permute in enhancing

the reactions. The percolation of the solution through the exceedingly fine interstices of these materials was a most efficient and thorough method of mixing them. He mentioned the case of a boiler feed water containing 33 pts. per 100,000 of total solids of which 6 pts. per 100,000 was sodium; after continuous steaming for three months the boiler water contained 844 pts. per 100,000 total solids of which 26 pts. was sodium; the boiler crust from the above contained 60% chloride.

The following table was interesting as showing the state of the water in some boilers.

Source of sample.	Pts. 100,000.	
	Total solids.	NaCl.
Before boiler	207	170
Boiler contents, after 5 days	5743	5174
Blow-off	9814	8643

In conclusion he cited an instance of a water containing 1657 pts. per 100,000 NaCl being used for cooling in a surface condenser.

THE LOW TEMPERATURE DISTILLATION OF INFERIOR COALS.

BY T. F. WINMILL, B.A., B.SC.

(Research Chemist to the Staveley Coal and Iron Company, Ltd.)

(COMMUNICATED.)

Accompanying the main coal seams in some parts of England are often found seams of inferior coal substances, which with different composition and in different districts receive different names, such as "Jacks," "Branch Coal," "Bastard Cannel." As the last name implies, these coals have often some resemblance to a cannel coal, but this resemblance is not very close. They are all distinguished by their high ash content, and the very voluminous nature of the ash, making them useless for ordinary fuel purposes. Jacks and black shale may leave 80% of ash when burnt, whilst a very good sample of bastard cannel may leave only 10%. Where they occur, considerable quantities of these coals have to be raised with the main coal, and form an expensive waste product, not only from the cost of raising, but because waste tips must be provided on the surface, forming unsightly heaps which often fire either spontaneously, or from other causes.

In some districts the bastard cannel is fairly uniform in composition over a wide area and contains generally between 20 and 30% of ash. The associated carbonaceous matter is intermediate in composition between a "soft" coal and a cannel, as is shown by the following limiting analyses, calculated on a dry, ash-free basis:—

	78	%	81
Carbon	5.7	"	6.0
Hydrogen	1.2	"	1.5
Nitrogen	1.5	"	5.0
Sulphur	10.0	"	10.1
Oxygen			

From these figures it is clear that the substance contains a large amount of potential energy which is at present wasted. The carbonaceous portion is comparable in composition to that of a good coal, so that in effect every 100 tons of branch or bastard cannel coal contains as much heat value as 70—80 tons of high grade coal.

Experiments have been made therefore to see whether any portion of this potential energy can be made available in the form of oil fuel or other valuable products.

Of recent years much attention has been given to the destructive distillation of coal at low

temperatures, and many accounts have been published of the results of such distillations. In general it is claimed that very large yields of tar and ammonia are obtained by this method—much larger than those from coke ovens or gas retorts—and further that the tars on re-distillation yield useful oils of different grades, some sufficiently volatile to replace petrol as a motor spirit. Such a process seemed therefore admirably suited for extracting the greatest possible quantity of valuable products from the branch coal. As the sequel shows, expectations of a large yield of oils have not been realised, and no workable quantity of volatile oils corresponding to petrol was recovered, despite the fact that a cannel coal should on the showing of previous publications have been the most favourable substance with which to work.

Apparatus. In designing the apparatus for the distillation, it had to be borne in mind that the coke residuum would in any case be valueless as its ash content would be above 50%. The aim of the design had to be, therefore, to secure the most rapid coking, with the biggest possible yield of by-products, without considering the effect on the residuum. The retort was made of cast iron two inches thick, built into a fire-brick chamber,

and heated by five evenly placed Bunsen burners. It held a charge of 8 cwt. of coal and was fitted with a very efficient stirrer working through a vacuum-tight stuffing box. The stirrer quickly ground up the charge and brought fresh portions of it continually against the hot walls of the retort, thus securing a rapid heating throughout the mass, instead of depending on the slow conduction of heat usual in any other coking oven. The distillation was carried out under a vacuum of from 26 to 28 inches of mercury, and had gone as far as it would at 500° C. in 3½ hours, after which the contents of the retort could be discharged by opening the bottom door and reversing the direction of revolution of the stirrer.

Whilst effecting such a marked shortening in the time of coking, the stirrer introduced experimental difficulties which at first gave much trouble. Part of the charge was, by the combined action of the stirrer and the effect of the temperature, quickly reduced to a fine dust which was carried out of the retort, blocking the ascension pipes and the condensers. To reduce this to a minimum the speed of the stirrer was reduced from 3 revolutions per minute to 2 revolutions in three minutes, but even at this speed the condensers became choked,

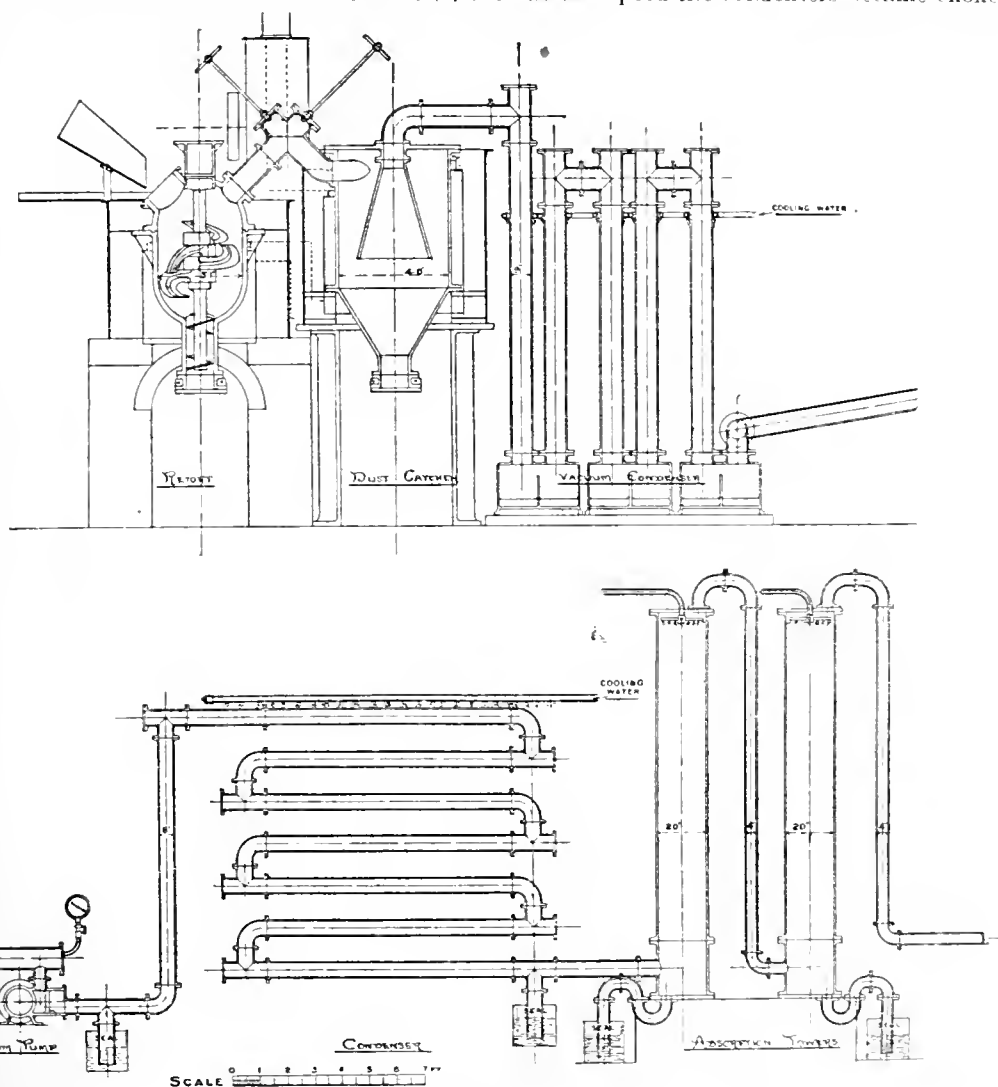


DIAGRAM.

Arrangement of coal distillation plant, *Slaveley Coal and Iron Co., Ltd., old works.*

until a dust-catcher and other appliances for dealing with the dust were introduced. An interesting, though very objectionable, property of this dust was its extreme liability to spontaneous combustion. A few pounds of it removed from the ascension pipe, even when absolutely cold, would by the absorption of oxygen from the air, and the consequent spontaneous generation of heat, burst into flame within about half an hour. The exclusion of oxygen from the dust prevents, of course, this firing.

The other details of the apparatus need no special remark, and are quite clear from the figure drawn by Mr. F. Smith, for whose assistance in the arrangement, building, and working of the plant the writer wishes to tender his best thanks.

Method of working. The retort was brought to a temperature between 500° and 550° C., the stirrer started, and a charge of 8 cwt. of coal introduced from a hopper. The retort door was then closed, and the valve leading to the vacuum pump opened. The whole charging operations occupied less than 5 minutes. The vacuum and a temperature of 500° C. were maintained for 3½ hours, at the end of which time experience showed that practically no more oils or gases were being evolved. The vacuum valve was then closed and air admitted to the retort through a ½ in. pipe from the bottom of the charge. The bottom door of the retort was then opened, the direction of revolution of the stirrer reversed, and the carbonised residue discharged from the retort in the space of a few minutes. The collected tar was then run off from the condensers, after which the apparatus was ready for another charge. The complete series of operations, from the introduction of one charge to the introduction of the next, occupied slightly less than four hours, so that a plant of the size described would be capable of dealing with nearly 2½ tons of coal per day of 24 hours.

Distillation products. The distillation produced (1) tar and aqueous liquor condensed *in vacuo*; (2) gas which passed through the vacuum pump and was in part burnt under the retort.

Treatment of tar. The vacuum tar was quite fluid when warm but on cooling became as viscous as ordinary coke-oven tar. It has a characteristic and not unpleasant odour, quite unlike that of the latter. About 30 gallons was produced per ton of coal distilled. Its separation from the admixed water is very difficult and nothing approaching a complete separation of the two could be obtained by "settling," or by reheating and settling.

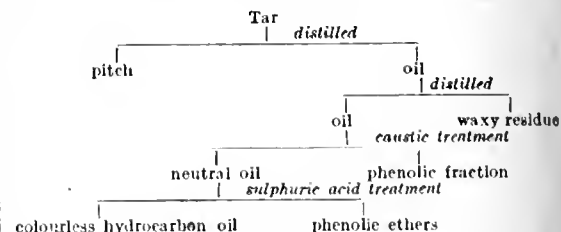
On re-distillation it undergoes decomposition even at temperatures as low as 150° C., depositing carbon and evolving hydrogen, sulphuretted hydrogen, and ammonia, the two latter gases probably coming from the admixed water, which in addition causes much frothing. Distillations were carried out both at ordinary pressure and under vacuum, but the products of the two distillations did not differ materially. The residue in the still consisted of a hard pitch which had to be chipped out. The distillate was a very dark-coloured oil containing suspended carbon, apparently formed partly by the thermal decomposition of the original tar and partly by oxidation of the cold oil. In this state chemical treatment of the oil was difficult and it was therefore subjected to a further distillation, when it left as a residue a semi-solid mass containing much free carbon, and furnished a distillate which was at first colourless, quickly becoming red and finally within a day black. This behaviour was not confined to any one fraction, all the distillates between 150° C. and 360° C. appearing to discolour with equal rapidity. The various fractions were then treated with 10% caustic soda solution. All the fractions yielded a soluble portion, varying in amount. Thus, for example, the oil distilling up to 180° C. yielded 18%, that between 200° and 220° C. 47%, whilst

that between 330° and 360° C. yielded only 21% soluble in the soda solution. Of the whole distillate 33% was dissolved. The remaining 67% on re-distillation gave a colourless oil which, however, soon blackened again. Treatment with successive portions of strong sulphuric acid finally gave an oil which on distillation remained colourless or only slightly yellow.

That part of the oil soluble in caustic soda consisted of a complex mixture of phenolic substances, but contained practically no phenol (carbolic acid). The simplest phenols present were the three cresols, and these were mixed with higher homologues and phenolic ethers containing non-esterified hydroxyl groups. The whole mixture can only find very limited uses similar to those of coal-tar creosote.

The fraction soluble in sulphuric acid consisted of a mixture of neutral phenolic ethers together with some hydrocarbons.

The "working up" of the vacuum tar followed therefore the following plan:



The quantitative results per ton of coal distilled were:—

Pitch	100 lb.
Semi-solid wax	50 lb.
Soda-soluble oil	4 gallons.
Phenolic ethers, extracted by sulphuric acid..	1.5 gallons.
Hydrocarbon oil	6.5 gallons.

The finally purified hydrocarbon oil formed the main bulk of the liquid products. It consists of a mixture of unsaturated and polymethylene hydrocarbons from which no chemical individual could be easily separated. The mixture has a characteristic and not unpleasant odour; it starts to boil at 150° C. and continues to distil in fractions of fairly equal volumes, for equal temperature rise up to 360° C., above which point about 5% of the total remains unvolatilised. The various fractions range in density from 0.794 to 0.910 at 15° C. No benzenoid hydrocarbons are present, and no commercially valuable compound can be isolated from the mixture. Even the higher boiling point oils are mobile liquids, and possess neither sufficient viscosity nor "body" for use as lubricants. The only obvious use for the mixture is as a fuel oil.

Ammonia production. The bulk of the ammonia formed was contained in the condensed aqueous liquor, and was equivalent to about 25 lb. of ammonium sulphate per ton of coal. A further quantity of 10—15 lb. can be extracted from the gas leaving the condensers, giving a total yield of about 35—40 lb. of ammonium sulphate per ton of coal.

Gas. The gas coming from the condensers is very similar in composition to ordinary coal gas, and contains very little extractable light oil. Some oil is carried mechanically with the gas, but no appreciable quantity of oil boiling below 150° C. could be obtained, either by condensation or by washing. About 6000 cubic feet of gas was produced per ton of coal distilled.

Conclusions. The experiments described show definitely that low-temperature distillation of a high-ash waste coal is not a commercially economical process. The initial low cost of the waste coal would at first sight seem to make it possible to work on comparatively small yields of by-products. It must not be forgotten, however, that in ordinary coking practice the price obtained for the coke made, as a rule, more than pays for the

slack from which it is made, and hence in the absence of coke from the waste fuels the apparent advantage of worthless coals more than disappears, and the whole costs of the process have to be defrayed by the increased value of the by-products. In previously published accounts the quantity and nature of these products claimed have been sufficient to pay for the process, but in the light of the experiments now described it would appear that these have been estimated too optimistically. The saleable products amount to 6 gallons of oil, 35—40 lb. of ammonium sulphate, and perhaps 2000—3000 cub. ft. of gas after allowing for that necessary for the distillation.

The value of the oil is difficult to estimate, as it is of a new type. It would seem to have little value except as a fuel oil, and for that purpose need not perhaps be so highly purified. Unless fairly complete purification is made, however, the oil will resinify and become of much less utility. The cost of complete purification is considerable. The phenolic substances which it is desired to remove are not very readily soluble in soda, being much weaker acids than carboic acid, and hence the partition coefficient between the oil layer and the soda layer is so large that a considerable number of washings with comparatively large volumes of soda solution are necessary. In practice it is found that a total volume of 10% soda solution equal to the volume of the oil washed, is necessary for the complete removal of the phenolic bodies. The cost of these washings, added to that of the distillations, would make it impossible to produce the refined oil at a profit in normal times. As a fuel, however, the crude unwashed oil might find a market, but in this state it could only compete with coal tar creosotes, for which the uses are limited and the price low.

It was thought that possibly by "cracking" the oil, benzenoid compounds might be obtained in sufficient quantity to make the distillation profitable, but small-scale experiments in which the oil vapours were passed over coke at 800° C. gave no encouragement for larger experiments.

It must be concluded, therefore, that low-temperature distillation cannot be made to pay on the value of the by-products alone, and hence is useless as a means of utilising waste fuels of high ash content. The process as applied to valuable coals is in somewhat a different position, for in this case a residue of "smokeless" fuel is obtained. At present it cannot be claimed that there is any very large market for such fuel in competition with coal itself, but what market may be created in the future it is impossible to estimate. Legislation in favour of smoke abatement would of course give a great impetus to the use of semi-carbonised fuels, since most boilers and all domestic fireplaces are not designed to burn ordinary coke, whereas the semi-carbonised fuels obtained by the low-temperature distillation of coal can often be burnt more or less successfully in existing apparatus, but they would then find a severe competitor in gas firing. Unless such measures are taken, however, the ease with which a coal fire can be maintained, and the smaller proportion of ash in a good coal (for by carbonising the proportion of ash in the residuum is made nearly double that in the coal from which it is produced), will severely handicap the extended use of smokeless fuel.

Annual Meeting.

MANUFACTURE OF SYNTHETIC NITRATES BY ELECTRIC POWER.

BY E. KILBURN SCOTT.

(See this Journal, July 31, 1917, 771—777.)

In a written contribution to the discussion, Captain C. J. Goodwin submitted that while every

credit was due for Mr. Scott's valuable work, it should be noted as a matter of interest that Dr. Helbig, of Rome, had previously developed and patented the use of a three-phase current in similar furnaces (see this J., 1908, 576, and Norton, Utilization of Atmospheric Nitrogen U.S. Department of Commerce, Special Agents Series No. 52, 1912, 92). Had the Bonecourt system of packing with refractory material boiler tubes such as those provided in Mr. Scott's furnace been tried? In this way, the rapidity of cooling, regenerative yield, and efficiency of the boiler should be increased. It was a popular fallacy that it was essential for the gases to travel upwards in absorption towers as usually designed. Particularly in the case of nitric oxide, the density of which is approximately that of the atmosphere, it was not only permissible, but, in theory, there was a slight advantage, if the gases travelled alternately upwards and downwards, as when the gases travelled in the same direction as the absorbing liquid, there was a slight increase in the time of contact, particularly if the packing was so designed that an appreciable time was required for the liquid to travel from the top to the bottom of the tower. The Moscicki system was not equally suitable in cases where the density of the gases differed appreciably from that of the atmosphere. A condition for efficient absorption was not necessarily a maximum of contact surface. In the present case, the main factors were ample time for oxidation, contact, and reaction, together with merely sufficient surface to absorb the higher oxides at the same rate as they were formed. In addition, adequate mixing was essential and this could only be efficiently obtained by continuous throttling and expansion, causing change of velocity. These conditions were not attained by quartz pebbles, which, moreover, themselves occupied so great a percentage of the volume of the tower that the velocity of the gases over the absorbing surfaces was excessive unless the section and volume of the tower were made greater than in cases where packing designed on scientific principles was used. He had himself used, about six years ago, the principle of alternate oxidation and absorption together with periodic flushing in a block of towers of rectangular shape. Horizontal instead of vertical flow for the gases was ingenious, but very few good filling materials were suitable, as they were usually designed for a flow of gas and liquid in the same direction, whereas in the Moscicki towers the liquid descended vertically and the gases moved horizontally. A modified form of ring filling of double conical shape, arranged irregularly, would be suitable and would give a large "free space" together with adequate surface and a good mixing action.

Communication.

ESTIMATION OF NITROGEN IN NITRO COMPOUNDS.

BY A. P. SACHS.

The recent paper by Colver and Prideaux (this J., 1917, 480) on the determination of NO_2 in nitro compounds by reduction with stannous chloride, indicates that the results already obtained in a research which has unfortunately been interrupted may prove of value. The problem was to determine the nitrogen content of a large number of samples of nitrated "solvent naphtha." For this the Dumas combustion method takes too much time. Cope's modification of the Kjeldahl method (J. Ind. Eng. Chem., 1916, 592; this J., 1916, 907) is highly satisfactory for nitrotoluenes and picric acid, but proved unsatisfactory for the material under investigation, giving low and erratic results.

The method of reduction with stannous chloride and determination of the excess of reducing agent by iodine titration in alkaline tartrate solution was found unsatisfactory. Reduction and titration under practically the conditions described by Colver and Pridaux (*loc. cit.*) gave results considerably too low and not concordant enough for use even as a comparative method. The cause of the low results obtained by these investigators and by ourselves is to be found simply in the incomplete reduction of the nitro compound under the conditions used. More strenuous reducing conditions must be sought. A modification of the method adopted by us gave excellent results in certain cases. The method adopted was to carry out the reduction in a sealed tube at 120° C. for 2 hours. Excellent results were obtained with mononitrobenzene, *m*-dinitrobenzene, mononitroxymerene, and with certain of the nitrated "solvent naphthas," but the problem cannot be considered as definitely solved. In this reaction each nitrogen atom (present as NO_2) is equivalent to six iodine atoms, or 1 c.c. of $\text{N}/10$ iodine solution is equivalent to 0.0002335 gram of nitrogen.

Procedure. About 0.2 gram of the sample, weighed to 0.0001 gram, is placed in the "tube." (If the sample is liquid the Lunge pipette is conveniently used for weighing the substance.) The "tube" is made of thin-walled glass tubing about $\frac{3}{4}$ inch in diameter, about 8 inches long, sealed at one end. 15.00 c.c. of the stannous chloride solution (made by dissolving 350 grms. of $\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$ in 700 grms. of 25% HCl) is then run in from a burette. Owing to the large normality factor of this solution as compared with the iodine solution used it is essential that the same amount of stannous chloride solution be employed for each determination and for the blank. Any solution which may adhere to the side of the "tube" is washed down with a fine stream of water from a wash bottle and the tube sealed in the blast flame and allowed to cool. A set of tubes and two blanks (as a tube improperly annealed sometimes cracks in the oven, though the pressure developed is so low that no breakage occurs with properly annealed tubes), properly marked, are heated in a constant-temperature oven at 120° C. for 2 hours, and shaken every 15 minutes. When the sample is not shaken dark particles due to carbonisation or the deposition of tarry matter sometimes occur. After the heating is completed the tubes are allowed to cool, standing in a rack, a file-mark made near the end, and the tip of the tube broken off. The contents of the tube are washed into a 100 c.c. flask, diluted to the mark, and 10 c.c. taken for titration. In all cases separate aliquot portions agree to within one drop of iodine solution. The liquid is titrated with carefully standardised $\text{N}/10$ iodine solution, using starch as indicator. In our experiments the titration was finished with $\text{N}/100$ iodine, but this is hardly necessary or even advisable. The end-point is sharp and distinct. To avoid if possible the introduction of error, the time of titration was made about equal in all cases, although aliquot portions measured from a burette and titrated without any effort being made to titrate in equal time intervals gave identical results.

(A) Reductions carried out in open flask on steam bath. Titration in acid solution: *Nitrobenzene*. The sample was distilled three times and the end fractions rejected in each distillation. Combustion showed 11.38% N. By reduction, 10.49% and 10.91% N. (In all cases the figures refer to separate reductions, and not to various aliquot portions of the same reduction.) *Nitrated solvent naphtha*. Sample produced on manufacturing scale. Nitrogen by combustion,

14.50%. By reduction, 14.51%, 13.90%, and 12.66%.

(B) Reductions carried out in sealed tubes as indicated in procedure described above: *Nitrobenzene*. Portion of the same material as used for experiment in (A). Preliminary reductions (first set tried with sealed tubes) gave 11.26% and 11.14% N. Another set gave 11.32% and 11.37% N. *Mononitroxymerene*. This material was prepared in an unpublished research and was purified by repeated distillation. It was a mixture of the 1-nitro and 2-nitro compounds. By combustion, 7.89% N. By Cope's modification of the Kjeldahl method (*loc. cit.*), 7.88% N. By reduction, 7.89% and 7.90%.

m-Dinitrobenzene. Good commercial material recrystallised from alcohol. By combustion, 16.67% N. By reduction, 16.38%, 16.63%, and 16.66% N. *Nitrated solvent naphtha A*. Sample produced on a commercial scale by nitrating a solution of naphthalene in solvent naphtha. The nitro compounds contain nitronaphthalenes. By combustion, 13.80% N. By reduction, 12.54%, 13.11%, 13.00%, and 13.01% N. *Nitrated solvent naphtha B*. This sample, as well as samples C and D, were prepared by nitrating solvent naphtha (without dissolved naphthalene) at various temperatures, strength of nitrating acid, etc. By combustion, 13.50% N. By reduction, 13.51%, 13.32%, 13.57%, 13.50%, 13.55%, and 13.48% N. *Nitrated solvent naphtha C*. By combustion, 13.10% N. By reduction, 13.10% and 13.08% N. *Nitrated solvent naphtha D*. By combustion, 13.54% N. By reduction, 13.47% and 13.62% N.

These results show that the proposed modification of the stannous chloride method is suitable as a method for routine analysis, especially where a number of similar samples have to be analysed. In such a case an occasional blank should be run on a sample of known nitrogen content. This will serve to check the standardisation of the iodine solution.

The method is quite rapid, and a dozen or more analyses can be made daily by one chemist, as compared with 3 or 4 determinations per day by one chemist using two electrically heated combustion furnaces. The combustion method as used in this laboratory requires copper oxide free from nitrogen, which takes a long time to prepare, and is very slow for explosive or volatile materials (like nitrobenzene and the nitrotoluenes), but gives the best results obtainable by any method, as duplicates agree usually within 0.05% and seldom differ by as much as 0.10%. On pure control samples of nitrobenzene or picric acid the figures agree within 0.02% to 0.05% of the theoretical nitrogen figure calculated from the formula.

Acknowledgment is made of the assistance of Mr. G. S. Andrews, of this laboratory, in making the actual analyses.

The work reported here was carried out in the Research Laboratory of Aetna Explosives Co.

Errata.

July 31st, 1917, issue.

Page 765, col. 2, line 6 from bottom. The reference should read:—"This Journal, 1890, 447 (Dinsmore process)."

Page 789, col. 2, line 31 of Dr. Stevens' remarks, for "weakening" read "darkening."

Page 835, figure 3. The figures along the base of the graph should read 10, 12, 14, 16, 18, 20, 22, 24.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

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Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

Oxyhydrogen gas explosions in compressed gas cylinders. L. Wöhler. *Z. angew. Chem.*, 1917, 30, 174—175.

THE author, after referring to the regulations which have been enforced in Germany since 1902 with regard to the filling and use of compressed gas cylinders for oxygen and hydrogen gases, gives details of some recent explosions to show that in spite of all these precautions, accidents, due to carelessness and negligence, are of frequent occurrence. The most disastrous of these, in which three men were killed and many were injured, occurred at Darmstadt. An empty oxygen cylinder, of 210 cub. ft. capacity, was filled with hydrogen, but the error was discovered before the gas was used and the cylinder was returned to the compressed gas works. Without emptying the cylinder, the men in charge of the oxygen filling machinery filled the cylinder to its maximum capacity with oxygen, and when the cylinder arrived at the railway workshops the second time, and was put into use, it burst. The author points out that owing to the shortage of copper the connecting gas couplings used at the filling works are now of iron or steel. The rule with regard to right- and left-handed threads to the cylinder fittings for the different gases is therefore easily evaded, for a steel or iron screw externally threaded when used with a powerful wrench will easily cut its own thread internally on a brass connecting piece whatever the thread may have been on this originally. The regulations with regard to the use of distinctive colours for the cylinders containing the two gases have also been often ignored lately, owing to labour shortage and similar difficulties, and cylinders have been used indiscriminately for oxygen or hydrogen, without regard to their colour or markings. As a precaution against similar accidents and explosions the author recommends the application of the Habber test for explosive gases before the gas from any cylinder is used, or the still more simple soap-bubble test, which consists in blowing a bubble with the gas from the cylinder, and then applying a light. These tests, however, are of little value if left in the hands of the workmen, since negative results can easily be obtained with them.—J. B. C. K.

PATENTS.

Separating solids from liquids: Process and apparatus for—. P. T. Sharples, West Chester, Pa. U.S. Pat. 1,232,104, July 3, 1917. Date of appl., May 6, 1916.

A MIXTURE of two constituents of different specific gravity is separated by mixing it with a carrier liquid of greater specific gravity than the constituents of the mixture and centrifuging the whole. The lighter constituent is discharged through one outlet and the heavier constituent, together with the carrier liquid, through another outlet of the centrifuge. The carrier liquid is then separated and returned to the process.—W. H. C.

Replacing and thickening apparatus. Process of replacement [for treating slimes and pulp]. G. Moore, Joplin, Mo. U.S. Pats. 1,231,409 and 1,231,410, June 26, 1917. Date of appl., Oct. 9, 1914.

THE pulp is passed down and the dissolving

solution and wash water are passed up a vertical, cylindrical vessel provided with groups of superimposed horizontal discs. The solids settle through the solution and collect on the discs and are then disturbed and broken up and again settled through a fresh portion of solution or wash water. The solids collect in the conical bottom of the vessel and the solution overflows at the top.—W. H. C.

Dewatering and replacement apparatus. G. Moore, Joplin, Mo. U.S. Pat. 1,231,411, June 26, 1917. Date of appl., Dec. 11, 1914.

THE pulp flows in one direction and the wash water in the opposite direction through a series of vessels formed by mounting a number of spaced plates in a tank. These plates can be tilted from a position in which the solid particles collect on the plates to one in which the solid particles slide off.—W. H. C.

Liquids; Process of separating the constituents of—. W. A. Schmidt, Los Angeles, Cal., and L. Bradley, East Orange, N.J., Assignors to Research Corporation, New York. U.S. Pat. 1,232,395, July 3, 1917. Date of appl., June 2, 1914. Renewed Mar. 24, 1917.

A MIXTURE of liquids of different degrees of volatility is sprayed into a current of heated gas so that the more volatile liquid is evaporated. The mixture of vapour and particles of less volatile liquid is then passed through an electric field to precipitate the particles.—W. H. C.

Separating air or other gaseous fluid from liquids; Means for—. W. H. Walker, London, Eng. Pat. 107,030, May 10, 1916. (Appl. No. 6706 of 1916.)

TO prevent the escape of vapour along with the air which is discharged from the air-collecting chamber, when the level of liquid in the chamber falls and causes the float-operated valve to open, the connection between the air chamber and the discharge valve is made by a spiral pipe, in which any vapour is condensed, the condensed liquid being returned to the air chamber. The air-escape valve, which is operated by the float and is counter-balanced by a weight, has a passage-way of small cross-sectional area and also a subsidiary valve which only opens when the main valve has moved a certain distance, so that the escape of air takes place in a steady manner.—W. H. C.

Refrigeration and the production of ice; Processes and apparatus for—. W. R. Ormandy, London, W. E. Calvert, Halifax, and The Seay Syndicate, Ltd., Manchester. Eng. Pat. 107,040, June 8, 1916. (Appl. No. 8132 of 1916.)

THE liquid absorbent and/or the liquid product of absorption of the gas used for refrigeration are absorbed by a solid such as kieselguhr, pumice, or a clay-like artificial absorbing material. The product is substantially a solid and is rapidly cooled during the absorbing and rapidly heated during the evolution period.—W. H. C.

Straining or filtering apparatus [for fuel oils]. Vickers, Ltd., London, and J. McKechnie and J. P. Clear, Barrow. Eng. Pat. 107,090, July 8, 1916. (Appl. No. 9665 of 1916.)

A NUMBER of perforated plates having an annular rib on one face, provided with small straining

channels, are fitted together, one above the other, in a casing. The oil is fed under pressure into the interior of the pile of plates and passes through the straining channels into the space between the outer casing and the pile of plates.—W. H. C.

Mixing mill; Continuous —. J. Crossley, Trenton, N.J. U.S. Pat. 1,231,499, June 26, 1917. Date of appl., Feb. 5, 1917.

A NUMBER of mixing-mills, each provided with an agitator and having discharge openings at their lower ends, are connected by conveyors, so that the materials pass from mill to mill.—W. H. C.

Grinding-mill. G. H. Blankmann, St. Louis, Mo. U.S. Pat. 1,231,478, June 26, 1917. Date of appl., Aug. 30, 1916.

GRINDING bars are disposed helically about the ends of radial beaters mounted on a rotating shaft. The distance between the grinding bars and the ends of the beaters is adjusted by means of rotating scroll rings having spiral grooves in which the outer ends of the grinding bars fit.

—W. H. C.

Ball-grinding machine. J. Vorraber, Munich-Trudering, Germany. U.S. Pat. 1,231,818, July 3, 1917. Date of appl., July 29, 1916.

A STATIONARY holder has grooved discs on each side and grinders co-operating with the grooved discs. Grinding balls are fed to and returned from the grooved discs, and the stationary holder is provided with wedge keys, by means of which axial pressure in opposite directions can be exerted by the holder.—W. H. C.

Dryer; Rotary —. N. M. Rosendahl, Winthrop Harbor, Ill., Assignor to F. C. Austin, Chicago, Ill. U.S. Pat. 1,229,524, June 12, 1917. Date of appl., Nov. 5, 1914.

A CURRENT of heated air is drawn through a horizontal rotary drum having several concentric inner cylinders attached alternately to opposite ends of the drum. The material is fed through a hollow trunnion at one end, travels backwards and forwards, and is discharged from peripheral openings in the outer drum.—W. H. C.

Dryer. W. J. Kuntz, York, Pa. U.S. Pat. 1,229,978, June 12, 1917. Date of appl., Jan. 19, 1917.

AN inclined rotary drum has an inner shell connected with a cylindrical shell in one side of the feed head. Heated gas is conveyed by a flue into the opposite side of the feed head and into the shell extension, and air is admitted through an enlarged opening around the flue into the inner shell of the drum.—W. H. C.

Drying apparatus. C. H. Currier, Newark, N.J. U.S. Pat. 1,230,282, June 19, 1917. Date of appl., Sept. 15, 1916.

HOT air is supplied under pressure to a drying chamber through a series of ducts in one wall, and the moisture-laden air is discharged through a series of ducts in the opposite wall. The openings of the ducts in both walls face downwards.—W. H. C.

Treating [clinkering] materials; Process of —. F. W. Yost, Assignor to E. A. Bern, Chicago, Ill. U.S. Pat. 1,231,831, July 3, 1917. Date of appl., June 23, 1916. Renewed Oct. 10, 1912.

THE surface of a mass of finely-divided material, which is capable of being clinkered and which contains some combustible constituents, is heated during the whole time of treatment. A current of

furnace gas is introduced through the heated surface and passed through the mass of material in such a manner that the mass is clinkered.

—W. H. C.

Clarifier; Centrifugal —. L. G. Camp, Santa Clara, Cuba. U.S. Pat. 1,230,560, June 19, 1917. Date of appl., Feb. 8, 1913.

A DRUM open at the top and bottom is mounted on and rotated by a vertical shaft. The drum is provided with a bottom disc and a helix, which when the drum is rotated at a high speed, causes the deposited solids to move downwards along the inner wall of the drum and the liquid to move upwards and be discharged over the upper edge. The speed of rotation is kept constant by a control sleeve or brake fitted on the central shaft and regulated by the amount of solid matter accumulating at the inner surface of the drum.—W. H. C.

Centrifugal separating machine; Liquid —. F. A. Reece, Hopkinton, Mass. U.S. Pat. 1,230,601, June 19, 1917. Date of appl., Feb. 8, 1915.

A FLOAT device, controlled by the specific gravity of the outflowing liquid, is provided in one of the outlets of a centrifugal separator, so that the relative dimensions of the two outlets for the separated liquids, and consequently the relative specific gravities of the liquids, are regulated by the specific gravity of the liquid flowing past the float.—W. H. C.

Gas engines; Utilisation of the waste heat of —. C. Schindler, Wiesbaden, Germany. U.S. Pat. 1,231,208, June 26, 1917. Date of appl., Jan. 24, 1914.

THE cylinder and exhaust pipe of a gas engine are provided with separate connected water jackets, and the exhaust pipe jacket contains a helical rod to cause a corresponding circulation of the water. The water circulates in a closed cycle containing a pump, a throttling device which prevents vaporisation on one side and permits it on the other, and also a heat-utilising device.

—W. F. F.

Condenser for cooling aeriform fluids. H. E. Cole, Yokohama, Japan, Assignor to Standard Oil Co., Bayonne, N.J. U.S. Pat. 1,231,709, July 3, 1917. Date of appl., Apr. 3, 1911.

A NUMBER of groups of parallel condensing pipes are arranged in the same plane; transverse inlet and outlet headers are provided for each group, and each header is connected by a pipe, at right angles to the condenser pipes, to a pair of common supply and discharge headers which are parallel to the system of condensing pipes. The groups of condensing pipes are arranged in such a manner that the combined length of the pipes leading to and from the headers of each set of condensing pipes is the same for all the pairs of headers.

—W. F. F.

Kiln. M. R. Isaacs, Philadelphia. U.S. Pat. 1,231,893, July 3, 1917. Date of appl., July 7, 1916.

A HORIZONTAL drying chamber is provided with means for heating the air entering at one end, and with a vertical exhaust flue at the other end. The opening between the chamber and flue is regulated by a door sliding vertically, and attached by a flexible member passing over a pulley above the door, to the outer edge of a damper in the flue pivoted in the vertical wall containing the sliding door. The door and damper are thus connected so that when one opens the other closes. An exhaust fan is provided below the damper.—W. F. F.

Superheated steam; Method of and apparatus for regulating the temperature of —. D. S. Jacobus, Jersey City, N.J., Assignor to The Babcock and Wilcox Co., Bayonne, N.J. U.S. Pats. (A) 1,231,894 and (B) 1,231,895, July 3, 1917. Date of appl., June 11, 1915.

(A) SUPERHEATED steam is cooled by conduction in contact with a cooling medium to a predetermined constant temperature, which is maintained by varying the amount of cooling medium by the action of a thermostat operated by the cooled steam. The thermostat comprises a closed vessel containing a volatile liquid in which a variation of temperature produces a variation of vapour pressure which controls the means for regulating the flow of cooling medium. (B) In apparatus as in (A) the variation of vapour pressure in the thermostat operates means to close an electric circuit which operates an electric motor. A valve in the pipe conveying cooling medium to the steam pipe is operated by the motor so as to vary the flow of the cooling medium. The flow of superheated steam from the boiler is not restricted.

—W. F. F.

Distributors or conveyors for lime and like materials. T. W. S. Hutchins, Middlewich, Eng. Pat. 107,875, Sept. 18, 1916. (Appl. No. 13,227 of 1916.)

Dry products from liquids, emulsions, and the like; Process and apparatus for obtaining —, also adapted for producing chemical reactions. G. A. Krause, Munich, Germany. Eng. Pat. 107,417, June 27, 1916. (Appl. No. 9046 of 1916.)

SEE U.S. Pat. 1,213,887 of 1917: this J., 1917, 329.

Solid matter in finely divided form; Process and apparatus for obtaining — from liquids, solutions, emulsions, and the like, with or without chemical reaction. G. A. Krause, Munich, Germany. Eng. Pat. 107,418, June 27, 1916. (Appl. No. 9047 of 1916.)

SEE U.S. Pat. 1,213,659 of 1917: this J., 1917, 377.

[Water] still. U.S. Pat. 1,231,857. See XIXb.

Method and apparatus for distilling and evaporating [water]. U.S. Pat. 1,232,269. See XIXb.

IIa.—FUEL; GAS; MINERAL OILS AND WAXES.

Combustion in the fuel bed of hand-fired furnaces. H. Kreisinger, F. K. Ovitiz, and C. E. Augustine. U.S. Bureau of Mines, Techn. Paper 137, 1916. pp. 76.

THE research is in continuation of an investigation of combustion in boiler furnaces (Techn. Paper No. 63; this J., 1915, 17). Three kinds of fuel were employed in the tests, viz., Pittsburgh bituminous coal, anthracite, and coke. Most of the results were obtained in a furnace of special construction, but they were confirmed on typical hand- and mechanically-stoked boiler furnaces. The experimental furnace was in the form of a vertical cylinder having a grate area of 1 sq. ft., placed above an airtight ash-box. The air supply was driven under suitable pressure (8 in.—20 in. water) through an orifice, the pressure drop at which enabled the volume of the air to be measured. The furnace was open at the top and placed under a hood communicating with a chimney. Through holes in the wall of the furnace and at different levels, water-cooled gas-sampling tubes could be introduced or observations of temperature made with an optical pyrometer. Fuel was added from above, and from above also the fuel

bed could be maintained at a desired thickness and its surface kept level. The fuel consumption was varied from 20 to 185 lb. per sq. ft. of grate area per hour. During a test the thickness of the fuel bed was kept constant, either 6 in. or 12 in. Accumulation of ash or clinker was prevented by frequent shaking of the fire bars. The general conclusions arrived at were that the fuel bed in most furnaces acts primarily as a gas producer. With a 6 in. fuel bed all oxygen in the air supply is consumed in the first 4 in. from the grate. At 4 in. the CO₂ content of the gases has reached a maximum of 10—16% and above 4 in. it decreases, giving place to carbon monoxide. At the surface of the fuel bed, if the latter is free from "holes," no uncombined oxygen exists, but 20—32% of combustible gases. The composition of these gases is practically independent of the rate of air supply. If the latter is increased the fuel consumption rises proportionately, so that the ratio of air supply to fuel consumption remains constant at about 7 to 1. The weight of air theoretically required is about 15 times the weight of coal, so that at least half of the air must always be supplied above the fuel bed. The temperature of the bed is highest at a level of 3—5 inches above the grate, i.e., where the carbon dioxide content is greatest. The ash fuses in and above this region where high temperature and reducing conditions occur together. Further down, where the temperature is lower and the atmosphere oxidising, solidification to clinker occurs. These results show that in practice a thick fuel bed is not necessary for quick combustion and high rates of steaming. A fuel bed 6 in. in thickness is sufficient if free from holes and clinker. Indeed a deep bed actually reduces the rate of combustion by hindering the passage of air which, as has been shown, determines the rate of fuel consumption.—H. J. H.

Tar oil fuel and Diesel engines. G. Porter. Engineering, 104, 75—78, 103—107.

THE author gives details of four specifications for tar oil for Diesel engines, and results of tests on seven different samples of oil. It is desirable to keep the sulphur content and the suspended solids low. The calorific values agree very closely, and should not be less than 15,800. The author suggests that tar oil is better stored under cover at a moderately high temperature. It has been found that tar oil produces a higher temperature than a residual petroleum fuel oil, but this is not serious if allowance is made for the slower burning of tar oil by advancing the fuel admission. The author gives a series of calculations from indicator diagrams of engines using tar oil with and without pilot jet ignition. In general the diagrams with the pilot jet are not so nicely shaped as when using petroleum or tar oil without pilot jet ignition, the prior ignition producing a "peaked" admission line as compared with the regular, drooping curve which denotes combustion at constant pressure. The ideal quantity of ignition oil at full load is 5%. In the ordinary course of running the speed control by the governor is satisfactory when using tar oil, impulses are regular, and it is seldom that a cylinder "misses." In using tar oil one or two adjustments must be made. Earlier fuel admission is necessary, the amount of advance depending on the quality of the oil. As with residual petroleum oil, the colour of the exhaust is a guide to correct timing. In using tar oil alone it is necessary to reduce the injection pressure to ensure steady operation. The compression pressure in the cylinders at no load should not be less than 480 lb. per sq. in. It is considered very desirable to fit relief valves to the cylinders when using tar oil. With regard to the pulverisers, there is considerable trouble owing to the choking of the cone grooves and

rings, deposits collecting rapidly. The deposit may be due to insufficient pulverisation or may be due to the oil itself, possibly to naphthalene or incombustible matter. Figures taken from daily records appear to indicate that the tar oil and pilot jet engine is better than the petroleum oil engine not only in cost of working but in efficiency also. The author gives figures relating to fuel cost in power stations, showing a saving in fuel cost varying from 0.26d. to 0.49d. per kilowatt-hour due to the use of tar oil.—J. E. C.

Water-gas plants; operating carburetted — for the production of blue water-gas. Gas. J., 1917, 139, 61.

In notes compiled and issued by the Council of the Institution of Gas Engineers, it is stated that blue water-gas can be made in carburetted water-gas plants without any structural alteration by readjustment of generating conditions. As heat is not required in the carburetting chambers, the object to aim at is to minimise the waste of heat due to the volume of carbon monoxide and the quantity of sensible heat in the blast products by slow steaming and quick blowing; this may be effected by gradually altering the timing of the cycle. The best method is to adopt a somewhat shorter cycle with the fuel depth unaltered. Thus for a customary cycle of 3-minute "blows" and 5-minute "runs," one of 2-minute "blows" and 5-minute "runs" may be substituted, keeping the carbon dioxide in the finished blue gas below 6%. The coke used in the generator should be of suitable size, dry, and free from dust and breeze. The analysis of blue water-gas is approximately: H_2 50.5%, CO 38.5%, CO_2 6.0%, N_2 3.5%, CH_4 1.0%, and H_2S 0.5%, the calorific value being about 300 B.Th.U. gross. In mixing blue water-gas with coal gas it is necessary in many cases to increase the calorific value of the coal gas, which should be at least 540 B.Th.U. if the mixture is to contain 20% of blue water-gas.

—J. E. C.

Petroleum industry in Assam; Development of the —. H. S. M. Jack. J. Roy. Soc. Arts, 1917, 65, 589—596.

The petroleum industry in Assam is of purely modern development. At present the Assam Oil Co. is the only company producing oil, the two areas it works being known as the Makum and Digboi areas. The strata found on the fields consist of hard shales and clays of various sorts, including bands of a very soft, spongy nature and sandstone of all degrees of hardness. Various methods of drilling have been used, the one finding most favour being a Parker rotary plant. The ideal method for work in Assam would be to use a rotary system for the soft strata and a percussion system for the hard, but a satisfactory combination has not yet been found. Considerable gas pressures are found and not until a well has reached a mature age is pumping necessary. The pure crude oil has sp. gr. 0.856, is very dark brown, almost black in colour, and is perfectly fluid at 82° F., at which point crystals of paraffin separate. At 77° F. the oil loses fluidity and becomes semi-solid. The crude oil after settling is pumped into boiler stills arranged in groups of three. Distillation is continuous. From the first still crude benzine is taken off, from the second intermediate kerosene, and from the third the bulk of the ordinary kerosene. The residue is distilled to dryness in intermittent pot-stills, the whole of the middle distillate being passed through an anhydrous ammonia and a carbonic acid refrigerating machine in succession. From the former is obtained the bulk of the wax of high melting point, from the latter the basis of the batching oil, used for softening jute fibre. Non-condensable vapours are

burnt in the furnaces. The crude benzine is redistilled with closed steam, giving two qualities of petroleum spirit of sp. gr. 0.710 and 0.750 respectively. To stimulate sales, the company has developed a system of lighting, by converting the spirit into vapour which is burnt with an incandescence mantle. The intermediate kerosene is of great power value in internal combustion engines, whilst a small amount of water-white kerosene is produced for the use of Europeans. The batching oil is concentrated to sp. gr. 0.885 to 0.890. The paraffin wax is a hard wax of very high melting point, the standard adopted being 135° F.; the wax is marketed in a semi-refined state. The waste in distillation has been reduced to about 5% of the crude oil.—J. E. C.

Bituminous and tarry substances and hydrocarbon oils; Action of sulphur monochloride on —. J. V. Meigs. J. Ind. Eng. Chem., 1917, 9, 655—658.

SULPHUR monochloride reacts with bituminous matter, tarry substances, and hydrocarbon (gas-engine) oils, hydrochloric acid being evolved. With asphalts, the reaction was so quiet as to be scarcely noticeable, but with tar binder, heat was developed, vigorous ebullition and frothing occurred, and a black, friable powder, insoluble in carbon bisulphide, was produced. By using a 10% solution of sulphur monochloride in dry carbon bisulphide, the reaction proceeds quantitatively and the hydrogen chloride evolved may be aspirated through water and titrated with $N/20$ sodium hydroxide solution, using methyl orange as indicator. The reaction may be used as a test for the relative stabilities of transparent lubricating oils. The colour produced by the action of sulphur chloride on gas-engine oils is an indication of the degree to which they have been refined.

—A. B. S.

Asphalts; Relations of the effect of overheating to certain physical and chemical properties of —. A. W. Hixson and H. E. Hands. J. Ind. Eng. Chem., 1917, 9, 651—655.

CARBENES (hydrocarbons extracted from asphalts by carbon bisulphide) are probably formed by the cracking of asphaltic hydrocarbons. To investigate the conditions of their formation, 100 grms. each of crude Trinidad asphalt, a brick filler consisting of a natural asphalt fluxed with 70% of asphaltic oil residuum, and an oil-asphaltic cement of unknown origin were heated to various temperatures for 5 hrs. in a porcelain crucible, poured out, and allowed to cool. In each case after the material had been heated to 200° C. there was an increase in the fixed carbon and in the melting point, and decreases in the penetration and in the carbene content which were proportional to the temperature at which the material had been heated. After heating to 235° C., the melting points continued to rise, the Trinidad asphalt and filler became harder, but the oil cement remained soft; the Trinidad asphalt and oil cement became more viscous and the brick filler showed its maximum fluidity. After heating to 265° C., a break was observed in the graphs depicting the various properties: the melting points, fluidity, and fixed carbon of the Trinidad asphalt and the oil cement were lowered and the proportion of carbenes in all three materials was greatly increased. After heating to 300° C., the Trinidad asphalt became very hard and infusible. The brick filler became hard, but the oil cement was soft and mealy. The penetration of the Trinidad asphalt and filler became less, but that of the oil cement greatly increased, whilst its melting point was reduced. In each case, an increase in fixed carbon and carbenes and a loss of fluidity occurred. It appears probable that heating up to 200° C. merely distils off the lighter hydro-

carbons. On heating to 235°–265° C., the proportion of carbon to hydrogen is reduced, indicating that hydrocarbons rich in carbon and of low boiling point distil over. The nature of the residue requires investigation. Upon heating to 300° C., the proportion of carbon to hydrogen is increased owing to cracking and the formation of carbonaceous consisting of either unsaturated hydrocarbons or naphthenes. It is suggested that the fixed carbon graph (corrected by multiplying the fixed carbon by the percentage of residue left on heating and dividing by 100) offers a means of tracing the changes in the molecular structure of the hydrocarbons when heated. There is a close relation between the proportion of carbon and the physical properties of asphaltic materials.—A.B.S.

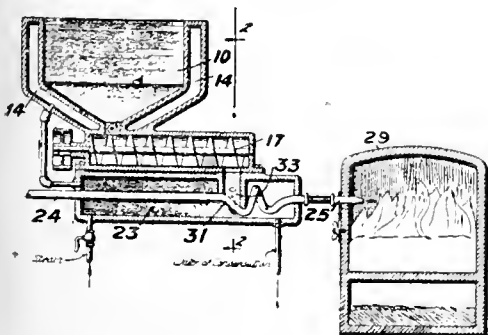
Effusion method of determining gas density. Edwards. See XXIII.

Specific gravity balance for gases. Edwards. See XXIII.

PATENTS.

Fuel; Apparatus for feeding powdered or pulverised —. F. Caldwell, Cincinnati, Ohio. U.S. Pat. 1,231,488, June 26, 1917. Date of appl., Sept. 26, 1916.

POWDERED fuel contained in the hopper, 10, is fed by the screw conveyor, 17, to the tapered outlet, 33, and thence through an opening in the inclined portion, 31, of the pipe, 24, through which



air is supplied for combustion. An inclined diaphragm in the pipe diverts the fuel into the current of air, with which it is mixed in the helical portion of the pipe, and finally discharged by the nozzle, 25, into the furnace, 29. Steam is passed through the chamber, 23, to heat the air, and through the jacket, 14, to dry the fuel.—W. F. F.

Water-gas producers; Apparatus for equalising the pressures in the producer and in the space below the grate of water-sealed —. B. Spitzer, Berlin-Wilmersdorf. Ger. Pat. 298,387, Feb. 13, 1915.

THE apparatus consists of a double valve containing two pistons of different diameter, on the same rod, supported by a counterweight over a pulley. Each piston runs in a cylinder, the larger being below. The pressure in the producer operates on the lower and that in the ash space on the upper side of the bottom piston. An increased pressure on the lower side of the latter, i.e., in the producer, causes it to rise and therefore lifts the upper piston, which opens air ports allowing an increased blast pressure to operate in the ash chamber. A fall in the producer pressure acts oppositely, and thus the apparatus prevents the development of pressure differences between the producer and the ash space.—H. J. H.

Water-gas; Continuous production of —. A. F. Holmgren, J. V. Aqvist, and G. Helsing, Trollhättan. Ger. Pat. 298,119, Jan. 16, 1915. Under Int. Conv., Nov. 18, 1911.

STEAM, unmixed with air, is passed downwards through an incandescent bed of carbonaceous material. The producer consists of a vertical shaft, with feeding hopper and steam inlet at the top, and a grate at the bottom. The water-gas formed passes out through an opening in the side just above the grate. Above this outlet, two horizontal electrodes are introduced into the producer at opposite sides so that the temperature of the charge can be maintained electrically. The necessity for interrupting the making of gas by the "air-blow" period, and hence the attendant loss of fuel as carbon dioxide, are thereby obviated; the gas is also free from nitrogen. Wet peat, sawdust, or bituminous fuel may be gasified in place of coke.—H. J. H.

Coal gas; Preparation of — for storage in iron vessels under pressure, for incandescence lighting. J. Pintsch A. G., Berlin. Ger. Pat. 298,223, Dec. 5, 1915.

IF coal gas is stored under pressure in iron vessels, iron carbonyls may be formed, and these render it unsuitable for use with incandescence mantles. To avoid this, the gas is freed from carbon monoxide prior to compression.—H. J. H.

Petroleum; Apparatus for refining —. A. F. I. Bell, San Francisco, Cal. U.S. Pat. 1,231,695, July 3, 1917. Date of appl., May 10, 1916.

A SLIGHTLY inclined rotating cylindrical still is mounted on a hollow fixed central shaft. This shaft serves to supply the oil and also to carry off the vapours. A scraper attached to the hollow shaft removes carbon deposit from the inner surface of the still, and a scoop pipe, also carried by the shaft, collects the carbon and transfers it to the shaft, from which it passes to a collecting chamber formed by an enlargement of the shaft outside the still.—W. F. F.

Petroleum and other hydrocarbons; Method for treating [distilling] —. C. P. Dubbs, Wilmette, Ill. U.S. Pat. 1,231,599, June 26, 1917. Date of appl., Nov. 27, 1916.

To produce hydrocarbons of lower boiling point, petroleum is passed through a series of receptacles where it is subjected to progressively increasing temperatures and pressures. The temperature varies from a minimum of 200°–500° F. (93°–260° C.) to a maximum of 500°–2000° F. (260°–1090° C.), and the pressure varies from a minimum of 50 lb. per sq. in. to a maximum of 1000 lb. per sq. in. The vapour from the vessel at lowest temperature is collected and condensed, and the vapour from the other vessels is passed through reflux condensers, the condensate being returned to its own vessel and the residual vapour being passed through the vessel of next lower temperature in the opposite direction to the flow of petroleum.—W. F. F.

Gasolene substitute. T. E. Rice, Des Moines, Iowa. U.S. Pat. 1,230,924, June 26, 1917. Date of appl., May 13, 1916.

A LIQUID fuel suitable for use in internal combustion engines is composed of kerosene 1 gallon, methyl ether 4 oz., carbon bisulphide, 8 oz. —W. F. F.

Oil; Process of decomposing [cracking] —. A. A. Wells, Montclair, N.J., Assignor to Ellis-Foster Co. U.S. Pat. 1,232,454, July 3, 1917. Date of appl., Mar. 31, 1913.

THE vapour of heavy petroleum oil of predetermined gravity is cracked by passing it through a heated tube provided with metal baffling prongs

which produce a greater baffling effect at the centre than at the sides. The vapour is maintained at a pressure directly proportional to its density, and the condensable vapour is condensed and removed.—W. F. F.

[Asphaltic] material; Process of producing a plastic —. C. Baskerville, New York. U.S. Pat. 1,231,985, July 3, 1917. Date of appl., Nov. 13, 1914.

ACID sludge obtained as a by-product in the refining of petroleum oil by means of sulphuric acid is heated sufficiently to separate part of the contained oil but not sufficiently to carbonise the sludge. The separated asphaltic portion is removed and neutralised with slaked lime.—W. F. F.

By-product ovens, furnaces, and the like; Ascension pipes or flues of —. W. H. Proctor, Bankfoot Crook, Durham. Eng. Pat. 107,536, Jan. 16, 1917. (Appl. No. 805 of 1917.)

Liquid fuel burners. H. N. Davis and W. R. Twigg, Luton. Eng. Pat. 107,814, July 12, 1916. (Appl. No. 9830 of 1916.)

Gas retorts; Method of and apparatus for charging —. A. E. White, London. From Riter-Conley Manufacturing Co., Leedsdale, Pa., U.S.A. Eng. Pat. 107,775, Aug. 7, 1916. (Appl. No. 5128 of 1916.)

Petroleum; Method of distilling —. W. Landes, Wichita, Kans., U.S.A. Eng. Pat. 107,502, Oct. 11, 1916. (Appl. No. 14,462 of 1916.)

SEE U.S. Pat. 1,199,909 of 1916; this J., 1916, 1211.

Straining or filtering apparatus [for fuel oils]. Eng. Pat. 107,090. See I.

Process of treating [elinkering] materials. U.S. Pat. 1,231,831. See I.

Production of chlorinated hydrocarbons [from oil gas]. U.S. Pat. 1,231,123. See XX.

Methane detector. U.S. Pat. 1,231,045. See XXXII.

III.—TAR AND TAR PRODUCTS.

Phenols; Spectroscopic identification of —. J. Formánek and J. Knop. Z. anal. Chem., 1917, 56, 273—298.

A CRITICAL review and reinvestigation of the results of Gisell (this J., 1916, 35, 1054) on the identification of phenols by the absorption spectra of their phthalein condensation products. Apart from the fact that some of the phthaleins examined by Gisell cannot have been pure, it is not sufficient merely to indicate the position of the head of an absorption band, but the form should be represented graphically for varying concentration; also, where possible, the examination should be made in several different solvents. The method for effecting the condensation is to heat at 100°—180° C. about 0.1 gm. of the phenol with about one-half the weight of phthalic anhydride and 0.1 gm. of zinc chloride or 2—3 drops of sulphuric acid as condensation agent. When zinc chloride or tin chloride is used the colour may be affected by the formation of a lake on subsequent addition of alkali, whilst a complication of the phenomena is also possible with sulphuric acid, the use of which may in some cases give rise to sulphonation. Alternative methods of spectroscopic identification for phenols are possible by the use of a larger proportion of phthalic anhydride and of sulphuric acid at 160°—200° C., when an anthraquinone derivative may be obtained, and by warming with alcoholic or aqueous

sodium hydroxide and chloroform, with formation of a xanthene derivative. The following phenols were converted into their phthaleins and the spectra examined in aqueous and alcoholic solution; the results are tabulated and also graphically represented:—Phenol, *o*- and *m*-cresol, thymol, guaiacol, quinol, hydroxyquinol, Carvacrol, α -naphthol, catechol, resorcinol, α -naphthoresorcinol, orcinol, and phloroglucinol were converted into phthaleins and also into xanthene derivatives, and pyrogallol into phthalein and anthraquinone derivatives. A xanthene was obtained from β -naphthol, but no satisfactory phthalein; *o*- and *p*-hydroxybenzoic acids gave phthaleins identical with phenolphthalein, whilst with *m*-hydroxybenzoic acid phthalein formation was uncertain.—D. F. T.

Tar oil fuel and Diesel engines. Porter. See IIA.

Action of sulphur monochloride on bituminous and tarry substances and hydrocarbon oils. Meigs. See IIA.

PATENTS.

Tar; Continuous distillation of —. B. E. D. Kilburn, London. From Sulzer Frères, Winterthur, Switzerland. Eng. Pat. 107,168, Jan. 2, 1917. (Appl. No. 77 of 1917.)

THE apparatus consists of two drums set horizontally at different levels in the furnace brickwork. The tar is fed continuously into the upper drum through a preheating coil arranged above the latter. The ammonia and light oil are distilled off in this drum and conveyed to a condenser. The hot tar then passes to the lower drum where the distillation is completed. The vapours pass to a separate condenser, and the pitch flows away continuously from the hottest part of the drum. The lower drum is heated by a furnace placed below, and the hot gases, after circulating round the lower drum, pass round the upper drum. A by-pass flue is provided so that all or any desired proportion of the products of combustion can be conducted directly to the upper drum.—W. H. C.

Aromatic hydrocarbons; Process of making —. C. M. Alexander, Port Arthur, Tex., Assignor to Gulf Refining Co., Pittsburgh, Pa. U.S. Pat. 1,230,975, June 26, 1917. Date of appl., Nov. 10, 1915.

BENZENE and toluene are obtained by passing vapours of hydrocarbons of high boiling point, e.g., solvent naphtha, through a heated zone at about 600°—1000° C., at a rate sufficiently rapid to give a condensate having about 70% of the volume of the original hydrocarbon and containing high-boiling oils. The vapours are condensed and the benzene and toluene separated. The solvent naphtha may be mixed with once-treated high-boiling oil.—F. W. A.

IV.—COLOURING MATTERS AND DYES.

Cochineal; Detection of ammoniacal —. C. F. Muttelet. Ann. Falsif., 1917, 10, 228—230.

AMMONIACAL cochineal gives an amethyst colour whereas cochineal carmine gives an emerald green colour on addition of aqueous uranium acetate solution to a neutral amyl alcohol solution of the colouring matter. The carmine may be separated from a mixture of the two colouring matters by treating the amyl alcohol solution with calcium carbonate to form its insoluble lake; the ammoniacal cochineal is extracted from the lake by cold water and identified as such or after conversion into the carmine by boiling with caustic alkali.—F. W. A.

Nitrosopyrrole Black. A. Angeli and G. Cusmano. Atti R. Acad. Lincei, 1917, [v.], 26, i., 273—278. J. Chem. Soc., 1917, 112, i., 413.

WHEN an aqueous solution of the sodium salt of isonitrosopyrrole is treated with carbon dioxide, or when pyrrole reacts with ethyl nitrite or nitrous acid, a black powder, named Nitrosopyrrole Black, is obtained. This product is almost insoluble in most solvents, but dissolves easily in alkali and is reprecipitated by acid; in alkaline solution it is instantly oxidised by permanganate and is decolorised by reducing agents, the dark colour subsequently reappearing in the air. The composition agrees approximately with the formula $(C_4H_5ON_2)_n$. Nitrosopyrrole Black does not melt, but at a high temperature deflagrates with liberation of red vapours. This compound appears to be accompanied by another, also black, which has not yet been investigated. In Nitrosopyrrole Black the CO-group of Pyrrole Black (this J., 1917, 210) is replaced by NO: $(C_4N)CO \rightarrow (C_4N)NO$.

PATENT.

Dyes or stains; Production of — [from bananas or plantains]. W. W. Coe and W. W. Coe, jun., London. Eng. Pat. 107,094, July 11, 1916 (Appl. No. 9775 of 1916) and Jan. 31, 1917 (Appl. No. 1584 of 1917).

THE pulp and/or skin of the banana or plantain is treated with an alkaline solution or a mineral acid, in presence or absence of a metallic compound, with subsequent neutralisation or partial neutralisation. The resulting dyes or stains may be used for dyeing with or without mordants.—F. W. A.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Wood gum in incompletely purified cotton; Determination of —. M. Freiburger. Z. anal. Chem., 1917, 56, 299—308.

THE author suggests a method for the examination and estimation of the organic constituents of cotton other than pure cotton cellulose and fat. The material is extracted with a cold 5% aqueous solution of sodium hydroxide for 24 hours, the dissolved matter being subsequently precipitated in fractions by successive addition of alcohol, neutralisation with hydrochloric acid, and acidification with hydrochloric acid, a period of 48 hours being allowed at each stage of the treatment for the completion of the precipitation. The first deposit consists largely of cellulosic material and he second of xylan with cellulosic substances, whilst the third also contains fatty acids. In each case the precipitated material contains sodium chloride for which a correction is made. After his treatment with cold alkali the cotton still contains a small quantity of oxycellulose, wood gum, and fatty material. This is removed by a further extraction for 5 hours at 100° C. in an apparatus from which air is excluded, with a 1% sodium hydroxide solution to which have been added a little resin and dextrose, the residual cellulose being well washed, dried, and weighed. Under these conditions approximately only 1% of the cellulose proper is dissolved and, in calculating the total weight of "wood gum," a corresponding correction is made for this loss and for the extracted it. A small quantity of "wood gum" persists in solution during the various operations in the first stage of the treatment and so is not included in the result.—D. F. T.

Paper; Physical testing of — as affected by humidity. R. Campbell. J. Ind. Eng. Chem., 1917, 9, 658—661.

WITH an increase of 50—98% in the relative

humidity, the shrinkage of paper increased 40—50%; longitudinal stretching increased 30%, and cross stretching 40—50%. Folding tests gave maximum results at 80% relative humidity. The time required for ink penetration decreased 40—50% as the relative humidity increased from 55—100% at 80° F. The effect of a good tub size on the physical properties of paper is very advantageous.—A. B. S.

PATENTS.

Paper; Process of making fibre for —. V. Drewsen, Brooklyn, N.Y. U.S. Pat. 1,229,422, June 12, 1917. Date of appl., Mar. 12, 1915. Renewed Feb. 27, 1917.

CORNSTALKS are boiled for 5—6 hours under a pressure of 40—120 lb. (preferably 60—70 lb.) per sq. in., in the absence of substantial proportions of free caustic alkali or strong acid, with a liquid containing sufficient sodium sulphite to represent about 25% of the dry weight of the raw material and remain alkaline to litmus during the entire digestion process.—J. F. B.

Paper [coated]. J. E. Baum, jun., Chicago, Ill. U.S. Pat. 1,230,095, June 19, 1917. Date of appl., Feb. 11, 1916.

THE paper, in sheet or web, has a coating of uncombined silica, in a state of impalpable powder, mixed with clay or a colouring matter and sufficient size to act as a binder and form a very smooth surface after calendering.—J. F. B.

Sizing paper, cardboard, and the like; Method of —. A. H. Haeflner, Skutskär, Sweden. U.S. Pat. 1,231,153, June 26, 1917. Date of appl., Jan. 15, 1917.

SIZING material is precipitated from fermented sulphite liquor by means of alum, aluminium sulphate or the like, before or after incorporation of the liquor with the pulp.—F. W. A.

Sized sheets; Apparatus for waterproofing —. S. Elliott, Newton, Mass. U.S. Pat. 1,230,068, June 12, 1917. Date of appl., Dec. 28, 1914.

THE apparatus comprises a closed chamber in which the sized sheets are suspended, containing a small vessel fed by means outside the chamber with a determined quantity of a volatile liquid, such as formaldehyde, which on heating gives off a vapour; a blower is provided inside the chamber which causes a mild circulation of air through restricted openings arranged on opposite sides of the chamber.—J. F. B.

Fibres; Treatment of — to increase their coefficient of friction on each other. W. E. Muntz, London. U.S. Pat. 1,232,374, July 3, 1917. Date of appl., Apr. 4, 1914.

SEE Eng. Pat. 8278 of 1913; this J., 1914, 546.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Cotton fibres; Chemical and physical changes in — with special reference to the processes of dyeing. R. Haller. Kolloid Zeits., 1917, 20, 127—145. J. Chem. Soc., 1917, 112, i., 436.

THE chemical and physical properties of cotton fibres lead to the conclusion that the outer membrane consists of two structural elements which show but small differences under normal conditions. When the cellulose is transformed into hydrocellulose and oxycellulose, the two components are much more readily differentiated. The difference is shown in the behaviour towards chemical reagents and in the appearance under

the ultra-microscope. The proof that two such structural elements are involved is considered to afford evidence in support of Nägeli's micellar theory of the structure of vegetable membranes. The absorption of mordants and dyes by the penetration of these substances into the micellar interstices is dependent on the degree of dispersion of the particles. The power of penetration is limited to particles of diameter less than about 5μ . In the case of mercerised fibres, the micellae are more widely separated than in the original untreated fibres, and particles of larger size than those above referred to may accordingly be absorbed, with the result that the depth of colour is greater.

PATENTS.

Printers' blankets; Fabric for — and other purposes. F. E. Ellis, Revere, Mass. U.S. Pat. 1,231,141, June 26, 1917. Date of appl., Mar. 21, 1917.

A BLANKET for printing presses consists of a body layer of relatively expensive material with a face ply of textile fabric secured by an adhesive, waterproof, and oil-proof cement, and a non-offsetting film of a smooth, non-porous, ink-repellent coating (e.g., nitrocellulose with sufficient emollient to render it flexible and non-brittle) attached to the outer side of the face layer.—F. W. A.

Weighting of silk filaments and fabrics in the form of hanks; Apparatus for the —. P. Schmid, Basle, Switzerland. U.S. Pat. 1,231,136, June 26, 1917. Date of appl., Sept. 20, 1916.

AN apparatus for weighting silk filaments and fabrics consists of a vat containing in its upper part a row of horizontal hank supports arranged so that they can be tilted, and provided with spraying tubes arranged above the hank supports in such a manner that all may be turned back together, and other tubes underneath the hank supports, with each tube connected to the corresponding hank support so that it can be turned back with it.—F. W. A.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Brines; Chemical examination of natural —. O. R. Sweeney and J. R. Withrow. J. Ind. Eng. Chem., 1917, 9, 671—674.

THE following determinations are recommended:—*Deposit on aeration.*—The sample is allowed to stand, with occasional shaking, for two or three days to aerate any iron compounds present. The height of the liquid in the bottle is marked and the whole is filtered and the deposited matter is washed (the washings being kept separate), dried, and ignited to constant weight. The volume of the sample is measured by ascertaining the capacity of the original container. The *specific gravity* of the filtered brine at 15°C . is determined by the Westphal balance. The sp. gr. of the fresh brine is different from that of the sample after several days. *Total solids* are determined on 25 c.c. of the filtered sample; the residue is dried at 160°C . *Silica* is separated in the usual manner, and the residue is treated with sulphuric and hydrofluoric acids and the loss of weight reported as silica. The residue is added to the iron and alumina precipitate. *Iron and alumina* are estimated by precipitating with ammonia from the filtrate and washings from the silica. A separation of the iron and alumina is seldom required. *Calcium.*—The filtrate from the iron and alumina is diluted, and the calcium precipitated as oxalate and ignited to oxide. Its

amount is checked by dissolving it in dilute sulphuric acid and titrating with potassium permanganate. The calcium should be reported as sulphate and chloride. *Magnesium.*—The combined filtrates and washings from the calcium are acidified with hydrochloric acid, and the magnesium precipitated with sodium hydrogen phosphate, ignited to $\text{Mg}_2\text{P}_2\text{O}_7$, weighed, and calculated to bromide and chloride. *Barium and strontium* should be looked for in the absence of sulphates. They are partially precipitated with the calcium and magnesium. When the proportion of barium and strontium is low, they may be neglected. *Ammonia* is seldom present in commercially important proportions. *Sulphuric acid.*—The barium sulphate precipitate is filtered, washed, and ignited in a porcelain crucible. It is then dissolved in a few c.c. of warm concentrated sulphuric acid and poured into 250 c.c. water, allowed to stand and then filtered, washed, ignited, and weighed. (This method of purifying the barium sulphate is very effective.) The sulphuric acid is reported as calcium sulphate. *Potassium and sodium.*—The filtrate from barium sulphate is used for determining the potassium and sodium, by the method described in "Mineral Waters in the U.S.A.," Department of Agriculture Bulletin 91. They are reported as potassium and sodium chlorides. *Chlorine* is estimated by titration with silver nitrate solution. The bromine value must be deducted. *Bromine* is liberated by treatment with chlorine and its amount determined colorimetrically. The bromine should be reported as magnesium bromide as it is so considered by the trade, but any free bromine should be reported as such. —A. B. S.

Bromides; Valuation of —. E. Rupp and E. Hollatz. Arch. Pharm., 1917, 255, 120—129. J. Chem. Soc., 1917, 112, ii, 327—328.

THE authors have developed a volumetric method for the estimation of bromides in the presence of small quantities of chlorides, which is designed especially for the valuation of pharmaceutical preparations, such as *Bromum compositum*, D.A.-B. ($\text{KBr}:\text{NaBr}:\text{NH}_4\text{Br}$, 2:2:1). The process is summarised in the following equations: $5\text{KBr} + \text{KBrO}_3 + 6\text{H}_2\text{SO}_4 = 3\text{Br}_2 + 6\text{KH}_2\text{SO}_4 + 3\text{H}_2\text{O}$; $\text{Br}_2 + 2\text{NaOH} + \text{H}_2\text{O}_2 = 2\text{NaBr} + \text{O}_2 + 2\text{H}_2\text{O}$; $\text{KBrO}_3 + 6\text{KI} + 6\text{H}_2\text{SO}_4 = 3\text{I}_2 + 6\text{KH}_2\text{SO}_4 + \text{KBr} + 3\text{H}_2\text{O}$. The reason for removing the bromine by the application of alkaline hydrogen peroxide, rather than by boiling, is that the excess of bromate is not stable in hot acid solutions. Ammonium salts tend to produce bromates at this stage, however, so the first step is really to expel any ammonia by boiling with sodium hydroxide. The solution is then cooled, acidified, treated with a definite excess of bromate, then mixed with alkaline hydrogen peroxide, and, after boiling, acidifying, and adding potassium iodide, the iodine is titrated by thiosulphate. Sufficiently trustworthy results are obtained even if the mixture contains as much as 25% of a chloride.

Perchloric ion; Micro-chemical reactions of the —. G. Denigès. Ann. Chim. Analyt., 1917, 22, 127.

THE reactions between perchloric acid and alkaloids, notably strychnine, brucine, and morphine (this J., 1917, 616), may be used conversely for the detection of the perchloric ion. A small drop of the solution of perchloric acid or a soluble perchlorate is stirred with the point of a drawn-out glass rod which has previously been dipped in a 2% solution of brucine in 0.01% acetic acid, or a 2% aqueous solution of morphine hydrochloride or of strychnine sulphate. Should a turbidity appear, either immediately or after further stirring, the drop is examined under the micro-

scope. Strychnine sulphate is capable of detecting 0.01 mgrm. of the perchloric ion (1 grm. per litre), whilst brucine acetate will detect the perchloric ion in a solution containing 2 to 3 grms., and morphine hydrochloride in a solution containing 5 grms. per litre.—C. A. M.

Alkali chromates and bichromates; Chemical evaluation of —. J. P. Sacher. *Farbenzeit.*, 1916, 22, 213. *J. Chem. Soc.*, 1917, 112, ii., 337.

THE following method is sufficiently accurate for technical purposes and permits the estimation of chromate in presence of bichromate. Potassium bichromate can be titrated with potassium hydroxide in the presence of phenolphthalein in accordance with the equation: $K_2Cr_2O_7 + 2KOH = 2K_2CrO_4 + H_2O$. The titration can be performed without the indicator, since, at the neutral point, the colour of the solution changes from reddish-yellow to greenish-yellow. Potassium chromate can be estimated by titration with sulphuric acid according to the scheme: $2K_2CrO_4 + H_2SO_4 = K_2Cr_2O_7 + K_2SO_4 + H_2O$; Congo-red can be used as indicator.

Arsenic trisulphide. E. Schmidt. *Arch. Pharm.*, 1917, 255, 45—64. *J. Chem. Soc.*, 1917, 112, ii., 331—332.

PRECIPITATED arsenious sulphide is appreciably decomposed by water and even by alcohol, with formation of hydrogen sulphide. It is also attacked to a very considerable extent by dilute hydrochloric acid, but the action with dilute acid or with water is checked by the addition of a small quantity of hydrogen sulphide. The estimation of arsenic by precipitation and weighing as trisulphide (Püller. *Chem. Soc. Trans.*, 1871, 24, 971; Friedheim and Michaelis, this J., 1896, 135) gives results which are very slightly high, but actually the precipitate diverges more widely from the composition As_2S_3 than the errors would indicate, containing to some extent both arsenic hydrosulphide, $As(SH)_3$, and arsenious oxide, the respective errors being in opposite directions and tending to neutralise each other. A slightly modified method is suggested for the treatment of precipitated arsenic sulphide in order to convert it into an arsenious solution suitable for titration with iodine.

[*Action of hydrochloric acid on alumina, thorina, and zirconia.*] *Velocity of reaction in heterogeneous systems and size of granules.* E. Podszus. *Z. physik. Chem.*, 1917, 92, 227—237. *J. Chem. Soc.*, 1917, 112, ii., 300.

CERTAIN oxides, which in ordinary circumstances are unacted on by hydrochloric acid, are dissolved by this reagent to a very appreciable extent when the oxides are reduced to a fine state of subdivision. Experiments were made with aluminium oxide, thorium oxide, and zirconium oxide, and in each case the oxide was dissolved when the diameter of the particles was of the order $1\ \mu$. The results recorded show the progress of the dissolution when the concentration of the acid and the temperature were kept constant, and, further, the influence of variation in the acid concentration.

Dryhydrogen gas explosions in compressed gas cylinders. Wöhler. See I.

The nature of cement-mill polish. Nestell and Anderson. See IX.

Determination of phosphoric acid in phosphate rock. Semple. See XVI.

Condensation products of ammonium thiocyanate and formaldehyde. Schmerda. See XX.

Recovery of ammonium molybdate from the filtrates obtained in the estimation of phosphoric acid. Kinder. See XXIII.

Determination of carbon dioxide and carbonates in solution. Van Slyke. See XXIII.

PATENTS.

Sulphuric acid; Method of concentrating —. J. V. Skoglund. Brooklyn, N.Y. U.S. Pat. 1,232,109, July 3, 1917. Date of appl. May 4, 1916.

SULPHURIC acid is concentrated by passing hot gases through a spray of the acid. The method is continuous, the weak acid being passed into one end of a container fitted with an arrangement for producing the spray by means of a suitable gas under pressure, and the strong acid drawn off from the other end of the container. The greater part of the spray falls back into the container, any acid which is carried over by the stream of hot gases being removed by passing these through a mass of acid-proof material.—B. V. S.

Acetic acid; Process of making —. H. Hilbert. Pittsburgh, Pa., Assignor to Union Carbide Co., New York. U.S. Pat. 1,230,899, June 26, 1917. Date of appl. Aug. 15, 1916.

ACETIC acid is produced by the action of oxygen on acetaldehyde in the presence of wood charcoal previously saturated with the strong acid.—B. V. S.

Potassium chloride; Process for obtaining — from certain waters containing borax. N. Winkle, Keeler, and W. W. Watterson, Bishop, Cal. U.S. Pat. 1,232,156, July 3, 1917. Date of appl. Dec. 11, 1916.

A SOLUTION of potassium chloride, containing also sodium borate, sulphate, carbonate, and chloride, is largely freed from carbonate by treatment with carbon dioxide and concentration to the saturation point of potassium chloride at ordinary temperatures. The clear liquor is again treated with carbon dioxide with formation of bicarbonate, cooled for the separation of part of the borate along with the bicarbonate, and further concentrated and again cooled to crystallise potassium chloride and borax. The mother liquor is returned to more fresh liquor for further treatment and the mixed crystals dissolved, treated with chlorine or an acid to convert the borax into chloride and boric acid, and again crystallised. Boric acid is removed from the resulting mass by treatment with alcohol, and sodium chloride by washing with cold water.—B. V. S.

Magnesium compounds from silicate material; Process of making —. S. Peacock, Philadelphia, Pa., Assignor to Mardon, Outh and Hastings Co., Inc., New York. U.S. Pat. 1,231,423, June 26, 1917. Date of appl. Aug. 7, 1916.

A SILICATE containing magnesium is digested with an alkali hydroxide, with the formation of an alkali silicate and magnesium hydroxide, which are separated by any suitable means.—B. V. S.

Magnesium chloride; Manufacture of anhydrous —. E. A. Ashcroft, London. U.S. Pat. 1,231,741, June 26, 1917. Date of appl. Dec. 5, 1916.

A MAGNESIUM oxy-compound "in a fused medium" is treated with chlorine in the presence of a substance which promotes exothermic reaction.—B. V. S.

Chlorides; Manufacture of anhydrous metal——. E. A. Ashcroft, London. U.S. Pat. 1,232,169. July 3, 1917. Date of appl. Dec. 5, 1916.

METAL oxy-compounds are heated "in a fused medium" with chlorine in the presence of a chlorine carrier, which is then removed by evaporation and used for a further charge. Alternatively, the metal compound may be mixed with carbon and treated with chlorine in a fused medium, dry air being subsequently passed through the mass. —B. V. S.

Oxalates; Manufacture of——. F. A. Dugan, Brooklyn, N.Y. U.S. Pat. 1,232,249, July 3, 1917. Date of appl. Sept. 27, 1916.

SODIUM or other oxalate is prepared by spraying the metal into a pebble mill in which a heated atmosphere of carbon dioxide is maintained. —B. V. S.

Thorium; Process of separating from soda solutions containing thorium oxalate. I. Kreidl, Vienna. U.S. Pat. 1,232,334, July 3, 1917. Date of appl. Apr. 18, 1916.

BY heating a very dilute solution of sodium carbonate containing a thorium salt, the thorium compound is precipitated.—B. V. S.

Furnace; Electric——for fixing nitrogen from the air. S. Garford, Oakland, Cal. U.S. Pat. 1,232,179, July 3, 1917. Date of appl. Jan. 19, 1916.

AN electric arc is produced between two electrodes, and a current of air or gas is delivered by suitable means through the sphere of action of the arc. The gas, when it leaves the arc, passes through a cup-shaped, water-jacketed, annular discharge passage, acting as cooler, and having a large area in comparison with its volume so as to cool the gas rapidly. Means are provided for rotating one or both electrodes, and simultaneously feeding them into the furnace as they are consumed in the arc, in order to maintain a uniform heating and reaction.—B. N.

Phosgene; Method of manufacturing——. N. L. G. Whitehouse, Pittsburgh, Pa. U.S. Pat. 1,231,226, June 26, 1917. Date of appl. July 26, 1916.

CARBON monoxide is bubbled through liquid chlorine maintained at a temperature below -34°C .—B. V. S.

Preservation of solutions of trichloride of iodine for purifying contaminated water. U.S. Pat. 1,231,853. See XIXB.

VIII.—GLASS; CERAMICS.

PATENTS.

Refractory brick. R. H. Youngman, Pittsburgh, Pa. U.S. Pat. 1,231,684, July 3, 1917. Date of appl. May 25, 1915.

THE brick consists of calcined bauxite with about 7% of magnesite, or its equivalent, and $1\frac{1}{2}\%$ of chromium ore.—W. C. H.

Kilns [for bricks, etc.]. L. W. McArthur, Montreal West, and P. S. McKergow, Montreal, Canada. Eng. Pat. 107,256, June 28, 1916. (Appl. No. 9106 of 1916.)

SEE U.S. Pat. 1,199,016 of 1916; this J., 1916,1110.

IX.—BUILDING MATERIALS.

Portland cement; Preliminary report on blended——. E. S. McCandless. Bulletin, Feb., 1917, School of Mines and Metallurgy, University of Missouri.

PARTICLES of Portland cement which will not pass a standard No. 200 screen are stated to have no cementing properties. According to the standard specifications for fineness, 22% by weight may be retained by such a screen, and this amount is practically inert as a cement. General experience of cement shows that the economic limit of fineness of grinding of the clinker has apparently been reached, and the suggestion has been made that some cheaper material of suitable sized grain might be substituted for the coarser, inert particles of clinker; such a mixture is termed a "blended cement." Experiments were made with three commercial Portland cements, and mixtures were made of (1) the portion of each cement that easily passed a No. 200 sieve, and (2) quartz sand, all of which passed a No. 65 sieve, and of which about 17% passed a No. 200 sieve. Mixtures were made with 10, 20, 30, and 40 parts by weight of sand in 100 parts of the blended cements. The physical tests made were, tension, neat and mortar, compression, neat and mortar, normal consistency, time of setting, constancy of volume (normal and accelerated tests), fineness and sieve analysis, and specific gravity. It appears that the tensile strength of both neat cement and cement mortar develops at approximately the same rate in both Portland cement and blended cements, and the former is not superior to the latter. In the case of the neat cement tests, the 10 and 20% blended cements were slightly inferior, but the 30 and 40% blended cements were equal to Portland cement. When the blending material did not exceed 30%, the blended cement mortar was superior to Portland cement mortar. The results obtained with neat cement under compression lacked uniformity, but when the blended material did not exceed 30%, the compressive strength of the blended compared favourably with that of Portland cement. In the case of mortar, the compressive strength varied inversely with the amount of blending material used, and was less than that of Portland cement mortar. The normal consistency of Portland cements varies within narrow limits and that of blended cements varies inversely with the amounts of blending material used. The initial and final setting of cements with more than 20% of blended material takes place more slowly than that of the cements from which they are derived, but up to 40% of blended material they may still satisfy the standard specifications. Cements with less than 40% of blended material satisfy the specification for soundness, and those containing 30% approximate most nearly to Portland cement in fineness and gradation of size of particles. In brief, Portland cements which pass a No. 200 sieve may be blended with 40% by weight of quartz sand which passes a No. 65 sieve and leaves a residue of 20% on a No. 200 sieve, and still pass the standard specifications. Quartz sand is a satisfactory substitute for the inert clinker particles in Portland cement and maintains the present physical characteristics of it when added in amounts not exceeding 30% by weight.—W. C. H.

Cement-mill polish; The nature of——. R. J. Nestell and E. Anderson. J. Ind. Eng. Chem., 1917, 9, 646—651 (see also this J., 1917, 458).

THE dust in the chimney gases from cement kilns contains, *inter alia*, considerable quantities (averaging over 10%) of potash in both a readily and a slowly soluble form, i.e., partly as sulphate

and carbonate and partly as silicate. The presence of lime or of moist soil increases the rate of solution of the slowly soluble form. Hence, this dust should be valuable as a fertiliser.—A. B. S.

PATENTS.

Blocks; Method of treating porous ——. C. E. Fuller, Kansas City, Mo. U.S. Pat. 1,231,007, June 26, 1917. Date of appl., July 13, 1916.

THE method consists in heating a porous block, compressing the air in the pores, and forcing liquid asphalt into the pores at a pressure greater than that of the air, then reducing the pressure to atmospheric and suddenly cooling the block.

—W. C. H.

Artificial wood composition. L. S. Gibson, Jamestown, N.Y. U.S. Pat. 1,231,519, June 26, 1917. Date of appl., June 10, 1916.

A PLASTIC composition composed of plaster of Paris, a pigment, a waterproof varnish, and a hardening material, such as formic acid.—W. C. H.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Zinc from cadmium; A method of separating—and determination of the latter iodometrically. E. J. Eriksen. J. Ind. Chem. Eng., 1917, 9, 671.

FIVE grms. of ore is dissolved in nitric or hydrochloric acid, according to the nature of the ore, evaporated with 20 c.c. of sulphuric acid, water added, and the liquid boiled and filtered. To the filtrate a slight excess of ammonia is added, and the liquid boiled and diluted to 500 c.c., filtered, and an aliquot portion, representing 3 or 4 grms., is pipetted off and evaporated to small bulk and until a slight white precipitate appears; sulphuric acid is then added and the liquid evaporated to 80–100 c.c., and zinc sulphate allowed to crystallise out. The solution is then decanted and the crystals washed thrice with cold water. The filtrate is diluted to 200 c.c. and hydrogen sulphide passed until all the cadmium is precipitated. The precipitate is allowed to settle for several hours and is then filtered, dissolved in hot hydrochloric acid, neutralised with ammonia, and 10 grms. of trichloroacetic acid added; the liquid is diluted to 200 c.c. and reprecipitated with hydrogen sulphide. The pure cadmium sulphide may be determined by any recognised method, the gravimetric being the most accurate. An iodometric method of determining cadmium consists in mixing the separated sulphide with about 125 c.c. of water, adding a measured excess of N/10 iodine solution, and then 30–50 c.c. of dilute hydrochloric acid. The liquid is shaken and titrated with sodium thiosulphate, using starch as the final indicator: 1 c.c. of N/10 iodine solution = 0.00562 gm. Cd.—A. B. S.

Phosphor-tin and a volumetric method for its analysis. R. E. Lee, W. H. Fegeley, and F. H. Reichel. J. Ind. Eng. Chem., 1917, 9, 663–668.

PHOSPHOR-TIN alloys contain 0.1–6% phosphorus. They are insoluble in 5N sulphuric acid or 5N hydrochloric acid, but dissolve immediately in sulphuric acid of sp. gr. 1.84 and in hydrochloric acid of sp. gr. 1.2 with quantitative evolution of phosphine. With *aqua regia*, they apparently ignite and burn with a blue flame. The following method of analysis is advocated:—0.5 gm. of the sample, in the form of sawings which have been freed from adventitious particles of iron by means

of a magnet, is placed in a flask fitted with a tap-funnel and connected to a train of three absorption vessels, each containing 90 c.c. of 0.2% potassium permanganate solution and 10 c.c. of nitric acid (sp. gr. 1.12). A current of carbon dioxide or coal gas is then passed through the apparatus to remove the air, after which 30 c.c. of hydrochloric acid (sp. gr. 1.20) is admitted through the tap-funnel into the flask. The contents of the flask are boiled until the alloy is completely decomposed, and carbon dioxide or coal gas is again passed through the apparatus for 3 mins., after which, without stopping the flow of gas, the train is disconnected from the flask. A known weight, between 1 and 2 grms., of ferric chloride (free from ferrous salts) is added to the contents of the generating flask and the solution is titrated at once with standard potassium bichromate solution (containing 4.126 grms. of the crystals dried at 105° C. in 1 litre) using potassium ferricyanide as external indicator. 1 c.c. of the bichromate = 0.005 gm. Sn. The contents of the three absorption vessels are transferred to a 500 c.c. flask and boiled for one minute, removed from the hot plate, and potassium nitrite added in small portions until the solution is colourless. The liquid is boiled to expel nitrous acid, cooled to 50° C., and made slightly alkaline with ammonia. The precipitated manganese phosphate is dissolved in a minimum quantity of nitric acid (sp. gr. 1.12) and 10 c.c. added in excess. The solution is then heated to 85° C., 50 c.c. of clear ammonium molybdate solution added, and the liquid stirred vigorously for 5 mins. The yellow precipitate of ammonium phosphomolybdate is filtered and washed with an acid solution of ammonium sulphate until the washings give no brown colour with ammonium sulphide. The precipitate is then dissolved in 7 c.c. of ammonia (sp. gr. 0.88) and 15 c.c. of water, the filter being subsequently washed with water until the filtrate and washings have a total volume of about 60 c.c., and 10 c.c. of sulphuric acid (sp. gr. 1.84) is added. The solution is passed through a Jones' reductor charged with amalgamated zinc; 2 c.c. more sulphuric acid is added and the solution is passed a second time through the reductor, followed by 200 c.c. of water, and titrated with N/10 potassium permanganate, of which 1 c.c. = 0.00008829 gm. P. Control tests showed that the phosphorus in the alloy is completely evolved as phosphine and that the latter is completely oxidised to phosphoric acid by the permanganate solution. The time required for determining both tin and phosphorus when the sample has been weighed is 15 mins.—A. B. S.

Mercury; Simple method for the purification of ——. H. B. Dunncliffe. Chem. News, 1917, 116, 41–42.

THE mercury is distilled slowly from an ordinary glass retort supported with its neck vertically downwards on a retort stand. Through the tubulure of the retort, the stem of a dropping funnel suitably bent, and a piece of glass tubing, are passed, and packed in place by means of asbestos. The neck of the retort passes through a perforated glass cover, into a glass beaker, and a sheet of asbestos board is placed between the retort neck and the Fletcher burner. Asbestos paper is placed over the retort to prevent loss of heat. The mercury is fed into the retort at about the same rate as it distils (about an ounce in four minutes).—T. H. B.

Germanium; Occurrence of — in Missouri and Wisconsin blenders. G. H. Buchanan. J. Ind. Eng. Chem., 1917, 9, 661–663 (see also this J., 1916, 894).

ZINC oxide or blende was mixed with twice its weight of concentrated hydrochloric acid, and

chlorine was passed through the mixture, which was then distilled in a slow current of chlorine until about half its volume was obtained in the receiver. The distillate was diluted with an equal volume of water and any germanium present precipitated by passing hydrogen sulphide through it. The precipitate was collected, dissolved in hydrochloric acid, re-precipitated as before, dissolved in ammonia, the solution evaporated to dryness, the residue moistened with concentrated nitric acid, again evaporated to dryness, and then ignited. The residue was treated with a little water and hydrofluoric acid, saturated with potassium chloride, and allowed to stand in the cold for 15 mins. Germanium, if present, forms a greyish, gelatinous precipitate, soluble on heating or diluting the solution. Positive results were obtained with Joplin and Wisconsin Separator ores, with "Special leaded oxide of zinc" from Mineral Point, a Mexican ore (La Bufa), ore from Austinville, Va., and with New Jersey "XXX oxides." None of these ores contained more than 0.01% of germanium, but larger proportions were observed in the residues in the zinc retorts, as germanium is not very volatile at 1350° C. In zinc oxide furnaces, the germanium is converted into oxide and passes off with the zinc smoke into the bags.—A. B. S.

Metals: The passive condition of—J. Slapenhorst. *Z. physik. Chem.*, 1917, **92**, 238—254. *J. Chem. Soc.*, 1917, **112**, ii., 290—291.

Iron which has been rendered passive by the action of chromic acid becomes active under the influence of hydrogen dissolved in the metal. In this experiment, the hydrogen was generated electrolytically on the opposite side of a thin iron plate, the hydrogen diffusing through the plate to the surface in contact with the chromic acid solution. This change cannot be explained by the removal of dissolved oxygen or by the destruction of an oxide film. Under suitable conditions, the reverse change may be brought about by the diffusion of nascent oxygen. The potential assumed by a metal in a neutral electrolyte depends on the quantity of oxygen present in the solution. If the surface of the metal is renewed by grinding with an emery-wheel, the potential changes from that characteristic of the passive form to the value peculiar to the active form of the metal. Hydrogen and nitrogen tend to preserve the potential of the active form, but otherwise behave as indifferent gases. Oxygen, on the other hand, is not an indifferent gas. Both in the gaseous and dissolved states it exercises a very considerable influence on the electrode potential and conduces to the appearance and maintenance of the passive condition.

Nickel alloys resistant to sulphuric acid. R. Irrmann. *Metall u. Erz.* 1917, **14** [N.F. 5], 21—30, 37—42. *Z. angew. Chem.*, 1917, Ref., 210. (See also this J., 1916, 425.)

THE system Ni-Cu forms a single series of solid solutions. The maximum resistance to acid attack is found in the 50% alloy. On treatment with acid, nickel passes into solution, but very little copper. Ternary alloys of nickel, copper, and tungsten were examined. Nickel-tungsten can take up copper to a limited extent which diminishes as the proportion of tungsten increases. These ternary alloys are more resistant to sulphuric acid than the Ni-W alloys, especially the following:—2% W, 20% Cu; 5% W, 45% Cu; and 10% W, 15% Cu. Electrical resistance is high—in all mixtures greater than that of constantan. The tensile strength is high—up to 47 kilos. per sq. mm., and the alloys roll well, especially the

most acid-resistant. Resistance to corrosion by acid and electrical resistance increase with the tungsten content. A series of quaternary alloys (Fe, Cu, Ni, W) was prepared from ferro-tungsten; the introduction of iron led to increased resistance to acid corrosion and better working properties. Alloys high in copper and iron and low in tungsten are both cheap and resistant to cold sulphuric acid. Other mixings are better for warm acid solutions. The addition of 0.2% of tungsten to German silver doubles its resistance to corrosion; probably, however, this is only an apparent improvement due to the formation of a surface layer of sulphate. Nickel in Cu-Ni alloys appears to prevent solution of the copper, and in the ternary and quaternary alloys studied, this is still more marked, leading to the production of mixtures with excellent acid-resisting properties.—H. J. H.

Results of recent investigation of the smelter smoke problem. Wells. See XVI.

Manurial experiments with manganese slag. Popp. See XVI.

Protective colloids. VIII. Tubera salep as protective colloid. Colloidal silver, arsenic, and antimony. Gutbier and Kräutle. See XX.

Volumetric determination of zinc. Springer. See XXIII.

PATENTS.

[Cast iron.] *Metallurgical process.* J. E. Johnson, New York. U.S. Pat. 1,231,259, June 26, 1917. Date of appl., Oct. 21, 1913.

STEEL scrap is converted into cast iron by melting the scrap and introducing a suitable quantity of silicon carbide into the molten bath.—W. R. S.

Ferro-silicon of high silicon content; Production of—in blast furnaces. J. E. Johnson, jun., Hartsdale, N.Y. U.S. Pat. 1,231,260, June 26, 1917. Date of appl., June 20, 1916.

FERRO-SILICON containing about 50% of silicon is produced by charging the blast furnace with ore and fuel and supplying a blast containing substantially equal parts by weight of oxygen and nitrogen.—W. R. S.

Iron and steel alloys; Deoxidation of—by ferro-silicon and silicon carbide. L. Treuheit, Elberfeld-Vanesbeck. Ger. Pat. 292,682, July 27, 1915.

COMPLETE deoxidation is effected by the addition of a mixture of cryolite and silicon compounds to the melt, which obviates the use of manganese or aluminium; e.g., equal weights of cryolite and ferro-silicon are placed in the ladle and the steel is poured on. The formation of blowholes and slag enclosures is almost entirely eliminated.

—H. J. H.

Iron; Production of a protective coating of mixed oxides on—A. Prettnner, Spandau. Ger. Pat. 298,207, Oct. 16, 1915.

THE articles to be treated are dipped in a melt of alkali polychromates or of a mixture of chromates and chromic acid. A coating of chromic and iron oxides is produced, the process requiring only a few minutes to complete. Excessive heating causes decomposition of the chromates and is to be avoided.—H. J. H.

Copper; Process of recovering —. F. J. Pope and A. W. Hahn, Douglas, Ariz. U.S. Pat. 1,232,080, July 3, 1917. Date of appl., July 29, 1914.

THE ore is leached with sulphuric acid whereby the copper and part of the iron and aluminium are converted into sulphates. The copper is deposited and the acid regenerated by electrolysis, the liquor being used again for leaching. To prevent fouling, a calculated quantity of liquor is withdrawn periodically and treated with material containing copper oxide to precipitate iron and aluminium. The filtered liquor is electrolysed and returned to the circuit.—W. R. S.

Copper alloys; Production of deoxidised —. Vereinigte Hüttenwerke Burbach-Eich-Dudelingen, Luxemburg. Ger. Pat. 297,859, June 24, 1916.

SUBSTANCES capable of combining with oxygen are added to the alloy in the melting bath. They should be in briquettes or in other form that can be easily added—metal filings, carbon, cyanides, water glass, borax, etc.—and should preferably be of such a nature as to produce a slag containing alkali manganosilicates.—H. J. H.

[Copper] slags; Process of treating —. J. B. Herreshoff, jun., New York. U.S. Pat. 1,231,349, July 3, 1917. Date of appl., Apr. 9, 1915.

THE molten slag is washed by agitating it with a series of baths (e.g., of copper matte) containing less copper than the original matte from which the slag was separated, each bath of the series containing less copper than the preceding one.—W. R. S.

Metals [lead, etc.]; Process for the recovery of — from ores. C. S. Vadner, Butte, Mont. U.S. Pat. 1,231,101, June 26, 1917. Date of appl., Nov. 18, 1916.

THE crushed oxide or roasted sulphide ore is treated with sulphur dioxide in presence of moisture. The excess of sulphur dioxide is oxidised by manganese peroxide, whereby lead is precipitated as sulphate. The insoluble portion is separated from the liquor and leached with a saturated solution of salt from which lead is recovered by precipitation with iron. The liquor is treated for the recovery of the dissolved metals.—W. R. S.

Ores; Conversion of ferrous to ferric sulphate in wet extraction of —. W. Borchers and A. Boever, Aachen. Ger. Pat. 298,342, Apr. 16, 1916.

PROCESSES for wet extraction from sulphide ores can be improved by conversion of the ferrous sulphate in the roasted ore to ferric sulphate. This may be effected by heating the roasted ore, mixed with iron hydroxide and water, in presence of air at 150°—200°C.; when the ferrous sulphate is in solution, the liquor may be concentrated with admixture of iron hydroxide and the crystalline product heated at 150°—200° in presence of air.—H. J. H.

Metal distillation furnace. E. E. Cherry, Assignor to M. Movshovitz, Trenton, N.J. U.S. Pat. 1,231,239, June 26, 1917. Date of appl., Mar. 30, 1917.

AN inclined retort is mounted within the combustion chamber of a distilling furnace, the roof of which is inclined at the same angle as the retort. Exhaust flues within the upper portion of the side walls communicate with the combustion chamber at a point near the front wall immediately below

the roof, and at their rear ends with each other and with a descending flue within the rear wall.—W. R. S.

Amalgamating process for recovering metals from ores. P. Kuehn, Detroit, Mich. U.S. Pat. 1,231,176, June 26, 1917. Date of appl., Dec. 17, 1912.

A BODY of mercury presenting an extended surface is surmounted by columns of ore pulp flowing quietly by gravity, with decreasing velocity, from the bottom of one to that of the other column. A gentle flow of ore pulp is maintained in proximity to the surface of the mercury without substantially agitating the pulp or disturbing the mercury, limiting the flow to a rate sufficient to keep in suspension the particles of lower specific gravity than the metals to be amalgamated.—W. R. S.

Metals; Process for electrolytically precipitating —. G. C. Westby, Ludwig, Nev., Assignor to Western Process Co. U.S. Pat. 1,231,829, July 3, 1917. Date of appl., Mar. 21, 1916.

A SLOWLY-SOLUBLE anode, such as iron, is employed in an acid solution, heavily charged at the commencement with the sulphate of the metal of which the anode is composed, and containing varying amounts of sulphur dioxide and copper sulphate, both electrodes being caused to rotate in the electrolyte.—B. N.

Gold coatings on metals; Electro-deposition of hard —. T. L. Tesdorf, Kiel. Ger. Pat. 298,687, Aug. 4, 1916.

THE metal article is covered with a thin deposit of gold from a potassium cyanide bath and then a second deposition is made from an acid solution of gold salts. A micro-crystalline gold deposit of unusual hardness and stability is produced.—H. J. H.

Tin-plate; Process of making —. F. Mueller, Vienna, Assignor to F. Mueller, Chicago. U.S. Pat. 1,231,285, June 26, 1917. Date of appl., June 18, 1914.

A PROCESS for tinning black plate on one side only consists in coating one side of the annealed and pickled plate with fat, dipping it into an acid copper solution, converting the copper deposit into copper sulphide, and subjecting the prepared plate to the tinning process.—W. R. S.

Tungsten, molybdenum, and tantalum, etc.; Production of alloys of — with highly infusible metals having oxides which cannot be completely reduced by hydrogen. E. Podszus, Neukölln. Ger. Pat. 293,952, Dec. 19, 1913. Addition to Ger. Pat. 292,483.

ALLOYS containing zirconium, thorium, boron, and titanium can be prepared by mixing the oxides with tungsten or other metal the oxide of which is reducible by hydrogen, and subjecting the mass to a current of ammonia in an electrically-heated furnace at a temperature at which the nitrides dissociate, followed by a rapid cooling to inhibit re-formation of nitrides. Pure alloys in compact form can be prepared by this process.—H. J. H.

Ores and the like; Apparatus for treating —. N. C. Christensen, Assignor to Holt-Christensen Process Co., Salt Lake City, Utah. U.S. Pat. 1,231,707, July 3, 1917. Date of appl., Mar. 30, 1915.

AN apparatus for leaching and sedimentation

comprises a vertical cylindrical tank with a central discharge opening at the bottom, an overflow rim launder at the top, a series of stationary superposed horizontal decks with openings alternately at the centre and the periphery, and rabble arms above each deck mounted on a central vertical revolving shaft, which move the ore through the openings on to a lower deck and finally discharge it. The ore is fed to the upper, and the leaching liquor to the lower part of the tank. Connecting-pipes provided in the periphery of the upper deck lead to the space above one of the lower decks.

—W. R. S.

Metal plates; Apparatus for treating and cleaning — [after tinning]. J. H. Cole, and Abertillery Works, Ltd., Abertillery. Eng. Pat. 107,552, Mar. 7, 1917. (Appl. No. 3391 of 1917.)

Classifying and concentrating apparatus for minerals and the like. W. W. Richardson, London. Eng. Pat. 107,927, Dec. 27, 1915. (Appl. No. 18,450 of 1916.)

Rabbles for mechanical roasting furnaces. W. Hommel, Zürich, Switzerland. Eng. Pat. 101,549, Sept. 18, 1916. (Appl. No. 13,238 of 1916.) Under Int. Conv., Mar. 6, 1915.

SEE U.S. Pat. 1,220,510 of 1917; this J., 1917, 509.

Lead plating metals; Processes for —. R. J. Shoemaker and J. C. McClintock, Topeka, Kans., U.S.A. Eng. Pat. 107,285, Aug. 7, 1916. (Appl. No. 11,138 of 1916.)

SEE U.S. Pat. 1,195,376 of 1916; this J., 1916, 1067.

Metals; Electrolytic recovery of — from their solutions, and apparatus therefor. U. C. Tainton and M. F. L. A. Aymard, Johannesburg, Transvaal. U.S. Pat. 1,231,967, July 3, 1917. Date of appl., Nov. 14, 1914.

SEE Eng. Pat. 12,669 of 1913; this J., 1914, 1013.

Gold and silver; Process for extracting — from ore containing gold, silver, and manganese dioxide. M. H. Caron, Weltevreden, Java. U.S. Pat. 1,232,216, July 3, 1917. Date of appl., Apr. 18, 1916.

SEE Eng. Pat. 101,665 of 1916; this J., 1916, 1161.

Replacing and thickening apparatus. Process of replacement [for treating slimes and pulp]. U.S. Pat. 1,231,409 and 1,231,410. See I.

Devaltering and replacement apparatus. U.S. Pat. 1,231,411. See I.

XI.—ELECTRO-CHEMISTRY.

PATENTS.

Electrolytic cell structure. H. B. Slater, Riverside, Cal. U.S. Pat. 1,231,955, July 3, 1917. Date of appl., Mar. 21, 1914.

SEVERAL tubular electrodes, with perforated walls for the passage of the electrolyte, are detachably and rigidly mounted in openings in a conduit by screw-threaded T-connections, the conduit extending into the receptacle of the electrolytic cell, and carrying off the electrolyte passing into the inner parts of the electrode tubes. The upper ends of the electrodes are closed by conducting

plugs, which are all connected to an electrical conductor. Each electrode tube is fitted with a sleeve of porous insulating material acting as a diaphragm.—B. N.

Furnace; Electric —. C. G. Miner, Berkeley, Cal. U.S. Pat. 1,232,362, July 3, 1917. Date of appl., Feb. 17, 1917.

The space between the outer and inner walls of the furnace is packed with heat-insulating material, and the space enclosed by the inner wall forms a reaction chamber in the form of two opposed "paraboloids." A crucible of conducting material, placed in the principal foci of the paraboloids, acts as a centre or common electrode for two arcs in series or in parallel. A second crucible may be substituted for the first one, and is adapted to co-operate with the upper electrodes to constitute a resistance heating device.—B. N.

Process of recovering copper. U.S. Pat. 1,232,080. See X.

Electro-deposition of hard gold coatings on metals. Ger. Pat. 298,687. See X.

Process for electrolytically precipitating metals. U.S. Pat. 1,231,829. See X.

Electric furnace for fixing nitrogen from the air. U.S. Pat. 1,232,179. See VII.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Oil of turpentine from various species of pine; Optical activity of —. D. E. Tsakalotos. Gaz. Chim. Ital., 1917, 47, I., 285—287.

OIL of turpentine obtained from the Aleppo pine (*Pinus halepensis*), which is the variety cultivated in Greece, consists largely of dextrorotatory pinene, $[\alpha]_D = +47^\circ$ to $+48^\circ$, whereas the oil of turpentine derived from *P. maritima*, the variety cultivated in France, Spain, and Italy, has for its main constituent levorotatory pinene, $[\alpha]_D = -40.5^\circ$. According to Gildemeister (*Die ätherischen Öle*, 1913, II., 133), however, the oil of turpentine derived from the buds of the Aleppo pine consists largely of levorotatory pinene. The author has therefore examined a sample of the bud oil of this pine, and has found its specific rotation to be $[\alpha]_D = +39.4^\circ$. He finds that this variety of pine produces an essential oil, the principal constituent of which is dextrorotatory pinene, whatever the part of the plant, or the locality (Greece, Provence, Algiers), or the period at which the oil is distilled.—C. A. M.

PATENTS.

Pigment and process for making same. S. Kohn, Westfield, N.J. U.S. Pat. 1,231,617, July 3, 1917. Date of appl., July 18, 1916.

A PURPLE pigment is produced by adding a solution of a metallic salt (lead acetate) to a warm aqueous solution of an alkali (ammonium) salt of purpuric acid in presence of free alkali.—E. W. L.

Stencil emulsions; Method of preparing —. J. A. Bailey and H. E. Kalusowski, Washington, D.C., Assignors to Addressograph Co., Chicago, Ill. U.S. Pat. 1,231,554, July 3, 1917. Date of appl., June 27, 1916.

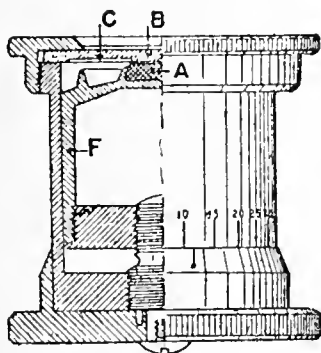
A HARD wax, such as paraffin, ceresin, or carnauba

wax, or a mixture, is melted with lanolin, and the mixture dissolved in a volatile solvent. The solution is then emulsified in a solution, preferably of gelatin, water, and glycerin, to which has been added a toughening agent such as potassium bichromate.—E. W. L.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Caoutchouc percentage in latex; Determination of —. Communication from the Netherlands Government Institute for advising the Rubber Trade and Industry. *India-Rubber J.*, 1917, 54, 95—96.

A RAPID method for determining the percentage of caoutchouc in latices is of the greatest importance on the plantation. Up to now three methods have been proposed:—(1) by means of densi-



mers; (2) by trial coagulations; (3) by determination of total solids, and deduction of a constant percentage for non-rubber compounds. Each of these methods has its disadvantages. Van Iterson has now devised an apparatus (see fig.) by means of which the caoutchouc content is estimated by comparing the opacity of a given sample of latex with that of a standard sample with which the instrument has been calibrated. The determination is carried out by adjusting the thickness of a central, circular film of latex, confined between an upper glass plate, *b*, and a lower ebony disc, *a*, until its colour matches that of an encircling annular surface, *c*, of a standard colour (oil-paint), applied to the under side of the observation glass. The adjustment is effected by moving the brass cylinder, *f*, up or down by means of the screw. The instrument is graduated to read direct in percentages of caoutchouc. With high concentrations the error may reach a few per cent., but with average and low concentrations the results are very satisfactory. —E. W. L.

XV.—LEATHER; BONE; HORN; GLUE.

Drum tannage. O. Riethof. *J. Amer. Leather Chem. Assoc.*, 1917, 12, 322—336.

For successful drum tannage of sole or belting leather, the hides must be pliable and therefore not too plump before entering the drum, otherwise tannage will be much retarded and the yield of leather very low; the pliability should be maintained throughout the process. The natural acidity of extracts is usually sufficient to make

and keep the stock sufficiently plump. It is further necessary to have the temperature low in the drum until the hides are well struck through; afterwards it is beneficial to let the temperature rise. Clear liquors should be used, since sediment fills up the pores and retards tannage. Oakwood extract should not be used until the final stages; if used too soon it causes a rapid surface tannage, and prevents tannin from reaching the interior, so that a raw streak in the leather may easily result. On analysis, drum tanned leathers usually show a lower degree of tannage than do leathers tanned in pits, though this does not necessarily indicate inferior quality. It is possible to get as high a yield of leather by drum tannage as by any other method.—F. C. T.

Tannery wastes; Purification of —. H. B. Donnon. *J. Amer. Leather Chem. Assoc.*, 1917, 12, 307—321.

In tests carried out at two large leather works, it was found that spent tan liquors were too concentrated to be economically filtered even when diluted and partly precipitated by other tannery liquors containing lime. The spent liquors were therefore treated with sludge from lime pits, the concentration being thus reduced by about one-half. Other liquors (including wash waters, lime liquors, waste from bleaching vats, etc.) were mixed and treated with ferrous sulphate (10 grains per gallon) which reduced their concentration considerably. The treated liquors were then combined and passed into settling tanks, where they remained for four hours, after which filtration was effected first by cinder filters (coke offers no advantage) and then by sand beds. By this treatment, suspended matter was reduced from about 1000 parts per million to 30, working at a rate of 250,000 and 200,000 gallons per acre per day for the cinder and sand filters respectively. The filtered effluent was only slightly coloured, and developed no odour on storage for 10 days in a warm room. Fish were able to live in it for over a month. The sludge from the settling tanks was black and finely divided, with little odour, and dried to a workable consistency in ten days when applied to a depth of ten inches over a bed of fine cinders one foot deep. The dry material contained about 2% of organic nitrogen, 20% of calcium as oxide, 0.3% of potassium as oxide, and 0.5—1.0% of phosphates, and proved to be a useful fertiliser. —F. C. T.

PATENT.

Tennis-gut; Process for manufacturing —. S. Kimata, Kobe, Japan. U.S. Pat. 1,231,911, July 3, 1917. Date of appl., June 10, 1916.

ANIMAL tendons are twisted into a string or cord, which is then degreased, bleached, impregnated with a mixture of sodium peroxide and magnesium sulphate, dipped into a mixture of gum treated in dilute sulphuric acid, and dried.—E. W. L.

XVI.—SOILS; FERTILISERS.

Soil solution. J. P. van Zyl. *J. Landw.*, 1916, 64, 201—275. *J. Chem. Soc.*, 1917, 112, i., 439—440.

VARIOUS methods of obtaining representative soil solutions were compared, and it was found that extraction by pressure gave the best results. Using this method, the soil from a particular field was studied in detail, samples being taken from a limed and from a dunged plot in summer and in

winter. These were subjected to pressure and the solutions obtained were analysed; the concentration of the solutions varied according to both the manurial treatment and the season of the year, but the percentage composition of the ash remained constant, thus lending support to the Cameron-Whitney theory of soil solution. The author points out that in order to get a true knowledge of the physical structure of a soil, its mechanical analysis should be carried out in its own soil solution. Comparative sedimentation tests were made, using distilled water and soil solution; when soil solution was employed the liquid cleared much more quickly, but fifteen washings only removed 2% of the clay; on the other hand, when distilled water was used, deflocculation was more complete and fifteen washings removed all the clay from the soil. Two series of mechanical analyses were then undertaken on the soil samples mentioned above (that is, limed and dunged plots in summer and winter); in one case distilled water was used and in the other soil solution. The results again showed evidence of the deflocculating action of the soil solution, so much so that the separation of the three finest fractions from one another was not attempted. These groups of three fractions (0.006 to 0.0005 mm.) were afterwards treated with distilled water and complete separation effected. It was found that the number of washings required for the operation varied from 80 to 120, was higher on the dunged plot than on the limed plot, and higher in winter than in summer.

Organic matter in the soil; Influence of soil conditions on the decomposition of —. E. J. Russell and A. Appleyard. *J. Agric. Sci.*, 1917, 8, 385—417.

OBSERVATIONS were made on field plots over a long period and determinations were made of the number of bacteria in the soil, the amount of nitrate in the soil water, and of carbon dioxide in the soil air, as being factors accompanying the decomposition of plant residues and other organic matter. The results were plotted in curves, and there was sufficient resemblance between all the curves to justify the conclusion that they were related. The curve for nitrate was always behind that for bacterial numbers, the lag amounting to 2—3 weeks, indicating that the stage of ammonia production must depend in part on organisms other than those counted or on some other factor. Decomposition does not take place below 5° C.; as soon as the temperature rises action begins and increases rapidly, but it is limited by the amount of moisture; in the summer, when the moisture in unmanured soil fell to 10%, decomposition was at a minimum. Decomposition was active after rain, due to the dissolved oxygen in the rain. The crop growing in the soil exerted a depressing effect on decomposition from causes not yet determined.—J. H. J.

Nitrification as a factor in soil fertility; Significance of —. P. L. Gainey. *Soil Sci.*, 1917, 3, 399—416.

CULTIVATED soils under normal conditions contain nitrifying organisms which transform ammonia into nitrate as rapidly as it is formed, as is shown by the fact that there is no accumulation of ammonia beyond a constant quantity. When conditions are abnormal and nitrification becomes impossible, then ammonia accumulates; and when conditions become normal again, the excess is rapidly nitrified. There is no relation between ammonia content and nitrifying power, nor between ammonia content and productivity; so that, although nitrification is associated with, and may be essential to, fertility, it is not the limiting factor.—J. H. J.

Soil bacteria and streptothrices: Are all the — that develop on dextrose-agar azoifiers? P. Emerson. *Soil Sci.*, 1917, 3, 417—421.

EXPERIMENTS were made to determine whether the organisms other than *Azotobacter* which grow on culture media free from nitrogen, are nitrogen-fixing organisms. The medium used was dextrose-agar without peptone and with added mineral salts. This was inoculated with dilutions of a soil suspension. The number of colonies capable of growing on this medium at the ordinary temperature was 2.4 millions per grm. of dry soil. The colonies on the plate cultures could be classified into four groups: a streptothrix group, a radiclecola group, a fluorescent group, and an opalescent group. Nitrogen-fixation experiments were made by inoculating sterile soil with cultures of the members of each group. At the end of three weeks, analysis showed that the amount of nitrogen in the cultures had increased on the average by 13—15 mgrms. per 100 grms. of air-dried soil. Only one organism failed to fix any nitrogen.—J. H. J.

Soil reaction; Effect of — on the availability of ammonium sulphate. R. C. Cook and F. E. Allison. *Soil Sci.*, 1917, 3, 487—498.

POT experiments with buckwheat were made on an acid soil supplied with ammonium sulphate, to determine whether lime was necessary to secure the production of sufficient nitrates to yield a good crop. It was found that small applications of lime produced as good a crop as a large application sufficient to neutralise all the acidity. The total crop on the more acid soils was smaller, but its percentage of nitrogen was higher, so that the recovery of nitrogen from an acid soil may be as great as from an alkaline one. The beneficial effects of lime were more noticeable on a sandy soil than on a silt loam. The addition of lime allows the soil nitrogen to be made available to a sufficient extent to satisfy the crop. Buckwheat was able to utilise the nitrogen from ammonium sulphate at an acidity equivalent to 3000—4000 lb. of lime per acre. Either the nitrogen was taken up directly as ammonia, or else there was much nitrification in the acid soil.—J. H. J.

Fixation of nitrogen in faeces. E. H. Richards. *J. Agric. Sci.*, 1917, 8, 299—311.

WHEN horse faeces is fermented aerobically in presence of moisture and calcium carbonate, there is a considerable fixation of nitrogen in varying amounts up to 30% of the nitrogen present originally in the faeces. Under the most favourable conditions 1 grm. of dry matter in the faeces fixes 4 mgrms. of nitrogen. The fixation varies with the diet of the animals, and faeces from animals fed on grass alone gave rise to no fixation of nitrogen. This is true of bullocks as well as of horses. The organisms concerned in the process were the same as those contained in garden soil, but *Azotobacter* alone did not bring about the fixation in quantity; it was necessary for *B. lactis aerogenes* to be present also.—J. H. J.

Peas; Influence of mineral matters on the germination of —. L. Maquenne and E. Demoussy. *Comptes rend.*, 1917, 165, 45—51.

COMPARATIVE experiments on the rate of germination (rootlet growth) of peas in sand moistened with solutions of salts of various metals, indicate that calcium exerts a much greater accelerating influence than other common metals.—J. H. J.

Smelter smoke problem; Results of recent investigations of the —. A. E. Wells. *J. Ind. Eng. Chem.*, 1917, 9, 640—646.

RECENT investigations have shown that the

damage to vegetation by dust and fume particles and acid mist from smelters is practically negligible. The recovery of solid matter from the smoke evolved in smelting lead, copper, and zinc ores may be made remunerative because of the value of the recovered material. The recovery of sulphurous gases is important because of their damage to vegetation, even 1 part of sulphur dioxide per million parts of air being injurious to the colour though not necessarily to the growth of the crops. Before injury to plants occurs with air containing sulphur dioxide, four factors must operate simultaneously in sufficient amount, namely, light (plants are not injured by this gas at night), humidity, wind prevalence, and temperature. Thus, air containing 1 part of sulphur dioxide per million, with a humidity of 70% and at a temperature of above 4° C., must remain for 3 hrs. in contact with the plants in daylight for bleaching to occur. The concentration of the sulphur dioxide is reduced by the use of a high chimney. It is better to discharge the chimney gases into the atmosphere at a high temperature after removing 85% of the impurities than to obtain a greater purification and discharge them at a much lower temperature. With a concentration of 0.45% of sulphur dioxide, the gases being discharged at 65% purification from a chimney 450 ft. high, the possibility of injury to vegetation appears to be negligible. It is desirable to ascertain the periodical occurrence of the critical times when all the factors resulting in injury to vegetation are present and to curtail the production of sulphur dioxide at these periods. Experiments in which the sulphuric acid, sulphur dioxide, and sulphur recovered from the chimney gases were used as fertilisers have proved successful, some of the treated crops yielding double the normal amount.—A. B. S.

Calcium phosphates; Solubility of — in citric acid. A. A. Ramsay. J. Agric. Sci., 1917, 8, 277—298.

NUMEROUS analyses were made of samples of calcium phosphate of commerce and of the same substance prepared by the methods usually recommended. It was found that the substances sold as "phosphate of lime" and "calcii phosphas B.P." were mixtures of di- and tri-calcium phosphates. Disodium phosphate added to ammoniacal calcium chloride, and bone ash dissolved in hydrochloric acid and precipitated with ammonia, both yield mixtures of di- and tricalcium phosphates and calcium hydroxide. When three equivalents of lime are made to act on one equivalent of phosphoric acid and the precipitate is filtered off at once, pure tricalcium phosphate is obtained; but when two equivalents of lime are used, the product is a mixture of di- and tricalcium phosphates. With regard to solubility in the prescribed 2% citric acid solution, it was found that 1% of the total phosphoric acid in pure tricalcium phosphate was soluble after 30 mins. shaking, but that the addition of calcium carbonate reduced the solubility to 84%. Extraction with the citric acid solution is not an exact criterion of the availability of the phosphoric acid, since the availability was reduced from 91% to 84.5% by the addition of 14% of lime as carbonate, and to 4.3% by addition of a further 14%. The citric acid is a solvent for the lime rather than the phosphoric acid, since all the lime not present as tricalcium phosphate is extracted. Dicalcium phosphate is soluble in the citric acid solution, so that it is not possible to distinguish between the di- and tricalcium phosphates by this solvent, and therefore the use of citric acid as indicating the manurial value of phosphates is questionable.—J. H. J.

Manganese slag; Manurial experiments with —. M. Popp. Pöhlings Landwirtsch. Zeit., 1916, 65, 354—360. Bull. Agric. Intell., 1916, 7, 1600—1601.

THE manufacture of ferromanganese and spiegel-eisen in Germany yields as by-product large quantities of manganese slag, of which the average composition is:—24.4% Mn, 30.5% SiO₂, 9.8% Al₂O₃, 33.4% CaO, 6.3% MgO, 1.2% S, and traces of iron. The manganese is insoluble in water but slowly soluble in weak acids. A series of pot experiments were carried out to compare its manurial value with that of anhydrous manganese sulphate. White Petkus oats were sown in pots each containing 10 kilos. of sandy soil (with 0.28% CaO, 0.14% P₂O₅, 0.13% K₂O, and 0.15% N), which received further 1.5 grms. of potash, 1 gm. of phosphoric acid, 1.5 grms. of nitrogen, and 60 grms. of calcium carbonate in the form of marl, besides dressings ranging from 0.5 to 10 grms. of manganese either as finely powdered slag or as sulphate. The manganese slag increased the yield of both grain and straw, and the increase was greater the larger the amount applied, except for the maximum dressing (10 grms.). In small amounts (0.5 and 1 gm.) the sulphate was more effective than the slag, but with the larger dressings (2.5 and 5 grms.) the reverse was the case. With manganese slag the yield of grain was affected more than that of straw, whilst the sulphate affected the yield of straw most.—J. H. L.

Phosphoric acid determinations in phosphate rock. C. C. Semple. Eng. and Min. J., 1917, 103, 1140—1141.

FROM $\frac{1}{2}$ to 1 gm. of the phosphate rock is decomposed by means of nitric and hydrochloric acids, and the silica is removed by evaporating twice to dryness in the customary manner. The dried mass is taken up by 10 c.c. of concentrated hydrochloric acid and after dilution with boiling water, the solution is filtered from the insoluble matter, and the latter is washed until the bulk of the filtrate and washings measures 175—200 c.c. Ammonia is added, with constant stirring, to this filtrate until a gelatinous precipitate of calcium, iron, and aluminium phosphates begins to form, and then 30 c.c. of ammonia solution (sp. gr. 0.9) is added in excess and the whole stirred vigorously; 10 c.c. of a saturated solution of citric acid is now added, and the solution is stirred for 2 minutes, at the end of which time, if the precipitated phosphates have not redissolved, more citric acid solution is added, drop by drop, until the phosphate solution is quite clear. 30 c.c. of the magnesium mixture is now added, and the solution is stirred until the precipitate of magnesium ammonium phosphate begins to form; after standing for three hours it is filtered. The volume of citric acid required to clear the solution is proportional to the amount of phosphoric acid present in the liquid, and by use of a solution of citric acid of known strength for this purpose, an approximate idea of the strength of the sample may be obtained. The results agree closely with those obtained by the molybdate method.—J. B. C. K.

Blood; Adulteration of dried —. M. Sirot and G. Toret. Ann. Falsif., 1917, 10, 220—227.

THE valuation of dried blood for use as a manure is discussed, and it is pointed out that, in its sale based on the "organic manure" content, the latter should not include any hide, etc., mixed with it. The content of nitrogenous matter is determined by multiplying the nitrogen content by the necessary factor (for hide, 6.25; for horn, 5.95); the content of organic matter is calculated by difference after determination of moisture and

mineral content. In all the adulterated samples examined the difference between the percentage of organic matter and of nitrogenous matter exceeded 3.5. In case hide only has been added, differences of 4.5, 8.0, and 11.5 correspond to 10, 20, and 30% of hide respectively.—F. W. A.

Manuring of sugar cane in Java. Comparative results with calcium cyanamide and ammonium sulphate. Geerts. See XVII.

Dissolved oxygen in rain water. Richards. See XIXb.

PATENTS.

Fertiliser material; Process of producing —. Process for treating distillery by-products. W. W. Haughey, Assignor to By-Products Reclaiming Corporation, New York. U.S. Pats. (A) 1,232,032 and (B) 1,232,416, July 3, 1917. Date of appl., Nov. 11, 1916.

DISTILLERY "slop" is (A) concentrated, dried at about 300° F. (about 150° C.), and then roasted at about 700° F. (about 370° C.) to render the material non-hygroscopic without driving off the nitrogen; or (B) continuously concentrated, dried in thin films, and roasted at a predetermined temperature—about 700° F.—sufficient to render the material non-hygroscopic without driving off the nitrogen.—E. W. L.

Fertilisers; Process for manufacturing —. W. D. Richardson, Assignor to Swift and Co., Chicago, Ill. U.S. Pat. 1,232,452, July 3, 1917. Date of appl., Aug. 28, 1915.

The insoluble potash in silicate rock is rendered soluble by mixing with calcium phosphate and a fluoride (fluoride material containing calcium phosphate) together with an acid capable of decomposing fluoride, conveying the mixture to a den or pile to complete the reaction, and afterwards drying it.—E. W. L.

Superphosphate reaction chambers; Apparatus for emptying —. H. W. Hall, Zürich, Switzerland. U.S. Pat. 1,232,295, July 3, 1917. Date of appl., Feb. 6, 1915.

See Eng. Pat. 2077 of 1915; this J., 1915, 881.

XVII.—SUGARS; STARCHES; GUMS.

Sugar cane cultivation; The effect of lime in —. W. E. Cross. Revista Industrial y Agrícola de Tucumán, 1916, 7, 173—178. Intern. Sugar J., 1917, 19, 312—315.

By the application of lime to soils in Tucumán, Argentina, a total increase of 26.1 tons of cane was obtained, or nearly 2 tons of sugar per hectare, as compared with plots not so treated. In this Province the soils are particularly deficient in this constituent, and the experiments undertaken indicate that this fact may explain in a certain degree the almost negative results which fertiliser experiments have generally hitherto given there.—J. P. O.

Sugar cane in Java; Manuring of —. Comparative results with calcium cyanamide and ammonium sulphate. J. M. Geerts. Arch. Suikerind. Nederland. Indie, 1916, 24, No. 44. Bull. Agric. Intell., 1917, 8, 244—245.

In 59 out of 78 comparative trials with ammonium sulphate and calcium cyanamide, during 1905—

1914 in Java, the former gave better results than the latter, yielding on the average 2.5% more cane and 2% more sugar. It appears probable that calcium cyanamide gives better results in light than in heavier soils, but in both cases it is less satisfactory than ammonium sulphate. In using calcium cyanamide it is best to apply a portion before planting. If, for example, a portion is given not less than a week before planting and the remainder in 3 or 4 lots at intervals after planting, without allowing it to touch the plants, the cyanamide is decomposed before it reaches the rootlets and there is scarcely any danger of injurious action. Partial substitution of cyanamide for ammonium sulphate is better than complete substitution, but the cyanamide should always be applied before the sulphate. Cyanamide has no influence on the ripening of the cane.

—J. H. L.

Sugar estimation; Modification of Fehling's method of —. E. Lenk. Deutsch. Med. Woch., 1917, 43, 43—44. J. Chem. Soc., 1917, 112, ii., 341—342.

The addition of 1 mgrm. of magnesium sulphate to each c.c. of the copper sulphate solution ensures rapid sedimentation of the colloidal cuprous oxide. Calcium salts are harmful in this respect. For example, on adding urine, drop by drop, to boiling Fehling's solution containing magnesium, the cuprous oxide suddenly cakes together and the next drop makes the solution perfectly clear; this point corresponds with the disappearance of copper from the solution, and is therefore the true end-point.

Sucrose and invert-sugar; Conservation of solutions of — by means of various antiseptics. H. Pellet. Bull. Assoc. Chim. Sucr., 1916, 35, 136—138.

HALF-LITRE portions of 5% sucrose solution were treated respectively with 0.5 gm. of thymol, 2 c.c. of toluene, 5 grms. of sodium fluoride, and 1.7 gm. of sodium salicylate, and left at the ordinary temperature. Some inversion occurred in presence of sodium salicylate within 2 days; only the solution containing thymol remained unaltered for 13 days, and that showed signs of hydrolysis within 20 days. In similar tests made with 5% neutral solutions of invert-sugar, the rotatory power remained unchanged in all cases for 38 days, though slight growth of mould was visible in the solution containing sodium fluoride. The experiments were made as a guide in the use of antiseptics for inversions by means of invertase at the ordinary temperature, which sometimes occupy 8—10 days.—J. H. L.

Molasses; Influence of amino-acids and of l-glutamic acid in the estimation of raffinose and sucrose in — by the inversion method. V. Staněk. Z. Zuckerind. Böhm., 1916, 41, 154—160. J. Chem. Soc., 1917, 112, ii., 342.

The presence of glutamic or l-glutamic acid diminishes the amount of sucrose found in all cases in which the ordinary methods of estimation are employed, only acid polarisation and the Clerget-Herzfeld formula giving accurate results. Aspartic acid increases the amount of sucrose given by ordinary direct polarisation or by inversion and polarisation. Acid polarisation gives correct results if the Clerget-Herzfeld formula is used, but the raffinose formula gives low numbers. In presence of aspartic or glutamic acid a positive amount, and in presence of l-glutamic acid a negative amount, of raffinose is indicated when this sugar is absent; the errors thus incurred are halved when acid polarisation is used. With pure

beet molasses it is well to discard the raffinose formula entirely and to determine the sugar content by the acid polarisation method and application of the Clerget-Herzfeld formula. No method is known by which raffinose may be estimated in presence of amino-acids.

Raffinose: Influence of — contained in beet molasses, on the determination of sucrose by double acid polarisation or by inversion with invertase. H. Pellet. Bull. Assoc. Chim. Sucr., 1916, 35, 112—117. (See also this J., 1917, 153.)

SAMPLES of beet molasses were found to contain 0.7—1.5% of raffinose by the method of Hudson and Harding (this J., 1915, 1065). The determination of raffinose in presence of sucrose by double polarisation and application of Herzfeld's raffinose formula, is vitiated by the presence of other optically active substances even if these remain unaffected by inversion, as is the case when invertase is used and the readings before and after inversion are made on neutral solutions (cp. Ogilvie, this J., 1911, 62). It is shown, for instance, from the known constants relating to raffinose and sucrose, that if a molasses contains non-sugars which influence the polarisations before and after inversion to the extent of -3 sugar degrees, the apparent sucrose-content, calculated by means of the raffinose formula, will be higher than the direct polarisation in spite of the presence of 1 or 2% of raffinose. The ordinary inversion formula:—

$$\text{Sucrose \%} = 100 (P - P_1) / (142.66 - t/2),$$

gives results higher than the true sucrose-content, to the extent of 0.67% for every 1% of anhydrous raffinose present, irrespective of the presence of other optically active substances which are not changed by inversion. If the raffinose-content is determined independently, e.g., by Hudson and Harding's method, and the direct polarisation and apparent sucrose-content (calculated by the above formula) are corrected accordingly, their difference will represent the rotation of the optically active substances present other than sucrose and raffinose. The author has compiled a short table showing the combined effects of 0.7—1.5% of raffinose and 0—3% of levorotatory non-sugars on the polarisation and apparent sucrose-content of molasses containing 44% of sucrose.—J. H. L.

Beet-molasses; Pentose-content of —. H. Pellet. Bull. Assoc. Chim. Sucr., 1916, 35, 117—121.

APPLYING the methods of investigation previously described (see this J., 1916, 1075), the author concludes that beet molasses normally contains no appreciable quantity of pentoses. It is probable, however, that small quantities of pentosans are present, as stated by Stiff and Komers (see this J., 1898, 475), who found 0.47—1%. The small amounts of reducing sugars often found in vinasses from beet molasses do not represent non-fermentable sugar, but probably consist of invert sugar which has escaped fermentation owing to the high alcohol-content and acidity of the vinasses at the close of fermentation.—J. H. L.

Molasses; Nitrogenous pigments of —. V. Staněk. Z. Zuckerind., Böhm., 1917, 41, 298—306. J. Chem. Soc., 1917, 112, i., 381—382.

WHEN dried molasses is extracted with alcohol, there remains undissolved a small percentage of non-saccharine substances which contain about 94% of the total pigment and 10% of the nitrogen of molasses. The author has separated the residue into various fractions. One of them apparently contains a fairly definite substance which is pre-

cipitated by lead acetate, is soluble in alcoholic hydrogen chloride solution, but not in ether, and contains 7.1—7.3% of nitrogen and about 0.2—0.3% of ash. It seems to be a product of the condensation of amino-acids with sugars, and is designated fuscazinic acid. The alkali salts of this account for about half of the colour of molasses.

Starch; Direct method for the estimation of —. T. von Fellenberg. Mitt. Lebensmittelunters. Hyg., 1916, 7, 369—383. J. Chem. Soc., 1917, 112, ii., 342—343.

THE method depends on the solubility of starch in calcium chloride solution, its precipitation by iodine, and the decomposition of the precipitate by alcohol. From 0.3 to 1.0 gm. of the finely-divided, fat-free substance under examination is moistened with water and mixed with 20 c.c. of 50% calcium chloride solution; the mixture is heated in a boiling water-bath for thirty minutes, then boiled for five minutes, cooled, diluted to 100 c.c., and filtered through cotton-wool and then through asbestos. If the filtrate is not perfectly clear, it must be submitted to centrifugal action. Fifty c.c. of the filtrate is treated with N/50-iodine solution until a flocculent precipitate is obtained; a large excess of iodine is to be avoided. After about twenty-four hours a quantity of asbestos is added, the precipitate and asbestos are collected in a Gooch crucible containing a layer of asbestos, and the contents of the crucible are washed four times with 5% calcium chloride solution containing a few drops of iodine solution. The precipitate is then washed with 60% alcohol (this is allowed to act on the precipitate for five minutes), then with 85% alcohol, and finally with 100 c.c. of 90% alcohol. If the contents of the crucible are not now colourless, a quantity of hot alcohol is added. After further washing with cold 95% alcohol, 5% calcium chloride solution, and dry ether, the crucible and its contents are dried, weighed, ignited, and re-weighed. The loss in weight gives the quantity of starch present.

PATENT.

Sugar-washer; Automatic — and reater-measurer for the same. J. Sailer, Oxnard, Cal. U.S. Pat. 1,230,328, June 19, 1917. Date of appl., May 5, 1915.

THE apparatus comprises a "film nozzle" through which the washing fluid is fed against the charge of sugar in the centrifugal machine, means for holding the nozzle in its extreme upper position so that it is clear of the basket and for reciprocating it between its extreme lower position inside the basket, and an intermediate position near the top of the basket. The actuating device comprises a main cylinder and piston, a nozzle carried by the piston, a water supply to the nozzle, valves for applying pressure to raise or lower the main piston, an auxiliary piston which actuates the valves, and means whereby the main piston automatically controls the pressure on the auxiliary piston.—J. F. B.

XVIII.—FERMENTATION INDUSTRIES.

Wines; Sulphurous acid in chemical combination in musts and —. Laborde. Rev. Viticulture, 1916, 45, 309—314, 373—376, 421—423, 437—440, 453—459. Bull. Agric. Intell., 1916, 7, 1676—1685.

WHEN quantities of 160 or 200 mgrms. of sulphur

dioxide per litre are added to grape must, by far the greater part enters into combination, chiefly with dextrose; though also to some extent with non-sugars, but not with levulose. The ratio of free to combined sulphurous acid increases with the amount added, but is not appreciably affected by changes in the acidity of the must nor by the direct action of *Botrytis cinerea* (cp. Müller-Thurgau and Osterwalder, this J., 1915, 1066; 1916, 900). In spite of the greatly reduced antiseptic properties of sulphur dioxide in the combined form, its presence in a fermenting must can modify the physiological action of the yeast; the production of aldehydes is increased (cp. *loc. cit.*), the rate of fermentation is slightly reduced, especially at first, and to a greater extent at 25° than at 15° C., and the yeast appears to ferment rather more levulose than dextrose. In respect of the proportion of added sulphur dioxide which enters into combination, cheap table wines (*vin ordinaire*) do not differ very much from the musts which produce them; but musts infected with *Botrytis cinerea* and very rich in sugar, generally yield sweet wines of much lower combining power, very much the same as that of *vin ordinaire*. The addition of sulphur dioxide to a must changes but little the combining power of the wine produced from it (*i.e.*, with respect to further additions), for the initial quantity is taken up by aldehyde formed during fermentation. The checking of fermentation may be effected in contact with living yeast without using excess of sulphurous acid, so long as sufficient is added to stop the fermentation completely and the lees are withdrawn as speedily and completely as possible to diminish risk of slow secondary fermentation, which would produce aldehyde and so reduce the amount of free sulphur dioxide. Since the total amount of added sulphur dioxide is subject to statutory limitation and only the free acid inhibits fermentation, it is important to avoid those conditions which favour the production of substances capable of combining with the acid; among these conditions are excessive aeration, too prolonged fermentation, precipitation in presence of sulphurous acid, and secondary fermentation after sulphiting. During 3 or 4 years (the normal period of preservation of wines) a certain increase in the amount of combined sulphur dioxide must be expected.—J. H. L.

Pentose-content of beet-molasses. Pellet. See XVII.

PATENTS.

Worts, fermented and distilled beverages, and other products resulting from the mashing of starchy materials; Manufacture of —. Wahl-Henius Research Laboratory, Assignees of R. Wahl, Chicago, Ill., U.S.A. Eng. Pat. 101,406, Apr. 7, 1916. (Appl. No. 5153 of 1916.) Under Int. Conv., Sept. 9, 1915.

MATERIALS such as wheat bran, offal of pearl barley, cortex of maize, and certain products of the milling of dried peas and beans, which contain translocation diastase and considerable amounts of proteins and phosphates, are used in place of malt as saccharifying agents in the preparation of mashes and worts for the manufacture of beers, spirits, non-alcoholic beverages, vinegar, etc. For example, beers may be prepared from wheat bran and cooked amylaceous materials, since under suitable conditions bran will saccharify 2 or 3 times its weight of gelatinised starch. The required malt flavour may be imparted by caramel malt or other known preparations, or bran which has been moistened and heated to 150°–200° C. may be used for flavouring. To render soluble the nitrogenous and phosphatic constituents of the saccharifying agents mentioned, the mashes may be acidified by addition of lactic acid or by use of

lactic bacteria (cp. U.S. Pat. 1,028,508; this J., 1912, 655) and held at temperatures favourable to proteolysis; or wheat bran which has been thus mashed with acid and subsequently dried may be used instead of raw bran. (Reference is directed, in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pat. 2587 of 1896; this J., 1896, 368.)—J. H. L.

Hops; Extraction of oils and resins from —. F. W. Wolff, London. Eng. Pat. 107,155, Nov. 9 and Dec. 13, 1916. (Appl. Nos. 16,104 and 17,932 of 1916.)

Hops are exposed to the action of steam containing alcohol vapour, to dissolve out the resins and volatilise the oils, at temperatures below that at which the resins would become hardened. The hops may be subjected, first, at a temperature below 100° C. to the action of a current of vapour of low alcohol-content (*e.g.*, produced by passing steam through 8% alcohol) by which the oils are volatilised and carried over into a separate vessel; next, at a low temperature to the action of vapours of high alcohol-content (*e.g.*, produced by passing steam through 67% alcohol), which condense on the hops and extract the soft resins, and finally the hops are submerged in warm water (with or without a small proportion of alcohol) and acted upon by vapours of low alcohol-content to dissolve the hard resins. The first operation may be omitted and the oils and soft resins extracted together by condensed vapours of high alcohol-content and afterwards recovered separately from the extract, the hops then being treated as before to extract the hard resins. An apparatus for carrying out the process is also claimed, consisting of a jacketed still in which the hops are supported on a perforated false bottom. For the volatilisation of the oils, heating liquid is circulated through the jacket, and the alcoholic steam is injected below the layer of hops so that it passes upwards through them to the still-head, which is connected with a condenser. For the extraction of the soft resins, cooling liquid is circulated through the jacket, the still-head outlet is closed, and the alcoholic vapour is admitted above the layer of hops and drawn off, after condensation, from the bottom of the still. Several features of minor importance are also claimed.—J. H. L.

Water [for brewing]; Process for eliminating carbonate hardness of —. G. Hess, Vienna. Ger. Pat. 297,873, June 25, 1914. Under Int. Conv., June 4, 1914.

SULPHATES of aluminium, iron, or other trivalent alum-forming metals are added to the water to convert alkali or alkaline-earth carbonates into alum or sulphates. Water thus treated yields light-coloured and highly palatable extracts in brewing. The excellent brewing properties of the water at Pilsen are ascribed to the presence of aluminate in the neighbouring rock strata. Water so treated has proved satisfactory in the extraction of sugar from beetroots.—H. J. H.

Hops; Process of leaching out —. H. Schneider, Essen, Germany. U.S. Pat. 1,232,098, July 3, 1917. Date of appl., Aug. 17, 1912.

SEE Fr. Pat. 447,382 of 1912; this J., 1913, 248.

Process of producing fertiliser material. Process for treating distillery by-products. U.S. Pats. 1,232,032 and 1,232,446. See XVI.

XIXa.—FOODS.

Beef; Changes in fresh — during cold storage above freezing-point. R. Hoagland, C. N. McBryde, and W. C. Powick. U.S. Dept. Agric., Bull. No. 433, Feb. 15, 1917, pp. 100.

SAMPLES of beef were kept in cold storage at temperatures above freezing-point for periods ranging from 14 to 177 days. It was found that the principal chemical changes were increases in the acidity, protease, non-coagulable, amion, and ammoniacal nitrogen, and in the soluble inorganic phosphorus; whilst decreases took place in the amounts of coagulable nitrogen and soluble organic phosphorus. There was also a pronounced increase in the acid value of the kidney and external fats. These changes were, in the main, progressive, and were of similar character to, though less pronounced than, those which took place when lean beef was autolysed under aseptic conditions for periods of 7 to 100 days. The chemical changes in the muscular tissue had no appreciable effect upon the wholesomeness or nutritive value of the beef, but the changes in the kidney fat and external fatty tissue after the longer periods of storage rendered those parts unfit for food. Bacteria and moulds which developed upon the surface did not penetrate the muscular tissue to any great depth, and the increased tenderness of meat which has been stored cannot be attributed to bacterial action. The chemical changes may be attributed largely to enzymic action. In practice beef is ordinarily stored at a temperature between 34° (1° C.) and 36° F. (2° C.), whilst 40° F. (4.5° C.) is regarded as the upper limit of safety. The condition of the beef is an important factor in the practicable length of storage, the meat from prime grain-fed cattle keeping much better than that from old animals or grass-fed cattle. Another factor is the degree of humidity. For example, beef could be kept for 177 days in an experimental cooler with 0 to 85% of humidity, whereas it could only be kept for 55 days in a modern packing house cooler with 92 to 95% of humidity.—C. A. M.

Potatoes; Desiccation of — in Germany. Parow, Georgine, Königsberg, 1916, 572. Bull. Agric. Intell., 1916, 7, 1685—1686.

THE number of factories for drying potatoes in Germany increased from 3 in 1903 to 488 in 1914; in 1916 there were 841, of which 551 were in the provinces of Brandenburg, Pomerania, Posen, and Silesia. With the present number of factories working day and night for 200 days, 12 million tons of dried potatoes can be produced from 30 million tons of raw material, but this output does not meet the requirements for cattle as well as human beings. The technology of desiccation is made rapid strides. Roller apparatus (*Walzenapparate*) and drum driers (*Trommelapparate*) are now generally used. The former can deal with 1.2—1.5 tons of potatoes an hour and the latter with quantities up to 5 tons an hour. The product can be preserved almost indefinitely. It is made in the form of flakes and cubes for cattle, and various flours for human consumption. The machines are easy to run, those of medium size requiring 8—10 H.P. and the larger ones 15—25 H.P. On an average, 12—14 tons of coal is used for 100 tons of potatoes, for the flaked product, and 8—10 tons of coke for cubes. Machines for making cubes can be used also for drying beetroots, peas, cereals, grass, and other vegetables.—J. H. L.

Cottonseed meal; Nutrition experiments with —. H. A. E. Richardson and H. S. Green. J. Biol. Chem., 1917, 30, 243—258. (See this J., 1916, 860.)

THE protein in a diet containing 50% of refined

cottonseed flour, protein-free milk, and butter-fat is sufficient for the normal growth of the albino rat and for reproduction to the third generation, but more general well-being and fertility was obtained by the addition of 5% of casein to the diet. The cottonseed flour employed contained 51% of protein and 11.4% of fat. Normal growth is not obtained with a diet of 50% of cottonseed flour in which there is a deficiency of butter-fat or protein-free milk; but 50% of cottonseed flour with 5% of casein and butter fat, without additional mineral other than that furnished by the cottonseed flour, supports normal growth and reproduction, although the second generation does not grow quite normally on this diet. No toxic effect is apparent in feeding 15—50% of cottonseed flour through prolonged periods and several generations, but the addition of the petroleum spirit extract of the entire cottonseed to a well-balanced diet has a depressing effect on the weight of the rat. The ethyl ether extract of the petroleum-extracted seed and the ethyl ether extract of the refined cottonseed flour have, on the other hand, no harmful effect. The addition of crystallised gossypol is injurious.—J. F. B.

Detection of ammoniacal cochineal. Muttelet. See IV.

PATENTS.

Milk product; Self-preserving acid — and process of making the same. W. P. M. Grelek, Evanston, Ill., Assignor to B. H. Grelek, Lincoln, Nebr. U.S. Pat. 1,230,179, June 19, 1917. Date of appl., May 10, 1915.

SOURD milk is heated to precipitate the casein, and simultaneously agitated to prevent aggregation of the precipitate; heating may be continued at a higher temperature until the finely-divided particles of casein become permanently non-adherent, after which the surplus fluid may be evaporated.—J. H. L.

[Milk]; Composition of matter for preparing foods, and process of making the same [from —]. H. W. Wiley, Washington, D.C. U.S. Pat. 1,230,452, June 19, 1917. Date of appl., Mar. 7, 1917.

SKIMMED milk is strongly acidified, e.g., by means of *B. Bulgaricus*, and then rendered homogeneous and quickly dried. The dry powdered product may be mixed with a carbonate or bicarbonate and a filler of dried milk.—J. H. L.

Food composition [containing milk and cocoa]. J. M. W. Kitchen, East Orange, N.J. U.S. Pat. 1,230,091, June 12, 1917. Date of appl., Nov. 20, 1916.

POWDERED cocoa seeds and a thickening material, e.g., a powdered cereal, are mixed with skimmed milk; the product may be partially desiccated under reduced pressure. Claim is particularly made for the dehydration of mixtures of skimmed milk and powdered cocoa seeds under reduced pressure, whereby a thorough emulsion is secured.—J. H. L.

Coffee substitute. W. A. Lorenz, Hartford, Conn. U.S. Pat. 1,230,184, June 19, 1917. Date of appl., Aug. 2, 1916.

CLAIM is made for products consisting of granulated roasted cotton seeds and granulated roasted vegetable colouring and flavouring matters, and in particular for one made from granulated roasted cotton seeds, rye, and figs.—J. H. L.

Fruits and vegetables : Method of preserving — fresh. H. C. M. Franks, Brooklyn, N.Y. U.S. Pat. 1,232,271, July 3, 1917. Date of appl. Apr. 21, 1917.

The fruit is placed in a container which can be hermetically sealed, and is introduced into a pressure apparatus into which carbon dioxide is forced at a pressure of 60—70 lb. per sq. in., which is maintained for 10 mins. The pressure is then gradually released and gas and air are pumped out of the apparatus to a vacuum of about 16 in. of mercury. Carbon dioxide is allowed to enter the apparatus slowly again to the same high pressure, which is maintained for 1 hr. The apparatus is slowly evacuated, and the vessel containing the fruit is sealed before removal. The second treatment with carbon dioxide may be replaced or followed by a similar treatment with nitrogen.—J. H. J.

Coconut ; Process of preparing or treating —. F. Baker, jun., Philadelphia, Pa. U.S. Pats. 1,203,364, 1,203,365, and 1,203,366, June 19, 1917. Dates of appl., (A) May 11, (B) and (C) June 17, 1916.

(A) COCONUT is preserved in a natural, moist, condition, by separating the milk from the kernel, hermetically sealing the cut, grated, or shredded kernel, together with a portion of the milk (which may first be heated, e.g., at 100° C.), in suitable receptacles, and sterilising by heating, e.g., at about 220° F. (104·5° C.) for half an hour. (B) Coconut kernels, cut, grated, or shredded, are packed in receptacles, which are then subjected, open, to the action of steam at a temperature not exceeding 250° F. (121° C.), e.g., 220° F., to destroy bacteria, and afterwards hermetically sealed and heated for a short time at a temperature not exceeding 250° F. (C) The process is similar to (A), except that instead of coconut milk, aqueous sugar solution is introduced into the receptacles. The sealed receptacles may be finally heated for a short time at a temperature not exceeding 250° F.—J. H. L.

Cereal food ; Process of preparing —. J. E. Engstad, Minneapolis, Minn. U.S. Pat. 1,231,143, June 26, 1917. Date of appl., Mar. 29, 1916.

CEREAL food products are prepared by subjecting the granular meal as it comes from the mill to dry steam under pressure at 235°—250° F. (113°—121° C.) for a sufficient time to break up the envelopes of the starch pellicles.—F. W. A.

Food ; Apparatus for electrical sterilisation of —. J. Hanssen, Christiania, Norway. U.S. Pat. 1,231,883, July 3, 1917. Date of appl., Oct. 7, 1916.

SEE Eng. Pat. 101,804 of 1916 ; this J., 1917, 563.

Margarine ; Manufacture of —. K. Erslev, Nijmegen, Netherlands. U.S. Pat. 1,232,016, July 3, 1917. Date of appl., Mar. 11, 1916.

SEE Eng. Pat. 103,343 of 1916 ; this J., 1917, 302.

XIXB.—WATER PURIFICATION ; SANITATION.

Hydrogen sulphide in water ; Determination of — at the source. G. Incze. Z. anal. Chem., 1917, 56, 308—311.

To 300 c.c. of the water is added 3 c.c. of a solution containing 85 grms. of silver nitrate and 200 grms.

of ammonium nitrate in a total bulk of 500 c.c. In the presence of the ammonium nitrate no silver carbonate is deposited, the precipitate consisting of silver chloride and silver sulphide. The excess of silver is measured by allowing the precipitate to settle for an hour and then titrating 101 c.c. of the clear liquid with N/50 ammonium thiocyanate. By performing a parallel experiment with water from which the hydrogen sulphide has been expelled by boiling, the quantity of silver nitrate consumed by the chlorides present can be determined.—D. F. T.

Carbon dioxide in water ; Determination of —. J. Tillmans and O. Heublein. Z. Unters. Nahr. Genussm., 1917, 33, 289—304. J. Chem. Soc., 1917, 112, ii., 332.

FREE carbon dioxide and that present as bicarbonates in water cannot be estimated accurately by precipitation with barium hydroxide and titration of the excess of the latter after the barium carbonate has settled; the inaccuracy of this method is due to the occlusion of barium hydroxide in the precipitated carbonate. The method is applicable, however, to solutions of carbon dioxide and bicarbonates in distilled water provided that the whole mixture (liquid and precipitate) is titrated, using phenolphthalein as indicator; the presence of magnesium salt renders this modification useless in the case of many drinking waters. The free carbon dioxide in water may be estimated by adding 1 c.c. of 0·0375% phenolphthalein solution to 200 c.c. of the water contained in a stoppered flask and then titrating the solution with N/20 sodium hydroxide solution until a pink coloration is obtained which persists for five minutes. If, at the end of the titration, the solution contains more than 440 mgrms. of carbon dioxide in the form of bicarbonate, the estimation must be repeated after the sample has been diluted with water free from carbon dioxide. Winkler's method (this J., 1915, 1111) is considered to be untrustworthy.

Sewage purification at Worcester ; Activated sludge process of —. T. Caink. Assoc. Managers of Sewage Disposal, July 7, 1917. Engineering, 1917, 104, 49—51.

THE tank employed in the process has a capacity of 626,000 galls. It is divided into rectangular bays, of which twenty are devoted to aeration and eight to settling. The floor is formed on the ridge and furrow principle, and in the furrows are porous tiles through which air is delivered to the sewage. These diffusers are placed 5 ft. apart in the first bays of the tank receiving the raw sewage, and 10 ft. apart in the other bays. The air escapes at the surface, and the circulation of the sewage tends to be a forward one. The floors of the settling bays are in the form of inverted pyramids, in the apices of which are air lifts whereby the sludge is raised to a main conveying it back to the sewage inlet channel for re-treatment. Excess sludge is drawn off to a sand filter for drying and disposal. The purified effluent is decanted from the settling tank. The volume of sewage treated is 750,000 galls. per day with 8 hrs. aeration and 2½ hrs. settling, the tank being worked on the continuous flow principle. The total area of the diffusers is about a tenth of the area of the aeration bays, and the volume of air used is 0·8 cu. ft. per gall. of sewage. The sludge from the settling bays when drained contains 95% of water. The analyses of the sewage and the effluent are respectively as follow in parts per 100,000: Solids in suspension, 10·4, trace; solids in solution, 151, 143; sodium chloride, 68·3, 67·7; free ammonia, 2·0, 2·6; albuminoid ammonia, 0·57, 0·17; oxygen absorbed in 4 hrs., 2·1, 0·56; nitrites and nitrates, 0, 0; dissolved

oxygen absorbed in 5 days by the effluent, 0.63. The effluent showed no putrefaction in 5 days by the incubation test. The standard to which the effluent has to conform is that it shall be incapable of putrefaction and shall not contain more than 4 parts per 100,000 of suspended matter. This has been fulfilled in the case of the dry weather flow but not in the case of the wet weather flow. The author recommends several alterations in the tank, of which the most important is that it should be provided with an air-tight roof, so that the air would have to travel horizontally over the sewage under the roof before leaving the tank, thus imparting a horizontal motion to the surface layer of sewage.—J. H. J.

Rain-water; Dissolved oxygen in —. E. H. Richards. J. Agric. Sci., 1917, 8, 331—337.

DETERMINATIONS of the dissolved oxygen in the rain falling at Rothamsted in 1915 were made by Winkler's method. The rain, collected at temperatures below 15° C. was only slightly below full saturation, average 93%. At temperatures above 15° C. the degree of saturation was much less, average 85%.—J. H. J.

Bacteria of the coli-aerogenes family; Improved chemical methods for differentiating —. W. M. Clark and H. A. Lubs. J. Biol. Chem., 1917, 30, 209—234.

ACCORDING to the method of Keyes (J. Med. Research, 1909, 21, 69) the ratio of the volumes of the gases CO₂:H₂ liberated in the anaerobic fermentation of dextrose by bacteria of the coli-aerogenes group affords an excellent means for the differentiation of these organisms, the species being divided into those which furnish a low gas ratio (*B. coli* group) and those with a high ratio (*B. aerogenes* group). The "methyl red test" has been devised to arrive at a correlated classification without the tedious gas analysis. This test is based on a differential production of acidity in the region of p_H=5.0 by the two groups of bacteria provided the quantity of dextrose available be restricted within certain well-defined limits. A medium suitable for this differential test is composed of 0.5% of dextrose, 0.5% of dipotassium hydrogen phosphate, and 0.5% of Witte's peptone. In view of the scarcity of Witte's peptone a revised formula has been worked out containing per litre 1 gm. of anhydrous disodium hydrogen phosphate, 2 grms. of potassium hydrogen phthalate, 1 gm. of aspartic acid, and 4 grms. of dextrose. The details to be attended to in performing the culture-tests are described and a satisfactory concordance between the methyl red test and the gas ratio test is recorded. Cultures showing low gas ratios turn the indicator red, while cultures with high gas ratios give yellow. The former type of bacteria occur in faeces and the latter in grain. The revised synthetic medium is also well adapted for carrying out the Voges-Proskauer colour reaction, but it is necessary to add some alkaline solution of casein to complete the development of the colour. This test affords a third means of differentiating the two types of bacteria and, although it is not always sharp and definite, perfect correlation with the gas ratio and methyl red tests is established.—J. F. B.

Benzene derivatives; Toxicity of various — to insects. W. Moore. J. Agric. Res., 1917, 9, 371—380.

ALL the benzene derivatives tested were more toxic to flies, molecule for molecule, than carbon disulphide. Physical characters such as the b. pt. and vapour pressure had a greater influence

than the chemical composition upon the toxicity of the compounds. Up to 250° C. the toxicity of the compounds increases with the b. pt., but in the case of compounds boiling above that temperature too little of the substance evaporates at the ordinary temperature to be effective. Lipoids are very soluble in benzene derivatives of low b. pt., but only sparingly soluble in those of high b. pt., so that there may be a relationship between the solvent action of the substances upon lipoids and their toxicity to insects. Compounds of low b. pt., such as xylene, chlorobenzene, and bromobenzene, will penetrate grain better than those of higher b. pt., and although less toxic, will probably be preferable for the fumigation of grain. For the fumigation of animals a compound of high b. pt. is necessary, and salicylic aldehyde is probably the best.—C. A. M.

Muscicides and other fly-destroying agencies; Experimental studies with —. E. B. Phelps and A. F. Stevenson. Hygienic Lab., Bull. No. 108. U.S.A. Public Health Service, Dec., 1916, pp. 37.

THE relative toxic action of solutions of various substances upon flies was determined, a N/1000 solution of sodium arsenite being taken as the standard basis for the comparison. It was found that quassia syrup and potassium bichromate were of little value, but that formaldehyde in 0.5 to 1% solution was a more efficient muscicide than the arsenite solution. Sodium salicylate in 1% solution, was almost equal to formaldehyde as a toxic agent, and was somewhat superior to solutions prepared from commercial fly-papers. Under the experimental conditions either of these solutions was much more effective than any sticky preparation.—C. A. M.

Purification of tannery wastes. Hommon. See XV.

Determination of carbon dioxide and carbonates in solution. Van Slyke. See XXIII.

PATENTS.

Sterilised liquids; Apparatus for the production and aseptic storing of —. Sanitätsgesellschaft M. Schaerer A.-G., Bern-Wabern, Assignees of E. L. Hug, Bern, Switzerland. Eng. Pat. 100,744, June 19, 1916. (Appl. No. 8638 of 1916.) Under Int. Conv., June 19, 1915.

THE apparatus consists of a boiler surrounded by a casing open at the bottom. The cover of the boiler is bolted on and carries a central hollow pillar with a screw-on top and two side arms. One arm is connected to a bacteriological air filter; the other may be connected on the inside by a screw-down valve either to the air space in the boiler or to a vertical pipe leading down nearly to the bottom of the boiler, and on the outside to a pressure gauge and draw-off cock. When the boiler has to be charged the top of the hollow pillar is removed and the liquid to be sterilised is poured in; the top is screwed on again and heat applied either externally at the bottom or internally by a low-pressure steam coil. During the heating, the air space in the boiler is placed in communication with the two side arms, and the escaping steam sterilises the two arms and connections. When sterilisation is completed, the draw-off cock is closed, the draw-off arm placed in connection with the vertical pipe leading to the liquid, and the whole allowed to become cold. Air or other gas is then pumped through a cooling coil and the air filter into the boiler. The desired pressure being reached, the valve on the air pipe is closed. When it is desired to withdraw some of the liquid,

the draw-off cock is opened, and the air pressure inside forces the liquid up the vertical pipe and through the side arm. The apparatus is specially suited for the storage of physiological and surgical solutions.—J. H. J.

Distilling and evaporating [water]; Method of and apparatus for —. J. S. Forbes, Philadelphia. U.S. Pat. 1,232,269, July 3, 1917. Date of appl., Oct. 10, 1913.

HEATED water from the discharge pipe of a condenser is submitted in a finely-divided form to a vacuum or heated by the exhaust steam of an engine obtained at the beginning of the exhaust; a portion is vaporised, the unevaporated portion being removed by the incoming body of water, and the vapour is condensed.—J. H. J.

[Water] still. G. W. Crispell, Albany, N.Y. U.S. Pat. 1,231,857, July 3, 1917. Date of appl., Sep. 29, 1916.

The raw water is contained in an air-tight vessel, the bottom of which is connected by a horizontal narrow-bore pipe with the bottom of the still, which has a greater diameter than the raw water vessel. Another rather wider pipe connects the top of the raw water vessel with the lower part of the still, which is a vessel of conical shape, the neck of the cone being surrounded by a condensing chamber surmounted by a cold water vessel.—J. H. J.

Water-softeners; *Chemical-feeding device for* —. C. A. Cartwright, Chicago, Ill. U.S. Pat. 1,231,128, June 26, 1917. Date of appl., Mar. 13, 1915.

A CONTAINER for chemicals is connected by a conduit to a receiver, to which also is connected the water supply conduit. A motor is placed in the water supply conduit and is operated by the flow of water. The motor operates an air pump which delivers air to the chemical container, and also operates a water pump which delivers into the container and has an injector relation with the chemical supply conduit.—J. H. J.

Trichloride of iodine; Method for preservation of solutions of — for purifying contaminated water. U. Corbelli and E. Antolini, Rome. U.S. Pat. 1,231,853, July 3, 1917. Date of appl., Nov. 7, 1916.

A CONCENTRATED solution of iodine trichloride is saturated, or preferably supersaturated, with chlorine at a low temperature, and the product is immediately put into small tubes which are hermetically sealed at the same low temperature.—J. H. J.

Cake for insecticidal and fungicidal purposes; Soluble — and composition therefor. F. D. Houghton, Worcester, Mass. U.S. Pat. 1,231,741, July 3, 1917. Date of appl., Oct. 6, 1915.

LIME is slaked with hot water, flowers of sulphur being added during the slaking process; caustic soda is then added and the mixture boiled and stirred until the particles of sulphur disappear, when it is poured into moulds and allowed to set. The cakes are capable of retaining their shape and composition in the air, and are soluble in water; they contain about 22 % of lime and 22 % of sulphur.—J. H. J.

Insecticide. J. B. Barrett, Annapolis Royal, Nova Scotia. U.S. Pat. 1,230,648, June 19, 1917. Date of appl., Aug. 4, 1916.

The insecticide consists of naphthalene, 90 %

naphthalic acid, 8 %; and phenol, 2 %, mixed with an inactive agent as a filler. When exposed to the atmosphere a vapour is evolved and a "mineral oil" is liberated which coats the particles of the active agents and prevents too rapid an evolution of the vapour.—J. H. J.

Disinfectant. H. Bechhold, Frankfurt, Assignor to Chem. Fabr. Ladenburg Ges., Ladenburg, Germany. U.S. Pat. 1,232,187, July 3, 1917. Date of appl., Dec. 28, 1909.

SEE Eng. Pat. 25,472 of 1909; this J., 1910, 975. The halogenated β -naphthol derivative is specified to contain not less than three nor more than four halogen atoms per molecule.

Process for eliminating carbonate hardness from [brewing] waters. Ger. Pat. 297,873. See XVIII.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Quinine bisulphate; Decomposition of —. B. F. Howard and O. Chick. Brit. Pharm. Conf., 1917. Chemist and Druggist, 1917, 89, 612.

THE conditions have been ascertained under which quinine bisulphate is converted into quinicine or quinotoxin. Quinine bisulphate (containing $7H_2O$) decomposes to the extent of 0.25 % at 60° C., while if previously exsiccated at 35°–40° C., no decomposition at 60° C. takes place. The addition of small quantities of water (e.g., half its weight), at any dangerous temperature, increases the decomposition, while larger quantities of water retard it. The limiting temperature at which quinine bisulphate, heated alone or in very strong solution for 24 hours, first decomposes is 60° C. At 90° C., 50 % decomposes in 24 hours, and 75 % in 48 hours. In an open vessel, the decomposition is only 17 % in 24 hours, owing to exsiccation. Melting the hydrated salt probably always causes decomposition. The formation of a bright yellow melt, giving a highly coloured, very refractive solution, is a certain indication of decomposition. The authors suggest the use of the bihydrochloride or the bihydrobromide for solutions requiring sterilisation by heat.—F. Sp.

Extractum Cinchonæ Liquidum, B.P. O. Chick. Brit. Pharm. Conf., 1917. Chemist and Druggist, 1917, 89, 612.

PAUL'S statement that only about 20 % of the total alkaloids can be obtained from red cinchona bark by macerating with dilute hydrochloric acid, is confirmed. The finished extract may contain more glycerin than the authors of the B.P. process intended. It is therefore better to add a definite amount of glycerin to the extract when standardising it, particularly as glycerin has no solvent action on the alkaloids of the bark. The gummy substance often deposited on evaporation of the extract appears to consist of quinovic acid and cinchona red, probably produced from quinovin and cinchotannin by hydrolysis. The standardisation test in B.P. 1898 sometimes causes trouble owing to the formation of a mucilage when the extract is made alkaline with caustic potash and extracted with benzolated amyl alcohol. The B.P. 1911 therefore replaces the aqueous caustic potash with a solution of caustic potash in 90 % spirit; this, however, gives inaccurate results, because

about 4% of the total alkaloids is left in the rejected caustic liquor, and about 4% passes, with amyl alcohol, into the wash waters. The author therefore prefers the 1898 test, and states that there is little trouble with matelage formation if the solvents are used hot and thorough shaking is given.—F. Sp.

Alkaloids; Microchemical precipitation of — with zinc chloride-iodine solution. O. Tunmann. Apoth.-Zeit., 1917, 62, 76—78. J. Chem. Soc., 1917, 112, ii., 345—346.

THE results described were obtained with more or less impure alkaloid residues, such as are prepared by the Stas-Otto method. The reagent does not yield crystalline products with arecoline, brucine, cocaine, quinine, cinchonine, coniine, colchicine, narceine, nicotine, eserine, or veratrine. On the other hand, it is well adapted for the identification of strychnine, sparteine, the opium alkaloids, morphine, papaverine, cryptopine, and codeine, as well as atropine and hyoscyamine. With atropine, brown or dark red to blackish-red crystals, mostly rhombs, are immediately produced, which, at the commencement of the reaction, vary greatly in size. All the crystals shine but little between crossed Nicols, and do not exhibit pleochroism. The crystal crosses, consisting of four rhombs, are particularly characteristic. The limit of sensitiveness is 10—20 μ g. The iodide crystals of hyoscyamine shine feebly in polarised light, they are very small (4—8 μ), almost black, and without pleochroism. The platelets have generally a far less regular circumference than the atropine crystals. Limit of sensitiveness, 10 μ g. Zinc chloride-iodine yields crystals even with very impure morphine preparations; initially, fine, pale brown needles are formed, which after ten to twenty minutes unite to sheaves, and are then transformed into prismatic crystals with direct extinction. The latter are brown, the larger ones being nearly black; they do not exhibit pleochroism and scarcely shine between crossed Nicols. Limit of sensitiveness, 5 μ g. Papaverine and cryptopine give long, dull red, yellowish-red, or greenish-red crystals from 2—3 μ diameter, which have direct extinction, show red to blue polarisation colours, and exhibit pleochroism. The latter phenomenon yields an excellent method of differentiating between the three opium alkaloids considered here. Limit of sensitiveness, about 10 μ g. In addition to the crystals described above, deep red drops are also formed which, after some hours, pass into deep red aggregates; this points to the presence of a second alkaloid (? cryptopine) or papaverine. Codeine behaves very differently. A powdery precipitate is first obtained, which when warmed deposits larger and smaller particles, from which very slender, generally curved, pale brown crystals grow. The limit of sensitiveness is about 40 μ g. Excess of the reagent is to be avoided. Sparteine is preferably converted into the sulphate, and this gives with the reagent fine, yellowish-red crystal threads, which form sheaves and brushes at their ends. When warmed, coarser prismatic crystals appear after about thirty minutes, and in addition, when further heated, yellow aggregates are occasionally obtained. All the crystals shine strongly in polarised light, have extinction parallel to the long axis, and show very marked pleochroism. When warmed with zinc chloride-iodine, strychnine gives brownish-red or blackish-red spheres or aggregates which attain a diameter of 50 μ , and lie separately or are grouped in chains. They glow red between crossed Nicols, but do not exhibit pleochroism. Limit of sensitiveness, 15 μ g. Unless specific mention to the contrary is made, the above data refer to the crystals which are produced after one to two hours' action.

Atropine and related mydriatic alkaloids; Detection of —. R. Eder. Schweiz. Apoth. Zeit., 54, 501—504, 517—520, 534—537, 544—548, 560—563, 609—612, 621—624, 657—661, 669—670, 685—687, 717—719. J. Chem. Soc., 1917, 112, ii., 346—347.

THE methods employed in the detection of atropine and related mydriatic alkaloids are critically reviewed, and two new reagents for the detection and differentiation of the more important of these bases are described. Bromine water and bromine-potassium bromide are recommended as reagents for the microchemical detection of the *Solanaceae* bases. A drop of the solution of the alkaloid in N/2-sulphuric acid is brought on to an object-glass, and a drop of the reagent is added; after a short time, with small magnification, a fine turbidity appears, followed more or less rapidly by the formation of minute crystals, which present the appearance of fine, pale yellow needles. The crystals rapidly increase and sink to the bottom of the liquid, which gradually becomes clear. In the inner portions, individual needles frequently grow to stout, yellow rods; at the edge of the drop, on the other hand, the needles speedily begin to disappear, whilst the solution becomes colourless. The crystals also disappear more or less rapidly from the inner portions, and the solution becomes colourless as the bromine evaporates. The shape of the crystals is best studied with a 180—250 times magnification, and the solution should be protected with a cover-glass, thus rendering the crystals more stable. The reaction of atropine towards bromine water has the advantage over other atropine reactions that it can be repeated as often as desired with one and the same specimen. When the solution has become clear and colourless, the characteristic precipitate can be again obtained by renewed application of bromine water. The reaction is distinctly obtained at dilution of 1 in 3000. The macrochemical behaviour of atropine in N/2-sulphuric acid solution towards bromine-potassium bromide (Br 1 gm., KBr 2 gms., water 20 gms.) is similar to its action on bromine water, but the reaction is considerably more sensitive.

Hyoscyamine reacts with bromine water in much the same manner as atropine. The yellow, cloudy precipitate rapidly becomes crystalline, and disappears as the bromine evaporates. The highly magnified crystals, however, have a very variable character. For this reason, bromine water is a less suitable reagent for the detection of the alkaloid than bromine-potassium bromide. The limit of sensitiveness of the latter is reached at a dilution of about 1 in 5000. By means of the reaction, atropine can be detected in the presence of hyoscyamine in a mixture of the alkaloids.

The macrochemical behaviour of homatropine and scopolamine towards bromine water and bromine-potassium bromide exactly resembles that of atropine. The yellow precipitate obtained from scopolamine with bromine water appears under the microscope to consist exclusively of amorphous drops, crystallisation only occurring infrequently and at isolated points. Similar results are observed with bromine-potassium bromide. The precipitate of homatropine with bromine water is at first amorphous, but rapidly becomes crystalline, whilst that with bromine-potassium bromide closely resembles the precipitate with atropine.

With the exception of caffeine, the remaining alkaloids, which yield yellow or otherwise coloured precipitates with bromine water or bromine-potassium bromide, give only amorphous deposits. The crystalline compound from caffeine may be useful in the detection of the latter. Iodine-potassium iodide gives reddish-brown, crystalline precipitates with atropine, hyoscyamine, and homatropine, which are less characteristic than the

bromine-potassium bromide compounds. With scopolamine, as with most other alkaloids, the precipitates are amorphous.

There is no single reaction on which dependence can be placed for the detection of atropine and related alkaloids. Of the many reactions which have been previously proposed, only a few are suited to the practical detection of the bases. The following are to be recommended: physiological examination, Vitali's reaction, behaviour towards concentrated sulphuric acid in the cold (no coloration) and in the warm (odour after addition of water). Of colour reactions, with the exception of the negative tests with Froehde's and Erdmann's reagents, only Wasicky's reaction with dimethylaminobenzaldehyde and, possibly, Arnold's reaction need to be considered. Among microchemical methods and reactions, micro-sublimation, the iodine-atropine salt, and, particularly, the reactions with bromine water and bromine-potassium bromide, give good results. In the presence of other alkaloids which give amorphous precipitates with the bromine reagents a separation is necessary which can frequently be effected by micro-sublimation.

Solanine. A. Heiduschka and H. Sieger. Arch. Pharm., 1917, 258, 18—44. J. Chem. Soc., 1917, 112, i., 407—408.

ON account of the tendency of solanine to decomposition and to sublimation, the m. pt. of the substance is rather indefinite; a more valuable characteristic is the optical activity in 2% hydrochloric acid, $[\alpha]_D^{20} = -42.16^\circ$. The composition of the pure substance isolated from potato shoots agreed best with a formula $C_{22}H_{39}O_{16}N$. The hydrochloride ($C_{22}H_{39}O_{16}N, HCl$) was obtained in a crystalline condition, m. pt. $212^\circ C$. (decomp.), after sintering at $177^\circ C$. Hydrolysis of solanine is best effected with 2% hydrochloric acid solution; the resulting solanidine, m. pt. $207^\circ C$., judged by its composition and molecular weight in phenol, possesses the formula $C_{24}H_{45}O_4N$. Each molecule of solanine gives one molecule each of solanidine, dextrose, galactose, and rhamnose. Dehydration of solanidine by concentrated hydrochloric acid or other agents yielded not only solanine, $C_{24}H_{45}ON$, but also a base intermediate between this and solanidine, probably derived from solanidine by the elimination of semi-molecular proportion of water. Solanine forms an additive compound with phytosterol, and, when heated, evolves vapours which reddens a pine shaving. An examination of solanine from the *Palo Natri* of Chile showed this substance to be identical with the product from potatoes.

Medicinal substances; Preliminary work at the Soukhom Experiment Station, Caucasus, on the extraction of — from local plants (eucalyptus, wild mint, camphor, castor oil, etc.). M. N. Kozlov. Agric. of the Coast of the Black Sea, Soukhom (Russian), 1916, 13, 20—39. Bull. Agric. Intell., 1916, 7, 1621—1622.

NUMEROUS observations made by the Acclimatisation Section of the Soukhom Station have shown that it is quite practicable to cultivate species of eucalyptus, rich in essential oils, on the Batumi coast. The first attempt to extract these oils was successfully made in 1899—1900, but the work was not continued. The quantity of essential oils in the eucalyptus is greatest in the spring and early summer. Beklemichev extracted from *E. globulus*, for example, 0.8% in September, 0.7% in December, and 0.9% in March. In September the author extracted 0.6% from *E. viminalis*, 1.8% from *E. pulverulenta*, and 1.1% from the fresh leaves of *E. globulus*. The drying of the leaves reduces the cost of distillation without loss of oil. *E. globulus*,

E. maideni, and *E. pulverulenta*, all of which grow well on the Batumi Coast, yield very similar oils containing over 40% of eucalyptol. *E. maideni* yields a greater total leafage, of higher oil-content, than *E. globulus*. It is estimated that, assuming capital for laying out plantations at £19 per acre, and annual expenditure about £8 per acre, a return of £19—£22 per acre may be expected, representing interest at the rate of 13—30% on a capital of £2600—£3000 laid out on 25—30 acres of land and on the building of a factory. Investigations on the wild mint (*Mentha pulegium*) and castor oil plants, gave satisfactory results; 0.4% of essential oil was obtained from fresh mint and 1.09% from the air-dried material, whilst the proportion of oil in castor oil seeds reached 49.5%. From the fresh leaves of a tree of *Cinnamomum camphora* Nees, about 20 years old, 0.9% of raw camphor was obtained, consisting of 22.6% of oil of camphor and the rest camphor. With large branches 1.5—2 inches in diameter, negative results were obtained.—J. H. L.

Ninhydrin reaction with glycerol, etc.; The alleged —. V. J. Harding. J. Biol. Chem., 1917, 30, 205—208.

THE colouring matter produced in the ninhydrin reaction with amino-acids has been shown by Ruhemann (Chem. Soc. Trans., 1911, 99, 1486) to be the ammonium salt of diketohydrindylidene-diketohydrindamine. The same reaction is given with ammonium salts, provided the concentration is sufficient; the reaction with amines depends on the concentration of the amine and its constitution; with amides the results are negative. Halle, Loewenstein, and Pribram (Biochem. Zeits., 1913, 55, 357) have stated that glycerol gives a ninhydrin reaction, and the same statement has been made concerning other aldehydes, ketones, and alcohols, in all cases, however, only at high concentrations. The author has found that the reaction with glycerol varies with the purity of the sample and that it probably depends on the presence of a nitrogenous impurity in the glycerol, most likely an ammonium salt, which, owing to its small proportion, only reacts at a high temperature when the reaction is assisted by the reducing action of the glycerol. On the other hand, the reaction with amino-acids takes place in presence of small quantities of these substances at a moderate temperature and is not influenced by the action of alkalis and the presence of oxygen.—J. F. B.

Ammonium thiocyanate with formaldehyde; Condensation product of —. Schmerda. Z. angew. Chem., 1917, 30, 176.

AMMONIUM thiocyanate combines with formaldehyde in concentrated aqueous solution in equimolecular proportions without production of carbon dioxide. The condensation product can combine with further quantities of formaldehyde forming products which readily part with formaldehyde. The products were amorphous yellow compounds without definite melting-point, and were practically insoluble except in strong acids and strong alkalis, which decomposed them into their components. It is believed that the products may find some use for pharmaceutical purposes, for if placed on wounds they induce the growth of a protective skin.—J. B. C. K.

Odour and constitution; The relation between —. H. J. Prins. Perf. and Essent. Oil Rec., 1917, 8, 222—223.

MAJEWSKI's theory (Ber., 33, 3401) that the

odour of substances is due to the presence of "osmophoric" groups was modified by Marchand (Deuts. Parf. Z., 1915, 232, 243, 287), who concluded that the non-osmophoric part of the molecule determined the class of the odour, while its shade or tinge depended on the osmophoric groups. It is more correct to regard all groups as osmophoric, but different in strength. Thus the odour of benzene derivatives is similar because the substituting groups cannot entirely overcome the osmophoric influence of the benzene molecule. On the other hand, the different odours of octyl alcohol, octyl aldehyde, and octylic acid demonstrate the weak osmophoric influence of the aliphatic hydrocarbons. Chemically homologous substances have similar odours, e.g., octyl, nonyl, and decyl aldehydes, and octyl, nonyl, and decyl alcohols. If an alteration in the hydrocarbon part of an aromatic substance has a great influence on the chemical character of the strongest osmophoric group, there will be a considerable change in the odour (cf. the difference in odour between lauraldehyde and methyl-nonylacetic aldehyde). Double bonds in the neighbourhood of an alcoholic, aldehydic, or carboxylic group have a strong influence on odour (cf. decyl aldehyde with undecylene aldehyde, nonyl aldehyde with 2,3-nonylene aldehyde, citronellal with citral, α -ionone with β -ionone). Of two changes in the constitution of a compound, the odour will be most affected by that change having the strongest influence on the most powerful osmophoric group. The influence of formic acid preponderates over that of alcohols in the formic esters, the preponderance being least in the formates of strongly osmophoric alcohols such as borneol and menthol.—F. Sp.

Protective colloids. VIII. Tubera salep as protective colloid. Colloidal silver, arsenic, and antimony. A. Guthier and N. Kräutle. Kolloid Zeits., 1917, 20, 83—101, 123—127, 186—198. J. Chem. Soc., 1917, 112, ii., 244, 298—299.

THE preparation of colloidal solutions of silver by the action of sodium hydrosulphite in presence of extract of *Tubera salep* as protective colloid is described. The silver sols thus obtained are of great stability, and this stability does not seem to be affected by the fact that the colour of the solutions in transmitted light varies with the conditions.

The protective action of extracts of various plant colloids on colloidal arsenic, prepared by the reducing action of sodium hydrosulphite on lightly acidified solutions of arsenious oxide, is very marked, and it has been found possible to obtain by evaporation solid colloids containing about 3% of arsenic which are completely soluble in water. The protected solutions of colloidal arsenic are not appreciably influenced by the addition of hydrochloric acid, sulphuric acid, sodium chloride, and barium chloride, whereas sodium hydroxide and sodium carbonate change the colour from dark brown to light yellow.

Colloidal solutions of antimony, prepared by the action of sodium hydrosulphite on a solution of potassium antimoniate acidified slightly by the addition of tartaric acid, are found to have their stability considerably increased in presence of the extract of *Tubera salep*. The dialysed solutions may be evaporated to give solid colloids containing about 10% of antimony which dissolve completely in water. The stability of the protected solutions is not affected by the addition of acids and neutral salts, but alkalinity reduces the stability to a large extent. In this respect, the behaviour of the colloidal antimony solutions resembles that of solutions of the protective colloid.

Stabilization of bromides. Rupp and Hollatz. See VII.

PATENTS.

Chlorinated hydrocarbons; Production of —. B. T. Brooks and D. F. Smith, Assignors to Gulf Refining Co., Pittsburgh, Pa. U.S. Pat. 1,231,123, June 26, 1917. Date of appl., Dec. 10, 1915.

ETHYLENE and propylene are separated in approximate purity from oil gas by liquefaction and fractionation, and are chlorinated by passing them with chlorine into a liquid which dissolves both the chlorine and the hydrocarbons. The liquid employed contains dichlorinated ethylene hydrocarbons resulting from the reaction, the product of which is chiefly ethylene and propylene dichlorides.—F. Sp.

Arsenophosphorus compounds and process of making same; Organic —. A. Mouneyrat, Paris. U.S. Pat. 1,232,373, July 3, 1917. Date of appl., Feb. 16, 1915.

ARSENOPHOSPHORUS compounds are produced by treating aminophenylarsinic acid with phosphorus oxychloride. They form yellow powders soluble in dilute sodium carbonate solutions.—F. Sp.

Cinchona alkaloids and 2-phenylquinoline-4-carboxylic acid; Compounds of —. A. B. Davis, Indianapolis, Ind. Eng. Pat. 106,430, Nov. 27, 1916. (Appl. No. 16,995 of 1916).

A COMPOUND having antipyretic and antiphlogistic properties, and acting as a uric acid eliminant, is produced by adding a solution of a salt of quinine or other cinchona alkaloid to a solution of an alkali salt of 2-phenylquinoline-4-carboxylic acid.—F. Sp.

Apparatus for the production and aseptic storing of sterilised liquids. Eng. Pat. 100,744. See XI XB.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

PATENT.

Cinematograph films and the like; Process for the quick drying of —. E. Planchat, Turin, Italy. U.S. Pat. 1,232,077, July 3, 1917. Date of appl., Nov. 18, 1915.

CINEMATOGRAPH film is dried by passing it downward through a column of mercury or of liquid amalgam of a height sufficient to squeeze out the greater part of the water. The film passes upward through a second column separated by a partition from the first, to avoid contact between the film and the expressed moisture.—B. V. S.

XXII.—EXPLOSIVES; MATCHES.

PATENTS.

Explosive composition and method of producing same. H. Hibbert, Pittsburgh, Pa. U.S. Pat. 1,231,351, June 26, 1917. Date of appl., Apr. 17, 1916.

AN explosive composition is produced by dissolving a carbohydrate in a mixture of 1,2-glycols containing ethylene-, propylene-, and butylene-glycols

and polyglycols, nitrating the resulting solution to produce a mixture of nitro-carbohydrate, nitrated 1,2-glycols, and nitrated polyglycols.

—F. Sp.

Picric acid: Recovering — from wash water.
H. A. Gardner, Washington, D.C. U.S. Pat.
1,231,009, June 26, 1917. Date of appl. Dec.
16, 1915.

PICRIC acid is recovered from wash water by adding sodium bisulphate in sufficient quantity to form a solution of high specific gravity in which picric acid is practically insoluble. It separates in flocculent form on the surface and is removed, and the wash water is decolorised by adding bleaching powder.—F. Sp.

XXIII.—ANALYSIS.

Gas density: Effusion method of determining —.
J. D. Edwards, U.S. Bureau of Standards.
Gas J., 1917, 139, 108.

A PRELIMINARY report on a study of the Bunsen effusion method of determining gas densities is given. Platinum-iridium alloy (85:15) is recommended as material for the plate containing the orifice. The results obtained depend on the initial pressure of the gas. Mercury is preferable to water as confining medium. With the former, the orifice may be fouled by the condensation of water on expansion. Either displacement or expansion forms of apparatus may be used. The latter require a smaller quantity of containing medium, an advantage when mercury is used. With careful standardisation and correcting factors the effusion method applied to gases of a similar general nature gives results correct to within 2%, but with a given size of orifice there is no effusion pressure at which correct results are obtainable with different gases, and the necessary corrections are too complicated to admit of use in the form of tables.—H. J. H.

Gases: Specific gravity balance for —. J. D. Edwards, U.S. Bureau of Standards, Technol. Paper No. 89, Feb. 23, 1917. 19 pages.

THE effusion method of determining the density of natural gas has proved unreliable in practice (see preceding abstract), and other methods have therefore been investigated. If the pressures on two gases are regulated so that both gases exert the same buoyant force on the same body, then the two pressures will be inversely proportional to the densities at normal pressures. An apparatus has been devised for comparing the pressures of gases under these conditions. It consists of a balance beam carrying a sealed hollow globe at one end, counterpoised by a weight on the other. The balance beam is pivoted on a support mounted inside a gas-tight chamber to which a mercury manometer is attached. In practice the case is first filled with dry air and the beam brought to its zero position by adjusting the pressure of the air. The air is then replaced by the gas, the density of which is to be measured, and the pressure adjusted until the beam is again brought to zero. Descriptions are given of the construction of several instruments, differing in sensitiveness and portability. The accuracy of the method is such that the results agree with those obtained by the weighing method to 0.2% except with gases which show considerable deviation from Boyle's law. By making allowance for their deviations, an agreement to 0.2% can be obtained in these cases

also. Advantage is claimed for the speed of operation and also because no preliminary calibration of the instrument is necessary.—H. J. H.

Methyl red as an indicator. F. Lehmann and G. Wolff. Arch. Pharm., 1917, 255, 113—119. J. Chem. Soc., 1917, 112, ii, 326—327.

METHYL red (*p* - dimethylaminoazobenzene-*o*-carboxylic acid) is more sensitive to hydroxyl ions than is methyl orange, and has about the same general value for the titration of bases of all strengths that phenolphthalein has for acids. It is also more sensitive than methyl orange towards hydrogen ions, and might therefore be of more extended use in acidimetry. Oxalic and picric acids can be titrated readily with it, and also alkali borates and cyanides. Sulphites do not give sharp end-points, and sulphides and carbonates give intermediate orange tones which should be ignored, the titration being continued until the final change to bright pink occurs. The change from red (acid) to yellow (alkaline) is as sharp as the change from yellow to red, and solutions standardised with the aid of phenolphthalein are found to be practically of the same normality when tested with methyl red. The best results are obtained with two or three drops of a 0.1% solution in about 100 c.c. of liquid.

Carbon dioxide and carbonates in solution: Determination of —. D. D. van Slyke. J. Biol. Chem., 1917, 30, 347—368.

A SIMPLE one-piece apparatus is described for the determination of carbon dioxide or carbonates in aqueous solutions. It was devised primarily for the analysis of 1 c.c. samples of blood plasma but is applicable to aqueous solutions generally and to the determination of dissolved gases other than carbon dioxide. The apparatus consists essentially of a 50 c.c. pipette with 3-way cocks at top and bottom and a scale on the upper stem graduated in 0.02 c.c. divisions. The bottom of the apparatus is connected with a mercury levelling bottle and the lower cock with a bulb into which the solution is drawn after the extraction of the carbon dioxide and with a passage for the release of the vacuum by admission of mercury. The upper 3-way cock communicates with a graduated funnel and a capillary tube. The pipette is filled with mercury, and the solution is introduced and acidified in the pipette, the total quantity of water being preferably 2.5 c.c. A Torricellian vacuum is produced by lowering the reservoir; the carbon dioxide is extracted from the water by shaking for half a minute in the evacuated chamber and the water is drawn out of the 50 c.c. chamber into the lower bulb. Mercury is then admitted through the by-pass and the volume of the gas is read in the finely graduated upper stem. The observed volume is corrected by the subtraction of the amount of air dissolved in the water (0.04—0.05 c.c. according to temperature) and the addition of the 4—5% of the total carbon dioxide which remains dissolved in the water; these corrections may be determined directly or calculated with a high degree of accuracy from known data. The operation is performed at the ordinary temperature in about 3 minutes and the results are accurate within 1% of the amount determined.—J. F. B.

Zinc: Volumetric methods for the determination of —. J. W. Springer. Z. angew. Chem., 1917, 30, 173—174.

THE author discusses the various volumetric methods for the determination of zinc that have been proposed and tried experimentally, and points out the effects produced by the presence of manganese and iron in most zinc ores upon

the accuracy of these methods. The method which has been found most useful in the author's laboratory is a modification of that proposed by L. Blum (*Z. anal. Chem.*, 1892, 60). The following is a description of the modified method:—2 to 5 grms. of the ore is heated in a covered beaker with 20–25 c.c. of concentrated hydrochloric acid until the hydrogen sulphide is driven off; 10–25 c.c. of nitric acid is now added and the heating is continued until complete solution is effected. The contents of the beaker are evaporated to dryness, and the evaporation is repeated after moistening the residue with hydrochloric acid. After expelling the last traces of nitric acid the residue is taken up with 20–50 c.c. of hydrochloric acid, and is diluted to 200 or 400 c.c. and boiled. Hydrogen sulphide is now passed through the hot solution until it cools, the mixture is made up to 250 or 500 c.c., well shaken, and filtered. 50 c.c. of the filtrate is treated with bromine water and heated until the solution has become clear, after which the iron and manganese are precipitated by adding 25 c.c. of ammonia solution and the liquid is again boiled. The zinc is now titrated with potassium ferrocyanide in this hot solution. It is important to keep the volume of the solution approximately the same as that used for the check-test, which is carried out with 0.25 grm. of chemically pure zinc, 4 to 5 c.c. of hydrochloric acid, and 20 c.c. of ammonia solution.—J. B. C. K.

Manganese; Use of the platinised glass anode in electrolytic determination of—. F. A. Gooch and M. Kobayashi. *Amer. J. Sci.*, 1917, 44, 53–56.

ATTEMPTS to deposit hydrated manganese dioxide electrolytically from manganous sulphate solution, using rotating platinum electrodes, as described in a previous paper (this J., 1917, 671), were unsuccessful owing to the superoxidation to permanganic acid. The use of deoxidising agents to neutralise this led to unsatisfactory results. Successful results were obtained, however, by using a modified form of the rotating electrode of platinised glass described by Gooch and Burdick (*Amer. J. Sci.*, 1912, 34, 107). The anode used was made by heating, to a temperature sufficient to volatilise glycerin, a tube of lead glass shaped like a test tube, painting upon it a viscous emulsion of dry chloroplatinic acid in glycerin, and burning the film of deposited platinum into the glass by the softening point of the latter. The manganese was completely deposited from electrodes containing about 0.1 grm. Mn (as sulphate) in 100 c.c., in presence of acetic acid; the time required was 2½ hrs. when chrome alum was added to the electrolyte and 3½ to 4 hrs. with alcohol and ammonium sulphate.—T. H. B.

Ammonium molybdate; Recovery of— from the filtrates obtained in the estimation of phosphoric acid. H. Kinder. *Stahl u. Eisen*, 1916, 36, 1094. *J. Chem. Soc.*, 1917, 112, ii., 321.

THE following method is stated to be more simple than that described by Friedrich (this J., 1916, 5). The molybdic acid is precipitated by adding lithium phosphate to the solution, and the yellow precipitate is washed by decantation with 0.1% lithium sulphate solution until free from soluble phosphate and iron salts. The precipitate is then dried; each 325 grms. of it is dissolved in 1100 c.c. of ammonia (sp. gr. 0.96), the solution is treated with a mixture of 30 grms. of magnesium chloride and 130 grms. of ammonium chloride dissolved in water to make 100 c.c.; the precipitate is separated by filtration, and each 420 c.c. of filtrate is mixed with 1200 c.c. of nitric acid (sp. gr. 1.2).

The blue molybdic acid residues obtained in the gravimetric estimation of phosphoric acid may be treated in a similar way (dissolved in ammonia, acidified with nitric acid, precipitated with sodium phosphate, etc.).

Spectroscopic identification of phenols. Formanek and Knop. See III.

Detection of ammoniacal cochineal. Mattelet. See IV.

Physical testing of paper as affected by humidity. Campbell. See V.

Determination of wood gum in incompletely purified cotton. Freiburger. See V.

Chemical examination of natural brines. Sweeney and Withrow. See VII.

Valuation of bromides. Rupp and Hollatz. See VII.

Microchemical reactions of the perchloric ion. Denigès. See VII.

Chemical evaluation of alkali chromates and bichromates. Sacher. See VII.

Arsenic trisulphide. Schmidt. See VII.

Phosphor-tin and a volumetric method for its analysis. Lee and others. See X.

Separating zinc from cadmium and determination of the latter iodometrically. Ericson. See X.

Phosphoric acid determinations in phosphate rock. Semple. See XVI.

Influence of amino-acids and of L-glutimic acid in the estimation of raffinose and sucrose in molasses by the inversion method. Staněk. See XVII.

Modification of Fehling's method of sugar estimation. Lenk. See XVII.

Influence of raffinose contained in beet molasses on the determination of sucrose by double acid polarisation or by inversion with invertase. Pellet. See XVII.

Direct method for the estimation of starch. Von Fellenberg. See XVII.

Determination of hydrogen sulphide in water at the source. Incze. See XIXB.

Determination of carbon dioxide in water. Tillmans and Heublein. See XIXB.

Improved chemical methods for differentiating bacteria of the coli-aerogenes family. Clark and Lubs. See XIXB.

Extractum Cinchonæ Liquidum. Chick. See XX.

Microchemical precipitation of atkatooids with zinc chloride-iodine solution. Tunmann. See XX.

Detection of atropine and related mydriatic alkaloids. Eder. See XX.

Alleged ninhydrin reaction with glycerol, etc. Harding. See XX.

PATENTS.

Radiation-pyrometer. C. B. Thwing, Assignor to Thwing Instrument Co., Philadelphia. U.S. Pat. 1,232,408, July 3, 1917. Date of appl., May 4, 1914.

A HOLLOW refractory cylinder is mounted in the wall of a furnace so that its closed end projects within the furnace. A thermocouple is mounted in a casing at the opposite end of the cylinder so that its hot junction does not project beyond the furnace wall, and is acted on by heat radiated from the heated end of the cylinder. The cold junction of the thermocouple is contained within a cap closing the outer end of the refractory cylinder.
—W. F. F.

Flash-point tester. F. Von Bichowsky, Berkeley, Cal. U.S. Pat. 1,232,413, July 3, 1917. Date of appl., July 25, 1914.

OIL or other inflammable liquid is heated in a container and automatically stirred. Sparks are periodically passed above the surface of the heating oil and means are provided for registering the temperature at which the vapour ignites. The container is provided with vents having closing members which are normally held open by a string against the action of a closing weight. When the vapour ignites, the string is burnt and the weight allowed to fall, thus closing the vents and extinguishing the flame.—W. F. F.

Methane detector. C. M. Means, Assignor to W. A. McCutcheon, Pittsburgh. U.S. Pat. 1,231,045, June 26, 1917. Date of appl., Jan. 27, 1916.

GAS to be tested is passed through a casing containing two wires connected in series to a source of electric current, one wire being catalytically active and the other inactive. The amount of methane is estimated by a comparison of the relative luminosities of the two wires. The catalytic wire has a positive resistance coefficient, the presence of methane thus reducing the current flowing in the second wire, the temperature of which is not affected by the gas. Means may be provided for short-circuiting the second wire so as to cause increased current to flow in the catalytic wire to restore its catalytic properties in the event of deterioration.—W. F. F.

Books Received.

THE TRAINING AND WORK OF THE CHEMICAL ENGINEER. Reprinted from the Transactions of the Faraday Society, Vol. XIII., September, 1917. 60 pages. Price 3s. 6d. (see this J., 1917, 276).

HOW TO BECOME A DISPENSER. A NEW PROFESSION FOR WOMEN. By Miss EMILY L. B. FORSTER. T. Fisher Unwin, Ltd., Adelphi Terrace, London, W.C. 99 pages, 7½×4½ in. Price 2s. 6d.

ROYAL ONTARIO NICKEL COMMISSION. REPORT AND APPENDIX. 1917. A. T. Wilgress, Toronto. XLVIII. +765 pages. 9½×6½ in.

THE introductory portion of this volume contains the text of the Commission of September 9th, 1915, and of the Supplementary Commission of March 19th, 1917, and also the summary and conclusions, of which an abstract has already appeared (this Journal, 1917, 490).

The Report is divided into chapters as follows:— I. Agitation for home refining of nickel. II. Historical sketch of nickel discoveries. III. The operating nickel companies. IV. Nickel deposits of the world. V. Properties and uses of nickel and its compounds. VI. Non-ferrous nickel alloys. VII. Nickel steel and other nickel alloys containing iron. VIII. Smelting nickel ores. IX. Refining processes. X. Recovery of metals of the platinum group. XI. Recovery and utilisation of sulphur. XII. Statistics. XIII. Taxation of mines and mining industries. XIV. Bibliography of nickel. The Appendix contains the Minutes of Evidence, memoranda, and papers presented to the Commission. The volume is fully illustrated and forms a most valuable addition to the literature of the subject.

INDUSTRIAL AND MANUFACTURING CHEMISTRY. PART II. INORGANIC. Vol. II. By G. MARTIN. Crosby Lockwood and Son, 7, Stationers' Hall Court, London, E.C. 482 pages, 9½×6½ in. Price 25s.

THE sections into which this volume is divided, and their authors' names, are as follows:—LII. Disinfectants and antiseptics (G. Martin). LIII. Insecticides, fungicides, and sheep-dips (G. Martin). LIV. Artificial manures (A. S. Carlos). LV. The industry of aluminium compounds (G. Martin). LVI. The artificial zeolite or permutite industry (G. Martin). LVII. The artificial gem industry (G. Martin). LVIII. Aluminium-thermics. "Thermit" and its applications (H. S. Redgrove). LIX. The calcareous cements industry (E. A. Dancaster). LX. Sorrel cement (J. Shelton). LXI. Artificial stone (J. Shelton). LXII. Sodium silicate, water-glass, soluble glass (J. Shelton). LXIII. Lutes and miscellaneous cements (G. Martin). LXIV. Clays and allied materials (A. B. Searle). LXV. Pottery (A. B. Searle). LXVI. Earthenware (A. B. Searle). LXVII. Porcelain (A. B. Searle). LXVIII. Stoneware and sanitary ware (A. B. Searle). LXIX. Bricks (A. B. Searle). LXX. Fine-sand bricks (J. Shelton). LXXI. Tiles (A. B. Searle). LXXII. Furnace linings and other refractory materials (A. B. Searle). LXXIII. Glass (A. B. Searle). LXXIV. Enamels (A. B. Searle). LXXV. The asbestos industry (F. W. Penny). LXXVI. The mica industry (F. W. Penny). LXXVII. The thorium and cerium industry (S. J. Johnstone). LXXVIII. Titanium (S. J. Johnstone). LXXIX. Zirconium (S. J. Johnstone). LXXX. Tantalum and niobium (S. J. Johnstone). LXXXI. Tungsten (S. J. Johnstone). LXXXII. The incandescent electric glow lamp industry (S. J. Johnstone). LXXXIII. Uranium (S. J. Johnstone). LXXXIV. Vanadium (S. J. Johnstone). LXXXV. The industry of radioactive substances (A. S. Russell). LXXXVI. Electric furnace products industry (H. D. K. Drew). LXXXVII. Grinding and polishing materials (A. B. Searle). LXXXVIII. Phosphorus (C. A. Mitchell). LXXXIX. Matches (C. A. Mitchell). The volume is arranged on the same principle as the first part of the work, each subject being treated very briefly, and references to literature provided.

METAL-MINE ACCIDENTS IN THE UNITED STATES DURING 1915. Compiled by A. H. FAY. U.S. Bureau of Mines. Tech. Paper 168. Government Printing Office, Washington. 114 pages, 9×6 in. Price 15 cents.

COAL-MINE FATALITIES IN THE UNITED STATES, 1916. Compiled by A. H. FAY. U.S. Bureau of Mines. Government Printing Office, Washington. 42 pages, 9×6 in. Price 5 cents.

THIS pamphlet also contains a list of "Permissible explosives," lamps, and motors tested prior to January 31st, 1917.

Journal of the Society of Chemical Industry.

No. 17, Vol. XXXVI.

SEPTEMBER 15, 1917.

No. 17, Vol. XXXVI.

Official Notices.

SPECIAL NOTICE TO MEMBERS.

At a Special General Meeting of the Society held on *Wednesday, August 15th, 1917*, the resolution to increase the yearly subscription and the amounts payable for life composition, which was adopted at the Annual General Meeting at Birmingham on July 18th last, was unanimously confirmed.

It is therefore hereby intimated that on and after 1st January, 1918, the yearly subscription will be £1 10s., and the sums payable under By-law 11 for life composition will each be increased by £5.

J. P. LONGSTAFF.

Broadway Chambers, *General Secretary.*
Westminster, S.W. 1.

PROHIBITED EXPORTS.

ORDER-IN-COUNCIL, 28TH AUGUST, 1917.

The following headings are deleted* :—(B) Beeswax; (A) Saccharin; (A) Malt extract, and preparations containing malt extract; (A) Malt sugar; (A) Quercitron bark extract; (A) Tanning extracts and substances for use in tanning, including cutch; (C) Vanillin; (A) Wire, iron; (A) Wire, steel.

The following headings are added :—(A) Beeswax; (C) Dyes, vegetable, and dyestuffs and their extracts used in the preparation of vegetable dyes, and articles containing such dyes, dyestuffs and extracts, not otherwise prohibited; (A) Saccharin, and articles, mixtures, and preparations containing saccharin; (A) Cutch and extracts thereof; (A) Gall nuts and extracts thereof; (A) Gambier and extracts thereof; marjoram leaves; (A) Invert sugar, and articles, mixtures and preparations containing invert sugar; (A) Malt sugar (maltose), and articles and preparations containing malt sugar; (C) Pyrites cinders; (A) Quercitron bark and extracts thereof; (A) Tanning extracts and substances for use in tanning; (C) Thyme leaves; (B) Vanadium ore; (C) Vanillin, vanilla and vanilla pods; (A) Wire, iron, and articles wholly manufactured thereof; (A) Wire, steel, and articles wholly manufactured thereof.

TRINITROTOLUOL.

ORDER IN COUNCIL, AUGUST 22ND, 1917.

On Order in Council, dated Aug. 22nd, revokes the Order made on June 11th, 1910, whereby trinitrotoluol was exempted from certain of the provisions of the Explosives Act, 1875.

STEEL SCRAP, WROUGHT IRON SCRAP, AND TINPLATES AND TERNEPLATES.

The Minister of Munitions has issued an Order dated Aug. 28th, according to which steel scrap is classed as "War material"; maximum prices are fixed for dealings in such material. On the same date certain modifications of the general permit relating to dealings in wrought iron scrap came into effect.

* The prohibition of exports is as follows :—

Goods marked (A), to all destinations;
Goods marked (B), to all ports and destinations abroad other than ports and destinations in British Possessions and Protectorates;

Goods marked (C), to all destinations in foreign countries in Europe and on the Mediterranean and Black Seas, other than France and French Possessions, Russia, Italy and Italian Possessions, Spain and Portugal, and to all ports in any such foreign countries, and to all Russian Baltic ports.

A Ministry of Munitions Order, dated Aug. 24th, regulates dealings in tinplates and terneplates and fixes maximum prices for these.

The above Orders and notices are printed in full in the "Board of Trade Journal" for August 30th.

BLAST-FURNACE DUST.

An Order, dated 7th August, 1917, has been issued by the Ministry of Munitions to the effect that :—

1. No person shall buy, sell, deal in or dispose of any blast-furnace dust except under and in accordance with the terms of a licence issued on behalf of the Minister of Munitions by the Controller of Potash Production.

2. No person shall treat any such dust so as to extract any component part thereof except under and in accordance with the terms of a licence issued as aforesaid.

3. All persons producing or in possession of blast-furnace dust shall make returns in regard to rate of production, stocks, purchases, sales, dealings, or other matters relating to blast-furnace dust in such form and at such times as may be required by the said Controller.

4. Samples of any blast-furnace dust produced by or in the possession of any person shall be furnished to the said Controller by such person in such form and quantity and at such times as the said Controller may prescribe. Such samples shall be taken in such manner as the said Controller or his authorised representative may prescribe.

5. For the purpose of this Order blast-furnace dust shall mean dust deposited or otherwise derived from the gases of any furnace used for treating ores for the production of iron or any of its alloys.

6. All applications in reference to the above Order should be made to the Controller of Potash Production, Ministry of Munitions, 117, Piccadilly, W.1.

BASIC SLAG.

A Notice, dated 1st August, 1917, has been issued by the Food Production Department, relating to basic slag. It is stated that the slags which are now available for grinding have a low phosphatic content, and the supply of high-grade slag is therefore much less than was formerly the case. All the suitable slag available is being ground, and the total tonnage is fully equal to what it was before the War. As no export is now allowed, the quantity available for home consumption is much larger, though it is still below the demand. Arrangements are being made in certain cases to grind a low-grade slag, which has not hitherto been used as a manure. It can be economically used on land within a moderate distance of the works. The Food Production Department, in conjunction with the Ministry of Munitions, has come to an arrangement with makers in regard to the maximum prices to be charged by them, and the Notice in question enumerates these prices.

DEALINGS IN CHROME ORE.

The Minister of Munitions has made an Order, dated 31st August, ordering that as from that date, until further notice, no person shall purchase

or take delivery of chrome ore of any grade, except under and in accordance with the terms of a permit issued under the authority of the Minister of Munitions; and, further, that no person shall sell, supply or deliver chrome ore of any grade except to the holder and in accordance with the terms of such a permit to purchase or take delivery as aforesaid.

DEALINGS IN CRUDE BENZOL, CRUDE NAPHTHA, AND LIGHT OILS.

The Minister of Munitions has issued an Order, under date 29th August, ordering that as from 1st October, until further notice, no person shall supply to any person, or take or accept or attempt to obtain delivery of any crude benzol, crude naphtha or light oils containing recoverable quantities of benzol or toluol, except under and in accordance with the terms and conditions of a licence issued by or under the authority of the Minister of Munitions, or under and in accordance with the terms and conditions of a contract in writing for the delivery of such articles existing at the date of this Order.

All persons engaged in producing, treating, distributing, storing, selling or dealing in crude benzol, crude naphtha or light oils, or in any manufacture, trade or business in which the same or any of them are used, shall make all such returns with regard to their businesses as may from time to time be required by or under the Authority of the Minister of Munitions.

For all purposes of this Order the following expressions shall have the meanings stated below:

"Crude benzol" and "crude naphtha" shall mean crude benzol and crude naphtha obtained by distillation of coal tar or extracted from coal gas, including benzolised wash-oil before separation of the crude benzol.

"Light oils" shall mean light oils obtained by the distillation of coal tar.

NOTE.—All applications in reference to this Order, including applications for Licences, should be addressed to the Director of Raw Materials Supply, Ministry of Munitions, Department of Explosives Supply, Storey's Gate, Westminster, London, S.W.1.

DEALINGS IN COAL TAR.

The Minister of Munitions has issued an Order, under date 14th September, which is to the following effect:—

1. No person shall as and from 1st October, until further notice, purchase or offer to purchase any coal tar (whether crude or dehydrated) except under and in accordance with the terms and conditions of a licence issued by or under the authority of the Minister of Munitions. Provided that no licence shall be required—

(a) By a tar distiller for the purchase of coal tar in any quantities, provided that the whole quantity purchased is intended to be and is in fact distilled by such distiller.

(b) By any person for the purchase of coal tar (whether crude or dehydrated) in quantities not exceeding ten gallons, provided that the total quantity purchased by any one person during any one calendar month does not exceed 50 gallons.

2. No person shall as from 1st October, until further notice, except under and in accordance with the terms and conditions of a licence issued by or under the authority of the Minister of Munitions, accept delivery of or make payment for any coal tar tendered for delivery under any contract existing at the date of the Order unless (a) such contract is in writing, and (b) full written par-

ticulars of such contract have been furnished to the Minister of Munitions before 1st October by the person for the time being entitled to deliveries thereunder.

3. For the purpose of this Order the expression "coal tar" shall mean and include tar produced or derived from the destructive distillation of bituminous material by any means other than blast furnaces.

NOTE.—All applications in reference to this Order (including applications for licences) should be addressed to The Ministry of Munitions, Department of Explosives Supply, Storey's Gate, Westminster, London, S.W.1, and marked "E.G.S."

Communications.

THE CATALYTIC BLEACHING OF OILS, FATS, AND WAXES.

BY HASHMAT RAI.

The general methods used for bleaching oils, fats, and waxes are:—

1. Spontaneous clarification, the oils and fats being allowed to rest for some prolonged time, when moisture, mucilaginous matter, etc., settle out.

2. Filtering over char or fuller's earth, or through a suitable filter at a suitable temperature.

3. Washing with boiling water.

4. Exposure to air and sunlight.

5. Exposure to ultra-violet rays.

6. Blowing air, oxygen, or ozone through the material at a suitable temperature.

7. Treating with manganese dioxide or potassium bichromate, and sulphuric acid.

8. Treatment with chlorine, bleaching powder, or potassium bichromate and hydrochloric acid.

9. Treatment with reducing agents alone or in presence of certain catalytic agents.

10. Blowing air, oxygen, or ozone through the heated substance in presence of certain catalytic agents.*

The processes adopted on a manufacturing scale vary essentially with the nature of the individual oil or fat.

The object of this investigation was to ascertain how far it is possible to bleach oils, fats, and waxes by blowing air through them at a suitable temperature in presence of certain catalysts.

Catalysts.

The catalysts used consisted of air-bleached palm-oil, oleates of manganese, copper, cobalt, lead, iron, and nickel. Silkstone soap of Messrs. A. Finlay and Co., Ltd., Belfast, and the cobalt salt of Silkstone soap. The metallic soaps were prepared by treating the chloride or the nitrate of the metal concerned with a boiling solution of sodium oleate or Silkstone soap, filtering the metallic soap in a Buchner funnel, and ultimately drying in a desiccator for a few days.

Apparatus.

The apparatus consisted of a glass flask fitted with a cork through which two holes were bored. Through one of them passed a glass tube flush with the cork and connected to a filter pump. A wash-bottle was interposed between the pump

* English Patent 17,784 of 1913 (this J., 1914, 1018). S. G. Sastry, Journ. Chem. Soc., 1915, 1828 (this J., 1916, 126).

and the bleaching flask. Through the other hole passed another tube reaching to the bottom of the flask. The bleaching flask was placed in a water-bath, the temperature of which was maintained throughout the experiments at 80°–90° C. Air was drawn by means of the filter-pump through the oil, fat, or wax contained in the bleaching flask, with or without the catalysts. Samples were taken at regular intervals on glass plates and compared with the best bleached sample supplied by Messrs. Alexander Finlay and Co. Temperature readings were taken after every fifteen minutes.

Palm-oil.

Two sets of experiments were performed with palm-oil. Two varieties, commercially known as "Sherbro" palm-oil and "Semi-soft" palm-oil, were used. The commercial oil was melted in a corrugated bucket and a little powdered common salt was added to the molten material. The oil was allowed to cool and to stand for 24 hours so as to separate water and other impurities which settled at the bottom. On cooling, the top portion was ladled off to an enamelled bucket and preserved for all the experiments. One pound and a half of the treated oil was used for an individual experiment and the desired amount of the catalyst was added to the heated oil. Samples were taken out after every hour.

presence of metallic soaps the time of bleaching is considerably shortened, especially in the case of cobalt and manganese salts, the cobalt salts being by far the best catalysts. It is remarkable and highly significant that both the oleate and the "Silkstone" soap of cobalt behave in exactly the same way. Thus "Silkstone" soap, which is cheaper than pure sodium oleate, can be used with advantage instead of the latter. Another striking point noticeable in Table I. is that manganese oleate acts as the second best catalyst of all, but at the same time it must be observed that cobalt salts are far dearer than manganese salts. On the whole it would be economical to use manganese soap for the commercial bleaching of oils in general and for palm-oil in particular.

Tallow.

Some experiments were tried with two commercial varieties of tallow, both treated and untreated. It was first heated and allowed to stand for some time to remove the impurities which settled at the bottom. The amount of tallow taken for each experiment varied between 24 oz. and 26 oz. Samples were taken out every half an hour in the case of the untreated tallow, and after every fifteen minutes in the case of the treated variety.

Table III. gives the experimental results :—

TABLE III.

No. of expt.	Variety of tallow.	Range of temperature.	Catalyst.	Percentage of catalyst.	No. of hours air was passed in.	Colour after expt.
.....	Untreated	100° C.	None	0.00	3.5	White
.....	Untreated	100° C.	Cobalt oleate	0.10	3.5	No improvement
.....	Treated	85°–90° C.	None	0.00	2.25	White
.....	Treated	85°–90° C.	Cobalt oleate dissolved in stearine.	0.11	2.25	Better white

The results of the experiments are summarised in the following tables :—

TABLE I.

Weight of "Sherbro" palm-oil, 1½ lb. Mean temperature, 80° C.

No. of expt.	Catalyst.	% of catalyst.	No. of hours that air was passed in.	Colour after expt.
1.	None.	0.00	19.5	White.
2.	Bleached oil from expt. 1.	0.12	19.0	White.
3.	Manganese oleate.	0.10	5.0	White.
4.	Copper oleate	0.10	9.0	Greenish.
5.	Cobalt oleate.	0.03	4.0	White
6.	Lead oleate.	0.10	16.0	White.
7.	Iron oleate.	0.10	17.0	Dirty white.

TABLE II.

Weight of "Semi-soft" palm-oil, 1½ lb. Mean temperature, 80° C.

No. of expt.	Catalyst.	% of catalyst.	No. of hours that air was passed in.	Colour after expt.
1.	None.	0.00	20.0	White.
2.	Nickel oleate.	0.10	15.0	White.
3.	Cobalt soap (Silkstone).	0.09	5.0	White.
4.	Cobalt oleate.	0.03	5.0	White.
5.	"Silkstone" soap.	0.12	17.0	White.

It will be seen from the above results that in

It is evident from the above results that cobalt oleate by itself does not act as a catalyst, but when dissolved in stearine before adding to tallow it does behave as a catalyst. This may be partially explained by the fact that cobalt oleate does not by itself dissolve in tallow and consequently does not take part in the reaction. On the other hand, when cobalt oleate is dissolved in stearine, it is diffused throughout the entire mass of tallow in a fine state of division and is in quite a suitable form to act as a catalyst. It may be that stearine also acts as a partial catalytic agent.

Beeswax.

Air was passed through about 4 oz. of beeswax for fourteen hours at a temperature varying between 85° C. and 100° C., but there was no visible sign of bleaching. Subsequently 0.37 grm. of cobalt oleate, i.e., 0.33%, was added, and the experiment continued at 100° C. for 6.5 hours without any effective bleaching. Then 2 grms. of tallow was added and the experiment again continued at 100° C. for 8.5 hours, but with no effect. Thus during a run of 29 hours; even on the addition of cobalt oleate and tallow, no improvement was obtained.

Commercial-scale experiments.

The laboratory experiments with palm-oil being highly successful, a few experiments on a commercial scale were conducted.

Palm-oil was heated in an autoclave by means of steam, and air was blown through it from an air-compressor.

The results are given in the following table :—

TABLE IV.
Weight of palm-oil, 25 cwt.

No. of expt.	Catalyst.	% of catalyst.	No. of hours that air was passed in.	Colour after expt.
1.	None.	0.00	14	White.
2.	None.	0.00	12—14	White.
3.	Cobalt soap (Silkstone).	0.08	4	White.
4.	Cobalt soap (Silkstone).	0.02	6	Dirty white.
5.	Cobalt soap (Silkstone).	less than	8	White.
6.	Manganese soap (Silkstone).	0.10	4	White.

Experiments 3, 4, and 5 were performed one after the other. In experiment 4 the colour of the oil was dirty white because of the suspended impurities; probably iron scale in a very fine state of division came off the bleacher. In experiment 5 no fresh catalyst was added, but only the bottom residues from experiments 3 and 4 were put in.

From the above results it is evident that cobalt and manganese soaps act as catalysts, and that both act equally well. Further it is found that even the bottom residues retain their catalytic properties. In experiments 3 and 4 the amount of catalyst is different, being in experiment 4 only one-quarter of that used in experiment 3. The difference in the duration of bleaching, though not great, is still appreciable.

Palm-oil is largely used in the manufacture of soaps and is generally bleached with potassium bichromate, which gives a very fine bleach to the oil. Hence it was considered desirable to compare the qualities of soaps prepared from the oil bleached by the bichromate and the catalytic processes respectively.

Two frames of soap about 20 cwt. each were made, one with the air-bleached palm-oil and the second with oil bleached by the bichromate process under similar conditions. The colour of the soap from the air-bleached oil was lighter than that of the soap from the oil bleached by the bichromate process. As regards hardness, there was no marked difference between the two qualities. The bichrome-oil looked cleaner but was far deeper in colour.

Summary and conclusions.

This investigation on the whole elucidates the following points :—

1. Most metallic soaps act more or less as catalysts in the bleaching of palm-oil and tallow, but not in the case of beeswax.
2. Different metallic soaps possess different catalytic properties.
3. With the same substance the catalytic effect depends to some extent on the amount introduced.
4. As regards the soap-forming quality, palm-oil bleached by the catalytic process is in no way inferior to oil bleached by the bichromate process.
5. The catalyst after being once used still retains its catalytic properties.

This work was carried out in the works of Messrs. Alexander Finlay and Co., Belfast.

I am indebted to Prof. F. G. Donnan, who suggested this work, for his valuable suggestions, and to Mr. Robert Finlay for his material help and the keen interest which he took in the investigation.

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VULCANISATION CATALYSTS.

BY S. J. PEACHEY

(Municipal School of Technology, Mancheste.).

In a paper brought before the Annual Meeting of the Society by Dr. D. F. Twiss on the chemistry of vulcanisation (this Journal, 1917, 782), a comparison is made between the accelerating effect of *p*-nitrosodimethylaniline and that of certain alkalis, ammonium salts, and ammonia derivatives. Dr. Twiss prefaces the account of his experiments with the statement that "almost the whole of the known effective organic accelerators are basic, a rough proportionality apparently existing between their activity and their alkalinity, relatively feeble bases like aniline and methylaniline having little influence on the rate of vulcanisation," and his line of investigation appears to have been directed wholly from this standpoint. The erroneous impression that basicity is an invariable concomitant of accelerating power is thereby likely to gain ground, and as this may mislead other workers in the field, I think it is desirable to place on record one or two new facts which are opposed to the above view.

There can be little doubt that in the case of most of the known vulcanisation catalysts the accelerating power is in some manner bound up with the possession of basic or alkaline properties; further the results of numerous experiments which I have personally carried out point to the fact that the dissociation constant 1×10^{-8} referred to in Bayer's patent does actually form a dividing line between accelerating and non-accelerating bases and that all the useful accelerators of the basic type appear to be covered by their claim. Organic (and inorganic) bases, however, constitute merely a particular class of accelerator; there undoubtedly exists at least one other class represented at the present moment by certain organic compounds which contain the nitroso group directly linked to a benzene ring or similarly constituted nucleus. Of these *p*-nitrosodimethylaniline was the first to be discovered and is probably the most effective. The activity of accelerators of this type appears to be in no way connected with the possession of basic properties and such activity may be exhibited even by substances of distinctly acidic character. Even where accelerators belonging to this group are basic their basicity is naturally low and would probably in every case fall far below that represented by the dissociation constant 1×10^{-8} .

The following facts will suffice for the present to show that nitroso compounds owe their accelerating properties to the presence of the nitroso group directly connected with a carbon nucleus and not to any basic properties which they may happen to possess.

(1) Dimethylaniline (dissociation constant 2.4×10^{-10}) is destitute of any appreciable accelerating properties although it is a stronger base than *p*-nitrosodimethylaniline (dissociation constant 1.9×10^{-10}).

(2) *p*-Nitrosodimethylaniline possesses a dissociation constant lying far below 1×10^{-8} . Up to the present all the known powerful accelerators of the basic type possess a dissociation constant lying above this figure.

(3) *p*-Nitrosophenol and its homologues, although acidic in character, exhibit marked accelerating power.

(4) *p*-Aminophenol, in which the basic NH_2 group replaces the acidic NO group of the nitrosophenol, exhibits no appreciable activity.

(5) Whilst nitroso-bases are powerful accelerators the isomeric nitrosoamines (in which the nitroso group is not in direct combination with the nucleus) are inert.

Industrial Notes.

REPORT OF THE COMMITTEE OF THE PRIVY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, 1916-1917.

This Report has just been issued as a Government Paper (Cd. 8718, price 3d.). The Committee reports the progress made during the twelve months ending July 31st, 1917, and mentions the creation of the Imperial Trust for the Encouragement of Scientific and Industrial Research. The fund which the Government have placed at the disposal of the Committee will be deposited with the Trust and spent in the form of grants in aid of research undertaken by firms in any industry which may combine to conduct it on a co-operative basis. The Committee has approved the establishment, under the Companies' Act, of Associations for Research limited by guarantee and trading without profit.

During the year in question negotiations have been concluded with the Royal Society for the transfer of the property of the National Physical Laboratory, together with the responsibility for its maintenance and development, to the Department. The scientific management of the Laboratory will remain in the hands of the Executive Committee, which will be appointed as heretofore, but which, on its appointment, will become a Committee of the Department.

Mention is made of the appointment of the Fuel Research Board (see this J., 1917, 203), and the appointment by this Board of an Irish Committee of Inquiry into peat as a source of power (this J., 1917, 741).

The Committee has considered and approved recommendations in respect of aid to forty-four researches of industrial importance, and has expended some £3550 on grants to individual students and research workers.

Report of the Advisory Council.

This Report is divided into two parts, the first describing the steps taken to organise a systematic approach to the problem of industrial research, on a co-operative basis wherever possible; reference is also made to the appointment of new Standing Committees and to the development of Research organisations in the Dominions. In the second part an account is given of sporadic investigations aided or initiated by the Department and of grants made to research workers. The Report concludes with a discussion of means of encouraging inventors and aiding individual manufacturers.

Research Associations. The Council sees no difficulty in the establishment of trade research associations which could, where necessary, co-operate with existing corporations having similar objects. During the next few years the fund provided will be applied in founding and maintaining Research Associations in co-operation with the industries of the country; afterwards it is expected that the larger industries, at any rate, will be able and willing to carry on the work of the Associations without assistance. The Government intends to make a contribution to the assured income of such Associations from the subscriptions of their members, varying in amount according to circumstances. A model Memorandum of Association has been drafted, and notes prepared for the guidance of those desiring to draft the articles of an Association for Research; a short statement of the conditions under which the Department will make grants to such an Association is also given. In the constitution of the Governing Body

of an Association for Research, capital, management, and science must be represented, and it is believed further that provision should also be made for the inclusion of labour. It is intended that these Research Associations should include as many of the firms in each industry as possible, but it is recognised that where there is a great variety of applications as in the engineering industry, it may be advisable to form a series of distinct associations for research purposes. Everything possible will be done to encourage co-operation between different Associations. Progress has already been made in the establishment of an Association for Research in Cotton, and the woollen and worsted manufacturers have appointed a Committee to draft the Constitution for an Association. The Irish flax spinners are taking the same step, and the Scottish shale oil industry and photographic manufacturers have also decided to establish Associations immediately. The hope is also expressed that an Association for research into non-ferrous metals may soon be formed. In regard to chemical industries, the tendency towards financial combination among heavy chemical and allied manufacturers is noted, and it is pointed out that such combination will render co-operation for research alone less attractive, if not unnecessary.

Fuel research. The Council describes the steps which led up to the formation of the Fuel Research Board, and mentions some of the work which the Board is undertaking, including a survey of the coal resources of each district, the collection, examination, and classification of typical specimens of various coal seams, investigations into the nature and origin of the various types of coal, and into the chemical and physical behaviour of their constituents under the action of heat and other agents, the utilisation of peat, town gas standards, domestic heating, atmospheric pollution, etc.

Other researches. The Concrete Institute is controlling with the aid of the Department a series of tests of concretes made from selected local aggregates. Tests are also being made to ascertain the fire-resisting properties of different forms of concrete. Progress has also been made in research on refractory materials used by glass manufacturers, and with investigations into methods of stirring and melting which will protect the glass from furnace gases, etc. The development of the electric furnace, particularly for burning refractories at a very high temperature, has proceeded satisfactorily, and a new type of resistance furnace has been developed.

Investigations into the composition of optical glasses has been carried out, and the batch mixtures for several varieties of glass hitherto made exclusively at Jena, including fluor-crown glass, have been defined. Three new glasses, with properties hitherto unobtainable, have also been discovered. An investigation of abrasives and polishing powders, primarily in relation to their use in grinding and polishing glass, is about to be started. In this connection mention is made of the establishment of the Glass Research Institute at Sheffield University and of the Society of Glass Technology. Systematic surveys are being made of other fields for research, and it is mentioned that a report on iron and other metalliferous ores has already been issued (see this J., 1917, 698). A survey of the field for research in tungsten has been entrusted to a Sub-Committee under the chairmanship of Sir Robert Hadfield. Surveys are also being prepared in connection with the zinc industry, the smelting and refining of copper, the qualities of copper and the copper alloys, lubricants and lubrication, etc. A Sub-Committee has also been appointed to make a survey of the field for research in illuminating engineering.

A short account is given of certain researches which have been aided or initiated by the Council. These include work on light alloys, the corrosion of non-ferrous metals, refractories, hard porcelain, insulating oils, heat treatment of high speed steel, recovery of tin and tungsten, salting and disintegration of salts, and the degumming of silk. No details of the results of these researches are given, but it is indicated that satisfactory results have been obtained in several cases.

Assistance to inventors and manufacturers. The Department has no funds with which to assist patentees to exploit their inventions, but in certain suitable cases where funds are needed to work out on a full scale a process or device already patented, the Department is prepared to recommend a grant for the purpose. In suitable cases the Department will also consider applications for assistance towards researches necessary to perfect for commercial use patented or protected inventions or processes. Assistance will also be afforded to inventors through the medium of the Research Associations. To assist manufacturers, arrangements have been made with the Royal Society by which they assist the Council in selecting an institution or worker best fitted to undertake a research on behalf of a manufacturer; the Department will then in suitable cases provide the problems for research and also the funds for an assistant if necessary. Where a manufacturer shows keen anxiety to place his works on a scientific basis, the Department is prepared to entertain proposals to attach a young research worker to the works' laboratory, and to pay his salary during the early part of the term of his employment.

REFRACTORIES RESEARCH AND STANDARDISATION.

At the Second Conference on Refractories Research and Standardisation, held on July 11th, 1917, the Report of the Committee appointed at the first conference (see this Journal, 1917, 370) was adopted.

The Report is divided into three parts, dealing respectively with—(I.) Information as to refractory materials required by the various industries represented at the conference. (II.) Laboratory facilities for research work on refractories in public institutions in Great Britain and Ireland. (III.) The facilities existing in this country for publishing information on refractory materials and for collecting information and making it generally available.

Part I. is divided into seven sections. Section 1 deals with general requirements in regard to: (a) Particulars as to the distribution, resources, and properties of raw materials in Great Britain and Ireland, India, the Dominions, and the Colonies. (b) The investigation of certain physical, physico-chemical, and mechanical properties of refractories under service conditions. (c) Standardisation of tests and formulation of specifications in each class of material. (d) A study of the properties of all refractories and metallic oxides associated with them, up to the highest attainable temperatures, with special reference to their physico-chemical transformations. (e) Development of micro-technology as applied to refractories. (f) A special study of the rarer refractories.

Section 2.—Iron and steel industry. (a) *Raw materials.* (1) A comparative investigation of the special clays and other special raw materials used abroad, or formerly imported into this country, and their nearest British equivalent. (2) Complete analyses, approximate and ultimate, and mineralogical description of the principal raw materials available in this country. (3) Influence

of impurities on the inversion temperatures of the principal compounds used in the manufacture of refractory products. (4) An inquiry into the practicability of eliminating lime from dolomite with a view to manufacturing magnesite bricks. (5) The concentration, purification, and preparation of the raw material for the manufacture of chromite, bauxite, zirconia, and other rare refractory materials. (b) *Refractory products.* (1) An investigation of the physico-chemical changes that occur during the manufacture and subsequent utilisation under service conditions of the more important refractory products. (2) The influence of texture, bond, and previous thermal history of the principal refractory products on their durability under service conditions. (3) The erosion of refractory materials by rapidly moving currents of liquid steels and gases. (4) Physical and chemical properties of the more important refractory products at various temperatures, especially at the highest to which they are subjected during industrial service. (5) See also Section 3, Clauses *g* and *h*. (c) *Metallic alloys.* Reference is made to the use of metallic alloys whose particular properties render them valuable as refractory materials. The use of alloys of silicon and iron where acid liquors are contained or transferred is firmly established in practice, and might be extended if their properties were more widely known. Certain alloys with chromium as a dominant constituent, possessing great mechanical strength and retaining the high degree of thermal conductivity that characterises the metals, can be subjected to temperatures in the neighbourhood of 1000° C. under oxidising conditions without deterioration. The significance of this can hardly be over-estimated, for it would only be necessary for a comparatively small rise in the upper limit of the available temperature range to be achieved, when the claims of counter-current recuperation as opposed to reversible regenerators or stoves for smelting, melting, and reheating by-product coke-ovens, gas-retorts, furnaces, etc., would have to be seriously considered. Certain alloys of titanium and iron are insoluble in molten steel, and have a melting-point certainly higher than 1600° C. and probably near 1850° C. The possibilities of titanium alloys as refractory materials are thus strongly suggested. There is little reason to doubt that an investigation of the metallic alloys mentioned, and of others that might suggest themselves, with a view to determining their properties as refractory materials, could not fail to furnish results not only of limited application, but possibly of far-reaching significance.

Section 3.—Non-ferrous metal industry. (a) In the copper industry research is particularly necessary in the direction of securing bricks—or other forms of refractories—having a high resistance to the cutting action of copper slag; the question of brick bottoms for reverberatory furnaces used in copper smelting and refining also needs attention. (b) In the aluminium industry there are needed:—(1) Improved refractory insulating material in reduction furnaces. (2) Improved bricks for use in furnaces for calcining coke. (3) Researches relating to the manufacture of carbon (graphitic and amorphous) electrodes, including the construction of saggars for baking electrodes. (c) Refractories for retorts used in zinc distillation. (d) Problems connected with plumbago and other crucibles. (e) Investigation into the best material for linings of pit-fired type furnaces used for:—(1) Brass and alloys at about 1150° C. (2) Cupro-nickel and similar alloys above 1400° C. (3) Crucible melting of steel. (f) Linings for coke, gas, and oil-fired tilting furnaces with air or gas under pressure. Effect of the blast on refractory linings.

Section 4.—The gas industry. (a) See Section 2, Clauses (a) 1, 2 and 3, (b) 1 and 2, and (c). The clauses apply to the gas industry also. (b) Study of clay for jointing purposes. Influence of adding grog to cement used in retort settings. (c) Relative effects of oxidising and reducing gases on refractoriness, and on after expansion and contraction. (d) The influence of the flue dust carried into the settings with the furnace gases, and of the mineral constituents of the coal carbonised on the refractoriness and life of the material employed. (e) Investigation of the effect of the admixture of highly silicious rock, such as ganister (raw or calcined), on the working quality of fire-clay goods. (f) Further investigation of the most suitable means to be used in the manufacture of the retorts used for the carbonisation of coal, in order that these may withstand temperature fluctuations to which they are exposed, owing to their periodic filling with cold coal when at high temperature, and at the same time render them impervious to the passage of gases. (g) Coke-oven and retort linings to resist action of salt vapours and steam. (h) The development of a material which will conduct heat more quickly to the charge.

Section 5.—The chemical industry. The industry requires materials to withstand both acid and alkali gases and liquids at moderately high temperatures. Effects of reducing and oxidising flames must be studied. Information at present is in the hands of users and not manufacturers of refractories. There is no uniformity in material at present available. Enamels to resist acids and alkalis and which will transmit heat are required in the fine chemical industry.

Section 6.—The glass industry. (1) Study conditions which determine corrosion, dissolution, and pitting of bricks, blocks, and pots in glass furnaces. Consider especially effect of composition, texture, and impurities (e.g., titanium oxide). (2) Investigation with regard to materials best suited for glass furnaces. Substitutes for some of the best grade materials at present used. (3) Study of protective coating and washes. (4) Methods of purifying fire-clay. (5) Use of non-calcined material, such as stone blocks. (6) Study of possibilities of water-cooled tanks. (7) A geological research in all measures to find out where the change from fresh-water to salt-water conditions of deposition took place. (8) A geological research in the Lancashire coal beds for refractory materials.

Section 7.—The pottery industry. The firebricks employed in pottery manufacture for oven, muffle, and kiln building are covered by the requirements indicated for the other industries. Similar remarks probably obtain for the bricks used in frit-kiln bottoms, for they are required to withstand the action of highly corrosive molten lead and alkali silicates and borates. The saggar question is an important one, since saggars require a high tenacity and high temperature crushing strength, resistance to sudden or abrupt changes of temperature, and they must also be free from impurities which are liable to spurt. The question of high-temperature porcelains will be taken in hand shortly, and this will require much more resistant saggars than are at present in use. Study of porcelains for high voltages, or having a high electrical resistance when heated.

Part II. deals with laboratory facilities for research work on refractories in public institutions in Great Britain and Ireland, and Part III. details the facilities existing in this country for publishing information on refractory materials and making it generally available. In this connection the Committee, having given consideration to the present position as to abstracts, submitted the following Resolution:—"Resolved, that with a view to

rendering the work hitherto done by the Ceramic Society more readily useful, the Societies and Institutions represented at the Conference on Refractories held on March 22nd, 1917, co-operate in the preparation of a complete index with Abstracts of important papers on Refractories, and their publication in a form that will render them available for the members of the co-operating Societies."

WOMEN IN CHEMICAL INDUSTRIES.

In a pamphlet issued by the Home Office and the Board of Trade on the employment of women in chemical industries, it is stated that substitution of women for men has taken place in all the principal centres of the industry and has made appreciable advance both in direction and extent during the past fourteen months. Owing to the heavy nature of some of the work and to the fact that in the past it has been customary for the same man to be employed on different kinds of work, some too heavy for women, some comparatively light and suitable for them, a certain amount of re-organisation and adaptation is necessary in order to enable women to be successfully brought in.

The following is a list of the processes in which women have, under suitable conditions, already been or can be successfully substituted for men. Processes not included in the list are those in which inquiry has not at present discovered cases of successful substitution:—

Alkali and acid manufacture.

1. *Alkali.*—Emptying roll sulphur moulds. No substitution has been found in the process of alkali manufacture proper.

2. *Acid.*—Filling, stoppering, and packing carboys.

Manufacture of light chemicals.

1. *Filter press work.*—Scraping and cleaning ordinary filter presses. Manipulating pump or valve regulating the flow of liquor. Screwing-up, emptying and cleaning gravity filter press. Working hydraulic press; for example, for compression of guncotton and for oil extracting.

Centrifugals or hydro extractors.—Loading, working, and emptying centrifugals (up to 50-inch cage diameter).

Electro-chemical processes.—Refining and separation of metals. (The adoption of women's labour to any great extent in this department, e.g., in copper refining, depends on the size of the cells and on the use of lifting tackle when the anodes and cathodes are too heavy.*) Feeding cells with solution. Removing deposit of precious metals from cells. Fitting cells with carbons and making plastic parts of cells. Making cell luting.

Management of stills.—Supervision of water distillation plant.

Feeding or working the following machines.—(i.) Feeding only: Disintegrator. Mechanical sieve. Grinder. Bucket elevator. Edge runner. (ii.) Working: Band saw. Using hand, over-head, lifting tackle (for moving drums up to 1 ton in weight).

Laboratory work—skilled and unskilled.

Emptying cooling or crystallising tanks. † (Use

* The Factory Inspectors consider that women could satisfactorily be employed to a greater extent than has been yet attempted on the management of cells.

† (i.) Women have been found employed on coolers (or crystallising tanks) 5 feet 6 inches deep. Two women emptied and one carried away. A strong type of woman is essential. One cooler containing over two tons of material would be emptied daily. Women have been employed on borax coolers for years and are considered satisfactory.

(ii.) It is desired to call the attention of employers to the possibility of employing women on the analogous operation of emptying sulphur tanks in the chance recovery process—in which the work is certainly less arduous than that involved in the above case.

of lighter picks and shallower coolers desirable.) Breaking up solid crystals (except large blocks requiring the use of a heavy pick or crowbar). Drying-cupboard work. (i.) Conveying drying shelves or solids. (ii.) Spreading out and raking over solids. Emptying subliming chambers. Stacking blue beds in white lead works. (Performed in some factories prior to the war.) Feeding and supervision of small boiling pans, and of reaction vessels. Supervision of evaporating tanks. Washing crystals in fine chemical works. Siphoning liquors into crystallising tanks.

Dry packing generally. Wet packing. Soldering tins and tin-paper linings of cases. Weighing and packing copper ingots. Storekeeping. Checking for dispatch.

General labouring work.

Unloading boats and trucks of slack, coal, coke, fire-bricks, timber, sand, and drain pipes. Loading barges with coal, etc., and trucks with sacks. Filling and wheeling barrows (loads up to 1½ to 2 cwt., including barrow). Wheeling carboys of acids. Washing, rolling, and painting iron drums. Bagging coke, chemical manure, etc. Cleaning and emptying evaporating tanks. General cleaning operations. Trimming coal for furnaces, and levelling ashes. Washing bogies. Breaking up pyrites. Carting.

The greater part of the operations performed require no special training or skill apart from careful instruction at the works in methods of tackling and of systematically arranging the work. Practice in hard manual labour and strict intelligent attention to instructions are chiefly necessary. In certain exceptional operations—for example, management of vacuum stills—long experience appears requisite for rapid appreciation and successful control of different combinations of causes which may affect the work, and which it is said to be almost impossible to schedule for the guidance of the new worker.

Women of strong physique are required for much of the work and intelligent women of a superior type for that which is more responsible. A careful selection of workers, with reference to the particular class of operation, is the primary condition of successful substitution. It is not anticipated that there will be any difficulty in securing the right type of worker if suitable arrangements are made and adequate remuneration is offered.

In certain branches, the necessity of carrying on the work continuously makes the introduction of women dependent on some relaxation of the law. Applications for such relaxations will be favourably

considered by the Home Office where they are needed to facilitate production of supplies for the Crown, or to enable other work required in the national interest (e.g., manufacture for export) to be carried out. The attention of employers is particularly directed to the arrangement found in certain parts of the country of working in eight-hour shifts, which appears specially suited for introduction of women's services.

Special arrangements of a simple and practical character are necessary to render the heavier and more dangerous work suitable for women. A good example of labour-saving arrangements in connection with the loading and unloading of trucks is the erection of rough platforms with access by planks on a gentle incline, which have been found of great service. Other mechanical appliances, such as arrangements for "blowing over" liquors instead of carrying by hand; introduction of lifting tackle where heavy plates, etc., have to be lifted and of lighter implements (barrows, pulleys, spades, etc.); and the provision of suitable protective clothing for wet, dangerous, and dirty processes, have facilitated introduction of women.

Correspondence.

SIR,

I have read with interest Mr. McLellan's note on "Boiler Corrosion" (this J., 1917, pp. 853—856) and I think that in the addendum he has proved that the corrosion was due to electrolytic action. Nitrogen, in apparatus with rubber connections, is more satisfactory than hydrogen.

A layer of oil is useless for preventing the transmission of the gases of the air. This fact, though mentioned by two speakers in the discussion, is not well known. I found some time ago that the absorption of oxygen from air by water under relatively thick layers of various oils was considerable. Gniewosz and Walfisz (Zeits. physik. Chem., 1, 70) found that "the coefficient for the absorption of oxygen and many other gases by petroleum is much higher than that for water. The authors consider it illusory therefore to try to protect liquids from oxidation by covering them with a layer of petroleum." (Abstract; this J., 1888, 772.) The petroleum layer is a weak point in Ramsay and Homfray's method for the determination of dissolved oxygen (this J., 1901, 1071).

Yours, etc.,

Aug. 30, 1917.

J. H. COSTE.

Journal and Patent Literature.

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I.—GENERAL; PLANT; MACHINERY.

Granular calcium chloride as a drying agent. A. T. McPherson. J. Amer. Chem. Soc., 1917, 39, 1317—1319.

Air containing a known amount of water vapour was aspirated over a long column of anhydrous granular calcium chloride and the residual moisture absorbed and weighed in a glass-stoppered phosphorus pentoxide tube. The calcium chloride had been previously dried at 260°—275° C. in a current of air dried over phosphorus pentoxide. A tube

100 cm. long and 2 cm. diam., filled with the dry calcium chloride and kept at 25° C., removed at a rapid rate (9 litres per hr.) the whole of the weighable moisture from a fairly large volume of air (40 litres) saturated with water vapour at 25° C. The amount of air that may be dried at maximum efficiency decreases as the rate of passage increases but not in the same proportion, the rate at 23 litres being about half as great as at 5 litres per hour. Experiments showed that the efficiency of a calcium chloride drying tube depends upon the volume of gas and the rate of flow rather than on the amount

of moisture in the gas, and that granular calcium chloride when absolutely dry will remove every trace of moisture from a gas passed over a sufficiently long column of it.—J. H. P.

PATENTS.

Refrigeration; Process of mechanical — J. C. Bertsch, Edgewood Park, Pa., U.S.A. Eng. Pat. 101,514, Sept. 13, 1916. (Appl. No. 13,015 of 1916.) Under Int. Conv., Sept. 17, 1915.

The working liquid used has a higher specific gravity but a lower boiling point than water, as for example carbon tetrachloride. It is sprayed into the refrigerating chamber, evaporated, and the vapour withdrawn by a vacuum pump and compressed. The compressed vapour is delivered into a condenser below the level of the condensed liquid. The condensed liquid is sealed by a layer of water, or water and glycerin, which also serves as a lubricant. The condenser is open to the atmosphere and is provided with a coil through which water is passed to carry away the heat of condensation, and with an overflow by which the sealing water can pass to the compressor to serve as a lubricant. The liquid to be cooled is passed through a coil in the evaporator chamber.

—W. H. C.

Separators; Magnetic — O. C. Jones, Maidstone, Eng. Pat. 107,284. (Appl. Nos. 11,064, Aug. 5, and 15,643, Nov. 2, 1916.)

Two or more permanent or electro magnets are provided with pole pieces and so arranged that a narrow tunnel-like passage is left between the pole pieces through which the material to be treated is passed from a non-magnetic duct. The apparatus is intended primarily for separating particles of iron from semi-liquids such as paper pulp, potters' slip, etc., but may also be used with granular or finely-divided materials.—W. H. C.

Furnaces; Heating — Stein and Atkinson, Ltd., and J. S. Atkinson, London, and Kayser, Ellison and Co., Ltd., and C. W. Kayser, Sheffield, Eng. Pat. 107,332, Nov. 18, 1916. (Appl. No. 16,550 of 1916.)

The furnace is furnished with two sets of flame inlets and outlets, which have separate regulators in order that the rate at which the material is heated or cooled may be varied at will. A recuperator is provided below the furnace in which the air and/or gas flow vertically upwards through small passages and the heating agent flows horizontally through relatively wide passages.

—W. H. C.

Furnaces; Gas-fired — I. Hall, Birmingham, Eng. Pat. 107,876, Sept. 20, 1916. (Appl. No. 13,318 of 1916.)

In a gas-fired furnace using air under pressure, the gas and air are supplied to the burners from separate distributing chambers, and the nozzles or burner caps (see Eng. Pat. 12,695 of 1915) which deliver the mixture of gas and air tangentially into the combustion chamber, have conical mouths and are arranged just outside the apertures, so that the gaseous mixture will induce a current of secondary air into the openings.—W. H. C.

Steam and gas superheaters, heating and cooling appliances — E. E. Tasker, Brentwood, Eng. Pat. 107,821, July 14, 1916. (Appl. No. 9923 of 1916.)

The ends of the superheater pipes are connected with the steam-chests by means of conical plugs and seats. The ends of the pipes are provided with flanges over which a collar fits. The joints are tightened by nuts and studs which pass through the collars.—W. H. C.

Cleansing various materials or objects for domestic and industrial purposes; Process for — O. Röhm, Darmstadt, Germany, Eng. Pat. 107,191, May 18, 1916. (Appl. No. 7091 of 1916.) Under Int. Conv., Apr. 12, 1915. Addition to Eng. Pat. 2151 of 1915 (this J., 1915, 1204).

An aqueous liquid prepared by adding pancreatic or tryptic enzymes to water, approximately in the proportion of 0.5—1 gm. of pancreatin to 100 litres of water, is employed for cleansing furniture, fittings, bottles, and utensils other than textile articles.—J. F. B.

Condensers for refrigerating machines — B. S. McClellan, Chicago, U.S.A. Eng. Pat. 108,196, July 27, 1916. (Appl. No. 10,623 of 1916.)

SEE U.S. Pat. 1,201,208 of 1916; this J., 1916, 1206.

Apparatus for harvesting the constituents of wood and vegetable substances, distilling and purifying them — U.S. Pat. 1,231,247. See V.

Appliances for ascertaining the hardness of metals and other solid materials — Eng. Pat. 107,685. See XXIII.

II A.—FUEL; GAS; MINERAL OILS AND WAXES.

Mine gases and industrial gases; Limits of complete inflammability of mixtures of — with air. G. A. Burrell and A. W. Gauger, U.S. Bureau of Mines Tech. Paper No. 150. 1917. 11 pages.

THE report summarises the results of experiments to determine the above limits, dealing with gasoline vapour, ethane, methane, natural gas, acetylene, illuminating gas, blast-furnace gas, and hydrogen. Flame is said to be self-propagated through a mixture when enough of the combustible gas is present to permit combustion to spread through the mixture from any given point of ignition, the propagation of flame then taking place from layer to layer without the continued presence of the igniting source of heat. The limits are slightly affected by varying conditions, being lower when ignition occurs from the bottom than when it occurs from the top. The limits of complete inflammability are shown by the following percentages of the particular gas in air. Gasoline vapour, 1.5 to 6; ethane, 2.5 to 5; methane, 5.5 to 14.5; natural gas, 5 to 12; acetylene, 3 to 73; illuminating gas, 7 to 21; hydrogen, 10 to 66; carbon monoxide, 15 to 73; blast-furnace gas, 36 to 65. Variations in pressure and temperature affect the above figures only very slightly. With reference to the use of oxygen, the low limits of inflammability are apparently not much affected thereby, but in the case of methane the higher limit was raised from 14.5 to 45%, and presumably the upper limits with other gases would be similarly affected. Details of tests on blast-furnace gas are given, and typical analyses of such gases from various types of furnaces. In general, the lower limit for blast-furnace gas varies with the amount of combustibles present in the gas from 36 to 57%. The upper limit is, however, approximately 65% of gas for all cases.—J. E. C.

Lubricating oils; The testing of — H. K. Moore and G. A. Richter, Met. and Chem. Eng., 1917, 16, 692—694.

An apparatus has been devised to measure relatively the durability and also the internal friction or "power consumption" of the oil. It consists essentially of a conical bearing, with a vertical angle of 30°, rotating in a conical sleeve, the latter being long enough to take cones of different sizes.

The desired pressure is maintained by a suspended weight of 100 lb. acting on the shaft. The conical sleeve is jacketed to maintain any desired temperature at the bearing surface. The revolving cone is furnished with a spiral feeding groove to bring the oil to the bearing surface, the oil travelling through the hollow shaft to a small oil pump which returns it to the bearing surface. The shaft is rotated at 80 revs. per minute by a motor through a gear drive, and the power consumption is measured by an ammeter and voltmeter. Knowing the efficiency of the motor, the results obtained are strictly comparable. Where the power consumption is the determining factor, the input in watts is plotted against time, and the "durability" of the oil may thus be studied. In another method of testing, the oil pump is not used, and the oil is dropped on the bearing as required to keep the power input below a pre-determined limit, the amount of oil required per hour being thus obtained; or the lower end of the groove may be plugged, and 3 c.c. of oil added to the bearing, the power input being recorded each minute. The machine is allowed to run until a maximum allowable power input is reached and the power is plotted against time. In one series of experiments the amperage of the motor was allowed to reach 3.4, the voltage being kept constant at 120, and at the end of each run the bearing was cooled to the starting temperature of 20° C. before beginning another run. It has been noted that the oil which "stands up" for the longest period of time without exceeding the allowable power consumption, requires a comparatively higher power input during that time than other oils which reach the predetermined maximum in shorter time. The cost of the lubricant and power must be considered in selecting the most economical oil, and the most economical is not necessarily the most suitable, as the bearing temperature, gumming, and cold test must also be considered.

—B. N.

Unsaturated organic compounds; Action of anhydrous aluminium chloride on —. H. W. C. Gangloff and W. E. Henderson. J. Amer. Chem. Soc., 1917, 39, 1420—1427.

Dry aluminium chloride absorbs gaseous unsaturated hydrocarbons very slowly, but in solution the combination is much more rapid. *Acetylene* passed into a solution of aluminium chloride in absolute ethyl alcohol yielded a light yellow, granular, very hygroscopic product, $\text{AlCl}_3 \cdot \text{C}_2\text{H}_2 \cdot 2\text{C}_2\text{H}_5\text{OH}$, which decomposed very readily on standing. Using purified methyl alcohol as solvent a similar product was obtained, $\text{AlCl}_3 \cdot \text{C}_2\text{H}_2 \cdot \text{CH}_3\text{OH} \cdot \text{H}_2\text{O}$. *Ethylene* gave $\text{AlCl}_3 \cdot \text{C}_2\text{H}_4 \cdot 2\text{C}_2\text{H}_5\text{OH}$ with ethyl alcohol as solvent and with methyl alcohol $\text{AlCl}_3 \cdot \text{C}_2\text{H}_4 \cdot \text{CH}_3\text{OH} \cdot \text{H}_2\text{O}$. *γ-Butylene* with methyl alcohol as solvent gave a product $\text{AlCl}_3(\text{CH}_3)_2\text{C}(\text{CH}_2\text{CH}_2\text{CH}_2\text{OH})_2$. *β-Isomylene* (b.pt. 36°—38°) when treated with dry aluminium chloride gave a series of yellow to red to sienna coloured tars as the amount of chloride was increased. The tars on fractionation from solution in alcohol produced carbinols, principally trimethylcarbinol. In alcoholic solution a crystalline product, $\text{AlCl}_3 \cdot \text{C}_5\text{H}_{10} \cdot \text{CH}_3\text{OH}$, was obtained. *Phenylethylene* gave two products, one of which is $\text{AlCl}_3 \cdot \text{C}_6\text{H}_5 \cdot \text{CH}(\text{CH}_3)$. In this instance water or alcohol of crystallisation appears to be unnecessary for the formation of a crystalline body. On standing loosely stoppered for six months it lost its crystalline character and became oily. The oil proved to be $\text{AlCl}_3 \cdot 2\text{C}_6\text{H}_5 \cdot \text{CH}(\text{CH}_3) \cdot 2\text{H}_2\text{O}$. *Oleic acid* mixed with aluminium chloride in methyl alcohol gave a crystalline mass like brown sugar which on analysis was found to be $4\text{AlCl}_3 \cdot \text{C}_{18}\text{H}_{33}\text{COOH}$. *Fumaric acid* used in varying amounts gave $\text{AlCl}_3 \cdot \text{C}_4\text{H}_4\text{O}_4$

in every case. *Furfuraldehyde* with a methyl alcohol solution of aluminium chloride produced $\text{AlCl}_3 \cdot \text{C}_5\text{H}_4\text{O}_2 \cdot \text{CH}_3\text{OH}$. *Benzaldehyde* gave $\text{AlCl}_3 \cdot \text{C}_6\text{H}_5\text{CHO} \cdot \text{CH}_3\text{OH}$. *Allyl alcohol* gave $\text{AlCl}_3 \cdot \text{C}_3\text{H}_5\text{O} \cdot \text{CH}_3\text{OH}$. Anhydrous ferric chloride gave similar reactions to aluminium chloride but they were less vigorous and not so complete. In the preparation of benzophenone from benzoyl chloride and benzene, aluminium chloride gave a yield of 70—71% as against 60—62% obtained with ferric chloride and 28—32% with zinc chloride. All the compounds of aluminium chloride described above are crystalline and are mostly unstable. They have no definite melting points, dissociation occurring before fusion. The possibility of compounds of aluminium chloride with unsaturated hydrocarbons being formed in the treatment of petroleum is considered. (See also this J., 1916, 917.)—J. H. P.

PATENTS.

Fuel; An improved —. R. Hleemann, Glasgow. Eng. Pat. 107,344, Jan. 2, 1917. (Appl. No. 25 of 1917.)

An improved fuel is composed of bitumen or pitch, an argillaceous substance, and a carbonaceous substance. The argillaceous substance is made fluid by addition of water, and poured into the molten pitch. The carbonaceous matter is then incorporated, and the mass pressed into blocks.—J. E. C.

Mine waste; Utilisation of — by means of the heat of waste fields. W. Ostwald, Grossbothen, Saxony. Eng. Pat. 107,446, July 25, 1916. (Appl. No. 10,462 of 1916.)

In dealing with rubbish heaps from collieries, oil shales, etc., solutions of chlorides such as sodium chloride are introduced to the burning heap through a series of tubes to convert the combined nitrogen into ammonium chloride, and another series of tubes is inserted for carrying off the resulting products. Separate cooling elements may be embedded in the portion of the waste heap being worked at any time, to reduce the temperature and avoid the formation of slag.—J. E. C.

Coke ovens; Regenerative —. A. G. Bloxam, London. From E. Coppee et Cie., Brussels. Eng. Pat. 107,879, Sept. 23, 1916. (Appl. No. 13,540 of 1916.)

An installation of regenerative coke ovens, adapted to be heated by poor or rich gas, is provided with regenerators arranged longitudinally with relation to the battery, and in two rows of sub-sections fitted end to end. One row at any particular period is receiving hot spent products of combustion, the other row at this same period being so arranged that one-half of the chambers is heating the poor gas and the other half is heating the air. The sub-sections dealing with gas are connected to a common hot gas flue, and the air sections to a common hot air flue respectively, whilst these two flues deliver their products to the base of the vertical flues of the oven proper. The division into sub-sections allows better control of temperature in each section, and the use of a common flue secures a more uniform temperature along the whole battery, whilst an individual sub-section may be repaired without stopping the whole plant.

—J. E. C.

Vertical [gas] retorts; Heating of —. P. G. Strassmann, Crefeld-Linn, Germany. Eng. Pat. 107,308, Sept. 15, 1916. (Appl. No. 13,006 of 1916.)

A VERTICAL retort adapted for continuous working is divided into three zones. Gas and air are fed into flues round the central portion of the retort constituting the main heating chamber. The

heated products of combustion rise vertically through flues surrounding the upper or preliminary distillation chamber, the heat of which gradually decreases towards the top. The lower section is surrounded by air- or water-cooled passages and constitutes a coke-cooling chamber. The air for combustion is preheated by the heating gases and the products of combustion.—J. E. C.

Carburetting air to form a gaseous fuel for internal combustion engines. C. M. Dyer, Hawthorn, Victoria, Australia. Eng. Pat. 107,357, Feb. 26, 1917. (Appl. No. 2793 of 1917.)

AN atomising device for carburetting air comprises a jacketed tapering casing with a number of gauze screens graduated in fineness of mesh from the inlet to the outlet. An auxiliary air admission device is fitted to the upper part of the casing, and a cylindrical or dome-shaped screen of gauze is placed over the inlet.—J. E. C.

Gas producers. The Tyne Glass Works, Ltd., Gateshead, and A. B. Roxburgh, Monksheaton. Eng. Pat. 107,525, Nov. 24, 1916. (Appl. No. 16,864 of 1916.)

THE stepped grate of a gas producer is composed of fluted or grooved bars adapted to be rotated on their axes. Water is conveyed to the grooves, and each bar may be withdrawn without interfering with the remainder.—J. E. C.

Gas producers. A. Sahlin, London. Eng. Pat. 107,561, Apr. 12, 1917. (Appl. No. 5160 of 1917.)

IN a gas producer having a central tuyère, means are provided for varying the area of one or more of the blast apertures to regulate the relative rate of combustion in the different zones of the fuel bed. Such means may be operated during the working of the producer without affecting the wind pressure in the wind box behind the blast apertures.—J. E. C.

Gas producers. D. Moffat, Wishaw. Eng. Pat. 107,567, May 7, 1917. (Appl. No. 6485 of 1917.)

IN connection with a gas producer, a pair of pivoted dampers with interlocking edges is provided within the gas outlet passage, along with lever mechanism for operating the dampers from the outside.—J. E. C.

Heavy hydrocarbons; Method of converting — into light hydrocarbons or hydrocarbon gases. F. B. Dehn, London. From Synthetic Hydrocarbon Company, Pittsburg, U.S.A. Eng. Pat. 17,822, Dec. 22, 1915.

THE heavy hydrocarbons are cracked by being passed into a tube suitably heated, *e.g.*, by electrical means, and containing at the top a small quantity of refractory filling material, such as steel balls. The gaseous products are drawn off by means of a suction pump through suitable condensing apparatus and the condensed liquid collected, the gases being passed into a gas-holder. The pressure should be below $\frac{3}{4}$ atmos. (absolute), the best yields being obtained below 4 lb. pressure. It is claimed that, by controlling the various factors, *i.e.*, rate of feed, temperature, and pressure, certain compounds, *e.g.*, benzene, toluene, ethylene, etc., can be caused to predominate in the reaction products. Also, as the gases are immediately drawn off from the cracking tube, polymerisation and the formation of undesired products is prevented. (Reference is directed, in pursuance of Sect. 8, Sub-sect. 2, of the Patents and Designs Act, 1907, to Eng. Pats. 9162, 9163, and 13,100 of 1915.)—L. A. C.

Liquids; Treatment of — with gases. [Production of motor fuel.] C. F. Killar, London. Eng. Pat. 107,217, May 19, 1916. (Appl. No. 7173 of 1916.)

TO obtain products suitable for use in internal combustion engines, a liquid hydrocarbon oil is sprayed in an atomised condition into a vessel filled with a gaseous hydrocarbon, *e.g.*, acetylene. To prevent subsequent separation, a small quantity of ether, acetone, or alcohol is previously added to the liquid hydrocarbon.—W. H. C.

Liquid fuels. G. E. Heyl, London. Eng. Pat. 107,454, July 31, 1916. (Appl. No. 10,781 of 1916.)

MIDDLE oil from coal tar, distilling from 170° C. to 230° C., is redistilled at a lower temperature, and a portion collected having a flash point up to about 35° C. The middle oil is previously neutralised, washed, and freed from naphthalene. By continuing the distillation, an oil with a flash point of 38° to 49° C. is obtained and the latter oil may be washed with sulphuric acid to decolorise it.—J. E. C.

Coke-ovens or other ovens, furnaces, or the like; Apparatus for manipulating the doors of by-product —. E. Blythe and C. Armitage, Dewsbury. Eng. Pat. 108,236, Sept. 27, 1916. (Appl. No. 13,728 of 1916.)

Coke; Method of improving — as heating medium for stoves and the like. Schollkohlen-Ges. m.b.H., Assignees of E. and A. Schollenbruch, Düsseldorf, Germany. Eng. Pat. 100,968, July 24, 1916. (Appl. No. 10,425 of 1916.) Under Int. Conv., July 22, 1915.

SEE Ger. Pat. 291,568 of 1915; this J., 1916, 827.

Coke; Method of improving — as fuel for stoves, hearths, and the like by filling up the pores thereof. A. Schollenbruch, Düsseldorf, Germany. U.S. Pat. 1,233,611, July 17, 1917. Date of appl., Nov. 11, 1916.

SEE Ger. Pat. 291,568 of 1915; this J., 1916, 827.

Peat gasification. T. Rigby, Dumfries, Assignor to Wetcarbonizing, Ltd., London. U.S. Pat. 1,233,606, July 17, 1917. Date of appl., Aug. 11, 1914.

SEE Eng. Pat. 16,918 of 1914; this J., 1915, 860.

Mineral oils; Process of treating —. G. Petroff, Petrograd, Assignor to Twitchell Process Co., Cincinnati, Ohio. U.S. Pat. 1,233,700, July 17, 1917. Date of appl., Sept. 10, 1915.

SEE Fr. Pat. 448,207 of 1912; this J., 1913, 415.

Gas-fired furnaces. Eng. Pat. 107,876. See I.

Production of hydrogen, pure Glauber salts, and a gas-purifying mass from iron scrap and bisulphate of soda. Eng. Pat. 107,807. See VII.

Gas filters [for gas analysing apparatus]. Eng. Pat. 104,880. See XXIII.

Gas testing apparatus. Eng. Pat. 107,811. See XXIII

IIB.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

Marble lamp for exposing [dyed] patterns. Gauswindt. See VI.

PATENTS.

Coal, shales, lignites, and other similar materials; Method of and apparatus for extracting volatiles from —. C. C. Bussey, Brooklyn, U.S.A. Eng. Pat. 107,824, July 17, 1916. (Appl. No. 10,003 of 1916.)

SEE U.S. Pats. 1,191,869 and 1,191,870 of 1916; this J., 1916, 919. The heating gases are produced by burning the carbonaceous material from which the volatile substances have been extracted.

Heating furnaces. Eng. Pat. 107,332. See 1.

III.—TAR AND TAR PRODUCTS.

Vacuum tar; Hydroxy-compounds and bases of —.

A. Pictet, O. Kaiser, and A. Labouchère, Comptes rend., 1917, 165, 113—116. (See also this J., 1913, 1098; 1914, 70; 1915, 604.)

VACUUM tar contains about 2% of hydroxy-compounds and 0.2% of bases. The bases were extracted with dilute hydrochloric acid, separated by fractional distillation, and purified as picrates. The hydroxy-compounds were separated from the tar as solid sodium phenolates, and fractionally distilled. The substances thus isolated are shown in the table, which reveals an interesting parallelism between the series of hydroxy-compounds and bases. The only product definitely identified was

Hydroxy compounds.	B.pts. °C.	B.pts. of acetates. °C.	Bases.	B.pts. °C.	M.pts. of picrates °C.
$C_7H_{11}O$	170—175	—	C_7H_9N	198—203	170
$C_8H_{10}O$	185—190	—	C_8H_7N	225	195
C_9H_9O	198—200	213—215	C_9H_5N	247—250	184
$C_{10}H_8O$	213—215	226—229	$C_{10}H_3N$	250—260	184
$C_{11}H_6O$	226—228	240—244	$C_{11}H_1N$	260—265	173
			$C_{12}H_1N$	270—280	166

the lowest hydroxy-compound, $C_7H_{11}O$, hexahydro-*p*-cresol. The others, forming a homologous series, differed from this in properties. Insoluble in alkalis when freshly prepared, they gradually became soluble, and from the solutions thus formed carbon dioxide precipitated phenolic substances. These compounds, unlike the lowest of the series, $C_7H_{11}O$, were unsaturated. Their acetic esters, readily obtained by means of acetyl chloride, were colourless liquids of pleasant odour, and instantly decolorised permanganate in cold sulphuric acid solutions. These hydroxy-compounds probably occur as such in coal, for those found in benzene extracts of coal appear to be similar. The series of bases showed corresponding differences. The lowest fraction (b. pt. 198°—203° C.) behaved as a primary aromatic amine and may possibly have been a mixture of toluidines. The other members of the series, on the contrary, were saturated secondary bases. They were colourless liquids, somewhat resembling the quinoline bases in odour, and yielded picrates only slightly soluble in alcohol. They are probably decomposition products of alkaloids present in coal.—J. H. L.

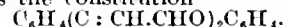
o-Nitroamines; Conversion of — into iso-oxadiazole oxides and of o-nitrosoamines into iso-oxadiazoles. A. G. Green and F. M. Rowe, Chem. Soc. Trans., 1917, 111, 612—620.

IN previous papers (Chem. Soc. Trans., 1912, 101, 2452; 1913, 103, 897, 2023; this J., 1913, 904) it was shown that many *o*-nitro-amines are converted into furoxans (furan oxides or iso-oxadiazole oxides) when oxidised in alkaline solution with sodium hypochlorite. The same reaction has been studied in the naphthalene series

and it was found that 2-nitro-1-naphthylamine and 1-nitro-2-naphthylamine both gave the same oxidation product, naphthafuroxan, m.pt. 127° C. 8-Nitro-1-naphthylamine did not yield a furoxan and 2,4-dinitronaphthylamine also failed to give the expected product, the oxidation resulting in a disruption of the ring accompanied by a strong odour of chloropierin. α -Nitroso- β -naphthylamine and β -nitroso- α -naphthylamine both yield the same furazan.—J. F. B.

Quinones; Action of acetaldehyde-ammonia on —. P. C. Ghosh, Chem. Soc. Trans., 1917, 111, 608—612.

WHEN *p*-benzoquinone in nitrobenzene solution is heated with powdered acetaldehyde-ammonia, the mixture suddenly solidifies at 85°—90° C. A deep black substance crystallising in needles is formed which does not melt at 290° C. and is insoluble or only sparingly soluble in the usual solvents. With nitric acid this yields a yellow crystalline nitro-derivative which does not melt at 300° C. The latter is soluble in alcohol and a molecular weight determination indicated the formula $C_{16}H_{12}O_6N_4$, which corresponds to $C_{16}H_{14}O_2N_2$ for the original black compound. This substance, therefore, has an anthracene structure, $O:C_6H_2:NI(CH(CH_3)_2)NI:C_6H_2:O$, but no known anthracene derivative could be isolated from it. With α - and β -naphthaquinones no definite condensation product with acetaldehyde-ammonia could be obtained. Anthraquinone on heating for 6 hours at 220°—225° C. with acetaldehyde-ammonia in a sealed tube, gives a colourless product crystallising in silky needles from alcohol and melting at 281° C. This product contains no nitrogen and gives a phenylhydrazone which does not melt at 300° C. Anthraquinone therefore condenses with acetaldehyde-ammonia in a different manner from benzoquinone, and the product has the constitution



—J. F. B.

PATENTS.

Tar; Apparatus for the continuous distillation of —. Sulzer Frères Société Anon., Winterthur, Switzerland. Eng. Pat. 107,345, Jan. 2, 1917. (Appl. No. 78 of 1917.)

THE tar is distilled continuously and the pitch discharged into the open. At the discharge point, an ejector worked by a fan draws off the vapours from the pitch, these being condensed in the discharge pipe and passed into a collecting tank. The fan may also be connected with one or more injectors to induce draught for heating the distilling drums.—L. A. C.

Crescote; Composition for use as a substitute for —. G. E. Heyl, London. Eng. Pat. 107,911, Nov. 10, 1916. (Appl. No. 16,169 of 1916.)

TAR oil is washed successively with 10—30% of caustic alkali, 2—5% of sulphuric acid, and water, and is then cooled to about 0°C. The coagulated "naphthalene-containing ingredient" is filtered off and the cakes dissolved at about 80° C. in an equal volume of mineral oil.—L. A. C.

Tar or tar oils or derivatives of tar; Method of treating — for the purpose of converting hydrocarbons having a high boiling point into hydrocarbons of low specific gravity and with a low boiling point. M. A. Melamid and L. Grötzinger, Freiburg, Germany. Eng. Pat. 1489, Jan. 29, 1915. Under Int. Conv., Aug. 18, 1913.

SEE Ger. Pat. 276,765 of 1913; this J., 1915, 22. The material is heated with phosphoric acid in presence of inert gases or vapours and is kept in constant movement during the treatment.

Tar or tar oils or derivatives of tar: Method of treating — for the purpose of converting hydrocarbons having a high boiling point into hydrocarbons of a low specific gravity and with a low boiling point. M. A. Melamid and L. Grötzing. Freiburg, Germany. Eng. Pat. 1490, Jan. 29, 1915. Under Int. Conv., Aug. 20, 1913.

SEE Ger. Pat. 278,192 of 1913; this J., 1915, 269.

Method of converting heavy hydrocarbons into light hydrocarbons or hydrocarbon gases. Eng. Pat. 17,822. See IIA.

Liquid fuels. Eng. Pat. 107,451. See IIA.

IV.—COLOURING MATTERS AND DYES.

Analysis of organic dyestuffs by Formánek's method: Qualitative spectrum —. J. Pokorný. J. Soc. Dyers and Col., 1917, 33, 162—166.

CERTAIN criticisms of Formánek's method for the spectrum analysis of dyestuffs (this J., 1899, 611) are dealt with and several misstatements refuted. Contrary to the statement dealt with by E. J. Muller (Revue, 1903, 71), Aurophosphine G and Brilliant Phosphine 3G may be distinguished spectroscopically (Formánek, Zeit. f. Farb. Ind., 1903, 488). The spectroscopic method of analysis may be carried out readily with a pocket spectro-scope (direct vision with wave length scale). The so-called secondary bands, caused by contrast action, will frequently be noted, and, according to André, can be reproduced on the photographic plate. By fractional extraction with different solvents, mixtures of dyestuffs may be identified. André has stated that when the possibility of chemical action is eliminated, a material influence of the vibrations in dyestuff mixtures does not take place; it is a purely additive action. The suggestion as to the possibility of mobile maxima is erroneously attributed by F. H. Eijdmann and by F. Weigert (Ber., 1916, 1496) to Formánek, who has stated definitely that the maximum intensity of an absorption band retains its constant position at varying concentrations.—F. W. A.

Dyestuffs containing the pyridine ring. W. Harrison. J. Soc. Dyers and Col., 1917, 33, 179—183.

A SUMMARY of known dyestuffs of the pyridine series, obtained by condensing pyridine with cyanogen bromide and coupling with 2 mols. of an aromatic amine, is given, with their melting-points and the colour of the dyeings on silk or fanned cotton. Practically none of these dyestuffs has found application in dyeing or for the sensitising of photographic plates. Of the quinoline dyestuffs, the constitution of Ethyl Red and the sensitising action of the Isocyanines, Orthochrome I, Pinaverdol, and Pinacyanol, and other quinoline derivatives, are discussed. "Azalin" is a mixture of Quinoline Blue and Quinoline Red. Other quinoline derivatives are Quinoline Yellow, and the naphtho- and anthra-quinolines.—F. W. A.

PATENT.

Ortho[hydr]oxyazo dyestuffs: Copper compounds of — and process of making same. B. Wuth and C. Jagerspacher. Assignors to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,233,133, July 17, 1917. Date of appl., Oct. 7, 1915.

SEE Eng. Pat. 12,249 of 1915; this J., 1916, 922.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

PATENTS.

Silk fibres: Process for treating —. Kanegafuchi Boseki Kabushiki Kwaisha, Tokyo-Fu, Japan. Eng. Pat. 106,593, May 16, 1917. (Appl. No. 7050 of 1917.) Under Int. Conv., May 16, 1916.

FOR dissolving the sericin and loosening the fibres of silk, the cocoons or silk-waste are treated with the proteolytic enzymes in the juice extracted from the bodies or cocoons of the insects or silk-worms, at 40° C. for 45—60 mins., until the fibres are fully loosened. In the case of waste silk fibres a moderate quantity of the usual scouring reagents may be used for an auxiliary treatment.—J. F. B.

Fabric and coating; Waterproof —. W. H. Adams, Kenyon, R.I. U.S. Pat. 1,231,687, July 3, 1917. Date of appl., Nov. 30, 1915.

A THIN fluid waterproofing composition is made up of viscous hydrocarbon material, wax, and oil dissolved in or softened by a volatile solvent and mixed with a filler of fine cement, insoluble in the volatile solvent but capable of forming colloid substances by the slow action of hygroscopic moisture or carbon dioxide, so as to increase the impermeability and coherence of the composition when spread. A suitable composition comprises a mixture of asphaltum, carnauba wax, ceresin, aluminium oleate, and castor oil in a volatile solvent combined with finely-divided Portland or other hydraulic cement.—J. F. B.

Pulp for paper-making purposes and the like: Method of and apparatus for washing —. S. Milne, Edinburgh. Eng. Pat. 107,410, June 26, 1916. (Appl. No. 8947 of 1916.)

PAPER pulp, particularly pulp produced by the complete disintegration of printed waste papers, is washed on a wire cloth through which sprays of water are directed on the pulp from the opposite side. The principle may be applied to any of the usual pulp-washing devices, such as rotating wire drums or endless wire bands. The preferred type of machine consists of an inclined tray with a wire-cloth bottom subjected to a reciprocating motion in a longitudinal direction. A set of sprinklers is carried on a frame underneath, which is reciprocated at a considerably lower speed than the tray. The pulp is caused to flow from one end of the tray to the other and the sprays of water impinging on the opposite side of the wire float the impurities and keep the meshes of the wire free of deposit.—J. F. B.

Wood and vegetable substances; Apparatus for harvesting the constituents of —, distilling and purifying them. W. K. Freeman, Oswawana, N.Y. U.S. Pat. 1,231,247, June 26, 1917. Date of appl., Aug. 14, 1913.

AN apparatus for extracting soluble matters from wood, etc., comprises a rotary container supported on two cradles in an inclined position, the upper cradle being adjustable to permit proper adjustment of the container; a gear passes around the container and a pinion driven by a motor engages the gear. A fixed hollow shaft passes into the container, and pipes lead from the exterior of the shaft and discharge into the container; a strainer is provided on the hollow shaft and pipes leading from the hollow shaft to the exterior of the shaft through which fluids may be passed into the container through the strainer and through the shaft to the exterior again while the container is rotating.—J. F. B.

Paper; Manufacture [sizing] of —. C. W. Fish, Rawcliffe, Yorks. Eng. Pat. 107,820, July 13, 1916. (Appl. No. 9898 of 1916.)

ONE or more colloid substances or substances capable of producing colloids is mixed with the pulp containing the size and colour, and nitre cake or sodium bisulphate is added. For instance, a pulp sized with 8% of a 30% sodium resinate size is treated with about 5% of a mixture of china clay and colloidal starch, sodium aluminate, aluminium silicate or the like with nitre cake.

—J. F. B.

Fourdrinier [paper] machine. A. J. Davies, Kenogami, Quebec, Canada. U.S. Pat. 1,231,717, July 3, 1917. Date of appl. June 26, 1916.

IN a paper machine of the Fourdrinier type, a suction box is provided with a vertically oscillatory support with adjustable means for imparting limited motions to the box and for guiding these motions.

—J. F. B.

Paper; Method of and means for drying —. A. H. White, Brooklyn, N.Y., Assignor to International Paper Co., New York. U.S. Pat. 1,232,141, July 3, 1917. Date of appl. May 29, 1915.

IN machines where the web of paper passes over a series of drying cylinders, a blast of air is directed against the paper, in the pocket formed between two adjacent cylinders, at the point where the web leaves the first cylinder and in a direction contrary to the travel of the paper. The air becomes laden with moisture and tends to flow laterally towards the cylinder on to which the paper passes after completing the loop, and is drawn away by suction operating near this second cylinder, also in a direction contrary to the travel of the paper.

—J. F. B.

Magnetic separators. Eng. Pat. 107,284. See I.

Process for converting cellulose into glucose. Eng. Pat. 107,219. See XVII.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Laundering; Conservation of garments in —. H. G. Elledge. Sci. Amer. Suppl., July 14, 1917.

PRELIMINARY treatment with kerosene containing 1% of oleic acid followed by wringing in a centrifuge is recommended for the removal of grease stains. Soap and sodium carbonate, in addition to their detergent properties, apparently tend to conserve the strength of the fabrics; a similar function is attributed to the centrifugal extractor employed in laundries as compared with domestic washing. The effect of exposure to sunlight and of smoke in air-drying is considerable. The mechanical wear in washing is reduced by the use of a thick lather. Soap solution at 40°C. has a bactericidal efficiency of 98% for all the common pathogens, and the subsequent laundering processes have been proved to effect sterilisation.

—F. W. A.

Lamp for exposing patterns; A new [marble] —. A. Ganswindt. Deutsche Färber-Zeit., 1917, 53, 49. Chem.-Zeit., 1917, 41, Rep., 219.

THE marble lamp ("Marmorlicht") of Engel (Ger. Pats. 265,027 and 267,065; see this Journal, 1913, 87; 1914, 137) has thin plates of marble, alabaster, etc., the transparency of which has been increased by immersion in a solution of resin or of a cellulose preparation, such as shellac or celluloid. It has been found cheaper to use thicker marble plates polished on both sides and soaked at a high pressure and temperature in

non-volatile hydrocarbons; the necessity for enclosing the marble plates in glass is thus avoided. Photometric measurements showed that such marble is more transparent than ground glass. A further advantage is the fact that the marble plates are equally illuminated up to the edge, whereas with ground glass the luminosity decreases greatly towards the edges. In spite of its high transparency, marble absorbs the dark heat rays to a degree not hitherto attained.—F. W. A.

PATENT.

Dyeing [with sea-weed]. N. Malcolmson and H. H. Kelsey, London. Eng. Pat. 107,005, Apr. 5, 1916. (Appl. No. 4986 of 1916.)

THE material to be dyed is placed in a bath of water or spirit containing in the raw state or in paste or powder a sea-weed of the Rhodospirum, Chlorospirum, or Melanosperm group, to which sulphuric acid may be added to intensify or vary the colour imparted to the material. The use of dulce (Eng. Pats. 142 of 1881 and 1789 of 1902) and of laminaria powder in indigo paste (Eng. Pat. 1789 of 1902) is not claimed.—F. W. A.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Sulphuric acid; Rapid determination of the strength of —. H. D. Richmond and J. E. Merreywether. Analyst, 1917, 42, 273—274.

FOUR hundred grms. of water at 18°C. is measured into a vacuum-jacketed flask, provided with a stirrer and with a thermometer reading to 0.01°C. The temperature soon becomes constant and is read off; 5 c.c. of the sample is then pipetted in, allowing the pipette to drain for 15 secs., and the mixture is stirred until the temperature is again constant. The water equivalent of the calorimeter used by the authors was found to be 14.5 grms., and the volume of sulphuric acid delivered by a 5 c.c. pipette 4.911 c.c. From these data and from the results recorded by Pickering (Chem. Soc. Trans., 1890, 57, 64) the following formula was calculated:—% $H_2SO_4 = 100 - 7.6 (3.994 - R)$ where R is the rise in temperature. The results obtained agree with those found by titration. (See also Howard, this J., 1910, 3.)—W. P. S.

Potash from felspar. D. J. Benham. Canadian Chem. J., May, 1917. Met. and Chem. Eng., 1917, 16, 701—705.

A MIXTURE (110 tons) of felspar, coal, calcium chloride, and limestone is heated to a high temperature in a blast furnace, the limestone being used to give a fluid slag. A certain percentage of the potash is volatilised at about 900°C., but the reaction is not complete until a temperature of about 1600°C. is reached. The volatilised potassium chloride passes into a condenser, where it meets a current of steam; the chloride dissolves in the condensed water, and is obtained in a high state of purity by evaporation and crystallisation, over 90% of the potash content of the felspar being recovered. A satisfactory process for obtaining sodium compounds from the vapour has also been developed. The slag is converted into sewer-pipe, tile, and paving brick, and has a peculiar porcelain-like surface. It is stated to be possible to adapt the process to utilise cement marl instead of felspar, and either rotary kilns or blast furnaces of a certain type may be employed for volatilising the potassium chloride.

—B. N.

Polash from cement at the works of the Riverside Portland Cement Co. J. Treanor. Met. and Chem. Eng., 1917, 16, 701—703.

CLAYS and shales suitable for the manufacture of Portland cement vary in K_2O content up to 2.5%; about 40 to 50% of the total leaves the kiln with the kiln dust, and about 80% of this may be recovered by electrical precipitation, the dust collected containing from 4 to 10% of potash, usually water-soluble. By keeping the mixture at a minimum temperature of 85° C. during leaching and filtration, and maintaining proper conditions of concentration, the formation of an insoluble double sulphate of calcium and potassium may be prevented, and the whole of the potash may be recovered. A process has also been developed for obtaining a better volatilisation of potash from the clinker, by adding 0.8% of calcium fluoride for every 1% of K_2O . Potassium fluoride, which is easily volatilised, is formed, but is reconverted by the oxides of sulphur in the combustion gases into potassium sulphate, with the liberation of hydrofluoric acid. The latter is neutralised by the calcium compounds present in the dust, re-forming calcium fluoride, and, after leaching, the filter cake containing the calcium fluoride is returned to the kiln for further use. In this way 90% of the potash in the raw mixture may be volatilised, and 80% of the volatilised potash is caught by the dust collectors, the yield being further reduced, however, by about 5% in the leaching process. —B. N.

Purification of salts [e.g., ammonium nitrate] by "clairage," or by fractional crystallisation. E. Rengade. Comptes rend., 1917, 165, 237—240.

"CLAIRAGE" is the name given to the displacement by pure water or other solvent of the mother liquor from the crystals. The name may also be applied to the process of purifying a mixture of a soluble salt and some equally soluble impurity by washing with a solvent at a low temperature. The method of purifying salts by fractional crystallisation is the exact reverse of "clairage," but when the equilibrium between solvent and salts is the same and the final temperature is also the same, the same final results will be obtained. The author examines the theory of purification by "clairage" as typical of both methods, and takes the more general case in practical work, namely, the purification of a salt containing a different base and a different acidic ion from the impurity, when the salts may react by double decomposition and yield two other salts, so that the problem is one of the equilibrium between four salts in solution. As an illustration the author takes the case of ammonium nitrate mixed with a small quantity of sodium chloride, and examines what will occur when this mixed salt is treated with a very small quantity of water at first, gradually increasing this until only pure ammonium nitrate remains. If the initial quantity of water added be sufficiently small, the composition of the solution produced will be the same at a given temperature, and will be a function of that temperature, whatever may have been the proportions of the original salt mixture. To determine which of the four salts possible will remain, a drop of the liquid to be used for "clairage" was placed upon a microscope slide, and the four salts projected into it successively; ammonium nitrate, sodium nitrate, and ammonium chloride remained unaltered, whilst the sodium chloride was immediately decomposed, the distinctive crystals of ammonium chloride being rapidly formed. Therefore when a mixture of ammonium nitrate and sodium chloride is treated with a small quantity of water at the ordinary temperature, the sodium chloride will be completely replaced by sodium nitrate and ammonium

chloride. If the quantity of water be increased progressively, the ammonium nitrate, sodium nitrate, and ammonium chloride will dissolve simultaneously, the second in larger proportion than the third, but the composition of the liquid will remain constant until all the sodium nitrate has dissolved and there remains only a mixture of ammonium nitrate and ammonium chloride. At this point, supposing all the original solution to have been removed, a new equilibrium will be established, with a solution of constant composition corresponding to the simultaneous solubilities of the two salts, until the point is reached (the treatment being continued) when the ammonium chloride is completely dissolved, and the ammonium nitrate remains alone in a state of purity. Thus the purification is effected in two stages, and in order to determine the quantity of water necessary to purify completely a given mixture at a particular temperature, it is sufficient to ascertain by analysis the composition of the two saturated solutions corresponding to these stages.—J. B. C. K.

Iron sulphide; Electrolytic valuation of —. H. Williams. Chem. News, 1917, 116, 13—14.

IRON sulphide is used in chemical works for removing arsenic and other metals of the same group from commercial mineral acids, and as its value for this purpose depends upon the amount of monosulphide it contains, the oxidation methods of determining the sulphur contents are inapplicable for its valuation. The author has found that the amount of monosulphide can be most accurately determined by precipitating cadmium sulphide from a solution of a cadmium salt by the hydrogen sulphide evolved when the iron sulphide is treated with hydrochloric acid and zinc. The cadmium sulphide is converted into chloride and then into hydroxide, which is dissolved in potassium cyanide solution and the cadmium deposited electrolytically on a rotating cathode.—J. B. C. K.

Chlorine and hydrogen; Temperature coefficients of photochemical action on mixtures of — in monochromatic light. M. Padoa and C. Butironi. Gazz. Chim. Ital., 1917, 47, 11, 6—9.

THE intensity of photochemical action on a mixture of chlorine and hydrogen prepared electrolytically from hydrochloric acid was measured by determining the contraction in volume after exposure at definite temperatures in white, ultra-violet, and coloured light. According to Bevan (Proc. Camb. Phil. Soc., 12, 398) the temperature coefficient for an interval of 10° C. in the case of a mixture exposed to white light is 1.21. In the authors' determinations the following coefficients were obtained:—In white light, 1.29; green light (nickel sulphate solution screen), 1.50; blue light (copper sulphate screen), 1.31; violet light (methyl violet solution screen), 1.21; and ultra-violet light (mercury vapour lamp with nitrosodimethylaniline solution screen), 1.17.—C. A. M.

Granular calcium chloride as a drying agent. McPherson. See I.

Rapid method for determination of water-soluble arsenic in lead arsenate. Scholz and Waldstein. See XIXB.

Inadequacy of the basic ferric acetate test for acetates. Curtman and Harris. See XXIII.

Recovery of molybdenum residues. Lenher and Schultze. See XXIII.

PATENTS.

Nitric acid, hydrochloric acid, and like gases; Condensation, absorption, or other chemical treatment of — A. E. Charles and F. J. Lancaster, Kingston-upon-Hull. Eng. Pat. 107,255, June 28, 1916. (Appl. No. 9088 of 1916.)

HOLLOW cylindrical units are arranged one on top of another to form a tower, the bottom unit being connected to the gas inlet, and the top to the outlet. The top of each unit except the uppermost is increased in diameter to form a rim which serves as a seat for the bottom of the unit next above, an acid-tight joint being made by means of putty or the like. Each of the units intermediate between the top and the bottom is provided with a series of separate cooling or heating pipes; each pipe projects through opposite sides of the unit and delivers water (or heated oil) into the open upturned end of the pipe next below. The intermediate units have each a perforated bottom on which suitable packing is placed. The holes through which the cooling (or heating) pipes pass through the wall of a unit are each made of two diameters, that portion of the hole which is of larger diameter providing a space round the pipe which is filled in with suitable putty so as to make a tight joint between the pipe and the reduced portion of the hole. A tapered groove extends downwards at an angle from the bottom of the hole through which a pipe passes, and there is an annular groove in the inside of the wall of the unit, connected with the tapered groove, by which means any acid settling on the inside of the tower, or flowing back on the underside of the cooling pipes, is caused to flow in streams down the inside of the tower.—T. H. B.

Hydrochloric acid; Production of — E. C. R. Marks, London. From Tentelev Chemical Works, Ltd., Petrograd. Eng. Pat. 107,312, Sept. 21, 1916. (Appl. No. 13,431 of 1916.)

PURE hydrochloric acid is obtained by distilling the commercial acid in the presence of a concentrated solution of zinc chloride of such strength that it may be heated to 125° to 135° C. The operation is continuous, crude acid being introduced in quantity equivalent to the pure acid obtained.

—T. H. B.

Acetic acid; Manufacture of — H. Wade, London. From Holzverkohlungs-Ind. A.-G., Konstanz, Germany. Eng. Pat. 107,606, Apr. 26, 1916. (Appl. No. 6010 of 1916.)

FORMIC acid and empyreumatic substances are removed from acetic acid by distilling a mixture of about equal parts of the latter and 70% sulphuric acid, the temperature of the mixture being maintained at about 130° C. Further quantities of crude acid are added, corresponding to the amount of acetic acid distilled off. A sufficient proportion of water must be maintained to prevent destruction of the acetic acid; concentrated aqueous solutions of soluble sulphates may be used as a diluting agent instead of water. At the temperature employed, formic acid is destroyed, but acetic acid is not affected. (Reference is directed, in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pat. 28,595 of 1902; this J., 1903, 291.)—T. H. B.

Zinc sulphide; Process for oxidising — C. J. G. Aarts, Dongen, Holland. Eng. Pat. 101,978, Oct. 26, 1916. (Appl. No. 15,260 of 1916.) Under Int. Conv., Oct. 26, 1915.

ZINC sulphide is oxidised to sulphate by heating it with oxygen or gases containing oxygen, under pressure higher than that of the atmosphere.

—T. H. B.

Strontium sulphate; Treatment of impure — A. A. Roberts, London. Eng. Pat. 107,324, Oct. 30, 1916. (Appl. No. 15,447 of 1916.)

IMPURE strontium sulphate—e.g., the waste obtained from the treatment of ground strontium sulphate spar on vanning tables—is lixiviated, dried, and re-ground. It is then agitated with strong commercial hydrochloric acid at about 110° C. The impurities are thus dissolved, and a subsequent thorough washing of the paste leaves it quite white and neutral, and ready, when elutriated, for use as a pigment. The acid vapours given off during the solution process may be utilised by passing them over heated strontianite or strontium carbonate to produce strontium chloride; or the vapours may be condensed and the aqueous acid used in a similar manner, or for the purification of a further quantity of strontium sulphate.—E. W. L.

Cyanogen compounds; Production of — A. R. Lindblad, Ludvika, Sweden. Eng. Pat. 107,426, June 29, 1916. (Appl. 9183 of 1916.)

AN alkali silicate is heated in an electric furnace, with carbon and lime, and exposed to the action of nitrogen while heated to such a temperature that cyanogen compounds are formed. The lime is added in such quantity that the slag formed will be suitable for cement making. The cyanogen compounds are led off from the furnace with other gaseous products. The addition of lime increases the yield of cyanide.—T. H. B.

Silicates; Treatment of — A. H. Cowles, Searan, N.J., U.S.A. Eng. Pat. 107,640, July 4, 1916. (Appl. No. 9418 of 1916.)

LEUCITE, felspar, or a similar silicate, is heated with a calcium compound such as the oxide, to a temperature which may be below the fusing point, but is sufficiently high to drive off approximately all the carbon dioxide, and cause chemical reaction between the constituents of the mixture. The proportions are such that the product contains two molecules of alkaline-earth oxide to one molecule of silica, and less than two molecules, but at least one, of alkali oxide to one molecule of alumina. Soluble alkali compounds and alumina are separated from the mass by leaching; at least 85% of the alumina may be thus recovered.—T. H. B.

Hydrogen, pure Glauber salts, and a gas purifying mass; Production of — from iron scrap and bisulphate of soda. P. Becquevort, Folkestone, and C. Deguide, Pas-de-Calais, France. Eng. Pat. 107,807, July 11, 1916. (Appl. No. 9747 of 1916.)

A SOLUTION of sodium bisulphate of density 20° B. (sp. gr. 1.16) is added to scrap iron in a suitable tank and heated by steam to 90° C. The liberated hydrogen is washed and collected in a holder. The resulting solution of ferrous and sodium sulphates is treated with an excess of powdered lime, producing a mixture of calcium sulphate and ferrous hydroxide, which is aerated to convert the latter into ferric hydroxide. The mass is filter-pressed, and the solution flowing away is concentrated to 30° B. (sp. gr. 1.26) and Glauber's salt separated by crystallisation. The material left in the filter-press is used as a gas-purifying agent.—T. H. B.

Aluminium nitride; Process of manufacture of — O. Serpek, Assignor to Soc. Gén. des Nitrures, Paris. U.S. Pat. 1,233,925, July 17, 1917. Date of appl., Aug. 12, 1915.

SEE Eng. Pat. 11,271 of 1915; this J., 1916, 115.

Aluminium nitride; Process for the manufacture of—O. Serpek, Assignor to Soc. Gén. des Nitrures. Paris. U.S. Pat. 1,233,926, July 17, 1917. Date of appl., Aug. 1, 1916.

SEE Eng. Pat. 101,091 of 1916; this J., 1917, 503.

VIII.—GLASS; CERAMICS.

PATENTS.

Furnaces for melting glass or other materials. L. Grote and A. W. H. Vivian, London. Eng. Pat. 107,211, Apr. 19, 1916. (Appl. No. 5735 of 1916.)

A RECTANGULAR furnace with one crescent-shaped end and the fires or burners at the opposite end, is provided with an outlet flue at each side, close to the junction of the sides and the rounded end of the furnace, one outlet being in a higher plane than the other. It is stated that the furnace gases travel straight forward until they reach the end of the straight sides of the kiln, after which they assume a cyclonic path and pass away through the outlet on the opposite side of the furnace to that along which they first travel.—A. B. S.

Drying china clay. T. M. Stocker, St. Austell. Eng. Pat. 107,866. (Appl. Nos. 12,368, Aug. 31, and 16,198, Nov. 11, 1916.)

THE clay is laid on a floor below which are longitudinal flues communicating with a chimney. Fireplaces are erected at one end of the drying floor, and the products of combustion pass through the flues under the floor to the chimney. The hot moist air rising from the clay is drawn off, and used in the combustion of the fuel, whereas in ordinary dryers of this type it remains in the drying chamber and hinders rapid and economical drying.—A. B. S.

Kilns or ovens for firing bricks, tiles, pipes, china, and such like ceramic ware. T. West, Durham, and W. I. G. Lewis, Tamworth. Eng. Pat. 107,678, July 28, 1916. (Appl. No. 10,688 of 1916.)

BENEATH the perforated floor of a round or rectangular up-draught kiln, flues are arranged so as to leave as open a space as possible in which the fire gases may circulate. In the case of a round kiln, for example, two annular flues are provided, connected by cross flues with each other and with segmental spaces between the double walls of the kiln. The products of combustion from the fires are discharged directly into the top of these segmental spaces and pass down them into the annular flues and up through the perforated floor of the kiln. In the case of a rectangular kiln with fires at each end, the products of combustion are passed through two or more downcast flues into an equal number of flues beneath the floor which run the whole length of the kiln and discharge their contents through the perforated floor above them.—A. B. S.

Enamels; Production of—J. E. Pollak, London. From R. Koepp und Co., Oestrich, Germany. Eng. Pat. 107,392, Mar. 28, 1916. (Appl. No. 4571 of 1916.)

THE addition of cobalt, nickel, manganese, copper, and some other oxides to an enamel greatly increases its adhesion. Cobalt oxide is the best, but is expensive. Nickel oxide is good, and much cheaper. Manganese and copper oxides are not satisfactory alone. It has, however, been found that cobalt ores containing (say) 23% manganese oxide, 4% cobalt oxide, and 2.6% nickel oxide may be used satisfactorily and much more cheaply than pure cobalt and nickel oxides. The ores

used for this purpose should be free from sulphur and arsenic; iron oxide is no detriment. The mixture, whilst excellent for groundwork, is almost useless for colouring the surface of enamels.

—A. B. S.

Magnetic separators. Eng. Pat. 107,281, See I.

IX.—BUILDING MATERIALS.

Silica; The refractory properties of—H. Le Chatelier and B. Bogitch. Comptes rend., 1917, 165, 218—224.

THE reputed melting point of kaolin (1700° C.) is the same as that of silica, but is really the temperature at which the clay can just sustain a load of about 1 gram. per sq. cm. If the material is loaded with 10 kilos. per sq. cm., its melting point will be 400° C. lower. Silica, on the contrary, has a true melting point which is independent of the pressure, and shows no appreciable softening. The pressure required to crush an article made of silica decreases progressively with increased temperature as shown by the following results on a "Star" (U.S.A.) silica brick: 15° C., 170 kilos. per sq. cm.; 520°, 158; 670°, 150; 800°, 139; 950°, 125; 1050°, 120; 1200°, 85; 1320°, 62; 1460°, 50; 1540°, 37; and 1600° C., 30 kilos. per sq. cm. On extrapolating these figures to 1700° C. (the normal temperature of the arches of steel furnaces), the crushing strength of the bricks would only be 12 kilos. per sq. cm., but as this is about ten times the pressure of the superincumbent brickwork, the stability of the bricks in the arches is assured. This mechanical strength at high temperatures is a special characteristic of silica bricks; it is not possessed by clay or magnesia bricks, though magnesia has a higher melting point than silica. In a silica brick the silica forms a continuous network the pores of which are penetrated by the molten silicates without affecting the strength of the brick. The formation of this network by the recrystallisation of the silica is due to the different solubilities of the various forms of silica, quartz crystallising from the molten magma first as cristobalite and later as tridymite. The quality of silica bricks depends primarily on the development of a satisfactory network by careful control of the proportion of fluxes, the temperature of the bricks when in use, the formation of the network, and its eventual destruction. Several bricks which gave excellent results in use were found to contain 3—5% metallic oxides corresponding to 8—14% sulphates, the ratio of the oxides to sulphates averaging 35:100. This ratio may be determined with fair rapidity and is characteristic of satisfactory silica bricks. The temperature at which the bricks should be burned depends on the purpose for which they are to be used. For lining steel furnaces, a burning temperature of 1700° C. is desirable. For the distillation of oil, on the contrary, a much lower burning temperature will suffice and the bricks may contain twice the amount of metallic oxides mentioned above.

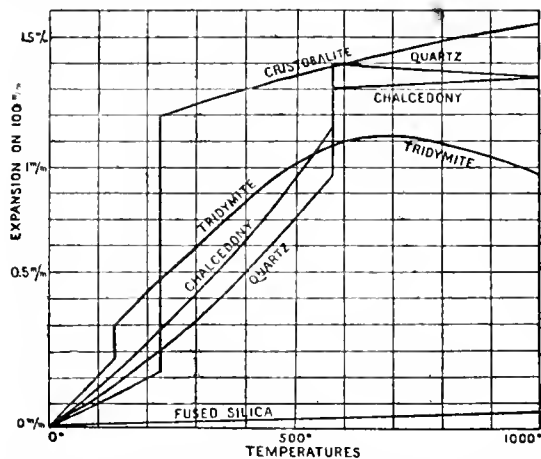
The formation of the network is the most delicate part of the manufacture of silica bricks. It requires a prolonged heating at about 1150° C. for several days, the rate of formation being most rapid when the grains of quartz in the brick are extremely minute. A sufficiency of larger grains must be present, however, in order to prevent the formation of the minute fissures which are produced when the material is composed wholly of fine grains.

When the bricks in use are heated rapidly to the temperature at which any unconverted quartz grains are inverted, the expansion which accompanies this change of form breaks the network and lessens the strength of the bricks. Moreover, the pressure of the brickwork in an arch opposes any

lateral expansion and produces spalling, which is one of the worst defects of badly-made silica bricks. In a well-burned brick, an expansion also occurs at the moment when larger grains of quartz are inverted to cristobalite, but its effect is less serious, as these grains are able to expand in all directions, and it occurs sufficiently slowly for the network to be reformed at the point where it has been damaged. Nevertheless, this phenomenon notably reduces the strength of the bricks. The results of determinations of the sulphate equivalent of the oxides, true and apparent sq. gr., and the crushing strength at 1600° C. after sixty re-heatings showed clearly that good silica bricks, after heating for 1 hour at 1600° C., have a crushing strength of at least 10 kilos. per sq. cm. A prolongation of the heating at this temperature reduces the crushing strength of well-fired bricks, but increases that of underburned ones.—A. B. S.

Silica bricks. H. Le Chatelier. *Rev. Mét.*, 1917, 14, 74—83.

THE chief phenomenon concerned in the manufacture and use of silica bricks is the transformation of quartz into two other forms of silica—cristobalite and tridymite. This transformation is



accompanied by a recrystallisation which makes the bricks very strong at high temperatures, and by an expansion, which causes an increase in the porosity and a loss in the strength of the bricks, and may result in their destruction. The various forms of silica may be divided into two groups according to the accuracy with which their chief characteristics have been established.

GROUP I.

Variety.	Symmetry.	Specific gravity.	Inversion point.
Quartz	Ternary	2.65	570° C.
Cristobalite	Quadratic	2.33	225° C.
Tridymite	Orthorhombic	2.27	117° and 674° C.
Vitreous silica ("fused silica")	Amorphous	2.22	—

GROUP II: Chalcedony; hydrated silica; calcined precipitated silica. The ratio of expansion to temperature for each of these materials is shown in the figure. At 1000° C., tridymite, cristobalite, and fused silica all have approximately the same specific gravity, viz., 2.20.

Formation of cristobalite. A specimen of "quinqet" (aluminous) glass examined by the author (this J., 1916, 837) contained irregular spherulites of cristobalite, 1—3 mm. in diameter, formed at 800° C. Arch bricks obtained during the demolition of old glass furnaces showed a superficial

fusion due to the action of sublimed alkali. Cristobalite crystals occur in part of this semi-fused material, these crystals also containing a large number of minute tridymite crystals which show under the microscope as granulations. Silica bricks made with more than the usual proportion of flux, when burned at 1700° C., form a glassy mass which unites the grains of sand, becomes saturated with silica from the latter, and slowly recrystallises on cooling. The crystals thus formed on the surface of the sand-grains are transformed by the heat into cristobalite. The abundance of these crystals shows that with suitable proportions of flux, the sand-grains would be united with a crystalline bond and to this the bricks owe their strength. Cristobalite also occurs in furnace linings composed of ganister and clay, and containing about 10% of metallic oxides. The most characteristic specimens are those taken from just below the superficial ferruginous crust in Bessemer converters in a region where the amount of re-heating is considerable and the cooling is rapid. The author concludes that in all cases where silica crystallises rapidly from a glass, it is in the form of cristobalite. The grains of quartz which are directly inverted into cristobalite are best recognised by their peculiar appearance—that of a mass of very small spheres—caused by fissures due to the sudden reduction in volume (about 1% linear shrinkage, at the transformation point (225° C.). These fissures reduce the strength of silica bricks; they may be lessened by cooling very slowly or increased by rapid heating to 500° C., followed by rapid cooling.

Formation of tridymite. Though cristobalite is more stable than quartz, it is less so than tridymite and is gradually inverted into the latter under the same conditions as those favourable to the inversion of quartz into cristobalite, though a longer time is required. In the customary burning of silica bricks a small proportion of tridymite is produced; its amount is increased on each subsequent heating; inversion to tridymite is complete in bricks which have been long in use in some steel furnaces. The rate of formation of tridymite is about one-hundredth of that of cristobalite.

Conditions of stability of tridymite. At temperatures above 1000° C., cristobalite is metastable and under some conditions is the most stable crystalline form of silica. Fenner's conclusion (*Amer. J. Sci.*, 1913, 36, 383; this J., 1913, 22) that tridymite only constitutes the stable phase up to 1480° C. and above this temperature and up to its fusion point (1780° C.), cristobalite is the stable phase, is opposed to those reached by the author. The latter found that bricks obtained from steel furnaces, where the temperature is much above 1480° C., contained tridymite, and he suggests that Fenner's conclusions are based on insufficient evidence. The author heated a piece of silica brick consisting wholly of tridymite to 1700° C., but whilst, according to Fenner, it might be expected that it would be converted into cristobalite, actually no change occurred. An examination of part of the arch of a Martin's steel furnace showed the same thing, the crystals of tridymite being present in material which must have been heated to 1750°—1800° C. Hence tridymite is the only crystalline form of silica which is perfectly stable at high temperatures.—A. B. S.

Polash from cement. Treanor. See VII.

PATENTS.

Furnaces or kilns for roasting cement, magnesia etc. B. E. D. Kilburn, London. From Beocor Cementgyári Ünio Részvenytársaság, Budapest Hungary. Eng. Pat. 107,209, Apr. 6, 1916 (Appl. No. 5075 of 1916.)

A VERTICAL shaft is fitted with a movable grate

provided with toothed or crushing bars. The grate may consist of a horizontal slotted disc, with radial, toothed bars, rotated by means of a pulley on the vertical shaft below the grate, or the grate-bars may form part of an endless chain conveyor, underneath which a screw conveyor is fitted at right-angles so as to remove the material which has passed between the bars. In another modification the bars are placed longitudinally on the periphery of a conical drum, the central shaft in which is mounted obliquely, so that the bars immediately below the shaft are in a horizontal position, the material falling through them passing to the ground beneath the drum or out through the wider end of it.—A. B. S.

Fire-resisting composition and its application to the moulding of boards, sheets, and flooring blocks, and as a covering for walls, roofs, and floors. R. Y. Ardagh, Hove. Eng. Pat. 107,402, June 14, 1916. (Appl. No. 8400 of 1916.)

COCONUT shell is ground in a disintegrator to the size of coarse oatmeal. The short fibre is passed through a sieve and is then mixed with an equal bulk of magnesite in the dry state, and the mixture is made plastic or even liquid by adding magnesium chloride solution. The composition readily adheres to soft wood, but harder woods require to be grooved, or corrugated paper or felt may be glued to them. It may be moulded on corrugated paper and then sawn into blocks or boards. (Reference is directed, in pursuance of Sect. 7 Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pat. 17,908 of 1898.)—A. B. S.

Road surfaces composed of mineral aggregates and bituminous binders; Construction of— H. Rorke, Kingston Hill, Surrey, legal representative of E. Rorke. Eng. Pat. 107,483, Sept. 20, 1916. (Appl. No. 13,337 of 1916.)

THE stone or other mineral aggregate is divided into two sizes, the larger size (over $\frac{1}{4}$ in. diameter) being coated with pitch, and the smaller size (less than $\frac{1}{4}$ in. diameter) with bitumen. The two coated materials may then be effectually mixed at a suitable temperature so that they may be laid on the road as one coat, the larger material automatically taking the lower position, and the finer material filling the interstices and forming a close surface coating during the subsequent operations of spreading, rolling, and beating the road. The proportion of each binder required depends on the nature and size of the mineral aggregate used.

—A. B. S.

Plastic composition for use in the manufacture of mouldings. F. J. Tomalin, Northampton. Eng. Pat. 107,557, Mar. 21, 1917. (Appl. No. 4108 of 1917.)

ABOUT 40 lb. of whiting is mixed with water, the mixture is left until sufficient water has evaporated to convert it into a stiff paste, and then 30 lb. of glue or size, previously melted in a hot-water-jacketed vessel, is added. About 1 pint of turps and $\frac{1}{2}$ lb. of stearin wax are added to the mixture, and the whole is thoroughly stirred; 5—10 lb. of taster of Paris or Keene's cement made into a thick paste with turps is then added to give the composition the required degree of firmness. The composition is placed in a hot-water-jacketed vessel, and when thoroughly mixed it is fed to the moulding machine.—A. B. S.

Bituminous cements. E. W. Pattison, Manchester. From T. Moniwa, Akasaka, Japan. Eng. Pat. 107,613, June 1, 1916. (Appl. No. 7756 of 1916.)

TO avoid the staining of glazed bricks, etc., laid in ordinary cement, and to provide a cement applicable to materials with smooth and non-absorbent surfaces, a cement is used consisting of bitumen

20—25%, asphaltine 14—17%, quartz, asbestos, and the like 66—58%. The coefficient of expansion of this cement may be made the same as that of the materials to be united by varying the proportion of quartz or silica. For use, the cement is melted and then applied thinly to the surfaces to be united.—A. B. S.

Cementing material and manufacture of compositions therefrom. T. D. Kelly, Hove. Eng. Pat. 107,951, Apr. 21, 1917. (Appl. No. 5612 of 1917.)

A TOUGH cementing material, proof against extremes of heat and cold, water, oil, and acids, is made by mixing 5—10 parts of an adhesive oxidised or polymerised oil, 5—30 parts of water glass, and 100—300 parts of Portland cement. To this mixture, while plastic, 500—1000 measures of any filling material which is not of a greasy or oily nature may be added, and the whole compressed in moulds or by means of rollers. The setting of the material is accelerated by heat; it neither expands nor contracts after heating to 2000° F. (about 1096° C.) for six hours, and is as waterproof and as hard after such heating as before.—A. B. S.

Cement; Acid-proof— R. Haddan, London. From Electro-Chemical Supply and Engineering Co., Philadelphia, U.S.A. Eng. Pat. 108,278, Mar. 26, 1917. (Appl. No. 4360 of 1917.)

SEE U.S. Pat. 1,220,575 of 1917; this J., 1917, 504. The composition from which the cement is made contains apatite or pure calcium phosphate in addition to silicious material and sodium silicate.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Steel; Quenching of— H. Le Chatelier. Comptes rend., 1917, 165, 172—174.

THE author points out the confirmation that A. Le Chatelier's theory of the transformation of the iron-carbon alloys (Bull. Soc. d'Encour., 1895, 1340) receives from recent experimental work, viz., that of Portevin (this J., 1917, 720) and Dejean (see below) by thermal methods, and Chevenard (this J., 1917, 881) by dilatation measurements. Martensite is regarded as a solid solution of carbon in α -iron. Pearlite is the product of resolution of austenite whereas troostite is the form of the mixture of cementite and ferrite as produced by the resolution of martensite.—H. J. H.

Iron; Carburisation of—by cyanides and cyanates. Portevin. Comptes rend., 1917, 165, 180—182.

WHEN iron is case-hardened by heating at 806°—900° C. in presence of cyanides or ferrocyanides, cyanates are always present. The effect of the cyanates was studied in the carburising of iron wires (C=0.03—0.08%, Mn=0.41%) in which mixtures of potassium cyanide and cyanate in different proportions were used. It appeared that cyanates were necessary to rapid carburisation, and the best results were obtained when 25—40% of cyanate was present in the mixture used. This is perhaps the reason for the inclusion of oxidising agents (potassium nitrate or bichromate) in case-hardening mixtures.—H. J. H.

Troostite and martensite; Formation of— P. Dejean. Comptes rend., 1917, 165, 182—185.

DIFFERENTIAL cooling curves for a steel (W=18%, Cr=4%) are given showing the influence of the initial temperature in the transformations. When the initial temperature varies from 850° to 900° C., a transformation (A) occurs between

700° and 800° C.; with initial temperatures above 900° a second transformation (B) appears just above 400°, while the first point disappears if cooling begins from temperatures above 980° C. Steels which have shown the point A are pearlitic or troostitic; those which have shown B are martensitic and those showing A and B together both troostitic and martensitic. It is concluded that A marks a resolution of austenite to pearlite or troostite. In the latter case, part of the carbon remains in solid solution in residual austenite which is resolved at a lower temperature into martensite. There is a marked discontinuity between the points at which troostite and martensite appear, but none between those at which troostite and pearlite are formed. To suppress the formation of troostite and obtain martensite alone it is necessary to start from an initial temperature which increases as the rate of cooling is diminished.

—H. J. H.

Manganese and chromium: Rapid determination of— in metallurgical products. Travers. *Comptes rend.*, 1917, 165, 187—189.

IN the estimation of manganese as permanganate by oxidation with ammonium persulphate in presence of silver nitrate, the solution should not be boiled after addition of the reagents, otherwise low results will be obtained, possibly by the reduction of permanganate by hydrogen peroxide formed from the persulphate. The permanganate is titrated with sodium arsenite solution, the latter being added to the former, except when small volumes are used, as in back titrations. Details of analysis are as follows:—0.2 gm. of carbon steel is dissolved in 20 c.c. of nitric acid (sp. gr. 1.1) and 30 c.c. of cold water is added so as to bring the temperature to 40—50° C.; 5 c.c. of N 10 silver nitrate and 1 to 1.5 c.c. of saturated solution of ammonium persulphate are added and the mixture shaken. Three minutes after the appearance of the violet colour, the mixture is poured into 100 c.c. of cold water and titrated at once with sodium arsenite until the colour is discharged. If the Mn content is greater than 0.5%, a greenish-yellow colour is produced. The arsenite solution should contain 0.650 gm. of As_2O_3 per litre, when 1 c.c. = 0.0002 gm. Mn or 0.1% Mn on the sample. Titrating at a temperature below 36° C. no appreciable re-oxidation of manganese occurs. With suitable modifications the method can be applied to chrome, tungsten, vanadium, and molybdenum steels, also to cast iron, iron and manganese ores, slags, brasses, and bronzes. In chrome steels, the chromium can be determined by titration with the same sodium arsenite solution, of the sample dissolved in nitric acid of sufficient concentration (20 c.c. of nitric acid of 36° B. per 100 c.c. of solution). Unlike ferrous solutions and titanous chloride, sodium arsenite is stable and does not reduce vanadium which often accompanies chromium in steels.—H. J. H.

[Copper ore] tailings; Ammonia leaching of Calumet— C. H. Benedict. *Eng. and Min. J.*, 1917, 104, 43—48.

A 2000-ton leaching plant is in operation for treating the tailings from the Calumet and Hecla Mining Co.'s mills. The principle of the process consists in dissolving the native copper in ammonium carbonate in presence of air; the cupric salt formed dissolves more copper, forming a cuprous salt which oxidises rapidly and is thus capable of dissolving more metal. The resulting solution is distilled with steam, the ammonia and carbon dioxide being recovered; the copper oxide is precipitated as a heavy powder which is smelted along with the native copper concentrates. The mill tailing is passed through settling tanks and classifiers, the slimes from which are wasted at

present. The sand is treated with ammonia solution by percolation in eight steel tanks 54 ft. in diameter and 12 ft. high, with water-sealed covers and filter bottoms of wood grating covered with coco matting and duck. The leaching liquors are oxidised by blowing air through them, the ammonia given up being absorbed in a wash solution. The time taken for leaching is 90 hours. The stills consist of superimposed cylindrical sections fitted with a central vertical shaft carrying a scraper for each section, to prevent adhesion of scale. 90% of the copper is recovered in two "roughing" stills connected in parallel, and the remaining 10% in a finishing still from which the spent liquor runs into a settling tank. The total cost is given at \$0.406 per ton of tailing, or \$0.05—0.06 per lb. of copper. The loss of ammonia is just under 1 lb. per ton of sand; the average extraction is now about 75%. There is no fouling of the liquors.—W. R. S.

[Copper ores:] Sulphatising [—] with weak sulphurous gases. G. C. Westby. *Eng. and Min. J.*, 1917, 104, 119—122.

THE low-grade ores from the Nevada Douglas Consolidated Copper Co.'s mine (Ludwig, Nev.), containing acid-soluble lime and alumina besides difficultly soluble copper minerals, are now successfully leached by direct contact with gases from the roasting furnaces in presence of steam and percolating liquor. The oxide or roasted sulphide ore is crushed to pass a 1-in. ring and discharged on to a 10 mesh-screen, oversize and undersize being treated separately. The coarse material is leached in six closed redwood towers, 40 ft. in diameter and 21 ft. high, provided with a filter bottom through which the hot gases are admitted; the gases are drawn off at the top of the ore column by hard-lead fans, and introduced into the next tower. The leaching liquors are sprayed on to the top of the ore by nozzles located around the inner periphery of the towers. The time required for leaching is as follows: 37% extraction, 10 days; 82%, 20 days; 92%, 30 days; 98%, 40 days. The slow action during the first 10 days is due to the sulphatisation of lime and alumina. The fine material is treated in four gas-tight tanks, 14 ft. in diameter and 20 ft. high, filled with a network of 1×1 in. wooden strips with 2×4 in. spacers, over which the fines and the liquor fall in retarded cascades through the sulphurous fumes. A steam jet blows the fumes through the tower and assists the action by raising the temperature. The cost of treatment is \$0.947 per ton of ore for coarse and \$0.930 for fine ore. The gases used contain from 0.3 to 5.5% of sulphur dioxide, but the process is equally successful with rich or poor gases. The dissolved copper is recovered by precipitation with iron.—W. R. S.

Copper refining: Impurities in electrolytic— L. Addicks. *Met. and Chem. Eng.*, 1917, 16, 687—692.

THE general question of impurities is discussed under five main headings: (1) sources, (2) exits, (3) distribution, (4) recovery of soluble impurities from the electrolyte, (5) recovery of insoluble impurities from the anode slimes. Apart from the pig copper, the chief sources of impurities are fuel, fluxes, and acids, and the exits are outgoing commercial products, slags, and stack gases; the tendency to-day is to check stack losses. The distribution of impurities depends partly upon their chemical characteristics and partly upon the metallurgical practice of the individual plant. Silver, gold, tellurium, and selenium, which do not dissolve in the electrolyte, show a cathode recovery of over 99%. Nickel passes into solution to the extent of nearly 99%, and arsenic forms a light slime, which passes chiefly into solution, the re-

covery being 97%. Iron and zinc also pass principally into the electrolyte, whilst lead, antimony, bismuth, and sulphur pass chiefly into the slimes. In the purification of the electrolyte, sufficient must be withdrawn daily to control the amounts of the chief impurities, generally nickel and arsenic. The early methods of purification consisted in separating the copper by means of scrap iron, but this was later displaced by the manufacture of commercial copper sulphate. The modern method of purifying the electrolyte is to divert part of it to tanks containing insoluble lead anodes, at a rate sufficient to keep the determining impurity, generally nickel or arsenic, at the desired point. From these tanks good cathode copper is obtained, then a poor copper which is returned to the anode furnaces, and finally sludge which passes to the smelter. The liquor is then passed into a steam boiling tank and into evaporators, and finally on to sand filters for removing the nickel salts, the liquor being afterwards cooled to separate the sodium salts. The strongly acid filtrate is then again used as electrolyte.—B. N.

Lead-zinc flotation; Selective —. L. L. Kirtley. Eng. and Min. J., 1917, 104, 64—66.

TESTS were made with quantities of 15—20 lb. of lead-zinc slimes such as are ordinarily treated on slime tables. The method of working aimed at obtaining the lead first in a concentrate as low in zinc as possible, with a tailing as low in lead as possible, and working up the latter for zinc. The highest lead extraction was obtained with 2 lb. of hardwood creosote per ton of dry slime, mixed with 5—7 times its weight of cold water containing 0.1% of sodium carbonate. For the recovery of zinc, a fuel oil called "Texana No. 7" proved a good filming agent, while Georgia pine turpentine No. 205 produced a serviceable froth. A mixture of the two oils was used (2 lb. per ton), the fuel oil always predominating. By adding $\frac{1}{2}$ lb. of copper sulphate per ton of slime, low-zinc tailings were obtained. The rough lead and zinc concentrates were again floated in "cleaners," the addition of oil being unnecessary. Some of the results obtained are tabulated below:

	Pb %	Zn %
average head assay	7.0	7.8
final lead product	35.8	12.4
final zinc product	16.2	29.3
extraction in lead product	58.3	18.1
extraction in zinc product	27.1	43.7

By making the zinc "cleaner" test shorter, the grade of the product could be raised to 33%. The machines used were of the Callow and Minerals separation type; the selective action seemed more pronounced in the Callow machine.

—W. R. S.

PATENTS.

Steel alloy. Stahlwerke R. Lindenberg A.-G., Remscheid-Hasten, Germany. Eng. Pat. 104,670, Aug. 17, 1916. Under Int. Conv., Feb. 26, 1916. (Appl. No. 11,664 of 1916.)

THE high speed steel contains, in addition to iron, 6—1.2% C, 1.0—2.0% Mn, 0.1—0.3% Si, 3.0—10.0% Cr, and 1.0—5.0% Co. It may be improved in efficiency by the addition of 0.15—2.0% of V.

—B. N.

Iron ore; Process for treating — for the recovery of iron and manufacture of steel therefrom. L. P. Burrows, Ottawa, Canada. Eng. Pat. 107,644, July 5, 1916. (Appl. No. 9475 of 1916.)

TEAM under pressure is allowed to expand within metal container surrounded by air, part of the

water is precipitated, whilst a portion of the oxygen in the steam is believed to "radiate" through the container. The gases passing from the container are heated, and then allowed to act upon the iron ore in a closed vessel, the product being finally withdrawn, and the metal recovered by melting.—B. N.

Crucible furnace for melting metals. P. V. Paisy, Paris. Eng. Pat. 102,959, Dec. 19, 1916. (Appl. No. 18,201 of 1916.) Under Int. Conv., Dec. 27, 1915.

THE crucible is placed in a small chamber communicating with a combustion chamber, below and to one side of it, having an inclined wall extending downward from the bottom of the crucible chamber. Gas burners are placed in the upper part of the lateral walls of the combustion chamber, and the burning gases pass over the crucible and thence into an exhaust chamber, through which or around which the secondary air for combustion is passed to preheat it. Any dross overflowing from the crucible runs down into the combustion chamber, from which it may be withdrawn through a door at the side.—W. F. F.

Crucible melting furnaces. I. Hall, Birmingham. Eng. Pat. 107,286, Aug. 10, 1916. (Appl. No. 11,279 of 1916.)

IN a crucible melting furnace using solid fuel such as coke, the crucible is supported on a stand carried by the firebars in a vertical cylindrical casing provided with a firebrick lining. An annular air passage is provided in the lining, below the firebars, into which air is injected tangentially and from which the air is delivered to the space below the firebars through radial openings in the lining. A door is provided in the outer casing extending above and below the firebars, so that the fire and the ash space below are both accessible. The door may carry a segment of the refractory lining containing the annular passage and radial openings.—W. F. F.

Crucible furnaces for use in melting metals. T. W. Aitken, Luton. Eng. Pat. 107,468, Aug. 21, 1916. (Appl. No. 11,828 of 1916.)

IN a crucible furnace for melting metals, an outer cylindrical casing supported on trunnions is provided with an inner refractory lining spaced from the casing so as to leave an annular space into which the air supply is delivered. Tuyères are provided in the refractory wall near the bottom, inclined downward and expanding laterally toward the combustion chamber, so that they practically meet one another at the inner wall and thus equalise the air blast. A similar set of tuyères is provided at a higher level to admit a further supply of air to deflect the hot gases toward the crucible. Each tuyère is provided with a corresponding inspection door in the outer casing.—W. F. F.

Furnaces. H. N. Davis and W. R. Twigg, Luton. Eng. Pats. (A) 107,263, (B) 107,264, and (C) 107,433, July 6, 1916. (Appl. Nos. 9543, 9545, and 9544 of 1916.)

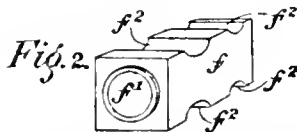
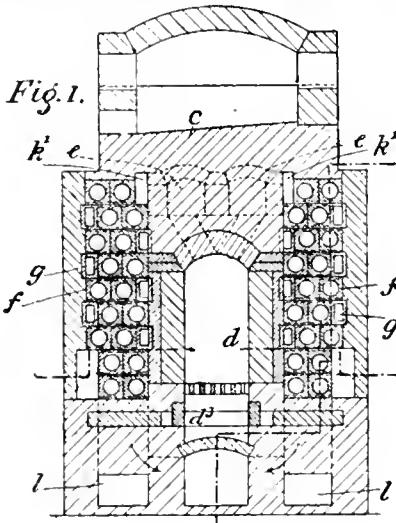
(A) IN a gas or oil fired furnace for heating steel billets or ingots, crucibles, or the like, the combustible gaseous mixture is sprayed from a horizontal series of burners through a number of horizontal openings just below the crown of a half arch forming the roof of the combustion chamber. The objects to be heated are supported on a platform raised above the floor of the combustion chamber so that the hot gases deflected downward by the arch pass over and under the platform to vertical flues at the side extending downward to an outlet flue below the combustion chamber. The secondary air for combustion is preheated by passing it through a pipe in the outlet flue. (B) In a gas

or oil fired furnace for heating steel billets or ingots, crucibles, or the like, the combustion chamber is in the form of a frustum of a cone surrounding the article or articles to be heated, and the combustible mixture is fed into it through a tangential inlet at the lower end. The combustion chamber may be eccentric with relation to the billet or crucible being heated. (c) The furnace described in (b) is adapted for "glory holes" such as are used for reheating articles during manufacture. The frusto-conical combustion chamber is placed with its axis horizontal, and the object to be heated is inserted at the smaller end. The flame from the burner is injected tangentially at the larger end and the outlet opens tangentially from the smaller end.

—W. F. F.

Furnaces; Melting and reheating — W. Bache, Glasgow. Eng. Pat. 107,532, Dec. 27, 1916. (Appl. No. 18,475 of 1916.)

IN a reheating or melting furnace suitable for melting copper, brass, or aluminium, the fire-box, *d*, is provided with a water tank, *a*³, and a water-supply pipe above the fuel bed, so that combustion gases mixed with water-gas pass upward into the

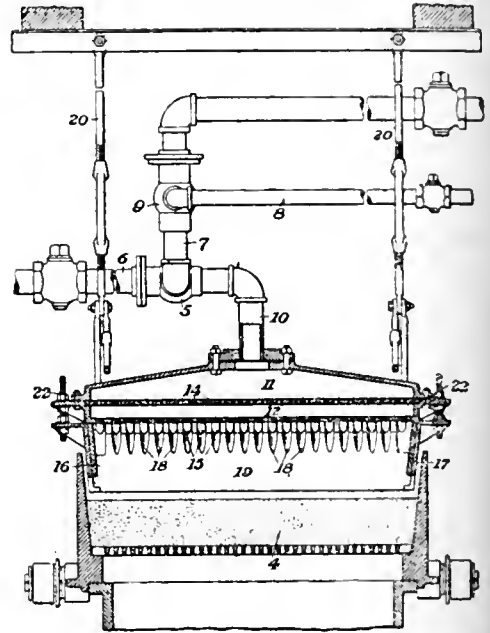


horizontal flues, *c*, below the furnace bed, *c*. Hot air from a regenerator is added through the passage, *k*¹, and the mixture burns in a vertical passage leading to the furnace bed, *c*. The combustion products pass down through vertical passages, *l*, provided with partition plates to divert the gases in a zig-zag path through the openings, *f*¹, in the regenerator bricks, *f* (see fig. 2). Air for combustion is heated by passing in a zig-zag path through the passages formed by the grooves, *f*², at right angles to the openings, *f*¹. To complete the regenerator structure, hollow bricks, *g*, are used and at the ends in each series, *f*, the bricks are provided with perforated stoppers fitted with glass windows for inspection and cleaning.—W. F. F.

Sintering machines; Ignition furnaces for — H. Wade, London. From Metallurgical Co. of America, New York. Eng. Pat. 107,474, Aug. 30, 1916. (Appl. No. 12,310 of 1916.)

IN an ignition furnace for sintering machines, particularly of the continuous Dwight and Lloyd type, blast-furnace gas of poor quality may be used and

is supplied by the pipe, 6, and mixed with air from the pipe, 7, in the mixer, 5. Richer gas may also be supplied by the pipe, 8, and mixer, 9, if desired. The mixed gas passes into the space, 11, and thence through the perforated diaphragm, 14, to the burner nozzles, 15. The combustion chamber, 16,



is provided with a firebrick lining, 17, which practically fills it except for narrow vertical openings, 18, leading into a narrow inverted V-shaped combustion space, 19, so that a continuous line of flame is directed against the sintering charge, 4. The furnace is supported by adjustable rods, 20, so that the combustion chamber, 16, may be arranged close to the upper surface of the sintering charge, 4. The relative positions of the spaces, 11, 12, and the combustion chamber, 16, may be adjusted by bolts, 22. When oil or tar is used as a fuel it is atomised from a nozzle into the open top of the pipe, 10, the latter being lined with firebrick which is maintained at a red heat to gasify the oil or tar.

—W. F. F.

Tanks for rust proofing metals. W. C. Parker, Detroit, Mich., U.S.A. Eng. Pat. 103,288, Nov. 1, 1916. (Appl. No. 15,608 of 1916.) Under Int. Conv., Jan. 12, 1916.

A TANK particularly suitable for the treatment of metals by hot acids, is made double walled, the inner vessel communicating with the outer only by means of a row of holes near the top, or by the rim of the inner vessel being slightly below the liquid level in the outer vessel. When the liquid is heated by gas burners beneath the outer vessel, the liquid in the inner vessel is heated without disturbing the sediment. The bottom of the inner vessel is provided with a short pipe projecting upward and fitted with a valve, so that when the valve is opened and the vessel is slowly lifted out, the liquid flows through the pipe, leaving the sediment in the shallow layer at the bottom. The rim of the outer vessel is provided with an angle bar projecting inward to prevent the liquid from boiling over.—W. F. F.

Ores; Concentration of — E. Edser, H. L. Sulman, and Minerals Separation, Ltd., London. Eng. Pat. 107,401, May 25, 1916. (Appl. No. 7468 of 1916.)

IN the agitation-froth process for the concentration

of ores, such as described in Eng. Pats. 7803 of 1905, 2359 of 1909, and 21,857 of 1910 (this J., 1906, 184; 1910, 496, and 1911, 1263), when a flotation agent other than a soluble soap is employed, the ores are subjected either before or during the separation process to the action of silicic acid sol. The process is applicable to sulphide ores with a gangue containing clay, slate, mica, kaolin, calcite, and the like. A proportion of 1–10 lb. of silicic acid sol per ton of ore may be used, and the flotation agent may be eucalyptus oil, or a mineral substance such as blast-furnace creosote oil with or without pine tar. In some cases 1–3 lb. of sodium sulphate per ton of ore may also be added.—W. F. F.

Cleaning metal for painting: Process of — H. Wade, London. From American Chemical Paint Co., Philadelphia, Pa., U.S.A. Eng. Pat. 107,921, Dec. 7, 1916. (Appl. No. 17,616 of 1916.)

METALS such as iron or steel are cleaned for painting by applying to the surface a relatively strong solution of phosphoric acid and subsequently a relatively weak solution. For example, the first treatment may be made with a 14% solution of phosphoric acid in water or alcohol, and the second with a 4% solution or with water.—B. N.

Alloys; Metal — A. E. White, London. From American Alloys Co., Newark, N.J., U.S.A. Eng. Pat. 108,164, Apr. 26, 1916. (Appl. No. 5989 of 1916.)

SEE U.S. Pat. 1,203,180 of 1916; this J., 1916, 1264.

Zinc; Production of metallic — A. J. F. de Bavay, Kew, Victoria, Australia. U.S. Pat. 1,233,652, July 17, 1917. Date of appl., Feb. 23, 1916.

SEE Eng. Pat. 102,142 of 1916; this J., 1917, 887.

Copper; Apparatus for production of — by electrolysis. M. Perreux-Lloyd, Boulogne-sur-Seine, France. U.S. Pat. 1,233,906, July 17, 1917. Date of appl., Mar. 19, 1913.

SEE Fr. Pat. 441,644 of 1912; this J., 1912, 932.

Appliances for ascertaining the hardness of metals and other solid materials. Eng. Pat. 107,685. See XXIII.

XI.—ELECTRO-CHEMISTRY.

Electrolytic evaluation of iron sulphide. Williams. See VII.

Impurities in electrolytic copper refining. Addicks. See X.

PATENTS.

Furnaces; Electric — D. F. Campbell, London, and Soc. Electro-Métallurgique Française, Froges, France. Eng. Pat. 107,465, Aug. 16, 1916. (Appl. No. 11,623 of 1916.)

THE hearth, together with the side walls and cover, of the furnace may be readily disconnected and removed from the back frame, which carries the electrodes, and to which it is rigidly secured under working conditions. The hearth may thus be replaced readily by a spare part when repairs are necessary.—B. N.

Electrical ozone generators. Ozonair, Ltd., and E. L. Joseph, London. Eng. Pat. 107,556, Mar. 20, 1917. (Appl. No. 4047 of 1917.)

THE electrodes are assembled so that the surfaces of those of the same polarity, in adjacent pairs of

electrodes, are close together, and a dielectric sheet is interposed between adjacent electrodes of opposite polarity. The electrodes are mounted upon a removable frame, formed from a removable cover, a bottom bar, and air inlet and outlet tubes connecting the cover with the bottom bar, and arranged in a closed container which is made watertight and immersed in a cooling tank. The air is led in parallel to the electrodes and passes between adjacent electrodes, and between electrodes and dielectrics. Several series of electrodes may be mounted within a single closed container, so that they are in substantially the same plane, and are thus adapted to act in succession upon the stream of air passed through.—B. N.

XII.—FATS; OILS; WAXES.

Orange-pip oil. D. G. Hewer, Analyst, 1917, 42, 271–273.

THE pips obtained from bitter oranges yield 37.5% of oil, or 55% calculated on the weight of the kernels alone. The oil is of a golden-yellow colour, odourless, and has a bitter flavour. Its analytical characteristics are as follows:—sp. gr. at 15° C., 0.9208; refractometer value at 40° C., 57.5; free fatty acids (as oleic), 0.3%; saponif. value, 193.7; iodine value, 100.3; titer test, 34° C.; unsaponifiable matter, 0.14%.—W. P. S.

The testing of lubricating oils. Moore and Richter. See 11A.

Studies on enzyme action. XIV. Further experiments on lipolytic actions. Falk. See XVIII.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

PATENTS.

Zinc compounds for use in paints or other purposes; Processes for the production of — A. Nihoul, Chatou, France. Eng. Pat. 107,265, July 7, 1916. (Appl. No. 9590 of 1916.) (See Eng. Pat. 14,226 of 1914; this J., 1915, 1009.)

INDUSTRIAL zinc residues are treated with hydrochloric acid, and when the attack is finished, the liquor is boiled with powdered zinc in order to precipitate lead, tin, and cadmium. The liquor is then treated with a current of chlorine, and zinc carbonate is added. To the filtrate from this liquor, consisting of a solution of zinc chloride, a proportionate quantity of magnesium carbonate is added and a current of carbon dioxide passed through; zinc carbonate is precipitated, and is filtered off and used as a pigment, or calcined to oxide. The residual liquor is evaporated to dryness and calcined at 150°–200° C. and up to 800° C. The magnesium oxide thus obtained is reconverted into carbonate, and the hydrochloric acid recovered in a coke tower, both being used again in the process.—E. W. L.

Synthetic resins; Method of manufacturing permanently fusible and soluble — from non-fusible phenolaldehyde resins. L. Berend, Amöneburg, Germany. Eng. Pat. 107,205, Mar. 15, 1916. (Appl. No. 3868 of 1916.)

THE non-fusible insoluble class of phenol-formaldehyde resins can be converted into soluble, fusible resins by heating them with fusible natural or artificial resins of various kinds, e.g., with colophony or coumarone resins, at 200°–300° C., in presence of such neutral salts or basic or acid contact substances as are used in effecting the phenol-formaldehyde condensation. For example, non-fusible resin, obtained by condensation of crude cresol with formaldehyde in the absence of a

contact medium, 106 parts, is heated with colophony, 150, and ammonium chloride, or hydrochloric acid, or caustic soda, 10 parts, for 3 hours in a closed vessel at 250° C. The resin compound obtained is completely soluble in a mixture of benzol and alcohol.—E. W. L.

Lithopone and process of manufacturing the same. R. B. Llopart, Cordoba, Argentine. Eng. Pat. 100,092, Feb. 19, 1916. (Appl. No. 2504 of 1916.) Under Int. Conv., Feb. 19, 1915.

SEE U.S. Pat. 1,139,127 of 1915; this J., 1915, 670.

Zinc sulphate solutions: Process for purifying — for use in production of pigments. R. B. Llopart, Cordoba, Argentine. Eng. Pat. 100,171, Feb. 19, 1916. (Appl. No. 2505 of 1916.) Under Int. Conv. Mar. 16, 1915.

SEE U.S. Pat. 1,140,354 of 1915; this J., 1915, 715.

Treatment of impure strontium sulphate [production of pigments]. Eng. Pat. 107,324. See VII.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Rubber in the latex: State of colloidal aggregation of —. Van Heurn. Communication from Netherlands Govt. Inst. for Advising Rubber Trade and Industry. India Rubber J., 1917, 54, 150.

THE author finds that the viscosity number—which gives a measure of viscosity independent of concentration—of the material forming the uncoagulated globules of rubber latex, as extracted from the latter by benzene, is certainly not lower than that of rubber obtained from the latex by coagulation. The extraction was effected with different proportions of benzene, viz., 10, 20, and 200 c.c. respectively to 10 c.c. of latex which had been preserved with ammonia and subsequently dialysed for six days, when it contained about 22% of caoutchouc. The two liquids were shaken vigorously together in a stoppered bottle. With the smaller quantities of benzene a homogeneous, more or less solid ball of emulsion was formed. This was transferred completely to a brown bottle and broken up in contact with 190 c.c. of benzene. The ball passed into solution in the course of about 2 days' shaking. The milky solution was left in a beaker in a desiccator for 13 days in a dark cupboard. The viscosity numbers of the clear solutions thus obtained were 81.5 and 68.8 respectively. When the larger quantity of benzene (200 c.c.) was used no ball of emulsion was obtained, and the viscosity number of the clear solution which separated was 60.1. The viscosity numbers of samples of rubber obtained from the same latex by coagulation with acetic acid (at a slightly elevated temperature) were 29, 62, and 64.7 respectively; these figures are, however, too low on account of incomplete solution of the rubber.—E. W. L.

[Rubber] latex: Non-caoutchouc compounds of —. P. Dekker. India Rubber J., 1917, 54, 154—155.

DIALYSIS of latex containing 29% of caoutchouc and 32.4% total solids, which had been preserved with ammonia, resulted in the removal of 3.2% of solid matter (calculated on the latex). The dark brown, hygroscopic solids of the dialysate were no longer completely soluble in water. They contained protein equivalent to 0.45% on the original latex, calculated from Kjeldahl nitrogen using the factor 6.25, but of this 0.06% was found to be present as ammoniacal nitrogen. Acetone and ether extracts of the dialysate evaporated to dryness with powdered pumice amounted to 0.66 and 0.25% respectively on the original latex.

After evaporation of the dialysate with half its volume of 25% hydrochloric acid, together with powdered pumice, the acetone extract in 6 hours amounted to 1.59% on the original latex. The extracts were not completely soluble in water. It is improbable that the increase of extract on treatment with acid is due to decomposition of the resins previously saponified by the ammonia, since only a few milligrams of residue was obtained on acidifying the dialysate and agitating with ether.—E. W. L.

Hevea brasiliensis: Bacteriological study of the natural coagulation of latex of —. Denier and Vernet. Comptes rend., 1917, 165, 123—126.

SAMPLES of latex were collected, with precautions against extraneous infection, from five trees near Saigon (Indo-China), and investigations were made of the bacterial flora at different stages in the course of spontaneous coagulation, which process occupied about 48 hours. Twenty-six species of various types were isolated, 25 of which were aerobes or facultative aerobes. The samples differed greatly in respect of the species present, but one organism was found in all. It is a short bacillus with rounded ends, only slightly motile, and not stained by Gram's method. Cultures on agar show a greyish white surface, not very characteristic. On agar containing latex serum, tinted with litmus, it develops rapidly, causing reddening and then decolorisation and shrinking (*dislocation*). Litmus agar containing sucrose or lactose becomes red and shrinks, and milk is also acidified and coagulated. The organism exerts no proteolytic action on coagulated egg-albumin, but liquefies gelatin. It gives rise to evolution of gas. By introducing this organism into latex, complete coagulation can be attained in 24 hours, and this practice has been adopted for several months past at Nha-Trang. To obtain the best results certain precautions are necessary. When coagulation is slow it may be accelerated by adding sugar (cp. Eaton and Grantham, this J., 1916, 263); 1 gm. of sugar per litre of latex is usually more than sufficient. The development of aerobic bacteria which produce an alkaline scum (cp. *loc. cit.*) may be checked by covering the surface of the latex with a simple wooden float. The rubbers produced in this way are white at first, but to prevent discoloration it is necessary to sterilise them by heat or by means of formalin, or the same result may be attained by protecting them from contact with the air for at least 4 days. Coagulation should not be conducted in zinc receptacles, as this metal appears to exert a toxic action on the bacteria of latex.—J. H. L.

Rubber: The different methods of preparing —. Dekker. Communication from the Netherlands Government Institute for Advising the Rubber Trade and Industry. India Rubber J., 1917, 54, 194.

A RECORD of observations on the influence of the method of coagulation on the properties of the final rubber. Rubber was separated from preserved latex taken from trees planted in 1898, by (1) evaporation, with subsequent washing of the product; (2) coagulation with acetic acid, followed by washing; (3) evaporation, followed by drying in a vacuum without washing; (4) evaporation, after dialysis of the latex for 4 days; (5) coagulation with acetic acid after the latex had been dialysed for 4 days; (6) evaporation after 14 days' dialysis; (7) coagulation with acetic acid after 14 days' dialysis. The product in each of the last four experiments being finally washed and air-dried. The various samples obtained were examined as to their content of moisture, ash, proteins, total matter insoluble in petroleum, and resinous matter; the portion of the acetone extract which was soluble in water was also determined and the viscosity of the benzene solution

of each product was measured. It was found that dialysis reduces slightly the proportion of resinous matter and also, as was to be expected, the proportion of mineral matter and water-soluble organic matter. The rubber obtained by evaporation had a higher protein content than the samples prepared by coagulation and was also exceptionally hygroscopic. The viscosity of rubber prepared by evaporation was somewhat lower than that obtained by coagulation, whilst with the sample obtained by evaporation of the dialysed latex the reduction in viscosity was still more marked. Reference is also made to other investigations of the above Institute, and it is stated that samples of rubber produced by an electrical method, although of normal composition, have been found to possess remarkable viscosity, speed of vulcanisation, and mechanical properties after vulcanisation.

—D. F. T.

Vulcanisation results obtained with rubbers from seven plantations. P. Schidrowitz and H. A. Goldsbrough. *Indiarubber J.* 1917. 54, 162—167 and 184—187.

A RECORD of the results of vulcanisation tests made by the authors' methods (this *J.* 1916. 550) with approximately 500 samples of rubber derived from seven plantations, four in Sumatra and the remaining three in the Federated Malay States. The results are tabulated and also summarised to show the relative average values for the various qualities and plantations. As an outcome of the work it is possible to draw the conclusion that smoked sheet vulcanises more rapidly than first latex crêpes, although the amount of the difference is variable. There is a marked variation as regards rate of vulcanisation between the products of the various plantations, more especially amongst the smoked sheet and first latex grades. The rate of vulcanisation of the smoked sheet samples was more nearly constant than that of the samples of first latex crêpe, 119 out of 148 of the former having a period of vulcanisation between 2 and 2½ hours, whereas only 88 out of 132 of the latter quality required a period of 2½ to 3½ hours. The results for the brown crêpes showed less wide variation in rate of vulcanisation than the better grades, although in "type" and mechanical properties they were much more irregular. In "type" the first latex crêpes showed a slightly but distinctly better average than the samples of smoked sheets, but in average tensile properties a slight advantage lay with the latter. The samples of brown crêpe were inferior to the two better qualities in "type" and were decidedly inconstant in tensile characteristics.—D. F. T.

Chicle and chewing gum ; The industrial chemistry of —. F. Dannerth. *J. Ind. Eng. Chem.* 1917, 9, 679—682.

THE estimated imports of chicle into the United States for 1916 amounted to 7,347,000 lb., equivalent to at least 30,000,000 lb. of chewing gum. As it arrives it usually contains about 40% of moisture ; other factors affecting its value are the shrinkage when cleaned, the chewing quality of the purified product, and the colour. The raw material costs about 55 cents (2s. 3½d.) per lb. A sample from Yucatan showed on analysis :—Acetone-soluble matter (resins), 40.0 ; gutta and carbohydrates, 17.4 ; proteins, 0.6 ; sand and foreign matter, 2.3 ; water, 35.0 ; mineral matter (ash), 4.7%. In sampling, about 1 lb. is cut from a block of the crude gum and immediately cut up into ½ in. crumbs which are rapidly sealed up in an air-tight jar. The moisture may be determined by drying for 5 hours in a well-ventilated air-bath at a temperature not exceeding 50° C. Alternatively it may be determined by difference in the determination of the acetone extract. For the determination of the viscosity 20 grms. of chicle,

dried for 12 hours at 70° C. *in vacuo*, is placed in a basket of 100-mesh wire which is suspended in 75 c.c. of "kerosene" ; when the liquid has completely strained through, leaving the foreign matter in the basket, it is diluted with kerosene to 100 c.c., cooled to 20° C., and placed in the small tank of a Stormer viscosimeter ; the lower portion of the capsule of the viscosimeter is filled with shot until it weighs exactly 20 grms. and the viscosity is determined in terms of revs. per min. of the rotating cylinder. The acetone-extract or "resin" is determined on 5 grms. of the sample granulated to pass a ½ in. screen and extracted in a folded filter paper in a Soxhlet apparatus for 5 hours. The extract is dried at 105° C. and the residue at 85° C. as it readily carbonises at higher temperatures ; the difference between the sum of the weights of extract and residue and the weight of the original sample indicates the moisture. As a rule the viscosity is proportional to the resin content. A number of problems for industrial research in connection with chicle are stated. Moist chicle readily undergoes fermentation by mould fungi with a considerable modification of its chewing properties.—J. F. B.

Vulcanisation catalysts. Peachey. See p. 950.

XVI.—SOILS ; FERTILISERS.

Soil flora studies. I. General characteristics of the microscopic flora of soil. II. Methods best adapted to the study of soil flora. III. Spore-forming bacteria in soil. IV. Non-spore-forming bacteria in soil. H. J. Conn. *Tech. Bull.* Nos. 57, 58, and 59. New York Agric. Exper. Stat., Dept. Agric., U.S.A. Jan. and March, 1917. pp. 1—42 ; 1—16 ; 1—18.

I. THE microscopic flora of various soils from New York State have been studied, the number of bacteria being determined by the plate method. For quantitative purposes the results thus obtained are regarded as inaccurate, and the chief use of the method is to estimate the relative proportions of the different organisms, and to distinguish them by the appearance of the colonies on the plate. Of all the soil micro-organisms the most abundant were non-spore-forming bacteria (mainly non-motile rods). Of these 40 to 75% liquefied gelatin either very slowly or not at all, whilst under 10% were short rods with polar flagella (principally *Ps. fluorescens*, which rapidly liquefied gelatin. From 12 to 75% of various types of actinomycetes were the next most important organisms, the remainder consisting of 5 to 10% of spore-forming bacteria (*B. subtilis* group), and a few micrococci. The bacteria isolated were quite different from those occurring in milk, cheese, or water. They showed a striking uniformity both in their character and in their quantity. In the case of every soil studied the predominating types were the same, whilst the number of colonies developing on gelatin or agar plates incubated for 7 days at 18° C. was usually between 5 and 50 million per grm. of soil. II. The best results are obtained by incubating the plates at fairly low temperatures (18° C. for gelatin and not over 25° C. for agar) for at least 7 days. For relative quantitative results the exact composition of the culture medium is not of material importance, but for qualitative work plates of definite composition are necessary. Thus spore-forming bacteria may frequently be recognised by the appearance of their colonies on 15 to 18% Gold Label gelatin (in tap water) ; whilst some, but not all, actinomycetes form characteristic colonies on asparaginate-glycerin agar. No suitable medium for the recognition of the different non-spore-formers has been found, although *Ps. fluorescens* may be readily identified. For a complete examination of soil flora it is advis-

able to make cultivations on plates of at least three media, and to make sub-cultures of the types not recognisable by the appearance of their colonies. III. The three most abundant spore-forming bacteria in the soils examined were:—*B. megathicum* (De Bary), *B. mycoides* (Flügge), and *B. cercus* (Frankland), whilst *B. simplex* (Gottheil) was present in smaller proportion. Occasionally other spore-forming bacteria were found, but not in sufficient quantity to be regarded as important. Hitherto, spore-forming bacteria have been considered as active agents in the soil, but the results now obtained indicate that they occur in normal soil only in the form of spores, and are apparently usually inactive. IV. The only non-spore-forming bacterium identified with species previously described was *Ps. fluorescens* (Flügge), which is abundant in freshly aerated soil or in soil to which organic matter has recently been added. In pure cultures it produces ammonia, and may therefore play a part in the decomposition of organic matter. Several other liquefying non-spore-forming organisms closely related to *Ps. fluorescens* were also isolated. Apparently these have similar functions. The numbers of non-spore-forming bacteria in soil show greater fluctuations than do those of the other soil bacteria. They are among the most active micro-organisms in the soil.—C. A. M.

Humus content of the soil as a criterion of fertility.
R. H. Carr. Soil Sci., 1917, 3, 515—524.

A CLAY surface soil deficient in organic matter was screened, mixed with various farm and green manures, and placed in double boxes, holding about 1 cu. ft., which were buried in a trench so that the tops projected a little above the level of the surrounding ground. In each box the proportion of manure mixed with chalk, lime, or lime-magnesia was equivalent to 1 lb. of dry substance. The ammonia-soluble material was determined at the time when the manures were added, and at various subsequent periods. The yields of maize in boxes fertilised with green manures were also determined. The results indicated that the growth of plants is greatly stimulated by the rapid humification of manure, this being particularly noticeable in cases where green manures were rolled under the surface and limed, rather than uniformly mixed with the soil. Certain manures, notably steer manure and alfalfa (lucerne) and to a less extent cow manure, appear to be as soluble in 4% ammonia solution immediately after admixture with the soil as after humification. In the case of horse manure, however, humification appears to take place very slowly, and it is largely unavailable as plant food during the first year. By the addition of dolomitic limestone the rate of humification of horse manure during the first year may be increased, and the boxes thus treated gave better crops. In the case of the other manures the organic matter left in the soil did not have any pronounced effect in stimulating the growth of maize during the second year. No relationship could be traced between the amount of ash in the humus and the growth of the plants, but the humification and vegetation tests indicated a close relationship between the amount of humus and the growth.—C. A. M.

Soil acidity: Effect of ammonium sulphate on —.
F. E. Allison and R. C. Cook. Soil Sci., 1917, 3, 507—512.

SERIES of five small pots with a capacity of about 2½ lb. each were filled with five types of soil and with nearly pure quartz sand. In each series four of the pots were treated with 1 gm. each of acid phosphate (superphosphate) and potassium sulphate, and half of these were treated with 0.5 gm. of ammonium sulphate. One each of the

treated and untreated pots was planted with buckwheat, whilst the others were left fallow. After each three months an additional 0.5 gm. of ammonium sulphate was added, until a total of 2 grms. was reached, and four crops had been grown. The total yields of the crops and the nitrogen left in the various soils were then determined and, after the last crop, the soils were air-dried and their lime requirement determined by the Veitch method. It was found that in the case of the soils which had received no ammonium sulphate the increases in the acidity during a year were practically the same whether crops had been grown in them or not. The quartz sand showed the smallest increase in acidity, and a loam soil the largest, but no relationship was established between the texture of the soil and the accumulation of acid. A pronounced increase in the acidity of the soil was found in the pots which had been treated with ammonium sulphate. Speaking generally, the removal of a portion of the nitrogen by the buckwheat had no pronounced effect upon the acidity, the quartz sand and heavy clay soil showing a decrease, whilst the loam showed an increase, the other three soils remaining practically the same. Excluding the quartz sand, the average increase in the acidity of the soils was equivalent to 4140 lb. of calcium oxide per 3,000,000 lb. of soil when left fallow, and to 4240 lb. where four crops had been grown. The average increase in the acidity of the soil under the experimental conditions was equivalent to about 80 lb. of calcium oxide for each 100 lb. of ammonium sulphate applied.—C. A. M.

Soil solution: Oil pressure method of obtaining —.
J. F. Morgan. Soil Sci., 1917, 3, 531—545.

IN the method of van Suchtelen and Itano (J. Landw., 60, 369) the soil is closely packed in a cast-iron cylinder, provided with a wire gauze bottom on a perforated plate, and having a small spout through which the soil solution is driven by means of paraffin oil forced through the soil by a pump. The amount of moisture thus removed depends upon the nature of the soil and the amount of organic matter present. In the case of fine sandy soils with little organic matter, over 70% of the total moisture may be extracted, but heavy clay loams may yield as little as about 2% of the moisture. Successive portions of the same extraction vary but slightly in physical properties, but show considerable differences in the proportions of the different forms of nitrogen. Calcium and magnesium also vary according to the treatment and reaction of the soil. The amount of phosphoric acid is fairly constant, but the potassium varies to some extent. Only a small proportion of the bacteria in the soil is found in the extract, since the soil acts as a filter. If the cylinder is allowed to stand too long an aerobic decomposition occurs, particularly in the case of clay soils and soils rich in organic matter. The results tabulated indicate that the method usually gives a fairly representative soil solution, but in some cases the oil does not completely penetrate the soil, and thus expels less moisture than might be otherwise obtained.—C. A. M.

Soils: Effect of sterilisation of — by heat and antiseptics upon the concentration of the soil solution.
G. P. Koch. Soil Sci., 1917, 3, 525—530.

SEVERAL soils were sterilised by methods similar to the "commercial" processes of steaming, treatment with formalin, and both, and two weeks later they were air-dried, and 20-grm. portions were mixed with water, and left for 12 to 16 hours in stoppered jars. The concentration of the soil solution was then determined by the depression of the freezing point as suggested by Bouyoucos (Mich. Agric.

Exper. Sta. Tech. Bull., 1915, No. 24), which was proved to give trustworthy results. It was found that in practically every instance sterilisation by the "commercial" methods increased the concentration of the soil solution. The heavier soils were more affected than the lighter soils by the treatment. Steaming alone was more effective in increasing the concentration than treatment with formalin (1:50 or 1:100), but the greatest increase was obtained by the use of formalin (1:50) followed by steaming at a pressure of 10 lb. If the amount of antiseptic used is in excess of what the soil can retain, a considerable amount of soluble matter will be removed and the concentration will be lowered. In the case of a sample of Norfolk sand containing a very small amount of organic matter, steaming effected no perceptible alteration in the concentration of the solution, but by adding 1% of dried blood to the sand an increase of concentration equivalent to 0.09 atmos. osmotic pressure was produced, whilst by the addition of 2% of cottonseed meal the increase was equivalent to 0.241 atmos. osmotic pressure. —C. A. M.

Hydrogen and hydroxyl ions; Effect of concentration of — on the growth of barley seedlings.
D. R. Hoagland. Soil Sci., 1917, 3, 547—559.

BARLEY seedlings were grown in solutions containing potassium phosphates and sodium nitrate, sulphate, and chloride. The OH-ion concentration was varied by using different proportions of potassium phosphate and dipotassium hydrogen phosphate, and the H-ion concentration of all solutions was determined electrometrically. It was found that the OH-ion in such solutions was more toxic than the H-ion. Under the experimental conditions a concentration of OH-ion greater than 1.8×10^{-6} was decidedly injurious, and one exceeding 2.5×10^{-5} was very toxic. Growth was promoted by a concentration of H-ions of about 0.7×10^{-5} , but a concentration of 0.3×10^{-3} was very toxic. Seedlings grown in solutions containing pieces of aluminium foil showed signs of injury to the roots. —C. A. M.

XVII.—SUGARS; STARCHES; GUMS.

Sucrose and invert-sugar; Action of acids on the rotatory power of — in presence of soluble salts.
E. Saillard. Comptes rend., 1917, 165, 116—118.

SOLUBLE salts, such as chlorides and acetates, augment the dextro-rotation of sucrose, and to a relatively greater extent the lævo-rotation of invert-sugar. The author made some experiments to ascertain the joint effect of sodium chloride and certain acids. The influence of the salt on the rotation of sucrose is not affected by the presence of sulphurous, acetic, or carbonic acid. Sulphurous and acetic acids reduce slightly the rotation of invert-sugar in presence of sodium chloride, i.e., they tend to annul the effect of the latter. Hydrochloric acid, on the other hand, increases the rotation of invert-sugar whether alone or in presence of salt; e.g., the author obtained a reading of -13.13° with a solution containing 4 grms. of salt per 100 c.c., and one of -14.15° with a solution containing the same quantities of sugar and salt besides 10 c.c. of hydrochloric acid per 100 c.c. —J. H. L.

Caramel; The chemistry of —. I. Caramelan.
M. Cunningham and C. Dorée. Chem. Soc. Trans., 1917, 111, 589—608.

WHEN sucrose is heated at 170° — 180° C., the loss of weight of 12% which takes place does not consist merely of water; even at 168° C. other products, including furfural, pungent vapours, and

carbon dioxide, are evolved. Nevertheless, by heating sucrose at 170° — 180° C. until the loss of weight is 12%, practically pure caramelan, free from sucrose and higher caramel products, is obtained; the treatment of 300 grms. of sugar requires about 4 hours. When perfectly dry, caramelan melts at 136° C., but if at all moist it begins to soften at 100° C. It is fairly soluble in 84% alcohol, pyridine, methyl alcohol, or hot glacial acetic acid. It reduces silver nitrate and Fehling's solution and gives red precipitates with hydrochloric acid and resorcinol or phloroglucinol. It may be precipitated from aqueous solution in a flocculent state by alcohol if acetic acid be present. Its composition corresponds to the formula $C_{12}H_{18}O_9$ or $C_{24}H_{36}O_{18}$, its reactions rather indicating the latter. It behaves as a tetrahydric alcohol, yielding a tetra-acetate (m.p. 107° C.), a tetrabenzoate (m.p. 105° C.) and an explosive tetranitrate. Caramelan forms compounds with phenylhydrazine and semicarbazide which appear to indicate the presence of one carbonyl group in each C_{24} unit, but in all cases these are formed with extensive dehydration, which, being variable according to the conditions, makes the evidence somewhat inconclusive. Concentrated non-oxidising acids, e.g., 40% hydrochloric acid, convert caramelan into caramelin, $C_{24}H_{36}O_{15}$; and therefore have a dehydrating action; caramelin is infusible and insoluble in alkali hydroxides. Dilute acids hydrolyse and dehydrate it, producing dextrose, methylfurfural, and humic acid. The humic acid forms chloro and nitro compounds. Dilute nitric acid has an oxidising, dehydrating, and nitrating action. On oxidation, caramelan tends to yield complex substances and in nearly all cases one carbon atom is removed per C_{24} unit. Among simpler products acetaldehyde has been recognised. Caramelan appears to mark the first step in anhydride formation and condensation which leads from simple sugars to such complex substances as cellulose, humus, and caramelin. —J. F. B.

PATENT.

Cellulose; Process for converting — into glucose.
R. A. Kocher, San Francisco, U.S.A. Eng. Pat. 107,219, May 23, 1916. (Appl. No. 7339 of 1916.)

CELLULOSIC material, e.g., sawdust, is treated with aqueous hydrochloric acid at a concentration of 40% or more, the quantity of liquid present being only sufficient to moisten the charge. For example the material, moistened with not less than 10% of water, may be contained in a closed vessel into which sufficient gaseous hydrochloric acid is introduced to saturate the moisture present. At the ordinary temperature almost quantitative saccharification is effected in 24—48 hours. The action may be greatly accelerated by operating at 40° — 60° C. but the gas must then be kept under pressure to maintain a concentration of 40% of acid in the moisture present in the charge. After hydrolysis the acid may be recovered. —J. H. L.

XVIII.—FERMENTATION INDUSTRIES.

Barley; Proteins of —, in the grain itself and during the brewing processes. IV. Investigations as to malting power of various sorts of barley.
H. Schjerning and J. Hempel. Comptes rend. Trav. Lab. Carlsberg, 1917, 11, 333—378. (See also this J., 1906, 1109; 1910, 583; 1913, 985; 1915, 43.)

THE object of the present investigation, which was commenced only two years before Schjerning's death, was to ascertain whether the malting quality of a barley is a typical hereditary quality, and if so, how far it may be affected by the nature

of the soil. Various races of barley, from the Stations at Svålof, Tystofte, and Abed, were studied, some for two and some for three years (1912-1914). The analytical data are given in numerous tables. They furnish no answer to the question at issue, the period over which the experiments extended being far too short for the solution of such a problem. No typical racial peculiarity was observed in respect of any of the factors chiefly studied, viz., protein transformation (though one race, Golden Barley, appeared characterised by a deficiency of proteolytic enzymes), carbohydrate conversion (formation of extract), production of acidity, and loss by oxidation and rootlet growth. There was evidence that size of corn is a racial character.—J. H. L.

Malt amylase: Influence of certain electrolytes upon the course of hydrolysis of starch by —. H. C. Sherman and J. A. Walker. J. Amer. Chem. Soc., 1917, 39, 1176-1193. (See also this J., 1915, 371.)

THE hydrolysis of soluble starch by highly purified malt amylase (see this J., 1913, 986; 1915, 371) was studied in neutral solutions and in presence of hydrochloric acid, phosphoric acid, and monopotassium phosphate. Amylase of diastatic power 1060 on the authors' scale (see this J., 1910, 1173), corresponding to about 1600 Lintner, was employed at concentrations ranging from 0.0000125 to 0.00120%, higher concentrations being too active for quantitative purposes. The conversions were carried out at 40°C., with Lintner's soluble starch, further purified, as substrate, usually at concentrations of 1 or 2%, and reducing powers were calculated in terms of maltose. The electrolytes named, added in quantities sufficient to produce approximately the optimum concentration of hydrogen ions, increased the activity of the enzyme throughout the whole course of hydrolysis. Their activating influence was less the greater the concentration of enzyme, and was imperceptible with the highest enzyme concentrations, which moreover produced yields of maltose much greater than that (80% of the theoretical) held by some investigators to be the highest attainable with malt amylase. The same optimum hydron concentration, $C_H = 10^{-4.4}$, was found to hold for each of the electrolytes, and throughout the course of hydrolysis. With the purified Lintner's starch used, twice as much electrolyte was required to produce this optimum reaction in 2% as in 1% starch solutions, probably owing to fixation of hydrogen ions by the starch itself or by the alkali previously added to render it neutral. When more than the optimum amount of hydrochloric acid was added, hydrolysis proceeded at less than the optimum rate throughout; when less was added, the initial rate was better sustained, the activating effect becoming relatively more marked as the concentration of starch diminished in the course of hydrolysis. Similar relations were observed with the other electrolytes, but the differences were less pronounced owing to "buffer" action; with acid phosphate in particular, variations in concentration from $\frac{1}{10}$ to 5 times the optimum did not affect the rate of hydrolysis very greatly. In experiments with small concentrations of enzyme and favourable amounts of electrolytes, the rate of maltose production was found to be proportional to the concentration of starch, i.e., the reaction proceeded as unimolecular, until about 50% of the theoretical yield of maltose had been formed. No "region of linear relation" was observed, though during the early stages of slow conversions the yield of reducing sugar was almost proportional to the time, as required by the law of unimolecular reactions. Within the limits of enzyme concentration suitable for quantitative purposes, the time required to form a

given amount of maltose, up to 50% of the theoretical yield, was found to be inversely proportional to the enzyme concentration, *ceteris paribus*; this observation broadens the range within which diastatic activities may be compared quantitatively.—J. H. L.

Malt amylase: Effect of bromides on the action of —. A. W. Thomas. J. Amer. Chem. Soc., 1917, 39, 1501-1503.

IN experiments on the activating influence of salts on highly purified malt amylase, sodium and potassium bromides differed from the chlorides, nitrates, sulphates, and phosphates, in exerting an inhibitory influence at concentrations below about 0.2 M. At higher concentrations the bromides produced activation, like the other salts.—J. H. L.

Reducing enzymes: Investigations on —. A. Bach. Monit. Scient., 1917, 61, 149-153. (See also this J., 1911, 917.)

EXPERIMENTS described indicate that the formation of nitrite from nitrate by the reductase of milk and potatoes takes place in presence of aldehydes generally, irrespective of their chemical constitution (see this J., 1917, 469). The quantity of nitrite formed is in all cases small, and does not exceed 0.6% of the nitrate present, even under optimal conditions, i.e., in liquids containing about 5% of nitrate and 1% of acetaldehyde. The smallness of the yield of nitrite is not yet explained. It does not appear to be due to a toxic action of aldehydes on the reductase, and experiments indicate that hydroxylamine, which may possibly be produced in small amounts by further reduction of the nitrite, is not sufficiently toxic towards the enzyme to account for the feeble activity of the latter.—J. H. L.

Enzyme reactions: Law of mass action and —. O. Bailly. Comptes rend., 1917, 167, 248-250.

FROM data published by Bourquelot and Verdon (see this J., 1913, 456) relating to the equilibria produced in aqueous methyl alcoholic solutions of dextrose under the influence of emulsin (β -glucosidase), the author calculates that the reactions involved conform to the law of mass action.—J. H. L.

Enzyme action: Studies on —. XIV. Further experiments on lipolytic actions. K. G. Falk. J. Biol. Chem., 1917, 31, 97-123.

THE experiments were carried out on two preparations from castor beans: an albumin-like substance, more active towards ethyl butyrate, called the "esterase" preparation, and a globulin-like substance, more active towards glyceryl triacetate, designated the "lipase" preparation. The conditions of the inactivation of these preparations by various agencies, such as acids, alkalis, neutral salts, alcohols, acetone, esters, and heat have been studied, and the results indicate that such inactivation is due to a tautomeric change. The hypothesis is put forward that the active enzyme grouping in these substances of protein nature possesses the enol-lactim structure C(OH):N which becomes inactive by tautomeric change into the keto-lactam structure CO-NH . This hypothesis has been tested by studying the action of simple compounds capable of existing in tautomeric modifications of the configuration indicated, viz., dipeptides, amino-acids, and an imino-ester (ethyl iminobenzoate). Conditions were established under which these substances exerted a hydrolysing action similar to that of the natural lipases, particularly in the presence of alkalis, which is held to favour the existence of the enol-lactim form. Agencies, such as heat, acids, and alkalis, outside certain limits of hydrogen-ion concentration, were found to destroy

the activity of these simple substances in a manner similar to the inactivation of lipases. Substances capable of hydrolysing esters were also produced by the action of alkalis on proteins (gelatin, casein, etc.) under conditions which might be expected to form the hypothetical active grouping mentioned. In these experiments it would appear that the association of the protein colloid with the active grouping plays a part in the results obtained.

—J. F. B.

Enzyme action; Studies on —. XV. Factors influencing the proteolytic action of papain. E. M. Frankel. J. Biol. Chem., 1917, 31, 201—215.

A COMMERCIAL sample of crude papain was concentrated and purified by macerating with water over-night, decanting off the clear solution, and precipitating with 2—3 vols. of acetone. The precipitate was collected, washed with acetone, and ground up with warm water; the turbid solution was allowed to stand for 36 hours and the clear liquid poured into 5 vols. of 95% alcohol. The conditions of acidity for the optimum activity of the purified papain were determined and found to correspond to a hydrogen-ion concentration of 10^{-5} . A consideration of the quantitative relations between papain and its substratum indicated that this enzyme acts like urease, invertase, and lipase, forming an intermediate compound which is broken up into the cleavage products and liberates the enzyme. The experiments also support the view that there is a definite quantity of enzyme required for a given amount of substratum and that an excess causes little more action. The influence of hydrocyanic acid in papain hydrolysis is specific. There is some difficulty in defining a hydrogen-ion optimum in the case of hydrocyanic acid; the enzyme is equally active, or nearly so, over a wide range of acidity. The quantitative relations of the enzyme, hydrocyanic acid, and protein lend support to the view that there is a ternary intermediate compound formed by the components, which then breaks down into cleavage products of the protein, liberating the enzyme and hydrocyanic acid. The hydrocyanic acid is not used up in the reaction and may be recovered almost quantitatively from the digestion mixtures. Papain, with or without hydrocyanic acid, appears to have no proteolytic effect on certain dipeptides studied. Hydrocyanic acid can renew proteolytic action in digestion mixtures which are almost in equilibrium.—J. F. B.

Citric acid fermentation of Aspergillus niger. J. N. Currie. J. Biol. Chem., 1917, 31, 15—37.

IN the citric acid fermentation of sucrose by *Aspergillus niger* the mycelium floats on the surface of the substratum and wrinkles up in such a manner as to present a very large surface of contact. These wrinkled structures often project 5—6 cm. into the medium and exhaustion of the substratum proceeds under very favourable circumstances. By a judicious selection of cultures and conditions the yield of citric acid can be varied from nil to over 50% of the sugar consumed. Conditions especially favourable to citric acid formation are low nitrogen supply, high concentration of sugar, and the use of ammonium salts instead of nitrates. As regards the reaction of the medium, the hydrogen-ion concentration is a far more important factor than the titratable acidity. For a given hydrogen-ion concentration (p^H) a mineral acid, such as hydrochloric, is less toxic than an organic acid. The addition of calcium carbonate is disadvantageous rather than helpful; the cultures readily produce a solution of 10% citric acid and the limiting hydrogen-ion concentration is exceptionally high. Fermentation can be started at a hydrogen-ion concentration which will greatly reduce the chance of infection

without interfering with the growth. Higher yields in a shorter time are obtained without calcium carbonate than with it, as the carbonate partially precipitates the magnesium and phosphate nutrients; moreover the formation of calcium citrate is a hindrance in recovering the citric acid. It is possible to ferment two or three batches of medium in succession with the same mycelial felt by draining off the liquid and running in a fresh batch. The most suitable medium for conducting the citric acid fermentation has the following approximate composition per litre:—Sucrose, 125—150 grms.; ammonium nitrate, 2.0—2.5; potassium dihydrogen phosphate, 0.75—1.0; crystallised magnesium sulphate, 0.20—0.25 gm.; hydrochloric acid to $p^H=3.4$ —3.5 (5—4 c.c. of N/5 acid). The use of this quantity of hydrochloric acid makes it possible to sterilise the liquid completely by steaming at atmospheric pressure for 30 mins. and prevents subsequent infection without interfering with the fermentation. In a medium of this nature there is little development of acid in the first 2 or 3 days; when a vigorous mycelium has developed the rise in acidity is very rapid—about 2% in 24 hours—until the 7th or 8th day. After remaining constant for 2 or 3 days the acidity begins to decline. In a proper fermentation the fungus does not produce spores but remains white. Under favourable conditions the acidity will reach 10—12% on the 8th day; oxalic acid may amount to 3—4% of the total acidity. Fermentation may be carried out successfully in shallow pans and the liquid pressed out from the mycelium in a filter-press.

—J. F. B.

Fermentation organisms; Preservation of — in nutrient media. A. Klöcker. Comptes rend. Trav. Lab. Carlsberg, 1917, 11, 297—311. (See also Hansen, this J., 1898, 1064.)

DATA are given respecting the longevity of a great variety of yeasts and moulds in 10% sucrose solution, beer wort of 13—14° Balling, and other media. Over 800 cultures, ranging in age from about 2 to 30 years, were examined, and the numbers of cultures of each organism found to be dead and living respectively after these various periods of storage, are shown in a series of tables. In general both sucrose solution and beer wort proved excellent media for preserving the organisms, many of which were capable of surviving storage in either for 30 years, though not all their cultures lasted so long. Sucrose solution is, however, considered preferable to beer wort except in special cases, as variations in the composition of worts occasionally give rise to very unsatisfactory results. Among the organisms of lower longevity were *Saccharomyces Ludwigii* and some *Schizosaccharomyces*, which lived longer in wort than in sugar solution, and the asporogenic varieties of *Saccharomyces*, which lived longer in sugar solution than in wort; but even in these cases cultures lasted for many years. *Aspergillus glaucus* succumbed much more rapidly (within 2 years) than other *Aspergillus* moulds in sucrose solution. Thirty-one cultures of *Bact. aceti*, *B. Pasteurianum*, and *B. Kützingerianum* were all living after storage for 5—9 years in "double beer."—J. H. L.

Effect of concentration of hydrogen and hydroxyl ions on the growth of barley seedlings. Hoagland. See XVI.

Uracil-cytosine dinucleotide [from yeast nucleic acid]. Jones and Read. See XX.

Guanine mononucleotide (guanylic acid) and its preparation from yeast nucleic acid. Read. See XX.

Determination of succinic acid [in fermentation products]. Grey. See XX.

PATENTS.

Brewing. E. Kenward, Eltham. Eng. Pats. (A) 107,391 and (B) 107,538, Mar. 23, 1916. (Appl. Nos. 4352 of 1916 and 924 of 1917 respectively.)

(A) BEVERAGES of specific gravity not exceeding 1.017 and containing less than 2% of proof spirit, are prepared by boiling solutions of glucose (e.g., sp. gr. 1.020—1.030) with hops (e.g., 2—3 lb. per cwt. of sugar) and salt (e.g., 60 grains per gall.), diluting the cooled liquid with water sterilised by boiling, fermenting with a small quantity of yeast (e.g., 2 oz. per barrel) until the required alcohol-content has been attained, and then separating the yeast and dry-hopping the product (e.g., with $\frac{1}{2}$ —1 lb. of hops per barrel). Colouring and other matters may also be employed. (B) Light beers prepared in the usual manner are mixed with a proportion, e.g., 25%, of beverages produced as described above.—J. H. L.

Process for cleaning various materials [by means of enzymes]. Eng. Pat. 107,191. See 1.

XIXA.—FOODS.

Milk cultures : Substitute for litmus for use in —. W. M. Clark and H. A. Lubs. J. Agric. Res., 1917, 10, 105—111.

In preparing litmus-milk for use as a culture medium, difficulty is experienced in obtaining constant initial shades of colour. This was found to be due in part to the changes in hydrogen-ion concentration which milk undergoes during sterilisation, and in part to the effect which the impurities in litmus solution have on the hydrogen-ion concentration of the milk. Further, the litmus undergoes a temporary reduction during sterilisation of the medium, and time must be allowed for the colour to reappear. When the medium is used for cultures, change of colour may be due to reduction or to destruction of the indicator. To measure accurately the degree of acid or alkali formation, it is advisable to use an indicator which will be affected only by changes in hydrogen-ion concentration. It was found that dibromo-o-cresolsulphonphthalein or "bromeresol purple" fulfilled this condition. It is a definite chemical compound, obtainable in the crystalline state. For use, 0.5 gm. is ground to a fine powder, 14 c.c. of N/10 caustic soda is added, and the mixture stirred well and diluted, with shaking, to 100 c.c. Of this solution, 10 c.c. is added to a litre of milk. After sterilisation the colour of the medium is tea-green; alkali changes the colour to blue, acid to yellow.—J. H. J.

Saccharin ; Determination of — in foods. C. B. Gnadinger. J. Assoc. Off. Agric. Chem., 1917, 3, 25—32.

SACCHARIN is more readily extracted from a solution acidified with hydrochloric acid than from one acidified with acetic acid. The best solvents are ethyl acetate and ether; chloroform is unsuitable. In the provisional method of the Association (U.S. Bur. Chem. Bull., 107, 182) the sulphur is determined in the ethereal extract, and the amount of saccharin is calculated from the result. This method is not applicable to foods containing ground mustard, since sulphur compounds in the mustard are simultaneously extracted. These may be eliminated, however, by evaporating the extract, and treating the residue with petroleum spirit and then with bromine:—From 50 to 75 grms. of the material is digested for 2 hours, with occasional shaking, with about 200 c.c. of nearly boiling water, and then treated with 5 c.c. of glacial acetic acid and a slight excess of 20% normal lead acetate solution,

made up to 250 c.c. with cold water, left for 20 mins., centrifuged, and filtered. 150 c.c. of the filtrate is acidified with 15 c.c. of hydrochloric acid, and extracted for 2 mins. each time, with three successive portions of 80 c.c. of ether. The united extracts are washed with 5 c.c. of water and mixed with 10 c.c. of sand, and the ether is evaporated by the aid of bellows. When the residue is quite dry it is thoroughly mixed with 25 c.c. of petroleum spirit (b.pt. 30° to 65° C.), the extract decanted on to a filter, and the extraction repeated with two fresh portions of solvent. The residual sand is then washed with hot water and the washings filtered into a separating funnel. The filtrate (about 75 c.c.) is cooled, mixed with 7 to 8 c.c. of hydrochloric acid, and treated with an excess of bromine water. After 5 mins. the excess of bromine is removed by means of a slight excess of sodium nitrite solution, and the acid solution is extracted with three successive portions (50 c.c. each) of ether. The ethereal extract is washed with 5 c.c. of water, the ether allowed to evaporate spontaneously, and the sulphur in the residue is determined by fusion in a nickel crucible with sodium peroxide or with a mixture of sodium carbonate and potassium nitrate (6:1). The weight of barium sulphate obtained multiplied by 0.7814 gives the weight of saccharin, and to this should be added 0.5 mgrm. as a correction for the saccharin dissolved by the petroleum spirit. To prevent loss of sulphur through imperfect oxidation during the fusion, an electrolytic method may be used:—The residue from the ethereal extract is dissolved in hot water and filtered, and the filtrate and washings (about 75 c.c.) are mixed with 25 c.c. of 16% sodium hydroxide solution, and electrolysed for six hours with smooth platinum electrodes (area of anode about 120 sq. cm., and of cathode about 1 sq. cm.), by means of a current of 2.7 to 2.9 amps. The electrolysed solution is rendered slightly acid with hydrochloric acid, and the sulphuric acid is precipitated with barium chloride. A blank determination should be made to ascertain the amount of sulphur in the 25 c.c. of sodium hydroxide solution.—C. A. M.

Determination of theobromine. Radford and Brewer. See XX.

PATENTS.

Pastes ; Apparatus for desiccating alimentary —. S. Martinenghi, Milan, Italy. Eng. Pat. 104,866, Jan. 2, 1917. (Appl. No. 83 of 1917.) Under Int. Conv., Mar. 13, 1916.

THE apparatus consists of a wooden structure of two floors, in the lower of which the pastes are placed. An extraction fan is placed in the wall of the upper floor. The lower floor is divided into four chambers which communicate with the outer air through a grille with shutters, and with the upper floor by a passage at the side. The upper floor is divided into three chambers, one of which is the fan chamber, and the other two connect with it by a pivoted door, which enables first the one and then the other to be put in connection with the fan. One chamber has four openings in the roof which can be closed when required. When the fan is in operation, air is drawn in two directions alternately through the apparatus, entering either by the grille or by the openings in the top chamber. The apparatus is placed in a room which is closed, so that the same air is drawn through the apparatus during the whole process of drying.—J. H. J.

Bread and the like ; Manufacture of —. A. J. Jenkins, Hinckley, Leicestershire. Eng. Pat. 107,218, May 19, 1916. (Appl. No. 7181 of 1916.)

A SPECIAL mixture is prepared containing 12 lb.

of strong wheat flour, 2 lb. of maize flour, 4 oz. of sugar, and 8 oz. of common salt. 6 lb. of this mixture is made into a paste with 1 gall. of water at 150° F. (66° C.) and is allowed to cool to 80° F. (27° C.). This paste is added to a paste of 7 lb. of good strong white flour with $\frac{1}{2}$ gall. of water at 80° F. (27° C.), and the whole is kneaded into a dough, which is weighed into round tins with perforated sides and perforated domed bottoms. When the tins are in the "prover," steam is admitted at 50—60 lb. pressure, which is sufficient to permeate the dough. After treatment for 10—15 mins. at about 300° F. (150° C.), the dough has risen sufficiently for the tins to be removed to a baking oven.—J. H. J.

Sterilising and preserving foods; Apparatus for —. E. C. R. Marks, London. From Anchor Cap and Closure Corporation, New York. Eng. Pat. 107,396, Apr. 26, 1916. (Appl. No. 5099 of 1916.)

THE food is placed in glass jars or other form of container with covers sealed on under a vacuum. These are placed in a sterilising retort and a mixture of steam and compressed air is admitted into the retort until the temperature has reached 240° F. (116° C.) and the pressure is 30 lb. These conditions are maintained by the aid of a thermostat for a period of $\frac{1}{2}$ —2 hrs. A valve, operated by a differential pressure of 2 lb. between the air inlet and outlet valves, is provided to permit of the introduction of steam when the temperature falls. After sterilisation is completed, the steam is shut off and water suitably warmed is introduced to cool the containers. During cooling, the pressure in the retort is maintained with cold air. A modified form of the apparatus is also described.—J. H. J.

Food products; Apparatus for the treatment of liquid —. A. E. White, London. From Mojonnier Bros. Co., Chicago, U.S.A. Eng. Pat. 107,778, Apr. 14, 1916. (Appl. No. 5514 of 1916.)

THE apparatus is of glass and is of tube form, consisting of an expanded lower portion closed at the bottom and an expanded upper portion closed by a stopper at the top; these two portions are connected by a narrower portion. Either at or just above the level of the narrow portion is a draw-off tube with a stopcock. The bottom of the apparatus may be furnished with an opening closed by an adjustable stopper. Milk or a product from which fat is to be separated, together with the necessary reagents, is poured into the apparatus, which is then centrifuged, and the solution of fat obtained in the upper portion is run off by the side tube.—J. H. J.

XIXB.—WATER PURIFICATION ; SANITATION.

Algæ; Use of copper sulphate in the destruction of —. G. Embrey. Analyst, 1917, 42, 264—267.

IN the treatment of the water in reservoirs with copper sulphate to destroy algal growths and keep the water free from weeds, 1 part of copper sulphate per 3 million parts of water is sufficient, and this amount has no injurious effect on fishes. The number of bacteria present increases shortly after the addition of the copper sulphate, and then decreases, the increase appearing to be due to the decomposition of the algæ. The best way of adding the copper sulphate is to place the salt in a perforated copper tank fixed at the stern of a punt, so that the crystals fall through the holes as the punt passes through the water.—W. P. S.

Nitrous air; Antiseptic properties of —. H. Colin. Comptes rend., 1917, 165, 191—196.

THE observation was made by Priestley in 1772 that "nitrous air" has preservative properties. In his case the gas contained ordinary air, so that nitric acid was produced and acted as the preservative agent. If air is carefully excluded, nitric oxide has no germicidal action, even on delicate organisms, after several days' contact, but if air is admitted along with nitric oxide, the bacteria are killed. Cultures of *B. pyocyaneus* showed this action very well, owing to the presence of the pyocyanin; if the culture retained the blue colour during the experiment, the organism remained alive, but if the colour changed to brown, it was found that the organism had been killed.—J. H. J.

Lead arsenate; Rapid method for the determination of water-soluble arsenic in —. H. A. Scholz and P. J. Waldstein. J. Eng. Ind. Chem., 1917, 9, 682—683.

THE following method is used for factory control: 0.5 gm. of the dried powdered sample or 1 gm. of paste is weighed into a 250 c.c. volumetric flask, 200 c.c. of recently boiled water is added, boiled 3—5 mins., allowed to stand 10—15 mins., cooled, made up to 250 c.c., and filtered through a dry paper. 200 c.c. of the filtrate is treated with a few crystals of potassium iodide and 7 c.c. of concentrated sulphuric acid and evaporated to about 50 c.c.; it is diluted with cold water, made alkaline to methyl orange with sodium hydroxide, acidified with dilute sulphuric acid, treated with an excess of sodium bicarbonate, and then titrated with *N*/20 iodine solution. The results have been compared with those obtained by the A.O.A.C. method (24 hours at 32° C.) and either agree with or are slightly higher than the latter. The water-soluble arsenic is often largely in the arsenious form, and the arsenious oxide is precipitated with the lead arsenate in a form which is very difficult to wash out with cold water but dissolves readily in hot water; hence the higher results by the boiling method. Water-soluble lead is not found in more than traces. If the solution be evaporated until sulphuric acid fumes are given off, there is a loss of arsenic by volatilisation.—J. F. B.

PATENTS.

Base-exchanging substances; Process for regenerating —. Staten Island Chemical Corporation, New York, Assignees of W. C. Foster, Rutherford, N.J., U.S.A. Eng. Pat. 101,207, June 23, 1916. (Appl. No. 8868 of 1916.) Under Int. Conv., Aug. 19, 1915.

A BASE-EXCHANGING substance, such as a zeolite, which has become inactive after use in a water filter, is treated with a 7% solution of sodium chloride, washed until free from chlorides, treated with a 1% solution of caustic soda until no more sodium is taken up, and then washed again. The substance is now ready for use again in a water filter. Base-exchanging substances with other bases than sodium, can be treated in the same manner with solutions of a like base.—J. H. J.

Sewage and other foul liquids; Apparatus for aerating —. R. Ames, Brighton. Eng. Pat. 107,937, Feb. 24, 1917. (Appl. No. 2725 of 1917.)

THE sewage is treated in a rectangular tank over which is a travelling carriage running on side rails and bearing a drum with a coil of flexible piping. One end of the piping is connected to an air compressor at the end of the tank, and the end

on the drum is connected to a horizontal pipe from which vertical pipes depend nearly to the bottom of the tank. Air diffusers, consisting of porous clay blocks in metal casings, are affixed to the ends of the vertical pipes. The sewage enters at the bottom of the tank by an inverted U-shaped pipe. An air-pipe connected to the compressor enters the upward limb of the U-shaped pipe; thus air can be passed into the sewage entering the tank, as well as into the sewage in the tank from the diffusers.—J. H. J.

Water; Apparatus for treating.—G. Ornstein, New York. Assignor to Electro Bleaching Gas Co. U.S. Pat. 1,233,371, July 17, 1917. Date of appl. May 9, 1913.

SEE FR. Pat. 469,275 of 1914; this J., 1915, 16.

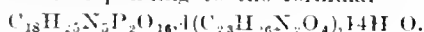
XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Theobromine; Determination of.—N. Radford and G. Brewer. Analyst, 1917, 42, 274—276.

A QUANTITY of 0.25 gram. of the sample is dissolved in water and 5 c.c. of ammonia (sp. gr. 0.880), the solution is boiled and treated with a hot solution of 5 grms. of silver nitrate. If a precipitate forms it is redissolved by the addition of a small quantity of ammonia. The boiling is continued until the volume of the mixture is reduced to about 10 c.c.; before this stage is reached a dark coloured gelatinous precipitate forms. This precipitate is washed by decantation until free from silver, then collected on a filter, and the nitrogen in it determined by Kjeldahl's method. When 0.25 gram. of the sample is taken, the volume of N/10 hydrochloric acid neutralised is multiplied by 1.89164 to obtain the percentage quantity of theobromine present. The presence of considerable quantities of caffeine does not interfere with the determination.—W. P. S.

Uracil-cytosine dinucleotide. W. Jones and B. E. Read. J. Biol. Chem., 1917, 31, 39—45.

YEAST nucleic acid is composed of the groups of four mononucleotides joined together through their carbohydrate groups. When heated with ammonia it forms adenine-uracil dinucleotide by hydrolytic rupture of its central nucleotide linkage. When heated with mineral acid, the central nucleotide linkage is not attacked but the two terminal nucleotide linkages are broken and uracil-cytosine dinucleotide is formed. Uracil-cytosine dinucleotide produces both uracil and cytosine but neither guanine nor adenine. It likewise forms both pyrimidine nucleotides but neither of the two purine nucleotides, and yields no easily liberated phosphoric acid. When an aqueous solution of the dinucleotide is treated with an alcoholic solution of brucine, a brucine salt is formed which crystallises from hot water in microscopic individual needles having a composition corresponding to the formula,



—J. F. B.

Guanine mononucleotide (guanylic acid) and its preparation from yeast nucleic acid. B. E. Read. J. Biol. Chem., 1917, 31, 47—53.

GUANINE mononucleotide can be produced from yeast nucleic acid by the action of ferments and

this is the probable origin of the guanylic acid of animal glands. The same substance can also be prepared by heating yeast nucleic acid with ammonia, and since the hydrolysis is quite simple the guanylic acid may be obtained perfectly pure. 100 grms. of nucleic acid is heated with 530 c.c. of 2.5% ammonia at 115° C. for 1½ hours, and the product, after cooling, is treated with 530 c.c. of absolute alcohol and allowed to stand. The solution which contains adenine-uracil dinucleotide is filtered off, the precipitate consisting of the ammonium salt of guanine mononucleotide is repeatedly dissolved in hot water and reprecipitated with alcohol until a sample, on hydrolysis with sulphuric acid, is found to be free from adenine groups. To purify it, a concentrated solution of the mononucleotide in hot water is treated with ammonia, boiled and filtered, and then precipitated with lead acetate after acidification with acetic acid. The lead compound is decomposed with hydrogen sulphide, the filtrate evaporated at 45° C. under reduced pressure to a small volume, and the guanine mononucleotide precipitated with alcohol. It forms a brucine salt melting at 203° C. and has been completely identified with the guanylic acid from ox pancreas.

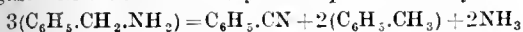
—J. F. B.

Succinic acid; Determination of.—E. C. Grey. Bull. Soc. Chim., 1917, 21, 136—141.

THE present method of separating succinic acid from other acid products of fermentation, based on Pasteur's method, is to add to a concentrated aqueous solution of the calcium salts of the acids sufficient alcohol to bring the concentration of the alcohol to 85%, at which strength calcium succinate is insoluble. Calcium is estimated in the precipitate, and from the result the amount of succinic acid is calculated. This method is liable to several errors, due to the solvent action of 85% alcohol on calcium succinate if peptone is present, the presence of substances preventing the crystallisation of calcium succinate, the presence of traces of acid in the alcohol employed, the loss on washing the precipitate, and the loss of succinic acid from the aqueous solution during concentration. The following process avoids these sources of error:—The mixture of acids produced by the fermentation is distilled in steam to remove volatile acids, and the remaining acids are extracted by ether, dissolved in hot water, and neutralised with calcium carbonate. A few drops of phenolphthalein is added, and sufficient lime water to keep the liquid red. The solution is kept warm for one hour to ensure the complete conversion of the lactone of lactic acid to calcium lactate, and is then filtered into a 200 c.c. flask. The calcium corresponding to the total acids is estimated in 50 c.c. of the filtrate. Another portion of the filtrate is slowly concentrated to 13 c.c. in a long-necked flask heated in an oven to just over 100° C. The volume is then made up to 110 c.c. with 96% alcohol, and the flask is well shaken and allowed to stand until the precipitate becomes crystalline. The solution is filtered, and the amount of calcium in 100 c.c. of the filtrate, multiplied by 1.1, gives the amount of calcium present as soluble salts in the portion of the original filtrate taken. The difference between the calcium equivalent of the total acids and the calcium equivalent of the soluble salts, gives the calcium equivalent of the succinic acid present. Figures are given to show that loss of succinic acid occurs from an alkaline solution of calcium lactate when evaporated in an open dish on the waterbath, and also to show the influence of peptone in preventing the complete precipitation of calcium succinate by 85% alcohol. Glycerin also causes an error, though smaller, but glucose does not interfere.—F. Sp.

Nitriles from amines with the same number of carbon atoms; Formation of—. P. Sabatier and G. Gaudion. *Comptes rend.*, 1917, **165**, 224—227.

SABATIER and Senderens in 1905 found that finely divided nickel at 200° C. is an effective catalyst for converting nitriles into amines in accordance with the equation: $R.CN + 2H_2 = R.CH_2.NH_2$. The reverse reaction, $R.CH_2.NH_2 = 2H_2 + R.CN$, has now been effected by the authors. When the vapour of benzylamine (b.pt. 185° C.) is passed over nickel at 300°—350° C., benzonitrile is formed, but the hydrogen set free reacts with the original amine forming toluene and ammonia, scarcely any hydrogen escaping in the form of gas. The reaction may be represented by:



one-third of the benzylamine being converted into benzonitrile. Isoamylamine, by a similar reaction, yields isovaleronitrile (b.pt. 129° C.), together with isopentane. Part of the latter is decomposed by the nickel with deposition of carbon and liberation of hydrogen, which gas is rendered luminous by the isopentane present in it. If copper is substituted for nickel, a temperature of 300°—400° C. is necessary and the products are much more complex.—A. B. S.

Acetation of anhydrous aluminium chloride on unsaturated organic compounds. Gangloff and Henderson. See 11A.

Citric acid fermentation of Aspergillus niger. Currie. See XVIII.

PATENTS.

Glutamic acid; Process of separating— from other amino acids. A. Corti, Dübendorf, Switzerland. Eng. Pat. 106,981, Apr. 7, 1916. (Appl. No. 16,015 of 1916.) Under Int. Conv., Apr. 7, 1916.

THE acid solution obtained after hydrolysis of albumins is filtered hot and then sufficient alkali or alkaline-earth hydroxide or carbonate is added to neutralise both the free hydrochloric acid and that combined with the amino acid, leaving the amino acid unaffected. When the liquid has cooled and stood for some days, the glutamic acid is separated by filtration or by centrifugal action and purified from resinous matter by recrystallisation from water and decolorised with charcoal. Other amino acids can be obtained by treatment of the mother liquors.—L. A. C.

Alkaloids of the morphine group; Manufacture of compounds of—. O. Imray, London. From Soc. Chem. Ind. in Basle, Switzerland. Eng. Pat. 107,409, June 24, 1916. (Appl. No. 8915 of 1916.)

ALKALOIDS of the morphine group, or their derivatives, are caused to react in equimolecular proportions with CC-diallylbarbituric acid, a CC-allylalkylbarbituric acid, or a CC-dialkylbarbituric acid, giving well crystallised compounds with valuable therapeutic (soporific or sedative) properties.—L. A. C.

Iodine compounds [of hexamethylenetetramine] and method of preparing same. H. P. Slater, Cedar Rapids, U.S.A. Eng. Pat. 102,254, Oct. 19, 1916. (Appl. No. 14,888 of 1916.) Under Int. Conv., Nov. 15, 1915.

SEE U.S. Pat. 1,226,394 of 1917; this J., 1917, 735.

Ethylene generator. W. K. Freeman, New York. U.S. Pat. 1,233,566, July 17, 1917. Date of appl. June 19, 1913.

SEE Eng. Pat. 24,019 of 1913; this J., 1915, 512.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

Dyestuffs containing the pyridine ring. Harrison. See IV.

Temperature coefficients of photochemical action on mixtures of chlorine and hydrogen in monochromatic light. Padoa and Butironi. See VII.

XXIII.—ANALYSIS.

Acetates; Inadequacy of basic ferric acetate test for—. L. J. Curtman and B. R. Harris. J. Amer. Chem. Soc., 1917, **39**, 1315—1317.

IN carrying out the basic ferric acetate test for acetates, a definite volume of a standard solution of sodium acetate was diluted to about 20 c.c. and made alkaline to phenolphthalein with 1% caustic soda solution. The pink coloration was removed with 1:10 hydrochloric acid. One c.c. of ferric chloride solution was added, the solution diluted to 50 c.c., boiled vigorously for 2 minutes and filtered; a reddish-brown residue indicates presence of acetates. Parallel experiments in which the final dilution was made to 200 c.c. and varying the concentration of the ferric chloride solution, i.e., 5—25 mgrms. Fe per c.c., showed that the test as conducted above was not sufficiently sensitive, that excessive dilution was not desirable, and that increasing amounts of iron tended to diminish the sensitiveness. A series of experiments in presence of sodium chloride in solution and using ferric chloride containing hydrochloric acid in varying amounts corroborated the above conclusions. Contrary to anticipation, the test did not furnish even a rough means of estimating the amount of acetate present.—J.H.P.

Molybdenum residues; Recovery of—. V. Lenher and M. P. Schultze. J. Ind. Eng. Chem., 1917, **9**, 684—685.

THE method consists in the precipitation of molybdenum sulphide by means of hydrogen sulphide from a solution slightly acid with nitric acid, or the formation of a sulphomolybdate solution by treating the alkaline solution of the "yellow precipitate" with hydrogen sulphide and acidifying with hydrochloric acid to precipitate the molybdenum sulphide. The latter on ignition gives MoO_3 which is in a condition to be used again. The waste molybdate liquors are usually strongly acid with nitric acid and should either be largely diluted or partially neutralised with sodium hydroxide so that the acidity is between 0.1 and 0.4%. The solution is slightly heated and hydrogen sulphide passed through. The supernatant liquor is siphoned off, the sulphide washed with water, collected, dried, and roasted. When much iron is present the washing water should be acidified with hydrochloric acid. The "yellow precipitate" may be dissolved in sufficient sodium hydroxide to make a solution which is slightly alkaline to phenolphthalein; any ferric hydroxide is filtered off. The filtrate is diluted and saturated with hydrogen sulphide. Excess of dilute hydrochloric acid is added and the molybdenum sulphide separated.—J. F. B.

Granular calcium chloride as a drying agent. McPherson. See I.

The testing of lubricating oils. Moore and Richter. See 11A.

Qualitative spectrum analysis of organic dyestuffs by Formánek's method. Pokorný. See IV.

Rapid determination of strength of sulphuric acid. Richmond and Merreywether. See VII.

Electrolytic evaluation of iron sulphide. Williams. See VII.

Rapid determination of manganese and chromium in metallurgical products. Travers. See X.

Substitute for litmus for use in milk cultures. Clark and Lubs. See XIXA.

Determination of saccharin in foods. Gnadinger. See XIXA.

Rapid method of determination of water-soluble arsenic in lead arsenate. Scholz and Waldstein. See XIXB.

Determination of theobromine. Radford and Brewer. See XX.

Determination of succinic acid. Grey. See XX.

PATENTS.

Gas fillers [for gas analysing apparatus]. Aktiebolaget Ingeniörsfirma F. Egnell, Stockholm. Eng. Pat. 104,880, Mar. 14, 1917. (Appl. No. 3740 of 1917.) Under Int. Conv., Mar. 2, 1916.

THE pipe leading from a gas conduit, *e.g.*, a boiler flue, to a gas analysing apparatus projects into the gas conduit and terminates in an open receptacle, preferably funnel-shaped, containing suitable filtering material such as sand. The receptacle is carried by a protective cylinder enclosing the pipe. —W. F. F.

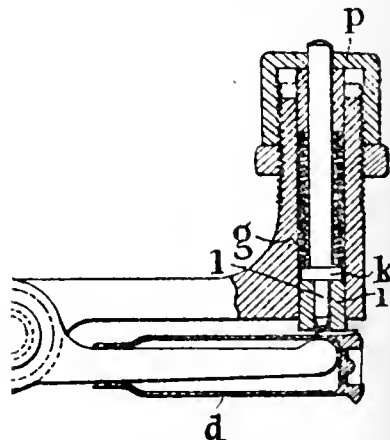
Gas-testing apparatus. H. R. Webster, Horsforth, Yorks. Eng. Pat. 107,811, July 12, 1916. (Appl. No. 9798 of 1916.)

In a gas-testing apparatus suitable for detecting and indicating the presence and proportion of carbon dioxide in flue gases of boiler furnaces or recovery plants, a cartridge of chemical absorbent is supported centrally within a closed porous cylinder upon a bottom closing plate, the cylinder being surrounded by filtering material. The gas diffuses into the cylinder and the amount absorbed is measured by a graduated U-tube pressure gauge. In a modification, the porous vessel is enclosed within a metal casing, the gas to be tested being circulated in the annular space between the two by a steam injector. In this case the filtering material is contained in a separate vessel through which the gas is first drawn, and the liquid vacuum gauge tube is connected with the porous vessel and with a closed liquid container below. The space above the surface of the liquid in this container is connected by a pipe to the gas space outside the porous vessel so as to equalise the pressures. In another modification the space within the porous cylinder is closed at the bottom by an elastic diaphragm which actuates an indicator to show the decrease in pressure within the cylinder. —W. F. F.

Metals and other solid materials: Appliances for ascertaining the hardness of —. Rudge-Whitworth, Ltd., and J. V. Pugh, Coventry. Eng. Pat. 107,685, Aug. 12, 1916. (Appl. No. 11,396 of 1916.)

In a device for testing the hardness of materials

by the depth of the indentation in the material, *d*, caused by the predetermined pressure of a hardened ball, the ball is carried at the end of a sliding spindle, *l*, pressed forward by a spring, *g*. The spindle is provided with a collar, *k*, which



abuts against a fixed bush, *i*, through which the ball projects a predetermined distance. The tension of the spring is adjusted by the screwed cap, *p*, and when the resilient resistance of the ball is overcome, any further pressure is taken between the bush, *i*, and the adjacent area of the material under test. —W. F. F.

Apparatus for the treatment of liquid food products. Eng. Pat. 107,778. See XIXA.

Books Received.

REPORT OF THE COMMITTEE OF THE PRIVY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH FOR THE YEAR 1916-17. [Cd. 8718.] H.M. Stationery Office, London. 63 pages. Price 3d (See page 951.)

FIFTY-THIRD ANNUAL REPORT ON ALKALI, ETC., WORKS, BY THE CHIEF INSPECTOR. PROCEEDINGS DURING THE YEAR 1916. H.M. Stationery Office, London. 62 pages. Price 1s. 6d.

A STUDY OF THE PRINCIPAL PLANTATION SOIL TYPES AS FOUND IN THE ISLAND OF HAWAII. By P. S. BURGESS. Hawaiian Sugar Planters' Association, Agricultural and Chemical Series, Bulletin No. 45. 100 pages, 9 × 6 in.

CHANGES IN THE PHARMACOPOEIA AND THE NATIONAL FORMULARY. By M. I. WILBERT. U.S. Hygienic Laboratory, Bulletin 107. Government Printing Office, Washington. 396 pages, 9 × 6 in. Price 30 cents.

A DIGEST of the changes and requirements included in the Pharmacopoeia of the United States (Ninth Decennial Revision) and is the National Formulary (Fourth Edition), with references to the titles not continued from the preceding editions.

Journal of the Society of Chemical Industry.

No. 18, Vol. XXXVI.

SEPTEMBER 29, 1917.

No. 18, Vol. XXXVI.

Official Notices.

IMPORT RESTRICTIONS.

The following Rulings and Decisions (Notification No. 13) respecting prohibitions of importation have been arrived at by the Department of Import Restrictions:—

Prohibited. "Bludtan" powder extract (chestnut extract). Blue powder. Cadmium. Cellulose acetate film scrap. Chromel resistance wire. Congo copal. Distilled waters. Manila copal. Nickel-chrome ribbons. Jasmin oil. Perfumed spirit. Phosphor bronze sheets. Quartz, fine and rough. Reclaimed rubber. Rubber scrap or waste. Selenium. Soap, hand cleanser, or pumice. Sodium selenite. Neutral spirit. Non-alcoholic wine.

Not prohibited. Acetone, ehlersulphonic acid. "Alumen of chrome." Aluminium flake. Amyl acetate. Antimony regulus. Ardolite. Arkansas powder (for polishing). Arsenate of lead. Balata, raw. Balsam, Canada. Balsam, Copaiba. Barium hydrate. Benzyl benzoate. Bog ore. "Boro-carbone." Boron-copper alloys. "Bromo acid." Camphor, Formosa. Carbon tetrachloride. Cellulose acetate. Chinese wood oil. Citron essence. Civet. Cocaoline. Colluputin. Copal varnish, not containing spirit. Copra. Copra meal. Cream of tartar. Cutch cake. Dyes:—Erythrosine, Methyl violet, Paraphenylenediamine. Ebonite containing less than 50% rubber. Elastic bitumen or "Elatrite." Ozone generators, complete. Ferment "D." Furnaces, electric, complete. Fusel oil. Gelatin emulsion, used in making photographic paper. Glass cotton. Glucose. Glycerin substitute (mainly glucose). Glycerophosphates. Grape juice, unfermented and non-alcoholic. Graphite paste. Gum Damar. Hematine (paste and solid). Hydrate of alumina. Indigo. Ink paste. Kamanga oil. "Kromoid" wax for tanners. Lead acetate. Lime juice, raw. Liquorice juice in blocks, mass and sticks, containing no added sugar. Litho red (Aniline dye). Maltose, made from rice. Mangrove bark. "Mercury gas." Metol. Mimosa bark. Moellon. Molasses. Myrabolams. Nitrate of soda. Oils:—Bean, chaulmoogra, Chinese wood, cod, fish, mixed fish, herring, kamanga, kernel, olive, peanut, salad, sardine, shark. "Paxolin" insulating material. Peanut butter or paste. Petroleum jelly, vaseline. Phthalic anhydride. Pitch, petroleum. Pitch, vegetable. Pituitary glands of animals. Platinum lustre, liquid. Potassium bromide. Protoxide of sodium. Pyrometers. "Raylux" (chemical decoloriser). Red gum acroïdes or yacca gum. Rock crystal. Rosin. Salicylic acid. Salol. Soda ash. Soldering flux. Soya cake. Starch, potato and sweet potato. Sugar syrup, cane, as molasses. Sulphate of alumina. Sumac, dried leaves for tanning. Tar, vegetable. Tetrachloride of titanium (liquid). "Thiol" (tar product). Tungsten. Turmeric. Vapo-cresolene. Vulcanite, containing less than 50% of rubber. Zinc powder. Zirconia.

General licence. Abrasive cloths. Electrodes. Filter candles and filter cylinders for water. Manufactures of gummite. Medicinal preparations containing sugar. Rennet, dry and extracts.

PATENTS, TRADE MARKS AND DESIGNS. FEES.

A Licence was granted by the Board of Trade on 7th December, 1915, permitting in certain

circumstances the payment of fees and agents' charges and expenses in respect of patents, trade marks and designs, payable in an enemy country or on behalf of an enemy.

The Board, under date Sept. 5, 1917, has amended this Licence as follows:—

(a) The words "person" or "persons" respectively wherever they occur in Clauses 1 and 2 thereof shall mean a person or persons being of British, Allied or Neutral nationality:

(b) In Clause 1 (b) and 2 (b) of the Licence there shall be added immediately after the words "His Majesty's Dominions" wherever they occur, the words "or of Allied territory not in hostile occupation."

The following provisos are added:—

Provided always that as regards payments on behalf of an enemy under Clause 2 of the said Licence as amended hereby, the same may only be made by the person making the same, out of moneys (a) remitted by or on behalf of such enemy, or (b) held for or on account of such enemy, and subject to the provisions of the next paragraph, nothing in the said Licence or herein shall permit any payments to be made on behalf of an enemy by way of gift or by way of advancement or loan to or on account of such enemy:

Provided also that nothing herein contained shall prevent persons of British, Allied, or Neutral nationality residing, carrying on business or being in the United Kingdom who have an interest in or under a patent or design belonging in whole or in part to an enemy from paying out of their own moneys fees payable in the United Kingdom for obtaining the renewal of such patent or for obtaining the renewal of the registration of such design or from paying agents in the United Kingdom (including themselves) their charges and expenses (if any) in relation to such matters.

DEALINGS IN LEAD AND LEAD COMPOUNDS.

The Minister of Munitions has made an Order, dated 1st September, whereby:—

1. He takes possession as from 1st September, until further notice, of all pig lead, whether virgin or remelted, old and scrap lead and lead residues, now or hereafter situated in the United Kingdom, subject to the following exceptions:—(a) All such lead as may be in the possession of or due under an existing lawful contract in writing for future delivery to a manufacturer for use in such manufacturer's own works; (b) all such lead as may be specially excepted under the written authority of the Minister of Munitions. The lead of which possession is taken will, until further notice, be paid for by the Minister of Munitions on delivery: as to virgin pig lead at the prices specified in the Schedule below; and as to remelted, old and scrap lead and lead residues, upon terms which will be communicated in due course to the various owners.

2. If any person having control of any lead of which possession has been taken under Clause 1, without the consent of the Minister of Munitions sells, removes or secretes it, or deals with it in any way contrary to any conditions imposed in any licence or permit that may be granted in respect thereof, he will be guilty of an offence against the Defence of the Realm Regulations.

3. All existing licences issued by or on behalf of the Minister of Munitions for dealing in any remelted, old or scrap lead or lead residues are cancelled.

4. No person shall, as from 1st September, until

further notice, purchase, sell, offer to purchase or sell, or, except for the purpose of carrying out a contract in writing existing prior to 6th April for the sale or purchase of white lead, lead oxides, lead manufactures, lead alloys or lead compounds of any kind, or a contract in writing existing prior to 2nd February for the sale or purchase of any other kind of lead, enter into any transaction or negotiation in relation to the sale or purchase of lead situated outside the United Kingdom, except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions.

5. No person shall as from 1st September, until further notice, offer to purchase, purchase or take delivery of any lead situated in the United Kingdom except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions, or offer to sell, sell, supply or deliver any such lead to any person other than the holder of such a licence, and in accordance with the terms thereof, provided that no such licence shall be required in the case of any offer to sell or purchase, sale, purchase, or delivery of such lead:—(a) For the purpose of a contract or order for the time being in existence, certified to be within Class "A" in the Order of the Minister of Munitions as to priority, dated 8th March, 1917, and made in substitution for Circular L. 33, or certified by or on behalf of the Minister of Munitions to be within Class "B" of the said Order. (b) For the purpose of necessary repairs or renewals requiring immediate execution and for which no other metal can be substituted, and requiring for the entire carrying out thereof the use of not exceeding 1 cwt. of sheet lead or lead pipe and not exceeding 28 lb. of solder and no other lead, and in respect of which repairs or renewals the purchaser shall have given to the seller at or before the time of purchase a declaration in writing specifying the nature of the work for which the same is required, and the place where the same is to be carried out, and that the lead purchased is for the purpose mentioned in this sub-clause and for no other purpose.

6. No purchase or sale of lead situated in the United Kingdom, or offer to purchase or sell any such lead, whether such purchase, sale, or offer is or is not under any licence issued under the authority of the Minister of Munitions, shall, in the case of any class of lead specified in the Schedule below, until further notice, be at a price exceeding the price set opposite the same in the said Schedule.

7. No person shall as from 1st September, until further notice, use any lead for the purpose of any manufacture or work except:—(a) For the purpose of a contract or order for the time being in existence certified to be within Class "A" of the Order of the Minister of Munitions as to priority dated 8th March, 1917, and made in substitution for Circular L. 33, or certified by or on behalf of the Minister of Munitions to be within Class "B" of the said Order. (b) For the purpose of necessary repairs or renewals requiring immediate execution, and requiring for the entire carrying out thereof the use of not exceeding 1 cwt. of sheet lead or lead pipe, and not exceeding 28 lb. of solder and no other lead. (c) For the purpose of type-casting from metal already in the form of type on the 2nd February, 1917, or from lead purchased for that purpose prior to that date. (d) Under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions.

8. All persons shall, within seven days from the first day of each month, send in monthly returns of:—(a) All lead held by them in stock or otherwise under their control on the last day of the preceding month, the lead actually in stock to be shown separately. (b) All lead purchased or sold by them for future delivery and not yet delivered

on such last day. (c) All lead delivered to them during the preceding month. (d) All contracts or orders existing on the last day of, or entered into during, the preceding month requiring for their execution the use of lead for any purpose, specifying the amounts of lead required monthly for the purposes of such contracts or orders, and distinguishing between the amounts required for work certified to be within Class "A" in the said Order of 8th March, and the amounts required for other purposes, or certified by or on behalf of the Minister of Munitions to be within Class "B" of the said Order. No return is required from any person whose total stock of lead in hand and on order for future delivery to him has not at any time during the preceding month exceeded 1 cwt.

Returns shall as regards remelted, old and scrap lead and lead residues, be sent in to the Director of Materials, AM2/ES Hotel Victoria, Northumberland Avenue, London, W.C.2, and as regards all other kinds of lead, to the Director of Materials, AM2/E Hotel Victoria, Northumberland Avenue, London, W.C.2.

9. For the purpose of this Order the expression "lead" shall mean pig lead, whether virgin or remelted, sheet lead, lead pipe, and old and scrap lead, lead residues, white lead, whether dry, in oil, or prepared for use, lead oxides, lead manufactures, lead alloys and lead compounds of every kind, or any of them.

10. All communications on the subject of remelted, old or scrap lead or lead residues shall be addressed to the Director of Materials, AM2/ES Hotel Victoria, Northumberland Avenue, London, W.C.2, and marked "Scrap Lead."

All applications for licences to purchase lead other than remelted, old or scrap lead or lead residues, shall be made to the Director of Materials, AM2/E Hotel Victoria, Northumberland Avenue, London, W.C.2, and marked "Lead Licence"; and all applications to use lead other than remelted, old or scrap lead or lead residues shall be made to the Controller, The Priority Department, 1, Caxton Street, Westminster, S.W.1.

11. The Order of the Minister of Munitions, dated 6th April, 1917 (this J., 1917, 408), relating to certain classes of lead is cancelled, except clause 8 thereof, but such cancellation shall not affect the previous operation of that Order or the validity of any action taken thereunder, or the liability to any penalty or punishment in respect of any contravention or failure to comply with the same prior to its cancellation, or any proceeding or remedy in respect of such penalty or punishment.

Schedule. Maximum prices.

Virgin pig lead, £29 per ton c.i.f.; £30 per ton ex store or ex refiners' works. Manufactured lead—Sheet lead, £39 10s. per ton, lead pipe, £40 per ton, delivered United Kingdom, less 2½% monthly account, the usual trade extras and allowances to apply. The rate of exchange between chemical houses and manufacturers of chemical sheet lead, for the old lead in pig lead shape, to be £8 per ton net for sheet lead, and £8 10s. per ton net for lead pipe, the manufacturer paying cost of delivery of the old lead; the sheet lead or lead pipe to be delivered United Kingdom. The usual trade extras to apply.

Lead compounds. Dry white lead, £16 per ton, less 5% monthly account delivered United Kingdom. The usual trade extras and allowances to apply. White lead in oil, £53 per ton less 5% monthly account for deliveries in packages of 5 cwt. and over, and £55, less 5% monthly account for lots of less than 5 cwt. White lead in packages less than 5 cwt. to be charged at the customary trade extra for packing. These prices for white lead in oil are based on a price of £50 per ton as the spot price for raw linseed oil in barrels. If

the average daily spot price of raw linseed oil during the preceding month rises or falls by multiples of £6, then the above maximum price of white lead in oil shall rise or fall by 10s. per ton for every £6 per ton rise or fall in the price of linseed oil. Red lead and litharge, £12 per ton, less 2½% monthly account in 5 cwt. casks delivered United Kingdom. The usual trade extras and allowances to apply.

RESTRICTIONS ON USE OF FLOUR FOR CERTAIN PURPOSES.

The Food Controller has, under Article 10 of the Flour and Bread (Prices) Order, 1917, determined that the following are purposes for which a person shall not, after the 15th September, 1917, take delivery of any flour except under and in accordance with the terms of a licence granted to him by or under the authority of the Food Controller:—Cake mixtures, baking powders, egg powders, blancmange powders, custard powders, Italian pastes, soup squares or pastes, macaroni, spaghetti, sweet manufacture, chocolate and cocoa powders, infants' and invalids' foods, mustard, spices, condiments, and all such preparations. The effect of this decision is to put the use of flour for the purposes named on the same footing as the use of flour for wholesale biscuit manufacture, industrial purposes, ships' stores, etc., and any person desiring to use flour for the purposes named must apply to the Ministry of Food (Flour and Bread Section), Palace Chambers, Westminster, London, S.W.1, for a licence which, if granted, will be issued on payment of the sum of 18s. per 280 lb.

CENSUS OF STOCKS OF OILS, FATS, ETC., IN FRANCE.

A French Presidential Decree, dated 4th September, is to the effect that all producers, owners, holders, or any one having charge of stocks exceeding 1000 kilos. (about 2205 lb.) of oleaginous seeds and fruits of all kinds; vegetable or animal fats and oils, pure or mixed; fatty acids; glycerin and liquids containing glycerin ("eaux glycéreuses"); soap and candles; shall before the 1st October next make a declaration of their holding of any of the foregoing articles on midnight of 15th September.

FRENCH COMMITTEE TO CONTROL CHEMICAL, PHARMACEUTICAL AND PHOTOGRAPHIC PRODUCTS, COLOURS, PERFUMES, ETC.

A French Presidential Decree, dated the 27th August, appoints a Committee to examine questions relating to the trade in, and industrial use of, chemical products, colouring materials, pharmaceutical products, photographic products, perfumes, etc. The Committee, which will be known as "Le Comité des Produits Chimiques," will ascertain, co-ordinate, and control the requirements of the State and of the public, and the means of meeting those requirements, and its functions include questions of priority in regard to purchase, transport, and manufacture, and of the import and export of the goods in question, and accumulations of stocks. In the case of goods included in the lists contained in Decrees to be issued by the Minister of Commerce, the functions, in regard to import prohibitions, conferred by Article 3 of the Decree of the 22nd March on the "Comité des Dégagements aux Prohibitions d'Entrée" are permanently

delegated to the "Comité des Produits Chimiques." This Committee is also empowered to advise on applications for export licences submitted to the "Commission des Dégagements aux Prohibitions d'Exportation." (See also this J., 1916, 1247.)

Annual Meeting.

Paper read on Thursday, July 19th, 1917.

PROF. HENRY LOUIS IN THE CHAIR.

CONSTRUCTIONAL STEELS AND THEIR HEAT TREATMENT.

BY FRED. C. A. H. LANTSBERRY, M.S.C.

For the purposes of this paper steels are to be regarded essentially as alloys of carbon with iron. In the processes of manufacture silicon and manganese are added for well-known reasons; the amount of the former element added in this way seldom exceeds 0.15%, while that of the latter usually runs from 0.2 to 0.6%.

Alloy steels are simply steels to which other elements or an excess of silicon and manganese have been added for some specific reason. Until about twenty years ago alloy steels were practically never used except for some highly special engineering work. The introduction of high speed engines, however, brought about the setting up of stresses, simple and compound, dynamic and static, which the plain steels, in their conditions as then known, were incapable of withstanding. Resort was then made to the addition of various alloying elements to the steels with the object of improving their mechanical properties. Improvements in electrical machinery and new appliances demanded the improvement of magnet steels. Further, the introduction of harder steels increased machining difficulties and consequent improvements were necessitated in cutting tools. At the present time the following elements are added to steels for some purpose or other:—Chromium, tungsten, nickel, silicon, manganese, vanadium, molybdenum, cobalt, titanium.

When originally introduced, alloy steels owed their merit to superior mechanical properties in their manufactured state. The superiority of mechanical properties was often more imaginary than real. It was soon discovered that by heat treating these steels, still further improvements in their mechanical properties could be effected, and it became apparent to metallurgists that the full value of the alloying element was only obtained after some process of heat treatment. This knowledge has only been made use of to any extent within the last few years, and even at the present time much alloy steel is used in its crude state when the cheaper plain steel will serve equally well.

Here it might be of advantage to give a few definitions:—

Annealing consists in heating a steel to a temperature above the critical range and allowing it to cool slowly through this range.

Hardening implies very rapid cooling from temperatures above the critical range.

Tempering consists in heating a hardened steel to some temperature below the carbon change point, known to metallurgists as A₁.

Heat treatment consists of a combination of the two latter processes.

The simple steels used for constructional purposes contain anything from 0.1 to 0.75% carbon. In the annealed state their mechanical properties are to all intents and purposes rectilinear functions of the carbon content and are included within the limits:—Yield stress, 16–45 tons per sq. in.;

ultimate stress, 20—65 tons per sq. in.; contraction, 70—30%. The elongation is so largely a function of the shape and relative dimensions of the test piece that no useful purpose is obtained by quoting it.

Alloy steels for structural purposes are divided up as follows:—Nickel steels, nickel chrome steels, chrome vanadium steels, manganese steels.

Nickel steels may be divided into two classes:—(1) Low carbon steels with 0.1 to 0.15% C. (2) Medium carbon steels with 0.3 to 0.6% C. The usual content of nickel is 3 to 4%, but in the case of the mild steels the nickel is sometimes made as high as 6.5%. Some makers produce nickel steels with a content as low as 1.0%, but it is very doubtful if steels containing below 2.5% of nickel possess any advantages over ordinary carbon steels.

Low carbon nickel steels are invariably used for case-hardening purposes. Their treatment consists in heating to temperatures in the region of 900° C. in some carbonising mixture for a period of time depending on the depth of case required and the size. The articles are re-heated to 900° C., quenched, and again re-heated to 780° C., and quenched in water or oil according to the degree of hardness required in the case. The reason for this twofold quenching is that in a case-hardening material we have to deal with a composite bar. After treatment the core of the steel has a yield stress of about 55 tons per sq. in. and an ultimate stress of 75 tons per sq. in., with a reduction of area of 55%, compared with 25 tons, 33 tons, and 65% respectively in the untreated condition.

Medium carbon nickel steels are very largely used in constructional engineering. Their method of treatment consists in heating to 800° C. and quenching in oil, followed by re-heating to a temperature not exceeding 725° C., according to the particular mechanical properties required. In the normal state an average steel will have the properties:—Yield stress, 28 tons per sq. in.; ultimate stress, 45 tons per sq. in.; contraction, 40%. By heat treating these properties can be varied within the limits:—Yield stress 28 to 100 tons per sq. in.; ultimate stress, 50 to 100 tons per sq. in.; contraction 60 to 40%.

Simple chromium steels are seldom used; chromium is usually added in conjunction with either nickel or vanadium.

Chrome nickel steels may be divided into two classes:—(1) Steels requiring quenching to attain hardness. (2) Air-hardening steels.

The first class contains C, 0.3 to 0.45%; Cr, 0.5 to 1.5%; Ni, 1.0 to 3.0%. This steel is treated by oil quenching from 800° C. and tempered according to the mechanical properties required. These can be varied between the following limits:—Yield stress, 35 to 125 tons per sq. in.; ultimate stress, 50 to 130 tons per sq. in.; contraction, 60 to 0%. It will be seen that the variations which can be obtained in the mechanical properties of these steels are enormous and this fact should make them the most widely used of the alloy steels. Unfortunately, however, they are not at all amenable to machining operations under the conditions now in vogue.

Air-hardening steels contain C, 0.25 to 0.35%; Cr, up to 0.15%; Ni, 5.5 to 3.5%. They are treated by heating to 800° C. and allowing to cool in the air. So treated a well-known air-hardening steel has the mechanical properties:—Yield stress, 85 tons per sq. in.; ultimate stress, 116 tons per sq. in.; contraction, 45%. These properties can be further varied by tempering. Experience has shown that better and more uniform results can be obtained by oil-quenching and tempering, but the advantage of air-hardening lies in the avoidance of the distortion which invariably occurs during quenching operations.

Chrome-vanadium steels are used containing C, 0.3 to 0.6%; Cr, 0.5 to 1.5%; V, up to 0.3%. These

steels are used very largely in America but to nothing like the same extent in other parts of the world. Their heat-treatment consists in quenching from 800° C. followed by tempering according to mechanical requirements. The variations in properties which can be obtained are:—Yield stress, 35 to 100 tons per sq. in.; ultimate stress, 45 to 120 tons per sq. in.; contraction, 70 to 25%. These steels possess the great advantage of machining fairly readily.

Manganese steels have been exhaustively dealt with in the numerous researches of Sir Robert Hadfield and his collaborators. They present great difficulties in machining and are only used for highly special purposes.

It is evident from this brief review that the mechanical properties of alloy steels can be varied within wide limits by heat-treatment and the question "how do plain carbon steels respond to heat-treatment?" naturally arises.

By oil-quenching and tempering the mechanical properties of a 0.5% carbon steel can be varied between the limits:—Yield stress, 25—87 tons per sq. in.; ultimate stress, 40—102 tons per sq. in.; contraction, 50—0%. Similarly the properties of a 0.75% carbon steel can be varied as follows:—Yield stress, 45—100 tons per sq. in.; ultimate stress, 65—120 tons per sq. in.; contraction, 45—0%. It is obvious, therefore, that the mechanical properties of ordinary carbon steels can be vastly improved by heat-treatment so that they could be made suitable for purposes for which alloy steels are used at present. In this note, however, only static tests have been dealt with, and it is in resistance to dynamic stresses that alloy steels show up to the greatest advantage. Some notion of the way in which a steel will behave under shock can be obtained from the value of the reduction of area given in the ordinary tensile test. Generally speaking, the higher the contraction the greater will be the resistance to shock. It will be noticed from the examples given above that for equal yield and ultimate stress an alloy steel will always have a greater reduction of area than the corresponding plain carbon steel.

London Section.

Meeting held at Burlington House, Monday, April 2nd, 1917.

BY MR. A. R. LING IN THE CHAIR.

THE ACTION OF NITRIC ACID ON CASTOR OIL.

BY R. BRIGHTMAN, M.Sc., A.I.C.

Nitrated castor oil is briefly mentioned by J. Lewkowitsch in his treatise on "Oils, Fats, and Waxes," Vol. III., p. 194, and its properties and industrial applications have been dealt with in a paper by W. F. Reid (this J., 1899, 972). No account, however, is given, either of the nature of the nitration, or of the chemical character of the nitrated oil, although Reid suggested that in the nitration the glyceride was split up, and that the glycerol was then decomposed, but he admitted that he was not sure what followed. The following research was carried out in order to throw light on these two points—the process of nitration and the chemical nature of the nitration product.

Lewkowitsch stated that nitrated castor oil could be obtained by treating castor oil with a mixture of nitric and sulphuric acids, exactly as in the nitration of glycerin. The reaction, however, is a very violent one, and the product itself

appeared liable to spontaneous decomposition on a slight rise of temperature. Several attempts were made to effect the nitration with a mixture of nitric and sulphuric acids. Various proportions of the acids were used, and the oil was added in small quantities to the well-cooled acid mixture. Even with the most rigorous cooling, both of the oil itself and of the acid mixture, the reaction always sooner or later became extremely violent and a charred mass was left. This was the case even when the nitrating mixture was cooled in a freezing mixture of snow and salt and the whole operation conducted in an open shelter at 40° F. (4.5° C.).

The procedure was then varied by first sulphonating the castor oil and then treating the sulphonated oil with nitric acid, hoping to replace the sulphonic group with the nitric acid group. These experiments, however, proved no easier to control than the first series, but tended to show that the violence of the reaction was due to the presence of the sulphuric acid.

To test this, an experiment was performed in which the sulphuric acid was replaced by acetic acid. A mixture of equal volumes of fuming nitric acid (sp. gr. 1.51) and glacial acetic acid was cooled to 15° C. and the castor oil slowly added, with thorough agitation, the temperature being maintained at about 15° C. The reaction proceeded without violence, and after standing over-night the mixture was poured into excess of cold water. A lemon-yellow oil collected at the bottom of the beaker. This oil was washed with dilute alkali and with water. After draining, the oil was dissolved in acetone, the solution filtered, and the acetone distilled off on the water-bath. The residual oil was then dried in a current of air. The product thus obtained was a reddish-brown viscid oil with a characteristic smell. It was easily soluble in acetone and ether but was insoluble in carbon bisulphide. It was easily recognised as a nitrated castor oil. This experiment indicated that not only was sulphuric acid unnecessary for the nitration of castor oil, but also that the violence of the reaction was due, at least in part, to the presence of this acid. An attempt was therefore made to effect the nitration with dilute nitric acid. The attempt was successful and it was found that under the proper conditions nitrated castor oil is easily obtained by the action of dilute nitric acid on castor oil.

Nitrated castor oil was obtained by this process, after purification, as a reddish-brown viscid oil with a characteristic smell. It is easily soluble in acetone, ether, alcohol, and acetic acid, but is insoluble in carbon bisulphide. The oil is somewhat heavier than water, its sp. gr. being about 1.05. It does not decompose at 100° C. but slowly darkens on keeping in the warm.

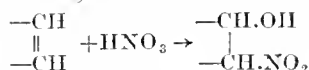
The analytical investigation of the nitrated oil was attended with some difficulty. Attempts to determine the saponification value met with unsatisfactory results. The end point could not be accurately ascertained for lack of a reliable indicator, the colour of phenolphthalein being masked by the dark-brown colour of the saponified oil. On acetylation the oil gave a dark, viscid, resinous mass unsuitable for quantitative work. The attempt to determine the acetyl value was therefore abandoned, particularly as it did not seem likely to throw much light on the nature of the oil, and in any case the process would be too tedious to be of use in the ordinary analytical characterisation of the oil. The iodine value was determined, both on the nitrated oil and also on the fatty acids. The results varied slightly with different samples of nitrated oil. It was found that nitrated castor oil is best characterised by determining its nitrogen content by a modification of the Kjeldahl process. About 0.3 gm. of the oil was taken, and 30 c.c. of a mixture of equal parts of Nordhausen and ordinary sulphuric acid

was used. Potassium hydrogen sulphate was added to raise the temperature, and in the later stages oxidation was completed by the addition of a little potassium permanganate.

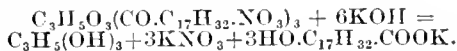
The analytical results on a number of samples of nitrated castor oil showed that the saponification value varied from 280 to 340. The iodine value was about 4 to 5, but one sample gave the figure 14.9. The iodine value of the fatty acids varied from 18.8 to 25.3. The nitrogen content varied between 2.3 and 3.8%, but was usually about 3%. The percentage of ash was less than 0.05%.

The foregoing analytical work throws some light on the constitution of the nitrated oil.

It is well known that castor oil consists practically of the pure triglyceride of ricinoleic acid. Ricinoleic acid contains one hydroxyl group and a double bond. When sulphuric acid acts on this acid the hydroxyl group is replaced by the sulphuric group and ricinoleo-sulphuric acid is produced. We should expect, by analogy, that when nitric acid acts on the glyceride of ricinoleic acid in the first place a nitric ester is produced, corresponding to the sulphuric ester produced with sulphuric acid. Failing this, the double bond is probably attacked, resulting in nitration of the type:—



In the former case the nitric group would easily be removed by hydrolysis, but in the latter case the nitro-group would probably not be thus eliminated. Experiment showed that the nitrogen in nitrated castor oil was entirely removed by hydrolysis. The fatty acids obtained from the saponified oil contained no nitrogen. This indicated that nitrated castor oil is the triglyceride of the nitric ester of ricinoleic acid. The hydrolysis of nitrated castor oil would therefore take place according to the equation:—



The saponification value of nitrated castor oil calculated from this equation is 301, a value which agrees with the approximate figures obtained.

To confirm this view of the constitution of nitrated castor oil, about five grams of the nitrated oil was saponified with alcoholic potash, and, after distilling off the alcohol, the soap was dissolved in water, decomposed with dilute sulphuric acid, and the product distilled in steam. The distillate was titrated with decinormal caustic soda, using methyl orange as indicator, and examined for nitric acid. Free nitric acid was found in the distillate, but the amount was very small, only 4.3 c.c. of N/10 alkali being required for its titration. It was evident, however, from the appearance of the distillation flask that considerable oxidation was taking place, and to this oxidising action of the nitric acid on its liberation the small amount in the distillate was probably due. The experiment, however, definitely proved that some nitric acid resulted from the saponification of nitrated castor oil, and this, with the fact that all the nitrogen is eliminated on saponification, affords strong presumptive evidence that nitrated castor oil consists largely of the glyceride of the nitric ester of ricinoleic acid. This experiment (which was quantitative) also showed the futility of any attempt to determine the acetyl value of the nitrated oil, due to the complex changes resulting when free nitric acid is liberated on acidifying the soap solution.

This view of the constitution of nitrated castor oil does not, however, meet all the facts. The iodine value of the nitrated oil should, on the above view, be very nearly the same as that of castor oil itself. As already stated, however, there is a decided drop. The iodine value fell from 84.4

(that of the castor oil used) to 14.9 at most, and usually to 4 to 5 units. These figures indicate that the double bond also has been attacked, and, since the foregoing work makes it unlikely that nitration takes place at this point, it is probable that oxidation has occurred at the double bond in the ricinoleic acid molecule. Various properties of the nitrated oil, particularly the dark colour of the solution of saponified oil and the appearance of the fatty acids obtained from it, led to the suspicion that the oil was an oxidised as well as a nitrated product. In the presence of ricinoleic acid, which is itself insoluble in petroleum spirit, it was difficult, however, to obtain evidence of the presence of oxidised acids other than that afforded by their colour. It was then found that acetylricinoleic acid is soluble in petroleum spirit, and this afforded a means of separating ricinoleic acid from any oxidised acids which would not acetylate or which gave acetyl derivatives insoluble in petroleum spirit.

The fatty acids obtained from nitrated castor oil were heated with acetic anhydride for some time, and the product, after removal of the excess of acetic anhydride, was extracted with petroleum spirit. It was only partly soluble, and the insoluble portion, which contained no nitrogen, had all the appearance and properties of complex oxidised fatty acids. This experiment afforded clear proof that oxidation of the ricinoleic acid takes place during the nitration to quite a considerable extent.

It appears therefore that nitrated castor oil is formed from castor oil as the result of the two simultaneous processes of nitration and oxidation. The nitrated oil will thus probably consist of the triglycerides of the nitric ester of oxidised ricinoleic acids. With this view its nitrogen content closely agrees. The pure triglyceride of the nitric ester of ricinoleic acid requires a nitrogen content of 3.7%, that of nitrated castor oil being about 3%.

DISCUSSION.

Mr. W. C. REYNOLDS stated that the fatty acids of castor oil formed a lactone when heated, and thought that the abnormal molecular weights found by the author in some of his results might perhaps be due to similar compounds.

Mr. WALTER F. REID was glad to hear that the subject was being investigated, because the nitro compounds of castor oil ought to be more extensively used in industry. Castor oil was not only an oil, but also partook of the nature of an alcohol. He did not think the author had really obtained true nitrated castor oil from his experiments. Nitration carried out with weak nitric acid was not complete; the acid used should be of sp. gr. 1.5. The presence of water caused oxidation and the formation of fatty acids. The nitrogen content should, he thought, be between 4 and 5%, certainly over 4%. The best factory test he had found for nitrated castor oil was the specific gravity. The author's figure of 1.05 agreed closely with figures he had found, although somewhat low, 1.127 being the average of several hundred determinations. He agreed that the presence of sulphuric acid was detrimental, the yield not being so good, nor the nitration so complete. He had nitrated many hundred tons in charges of from five to six hundred weights, of the oil and the temperature was controlled fairly well. During the operation the temperature rose rapidly until it reached a maximum and then fell again. This was necessary to a fully nitrated oil. He attributed it to the different components of the castor oil. There was also a solid form of nitrated castor oil. If highly nitrated oil were exposed to a temperature of 90° C. for a week it solidified, becoming like rubber, and would then amalgamate with rubber.

Mr. BRIGHTMAN replied that evidence of lactone formation would be obtained by determining the neutralisation and saponification values of the

fatty acids in the nitrated oil. Up to the present he had been unable to do this for lack of a suitable indicator, the dark colour of the oxidised acid over-masking the colour of the usual indicator. He did not think that the colour was due to the nitrous gases formed in the operation. The remarks of Mr. Reid confirmed the difficulties under which he had worked. He had no means of proving that the nitrated oil he had obtained was the same oil as that on which Mr. Reid and Dr. Lewkowitsch had worked. He had been surprised to find that dilute nitric acid nitrated fairly rapidly.

Meeting held at the Birkbeck Café on Monday, May 21st, 1917.

MR. R. F. HOWARD IN THE CHAIR.

THE UTILISATION OF CONDEMNED ARMY BOOTS.

BY M. C. LAMB.

In times of peace condemned Army boots were sold to contractors, who cleared all items of condemned clothing from the various barracks and camps. When war broke out and the Army grew rapidly, it was soon found that the standards of condemnation varied considerably, and an organisation was therefore set up to deal with old boots. By this means no boots are prematurely condemned, and all boots that are fit for further military wear are repaired for that purpose. The remaining boots are sorted into two grades, one of which is considered to be suitable for civilian wear after repair, and the other, although occasionally purchased by clog-makers, is generally speaking of no further use as footwear.

With an Army of such magnitude, although every step has been taken to secure economy in footwear, there must be an increasing quantity of boots unfit for further wear. The successful utilisation of this waste leather presents a very interesting problem. The Director of Army Contracts, who is responsible for the disposal of Army boots, has taken a great interest in this matter, and is of opinion that a solution can be found to the problem of discovering profitable utilisation.

The author has been permitted by the Director of Army Contracts to publish the results of the investigations of himself and others, including a special Committee of the British Association, in this field of operations, with a view to stimulating the interest of manufacturers in this waste material.

The average composition of this discarded footwear is as follows:—The total weight per pair varies from 3½ to 4 lb., consisting of approximately 11 oz. of leather uppers, and 45 oz. of sole, or say 20% uppers and 80% sole. The leather employed in the soling of Army boots is practically all vegetable tanned. The leather used in the manufacture of the uppers is of vegetable origin, to the extent of about 80% of the total quantity of boots contracted for, the remaining 20% being chrome tanned. The metal used in making of the boots is approximately 19% calculated on the total weight of the boot, and consists of 18.9% of iron, and 0.1% of brass; the latter is used chiefly in the eyelets.

Waste boot leather for road making. A promising way of utilising this waste leather is in the making of roads. In the early part of 1910, a patent was taken out by Mr. S. Brough, of Handsworth, for a road-making material which was subsequently known as "Broughite," in which scrap leather was incorporated with slag, granite, or limestone in conjunction with asphalt and bitumen. The claim made for this material was that a road was

obtained which possessed the hardness and rigidity of the ordinary tar macadam road, and at the same time reduced attrition and dust and was more resilient than the ordinary road, possessing an amount of "cushion" without liability of cracking on the surface.

The author was entrusted with the investigation into the merits of this method of road-making, and found that whilst all the reports which had been obtained upon the experimental roads which had been treated with this product, were of a laudatory character and in all cases where the experiment had been tried it had been found successful, no further progress had been made chiefly owing to the fact that the patentee had died. The Roads Board are now interesting themselves in this matter with a view to the use of leather from discarded Army boots as an ingredient in the process.

The quantity of leather used in compounding the macadam ranges from 5% when the roadway is to be subjected to very heavy traffic, to 10% when only light traffic has to be experienced. Assuming that the average amount of leather to be employed for the purpose is $7\frac{1}{2}\%$ of the road covering material, it will require 158 tons 8 cwt. per mile of roadway 8 yards wide. One ton of the tarred material is required for covering 6 square yards making an application 4 inches thick. Taking the average number of pairs of boots per ton at about 560 pairs, some 89,000 pairs of the worn-out product would be utilised in making each mile of the special roadway.

The method employed is simply to mix the scrap leather with the mixture of asphalt, bitumen, limestone, &c., lay the surface of the road with this composition, and afterwards give a top facing of slag, granite, or limestone.

Under the supervision of the Assistant Surveyor for Birmingham, Mr. H. H. Richardson, when District Surveyor for Handsworth, several pieces of roadway were laid. These experiments have indicated the advisability of the leather being in comparatively small pieces. The author has suggested that in the initial experiments now being carried out under the Roads Board the soles of the boots only should be used, a more profitable use for the uppers having been found. The soles should be cut into strips about one inch wide and the heels used intact, the strips from the soles being subsequently cross cut into pieces about 1 inch square. It is proposed, as above stated, to utilise the leather macadam mixture as a bottom dressing in making the roadway, as if used near the surface there is likely to be some difficulty owing to the fact that it would probably be too costly to remove the nails and the iron heel and toe plates before use.

The original experimental road made with "Broughite"—though laid as far back as 1910 and subsequently repaired with ordinary macadam, still retains to a considerable degree its original virtues of resilience and noiselessness under ordinary traffic conditions. It is a cheap and excellent substitute for wood paving, as in addition to possessing greater wearing qualities, and being equally silent, it costs much less than wood, and no more than bituminous macadam.

The experimental roadways provide excellent foothold for horses, as has been testified by the Officer Commanding the Military Riding School at Regent's Park Barracks; where an original Broughite roadway was laid in 1911; such a roadway also affords a good grip for rubber tyres.

Animal charcoal. Of the numerous investigations made by the author, the one which from the standpoint of commercial applicability is the most promising, is the use of the waste product in the manufacture of animal charcoal.

Animal charcoal is now almost exclusively

prepared from bones as a raw product, and is in considerable demand for use in the manufacture of munitions and as a decolorising agent for use in clarifying and decolorising sugar, oils and fats, gelatin, etc.

On submitting the leather to dry distillation the yield of crude charcoal obtained, in repeated experiments on a fairly large scale, was found to be in the neighbourhood of 35% of the total waste leather used. The resulting charcoal was boiled with dilute hydrochloric acid, treated with dilute caustic soda solution, and finally washed and dried, the result being a yield of comparatively pure charcoal equivalent in weight to about 25% of the total weight of leather distilled. The carbon so produced has been tested for its decolorising powers on sugar syrup and gelatin, with very satisfactory results; and the product, so far as could be ascertained from the small scale experiment, was in every way quite equal to any of the ordinary commercial products made from bones.

Ammonium sulphate. The distillation products were collected in sulphuric acid and resulted in a yield of 23%—25% of crude ammonium sulphate. The maximum amount available from leather is about 28% of the weight of material used.

Grease and fatty matters. On analysis the leather of the uppers was found to contain on an average 15% of extractable grease and fatty matter, consisting chiefly of wool stearine, cod oil, sulphonated oil, mineral oil, tallow, and paraffin wax. The fatty mixture as extracted from a number of representative samples of the leather was in the form of a moderately hard grease, of m. pt. 37°—39° C. This product was quite suitable for use in the currying of leather or for other purposes for which a low grade of grease is desired.

The present commercial price of charcoal prepared for decolorising purposes is in the neighbourhood of £40 per ton, crude ammonium sulphate for manurial purposes £16 per ton, and solid greases from £50 to £80 per ton. The value of the yield of products may therefore be taken as follows:—

1 Ton boots=560 pairs.	% lb.	Per ton.	Approx. value.
Metal.....	19.0=425	£ 5	£ s. d. 0 19 0
Grease and fatty matter (uppers).....	15.0=67	50	1 10 0
Purified charcoal.....	25.0=560	40	10 0 0
Crude ammonium sulphate.....	23.0=515	18	4 2 9
Total.....			£16 11 9

It would appear from the above figures that there is a good margin for profit in the employment of this raw material, which will be available in very large quantities, and as the process of conversion is very easy, requiring very simple apparatus, the matter should be of interest to practical charcoal burners and others, particularly in view of the fact that the raw material ordinarily employed is scarce in quantity, and not so commercially remunerative in the result; in addition, there is a considerable demand and extremely short supply of charcoal for commercial purposes at the present.

Manure. Leather waste is sometimes employed as a manure. The manurial value of leather, owing to its extremely slow decomposition, is small unless supplied in the form of dried or finely ground powder to the soil. It should be added that chrome leather, which will not decompose under ordinary conditions, is in consequence of no use as manure. It has also been noted that chrome tanned material is harmful to plant life.

Some of the specially compounded manurial products on the market possess a small quantity of leather as an ingredient, but this has usually been treated in some way to render it more suitable for the purpose.

The fusing of the waste leather with nitre cake after removal of the iron and brass rivets or eyelets, etc., was tried, fusing one part of the leather waste with two parts of the nitre cake. The result was a dry block of manure which could be easily powdered, and which on analysis gave the following results:—Ammonia 0.58% (equivalent to ammonium sulphate 2.2%). Total ammonia 1.8% (equivalent to ammonium sulphate 6.98%). This experiment was not very successful owing to the low manurial value of the resulting product, and the presence of large quantities of sodium salts.

Leather carbonised by aid of sulphuric acid is sometimes used as an ingredient in "patent" manures, and as the raw material now under discussion is cheaper than ordinary scrap leather, discarded Army boots might very well be used for this purpose.

Leather-board. The manufacture of leather-board has been the subject matter for a considerable number of patents, but as far as the author is aware, the manufacture of this article has not met with any considerable amount of commercial success, no doubt due to the fact that formerly the price of leather of inferior grade was not sufficiently high to enable leather-board to compete with it successfully. At the present time, the manufacture of leather board for use in insoles of boots, and soles of slippers, etc., employing this cheap discarded army footwear for the purpose of pulping, appears to be more attractive than in less strenuous times.

The following suggestions have also been made:

Clogs. Uppers of the old boots in a fair condition can be cut from the soles and nailed round wooden soles to make clogs.

Washers. The uppers of chrome tanned leather could be used for making washers for screw-down water taps. Experiment has shown that they possess considerable durability.

Mats. Waste leather can be used for making door-mats on the principle of chain belting.

Leather-pulp. Pulping the leather for leather board or paper is probably practicable but its competitor for this purpose would be the quantity of waste scraps, cuttings, and machine turnings of new leather which is more suitable to work up. The relative prices of the two materials would decide whether this would be a sound commercial proposition.

Leather powder. Leather powder for case-hardening could be obtained from vegetable tanned leather by treatment with wet steam.

Cyanides. The possibility of making cyanides has been discussed.

Glue and size. Glue of an inferior quality could be made, the chief difficulty lying in the presence of an admixture of chrome and vegetable tanned leathers. It is possible to separate these by treatment with wet steam, and there are two processes, one of which is already patented, for obtaining glue material from chrome leather. One of these consists in treatment with sodium peroxide, and the other treatment with a solution of Rochelle salt or a salt of some other hydroxy-acid. At present, the price of tartrates is a serious consideration, but they can be recovered almost quantitatively in the process.

The author desires to express his indebtedness to Mr. A. Harvey for his assistance in carrying out many experiments, and to Mr. A. Bradley for his kindness in making several tests of the prepared charcoal in decolorising sugar syrups.

DISCUSSION.

Mr. ROBERT STEWART said that many years ago—so far back as the early eighties—he had used several hundreds of tons per annum of leather waste in the manufacture of prussiate of potash by the old pot process. The works in which he had been interested was situated in Leeds, where,

at one time, the prussiate industry had been one of some magnitude. The locality was a particularly favourable one for the prussiate manufacture, inasmuch as there was always a plentiful supply of "animal matter" from the woollen mills in the neighbourhood, and leather waste from the tanneries and boot factories; there had been also a ready market for the finished prussiate, as it had been in those days extensively used in Yorkshire dye houses. There had been two or three good-sized prussiate factories at Manchester, but the most important one of all was just outside Glasgow, owned by the Hurlet and Campsie Alum Company. The trade had been heavily hit by German competition, although there had always been a decided preference in favour of English or Scotch prussiate, but the *coup de grâce* had been given to the industry by the growing use of aniline dyes and the continual development of methods for the obtaining of prussiate of potash and soda from gas residuals. Doubtless there would later on have been a partial resuscitation of the defunct pot process to meet the demand for cyanide for gold extraction but for the discovery of more direct methods of producing cyanides. There was a considerable amount of "prussiate char" produced as a by-product, but, at the time of which he spoke, it had been difficult to get more than a few shillings per ton for it. Some few years after the closing down of the last prussiate works in the United Kingdom, this char had been worth £20 per ton, several important applications, such as the bleaching of ozokerite and paraffin wax, having been found for it. To-day, as Mr. Lamb had mentioned, its value would be about £140 per ton. "Prussiate char," after having been freed from certain impurities, was said to have ten to twenty times the decolorising power of other forms of animal charcoal. He was under the impression that some of the decolorising charcoal met with in trade, and which he believed came from Germany, was actually made by the prussiate process, the ferrocyanide in this case being the by-product. Mr. Lamb had made some reference to the production of cyanogen compounds being one possible way of utilising leather waste, and he thought this suggestion was deserving of consideration in view of the present value of animal char. Except for the latter circumstance the fusion process of manufacturing prussiate of potash could not possibly compete with modern methods, such as the fixation of atmospheric nitrogen, and of course, unless or until potash was once more obtainable at something like pre-war prices it could not stand at all, even with animal char at £140 per ton. Given potash at £15 to £20 per ton, however, there was no doubt that the old pot or fusion process would be profitable. Much of the leather waste dealt with in Mr. Lamb's paper would consist of "uppers." Now whilst sole leather parings gave a very fair yield of prussiate the waste from upper leather gave very poor results. That was found to be due to the quantity of grease it contained, although why the actual nitrogen content was not recovered in the finished product had not been solved. The upper-leather waste was, therefore, first boiled to extract the grease, which on cooling rose to the top of the vat; the boiled leather was submitted to hydraulic pressure to squeeze out the adhering grease; the pressed cake on cooling became quite friable, in which condition it could be very easily ground in an ordinary disintegrator to a very fine powder which might be applied as a fertiliser. The pressed cakes were quite as valuable as the sole-leather for prussiate making. The grease obtained, amounting to 18–20% of the weight of the original leather, found an application in currying and soap making. The prejudicial effect of grease on the yield of cyanogen was very marked in all kinds of animal matter—such as woollen—used in prus-

prussiate making. It was a well-established fact that animal charcoal produced in contact with fused alkalis possessed a higher value as a decoloriser than the char obtained by the destructive distillation of animal matter *per se*, but he was not aware whether soda was as effective as potash. This was a matter well worth investigation, for, obviously, it would be far simpler to install a plant for producing animal char by the fusion of sodium carbonate and leather waste, than to rehabilitate the now obsolete pot process of manufacturing prussiate of potash. One process for utilising leather waste mentioned by Mr. Lamb consisted in treating the waste with sulphuric acid; this recalled some work he (the speaker) had been

however, always becomes intensely blue with the addition of the first drop of thiosulphate solution. The introduction of starch solution before the alkaloid is important, because if free iodine is liberated it reacts with the alkaloid, forming an iodo-compound which often vitiates the results. To study the effect of time and to ascertain what excess of iodic acid is required, the following experiments have been carried out. The solutions were placed in 500 c.c. Erlenmeyer flasks, set aside in a cool, dark place for stated periods, and titrated with *N*/10 thiosulphate solution to determine the amounts of unchanged iodic acid. It has been found that the oxidation of morphine is not complete in less than 10 minutes; the

Time.	15 min.	15 min.	15 min.	30 min.	60 min.	120 min.
Water	50 c.c.	50 c.c.	50 c.c.	50 c.c.	50 c.c.	50 c.c.
10-N sulphuric acid	5 "	5 "	5 "	5 "	5 "	5 "
1% starch solution	10 "	10 "	10 "	10 "	10 "	10 "
N/5 Iodic acid	10 "	20 "	40 "	20 "	20 "	20 "
1% morphine solution	10 "	10 "	10 "	10 "	10 "	10 "
N/10 thiosulphate required for back titration	9.5 "	29.4 "	69.0 "	29.3 "	29.4 "	29.3 "
Do. calculated	9.5 "	29.5 "	69.5 "	29.5 "	29.5 "	29.5 "

engaged in eight or ten years ago. Leather waste was macerated in strong sulphuric acid whereby it was quickly reduced to a pulpy mass; the strongly acid mass was mixed with ground mineral phosphate, the aim being to produce a nitrogenous superphosphate. The patent, however, had never got beyond the provisional stage as it was found that the finished product contained much less nitrogen than the quantity calculated from the nitrogen content of the leather used.

Communication.

TITRATION AND ESTIMATION OF MORPHINE WITH IODIC ACID.

BY JITENDRA NATH RAKSHIT
(Opium Factory, Ghazipur, India).

The liberation of iodine from iodic acid by morphine was observed by Serullas (Berz. Jahresh., 11, 238) and Dupré (Jahr., 1863, 704). A colorimetric method for the estimation of morphine by extraction of the liberated iodine by means of chloroform or carbon bisulphide was proposed by Procter and Stein (Jahr., 1871, 957); this method, however, has been found to be unsatisfactory. François and Luce (Ann. Falsif., 1916, 9, 83; this J., 1916, 315) have also described a colorimetric method for the estimation of morphine by means of iodic acid and ammonia, but the following titration process seems to be more reliable. If a solution of morphine be treated with an excess of iodic acid in the presence of dilute sulphuric acid, the oxidation of morphine is quantitative, two molecules of morphine absorbing three atoms of oxygen. $2C_{17}H_{19}NO_3 + 3O = (C_{17}H_{19}NO_3)_2O_3$. But the reduction of iodic acid in the presence of an excess of morphine is incomplete the degree of reduction depending much on dilution, temperature, and time.

The solution of iodic acid suitable for this purpose was prepared by dissolving 5.86 grms. in 1000 c.c. of water (equivalent to *N*/5 thiosulphate solution); it keeps well for a few months without altering its titration value. When about 1% solution of morphine is treated with an excess of iodic acid solution, the colour of the mixture changes to brown but the starch solution does not generally become blue. Experiments in which the starch solution is blue show little difference in titration from those in which there is no action on starch. The starch,

above results show that it does not proceed much further even after as long as two hours. Numerous experiments have been carried out and it has always been found that 15 minutes is quite sufficient to complete the reaction. In the estimation of morphine by this process it is convenient to use about 0.05 to 0.15 gm. of morphine (either in the form of free base, hydrochloride, or suphate), 50 c.c. of water, 5 c.c. of 10-N sulphuric acid, and 10 c.c. of 1% freshly prepared cooled starch solution, and shake well; 5 to 15 c.c. of *N*/5 iodic acid solution is then introduced, the mixture shaken again thoroughly, set aside in a dark place for about 15 minutes, and titrated back with *N*/10 thiosulphate. The number of c.c. of iodic acid consumed multiplied by 0.0190 gives the amount of morphine present in the quantity of sample taken. Satisfactory results are, however, obtained by using double the quantity of iodic acid solution that is required for oxidation. The following results have been obtained with pure morphine :—

Morphine taken.	N/5 Iodic acid required.	Morphine found.
gm.		gm.
0.100	5.15 c.c.	0.0979
0.120	6.20 c.c.	0.1197
0.080	4.25 c.c.	0.0807
0.090	4.75 c.c.	0.0902
0.150	7.99 c.c.	0.1501

While titrating it is essential to note that the end point should be taken when the blue colour has remained discharged for at least 30 seconds; the colour, however, often reappears after a few minutes and can be discharged with a drop or two of thiosulphate solution, but the same colour may return after a longer time.

It was thought that this reaction might be used for the estimation of morphine in opium, but it has been found that the results obtained are too high and are always discordant owing to the fact that codeine and narcotine also absorb a certain amount of oxygen under the same conditions, as is shown below :—

Sample.	N/5 Iodic acid reduced.	Equivalent quantity of morphine.
		gm.
0.100 gm. codeine, ...	1.0 c.c.	0.0190
0.100 gm. narcotine	0.25 c.c.	0.00475

Besides these alkaloids there are also other substances in opium which absorb oxygen under the same conditions.

Industrial Notes.

FIFTY-THIRD ANNUAL REPORT ON ALKALI, ETC., WORKS, BY THE CHIEF INSPECTOR, 1916.

The number of registered works in England, Ireland, and Wales was 1393 in 1916, compared with 1372 in 1915 and 1356 in 1914. There were also 167 works in Scotland registered under the Act, making a total of 1560. The amounts of acid gases escaping in the processes under inspection showed various differences but were generally higher than in 1915; the acidity of gases from chimneys in smelting works showed, however, a slight decrease.

Alkali and copper (wet process) works. The average escape of hydrochloric acid from the chimneys in these works was 0.086 gr. per cub. ft., compared with 0.074 gr. for 1915, the average condensation being 97.9%, compared with 98.31% in the preceding year. As in 1915, the use of nitre cake in place of sulphuric acid for decomposing salt in salt-cake furnaces lessened the production of acid made per ton of salt-cake produced. In certain localities also the furnaces were not worked to their full capacity. During the year a modern mechanical salt-cake furnace of the muffle type was introduced in one district, and after preliminary troubles, especially with the mechanical feed, had been overcome, fairly good results were obtained, though the amount of acid produced was only about 75% of the anticipated capacity of the plant. The use of mechanical furnaces in the larger works for the extraction of copper by the wet process has become general.

Smelting works. The average acidity of chimney gases from these works decreased from 3.056 grs. SO_2 per cub. ft. in 1915 to 3.010 grs. in 1916; the number of works was four less than in 1915, two works relinquishing smelting operations to work up material for munition purposes. The acidity of escaping chimney gases from works engaged in tin smelting and arsenic recovery was maintained at about the same as in 1915, through the continued use of limestone or milk-of-lime in suitable washing towers. Considerable activity in mining for wolframite in Cornwall is reported, and it is mentioned that the present tungsten production of the Cornish mines is more than three times that of the German and Austrian mines. In works in which zinc sulphide ores are calcined further progress was made in the utilisation of the sulphur for producing sulphuric acid, in spite of difficulties connected with the working of mechanical calcining furnaces and the scarcity of suitable labour for working the necessary hand furnaces. No great extension was seen in the application of electrical and mechanical means for arresting fume and dust.

Cement works were seven less in number than in 1915. Many works also were only partially in operation. The question of the recovery of potash from dust continues to receive attention, but no reports have been received of any practical trials having been made.

Sulphuric acid works. The average escape of gases from the lead chamber process was 1.269 gr. per cubic foot in 1916, an increase of 0.132 gr. over 1915; the majority of works, however, showed no increase in this respect. A high standard of proficiency was maintained in most of the works; in many of those where former

standards were not reached, it is noted that proper chemical aid was not at hand. The demand for acid, combined with difficulties regarding skilled labour and supplies, was more marked than in 1915. Constructive effort was actively maintained, so that at the end of the year the general conditions were better than at the end of 1915. An experiment was made at a Swansea works in washing down the coke in a Gay-Lussac tower with acid and then with water; the washing was continued for four days, until the wash-water was practically free from acid. The nitrous fumes evolved in the washing with water were led to the Glover tower of another set of chambers, whereby potting was saved for two days and the acidity of the exit fell to 0.50 gr. SO_2 per cub. ft. The washing resulted in the coke readily rolling out in loose pieces, thus avoiding the breaking up process necessary after long service in a coke-packed Gay-Lussac tower. Washing for 96 hours may not be necessary in every case, and when the nitrous gases can be readily utilised the preliminary wash with strong acid may be omitted.

Mechanically worked furnaces for calcining sulphide ores of zinc are still in the introductory stage, and mechanical furnaces for roasting pyrites and spent oxide came into more extended use.

There was considerable reduction in the chamber space allowed per unit of sulphur burned. Other aids to increased and efficient production were the use of large Gay-Lussac towers or other absorbing plant, fan draught, water sprays, externally cooled chambers, increased burner capacity, increased nitre consumption, and closer attention to all details of working. A suggestion of the Chief Inspector which is being introduced into two works is the provision of an iron contact tower between the burners and the Glover tower; this would effect a material conversion of the SO_2 to SO_3 . By erecting a second set of burners and iron contact tower, a further quantity of gases would be produced, and by passing both these quantities of gases through the Glover tower, a product would result containing little more sulphur dioxide for the chamber set to deal with than was formerly derived from one set of burners.

Sulphuric acid (Class II.) works. Contact processes. A large increase in the operation of contact plants is reported, both as regards extension of existing works and erection of new ones. Production was considerably increased, and further increase is in prospect. In using the iron oxide contact process in conjunction with chamber plant, trouble arose from the sluggish action in the chamber of the gases from the contact section. This was obviated later by the judicious use of steam, proper mixing with the chamber gases, and selection of the most suitable point in the chamber system for their admission. Extensive operations were carried on satisfactorily with the "Mannheim," the "Badische," and the Tenteleff processes, whilst during the year the Schröder-Grillo process was successfully introduced. *Concentration processes.* The average escape of acid gases showed an increase of nearly 25% over that of 1915. In addition to emission of unduly acid residual gases from flues and chimneys, there was much irregular escape from the plants themselves. In cascade concentrating plant, high acidity of exit gases may be due to excessive boiling in the lower basins (resulting in acid being projected into the flues), to insufficient size of scrubbers for the exit gases, and to insufficient draught in the basin flue. In other types of concentrating plant there was less opportunity for irregular escape of acid. In some cases also where spent acid containing nitrogen compounds was being recovered, an undue escape of nitrogen oxides occurred. Reference is made to the satis.

factory use of the Davis concentrator for concentrating acid from 110° Tw. to 144° Tw. The Thomas-Harris plant for making high strength acid is not yet a regular producer in quantity. Two new methods of treating the fume developed in concentrating plants have given satisfactory results in trials; one method consists in causing the particles to coalesce by means of high-tension electrical discharges; in the other method, water or weak acid is supplied to the fan used to induce draught on the fume fine of cascade units.

Chemical manure works. The number of works continues to decrease, two less being registered in 1916 than in 1915. The reduced supply of sulphuric acid was met to a limited extent by the use of nitre cake; this has proved satisfactory in some cases, a product with 17—20% soluble being obtained. Imports of certain fertiliser materials into the United Kingdom were as follows:—

	1914.	1915.	1916.
	Tons.	Tons.	Tons.
Guanos	34,285	26,720	21,644
Mineral phosphates	555,695	374,839	333,371
Sodium nitrate	171,910	132,158	20,896

Exports of sulphate of ammonia in 1916 amounted to 259,500 tons, compared with an estimated home consumption of 178,500 tons; the corresponding figures for 1915 were 294,000 and 128,000 tons respectively.

Sulphate and muriate of ammonia and gas liquor works. The number of works in this group continues to increase. The quantity of ammonia recovered as a by-product in the United Kingdom was:—

Ammonia recovered (as sulphate); tons.

	1914.	1915.	1916.
Gas works	175,930	173,675	172,269
Iron works	16,098	15,142	15,154
Shale works	62,749	54,826	57,988
Coke-oven works	137,430	145,496	159,596
Producer-gas and carbonising works (bone and coal)	34,205	33,218	28,786
Total	423,412	428,267	433,703

Of the total for 1916, 70,987 tons was produced in the form of concentrated ammoniacal liquor. The change from production of sulphate to the preparation of concentrated ammoniacal liquor continued in greater measure during the year under review. The use of a cheap oil, crude tar, etc., for facilitating the removal of those metallic sulphides precipitated in the saturator when crude pyrites acid is used for producing sulphate from gas liquor, is now in limited use in England; it has been in general use in Scotland for a long time. The "direct process" for the manufacture of sulphate of ammonia has been further investigated and some experiments have also been carried out on the sulphiding of hydrated oxide (see page 997).

Nitric acid works. Increased activity continued in these works, new plants being erected and large additions made to existing works. Increased condensing appliances were provided where more intensive working called for their use. In some localities there was still a surplus of nitre cake.

Muriatic acid works. The results of the limited inspection which these works received indicated that they were conducted without undue escape of noxious gases. The salt works, carbonising works, and works making hydrochloric acid were conducted without change in methods. A development in tinplate manufacture which dispenses with the necessity for "white pickling" is mentioned.

Sulphide works. An increase from 92 to 96 in the number of works registered in this class is noted, chiefly due to the extended manufacture of certain dyes. In the works in which metallic impurities were removed from acids by means of sulphuretted hydrogen, or works in which anti-mony sulphides were manufactured, the waste sulphuretted hydrogen was satisfactorily disposed of.

Arsenic works. In those works in which arsenious acid is obtained from arsenical ores or residues, or in which arsenious acid is refined, dry filters continued to prove more satisfactory than wash towers for treating the escaping gases, though in both types the final escape was satisfactory.

Picric acid works. The number of works increased from 13 in 1915 to 18 in 1916, all the new factories being of important productive capacity; large extensions were carried out in existing factories. The treatment of waste fumes leaves much to be desired, although advance has been made in some factories. Improved methods of reducing working losses of picric acid and for the recovery of waste acid have been introduced.

Tar works. An increase of 68, to 316 works registered, is recorded, almost entirely due to the rapid extension of the use of tar dehydrating plants in gas works. Continuous distillation plant was largely adopted, but in some cases these were not provided with sufficient condensing arrangements; apart from temporary escape of vapours due to this cause, the tar works were conducted satisfactorily as regards the requirements of the Act. The quantity of tar distilled in the United Kingdom in 1916 was 1,420,867 tons in gas works and 138,552 tons in other works; 715,051 tons of pitch was produced in gas works and 83,690 tons in other works.

Zinc works. Extensive additions were made to registered works, but no new works were added. No progress is reported in the treatment of fumes from zinc furnaces.

SCOTLAND.

The following statistics have been compiled:—

	1916.	1915.
Pyrites burned	Tons. 152,084	Tons. 144,946
Bones and phosphates dissolved	36,686	64,892
Salts of ammonia (expressed as sulphate)—		
Gas works	Tons. 21,365	
Iron works	14,310	
Shale works	57,988	
Bone, producer gas, coke, and carbonising works	21,030	
Tar distilled—		
Gas and coke oven works	139,197	
Other works	126,285	
Pitch produced—		
Gas and coke oven works	70,879	
Other works	75,274	
	146,153	143,011

Of the above total quantity of sulphate of ammonia the equivalent of 7246 tons was manufactured as concentrated ammoniacal liquor; the balance of 197,447 tons consisted of other ammonia products (sulphate, chloride, nitrate, etc.).

In sulphuric acid works, sulphuric acid (Class II.) works, and in zinc works, great activity prevailed, whilst in chemical manure works operations were greatly restricted owing to the moderate supply of sulphuric acid available.

Alkali works were conducted satisfactorily during the year, no discharge of chimney gases containing muriatic acid in excess of Act limits having been observed. The extended use of mechanical furnaces further lessened the danger

of local escapes of acid gases. At one works some local heating of the adjacent deposit of alkali waste, due to oxidation, was noted.

Sulphuric acid. At three works escapes of acid gases in excess of the limit fixed by statute were noted, and in addition escapes of acid gases occurred through leakages in the manufacturing plant. Additional plant was under construction, but none was completed at the end of the year.

Sulphuric acid (Class II.) works. Contact process works.—This description of works was satisfactorily conducted throughout the year. One new works was started towards the end of the year, and extensions were brought into use in works already registered. *Concentration process works.*—The pressure on these works was heavy and continuous. Plants of three types were in use—the Kessler, the Gaillard, and the cascade. The first two were worked satisfactorily, but the third gave cause for criticism as regards escape of noxious fumes otherwise than by the chimney. Imperfect distribution of heat over the system, with pressing of the plant for a large production combined to effect rapid deterioration of structure, and were largely responsible for the less satisfactory conditions in some of these plants.

Chemical manure works. In one works a new mechanical mixer was operated with satisfactory results alike as to production and to the working conditions inside the works. Conditions generally were good; the discharge of acid gases was low.

Sulphate and muriate of ammonia and gas liquor works. The liquor distilled from gas works was equivalent to 21,365 tons of ammonium sulphate, and the noxious gases were destroyed as follows:—In oxide of iron purifiers, 72%; by combustion, 16%; by Claus process, 11%; and by precipitation by metallic salts, 1%. At one work the stock of oxide was renewed after 14 years' continuous service; during this long period it largely increased in bulk and value. It was necessary to use exceptional means to maintain its vigour. Plans are in progress for conversion of several large sulphate of ammonia units to the production of concentrated ammoniacal liquor.

Zinc works. Associated with increased production of zinc there was a large increase in the calcination of sulphide ores. The use of prolongs to arrest the fume leaving the receivers for condensed zinc vapour was extended and improved, but difficulties were met with in ensuring their proper utilisation. The solid matter obtained by the condensation of fume in these prolongs is of high market value.

DEVELOPMENT OF THE AMERICAN DYESTUFFS INDUSTRY.

U.S. Comm. Rept., Aug. 15, 1917.

An examination of returns made to the Bureau of Foreign and Domestic Commerce by practically the whole dyestuffs industry in the United States indicates an increasing tendency to amalgamation of interests among certain plants making crudes and intermediates with others producing finished dyestuffs, which will probably result in the output of a greater variety of colours at a decreased cost of production. As far as actual figures are available, the total amount of capital invested in the industry in the United States would appear to be 163,025,650 dols. This amount does not include capital invested in dyestuffs production by ten firms, some of which are just beginning operations, while others are not incorporated and have no capital stock, but are amply financed or are owned by a single individual. These plants will probably be in full operation by 1918, and several million dollars of capital will thus be added to the

industry. From figures submitted by manufacturers, the following totals of monthly production for the current year have been compiled:—Twenty-two firms manufacturing crudes report a monthly output of 1,240,350 gallons of benzol, toluol, and some xylol and phenol, and 6,181,600 lb. of benzol, toluol, natural and synthetic phenol, cresol, naphthalene, anthracene, and some xylol, cumol, and anylene; forty firms report a monthly output of 10,120,600 lb. of intermediates; forty-six firms had an output of 5,000,000 lb. of artificial colours per month; and thirteen firms an output per month of 8,183,500 lb. of vegetable dyestuffs and extracts (including some tanning extracts not stated separately). For general purposes, it is said, these figures may be taken as fairly representative of the industry as a whole. The major portion of the total output of intermediates in the United States is probably consumed in the dyestuffs industry itself, although a large amount, especially trinitrotoluol, falls in the category of explosives. There is a constant increase in the variety of intermediates and chemicals produced in the United States for making colours. Dyestuffs manufacturers are now producing large quantities of toluidines, resorcinol, xylidine, dianisidine, naphthylamine, diphenylamine, tolidine, benzidine, benzaldehyde, benzyl chloride, nitrobenzol, nitrotoluol, 11-acid, phthalic, metanilic, sulphanilic, and naphthionic acids, naphthol-sulphonic acids, naphthylaminesulphonic acids, and aminonaphtholsulphonic acids, Schaeffer's salt, paraitraniline, dimethylaniline, and numerous others. A glacial acetic acid plant of large capacity is expected to begin operation immediately.

Coal-tar dyes in a variety of colours are now regularly obtainable from domestic sources. Several manufacturers carry full lines of direct, acid, basic, chrome, oil, and sulphur colours; while others confine their efforts to improving and extending their output of particular groups. Prominent among the colours produced are, nigrosines, indulines, triphenylmethane dyes, safranines, eosins, chrysoidines, rhodamines, rosanilines, direct fast reds, browns, and yellows for cotton, fast chrome colours for wool, Sudan colours, basic violets, synthetic indigo and indigotins, alkali blues for the silk and woollen industries and also for the lithographic trade, metanil yellow, methyl violet, methylene blue, benzopurpurine, benzo sky blue, primuline, naphthol green, rose benzale, gallo-cyanine and special chrome and khaki colours. Considerable attention is being given by about a dozen firms to developing as rapidly as the requisite intermediates are available, the triphenylmethane dyes, particularly fuchsin, methyl violet, methylene blue, magenta, and malachite green. The itemised figures given by only a few of the plants show a monthly production of this series of colours amounting to 62,200 lb. Of this quantity 18,200 lb. represents methyl violet and 13,450 lb. methylene blue. Two manufacturers specialise on intermediates for these dyes. There is a largely increased production and variety of reds, yellows, and scarlets. A wide range of fast reds, blues, greens, yellows, blacks, and greys for cotton is also available. Colours now produced on a commercial scale that were not made in the United States until recently are alizarin blues, browns, and yellows for calico printing, and for wool; para colours for lakes or pigments, vat dyes (indigoids) for cotton shirtings and gingham, synthetic indigo, rhodamine, patent blue, and Biebrich scarlet.

Present production and new developments contemplated also include blacks and greens in natural dyes for calico printers, a special logwood blue, special mordants for dyeing new shades in direct cotton colours, khaki dyes, cutch, archil, and logwood extracts, and powdered eudbear, orange and lemon flavines, Osage orange in a variety of shades,

American sumac extract, indigotin, and natural indigo shades. It is stated by several plants that their output depends on the domestic demand, ample facilities being available for a largely increased production at any time. Some plants operate at half capacity, while others are running 24 hours a day. One firm is making sulphur brown (not a coal-tar product) on an extensive scale, while another company is producing mineral colours in standard shades for wool. Soluble Prussian blue, Chinese blue, pigment brown, lakes in all the principal colours, para-toners, dry colours, and dyes for lake makers are handled by different manufacturers.

Announcement has been received of the entrance into the dyestuffs industry of the leading American company manufacturing explosives. Other new plants in process of construction or to begin operations before 1918 are two for coal-tar crudes, one for anthracene, one for glacial acetic acid, four new buildings for aniline dyes, one for chrysoidine and methylene blue, one for nigrosine, induline, and magenta, and one for nigrosine only. A producer of direct, acid, and chrome colours expects to double his present output of nearly 500,000 lb, annually during the next twelve months. One plant making methylene dyes is planning to double its capacity, two others making aniline colours will also double their capacity shortly, one manufacturer expected to have patent blue and fuchsin on the market after July, one of the larger corporations is now making auramine and lanafuchsin on a small scale and installing equipment for their increased output, and another contemplates the manufacture of primuline in considerable quantity. A producer of high-grade colours for silk is enlarging his factory and contemplates the early production of safranine, and the installation of a suitable plant for the extensive manufacture of aniline dyes. Experimental research is in progress on a great variety of products that are now being manufactured on a semi-commercial scale with a view to increasing production as the processes are worked out in different establishments.

Dyes and dyestuffs exported from the United States during the fiscal year ending 30th June, 1917, were valued at 11,719,887 dols., as compared with 5,102,002 dols. in 1916.

GERMAN CHEMICAL INDUSTRIES.

The "Neue Zürcher Zeitung" recently published a review of German activities in technical matters in the field of war economies, in which it is stated that systematic investigations into the properties of pit coal have been carried on by the "Kaiser Wilhelm Institut für Kohlenforschung," and have yielded important industrial results. The treatment of coal with liquid sulphurous acid at ordinary temperatures has produced viscous, golden-yellow mineral oils, the amount produced being 5 kilos. per metric ton (see this J., 1916, 1001). A process has also been elaborated by which through heating naphthalene under pressure, in the presence of aluminium chloride, an oil is produced which can be used for illuminating purposes in the same manner as petroleum (this J., 1913, 350). Finally, by treating with ozone, it has been found possible to alter the carbon compounds in coal to compounds soluble in water, the chemical importance of which cannot at present be estimated (this J., 1916, 1001).

The utilisation of lignite has been greatly extended. In the first place it is being used extensively as a fuel in the industrial establishments which have recently sprung up in the

Central German lignite fields, especially in the neighbourhood of Bitterfeld and Halle a/S, where the German air-nitrate factories are situated. A process has been discovered by which nearly twice the usual amount of ozokerite can be obtained from lignite, and the gas is being more extensively used for heating and smelting purposes.

In the production of nitrates directly from air a new process has been discovered, which works with quadruple air velocity through the reaction space and produces a result about 80% higher than could be obtained before.

In the metal industry further progress has been made with the production of substitutes for copper, brass, and bronze, especial mention being made of the different zinc and lead alloys, and of the increasing importance of aluminium. Recently there have been new developments in ore smelting. With copper schists the metallurgical possibility of going as low as 0.7% has been shown, whereas formerly the average lower limit was 2.5%. Operations have been commenced upon large deposits of sandstone containing lead. Successful experiments have been made in obtaining aluminium from clay, which will, it is claimed, make Germany independent of foreign bauxite in future. With nickel ores the workable limit has been reduced from 2.5 to 1.5%. A process has also been discovered for obtaining nickel and cobalt from mine waters containing these substances.

In the German rubber industry the situation is said to have been eased by the progress made in rubber regeneration, and by the substitution of mechanical spring wheels for pneumatic tyres. The idea of exploiting German caoutchouc plants has been given up.

Nettles have become more and more important as a source of fibre. The uses to which paper textiles are put are also constantly increasing, and qualities are being produced which are durable and will even stand washing. (*Board of Trade Journal* Sept. 13th.)

Correspondence.

CENTRAL SCHOOL OF ANALYTICAL CHEMISTRY.

SIR,

I have now been engaged in technical chemistry for over a year, and I have been struck pretty forcibly by the fact that a firm's analytical routine is apt to go on along the same lines for long periods of time. If, on the other hand, it is realised that some long-established method is by no means perfect, and reference is made to the Section on Analytical Chemistry in the Annual Reports of the Chemical Society, the number and diversity of new methods cited is bewildering, and hope of replacing an old and slow method by a new and rapid one is reduced by the great number of such new methods, trial of and selection from which might well take months. Learning new methods from books alone is never entirely satisfactory, and there is at present great need of a living contact between the pioneers of chemistry and those who might benefit by their work.

It is an established custom to hold Post Graduate courses for doctors. I write to suggest that something of this sort might be arranged for analytical chemists as well. Men and women busy all day in routine analytical work are unlikely to avail themselves of new methods; indeed the attempt to do so would much upset their routine on which the efficient running of factories so much depends.

What is wanted is a Central School of Analytical Chemistry to which analytical chemists could be sent occasionally by their firms for a short time, and where they could learn new and quicker methods, or improvements in old ones. The nett time such a scheme would save the country would soon be enormous. Such is the crude idea, and, of course, it requires a great deal of hewing into shape, and this cannot be done till after much discussion.

As an imaginary forecast of the Central School of Analytical Chemistry and its manner of working I venture to put forward the following. Let us suppose the School in existence, housed in such a building as that containing the Laboratory of the Institute of Chemistry; and let us also suppose that the management of a firm are painfully aware that one of their analytical methods is unsatisfactory. The management will then write to the Director of the School stating their difficulty, and asking if better methods exist. If the Director of the School can help it will be arranged that the firm's chemist shall attend the school for a time sufficient to gain complete mastery of the new process. I think that during this time the chemist should still be paid his usual salary by the firm, who should also pay the school fees. The firm should, however, be entitled to a refund of the fees from their employee if the latter leaves them before the new process which he has learnt is firmly established in their laboratory. I am against the chemist attending the school either in the evenings or during his usual holidays. It is only men of exceptional physique who can thus afford to work over their normal limits with advantage either to themselves or to those for whom they work.

The question of the upkeep of such a school is a difficult one, whether it should be run by the State or jointly by manufacturers to whom it is likely to be of service. But in any case movements of both sorts are in the air at the present time, and I put forward the above ideas as being, after all, only a particular case of what I am thankful to say is now a general tendency.

I am, etc.,

R. C. MENZIES.

Loughton, Essex.

September 27th, 1917.

LOW TEMPERATURE DISTILLATION OF INFERIOR COALS.

SIR,

In reading the interesting article by Mr. T. F. Winnill in the August 31st issue of the Journal, my attention is drawn to the point that the distillation of the coal was carried out under a vacuum of 26 inches to 28 inches of mercury. If the plant mentioned is merely an experimental one erected for academic purposes, this fact may pass, but if the carbonisation be carried out in future on a commercial scale, it appears to me that working under such an approximate vacuum as that mentioned in the article, would involve a collision with the patents held by the "Tarless Fuel Syndicate," which cover carbonisation of coal at low temperatures under vacuum, and I have no doubt that the proprietors of the patents would exert every effort through the proper legal channels to uphold their proprietary rights.

As far as using in the retort a "stirrer" or even a continuous screw or helix, it is curious how this idea has fascinated carbonizers, especially of the

amateur or patent-seeking type, for almost a generation past, and the records of the Patent Office bear testimony to this.

Quite recently I had in a foreign country the opportunity to work practically an installation of this type, erected at some considerable cost, and on quite a substantial scale. It was erected to deal with the easiest of coals to work, viz., a poor lignite, of course non-caking. It failed hopelessly, as it churned the lignite to breeze (some 30% to 40%), and failed to produce a reasonable amount of tar oils. The installation is to be displaced in favour of a more modern and perfected system which is now being effected, as the trials of the lignite sent to this country to be tested by the process indicated proved very successful, yielding—

Petrol	2.2 gallons per ton.
Light oils	4.4
Heavy oils	6.95
Sulphate	22 lb.
Good smokeless fuel ..	12 cwt.

My experience goes further; with screw retorts, working rich bituminous coals or cannel, there is the greatest mechanical difficulty in getting the screw to pass such coals or cannel, as when they get to the sticky stage, the power required to operate the screw is enormous.

Yours faithfully,

F. D. MARSHALL.

Past President, Institute of Gas Engineers.

19, Queen Anne's Chambers, S.W.,

September 12th, 1917.

Obituary.

CLAYTON BEADLE.

Clayton Beadle, who died on August 16th last, was born in 1868, and was educated at Dover College. After a short time spent in studying the routine of paper-making, he entered the laboratory of Cross and Bevan in 1886, and later became a partner in the firm. Whilst there he was engaged in investigations in connection with cellulose, and especially in regard to the work which led up to the foundation of the viscose industry. On the lapse of his term of partnership he joined with others in forming the British Viscoid Company, which launched an experimental works at Erith under his management. He was also actively interested in the work of the Viscose Syndicate and the Viscose Development Co. For many years he has been engaged in consulting practice, in partnership with Dr. H. P. Stevens, and their laboratories have become widely known in connection with the paper and rubber industries.

Beadle contributed largely to technical literature; he was the author of "The Theory and Practice of Beating," and also published "Chapters on Papermaking," in collaboration with Dr. Stevens.

His work received many recognitions from learned and technical societies, including medals from the Royal Society of Arts, Société d'Encouragement pour l'Industrie Nationale (Paris), and the Franklin Institute (Philadelphia).

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each, to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.
United States.—1s. each, to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—
 Patent number, date, name of patentee, and title of invention.
French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56, Rue Feron S. Paris (3e).
 Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

Desiccants; Comparison of the efficiency of some common—. M. V. Dover and J. W. Marden. *J. Amer. Chem. Soc.*, 1917. 39, 1609—1614.

Alumina was prepared from purified alum solution by precipitation with ammonia. The precipitate was washed with dilute ammonia, dissolved in hydrochloric acid, re-precipitated with ammonia, and washed with water and ammonia. The product was dried first at 100° C. and finally at 500° C. in a current of air dried over sulphuric acid. Calcium oxide was prepared by treating the nitrate with caustic soda, dissolving the hydroxide in hydrochloric acid, and re-precipitating with caustic soda. The hydroxide was then washed free from chlorides, and was ignited at 500° C. in a current of air free from carbon dioxide. Magnesium oxide was prepared in the same way as alumina. Cupric sulphate was prepared by three times recrystallising blue vitriol, drying at 100° C. and heating for some time at 400° C. In each case the freshly prepared desiccant was transferred to a U-tube whilst still warm. A known volume of moist air was aspirated at a uniform rate (1½ to 2 litres per hour) through a column of the desiccant, 30 cm. long by 15 mm. wide, and the residual moisture absorbed and accurately weighed in a counterpoised phosphorus pentoxide tube. Alumina proved to be a most efficient drying agent, but calcium oxide and magnesium oxide soon became exhausted. With cupric sulphate the colour showed that the first few cm. of the column of material was sufficient to absorb the moisture. From the results obtained by the author and by others, the weights of residual moisture in 1 litre of air at 25° C., after having passed a U-tube containing a 30 cm. column of the desiccant, are given as follow:—copper sulphate, 1.4 mgrms.; zinc bromide, 1.1; zinc chloride, 0.8; calcium chloride, 0.36; sulphuric acid (95.1%), 0.3; calcium bromide, 0.2; calcium oxide, 0.2; sodium hydroxide, 0.16; magnesium oxide, 0.008; alumina, 0.003; potassium hydroxide, 0.002 mgrm.

—J. H. P.

PATENTS.

Evaporators. The Griscom-Russell Co., New York. Assignees of R. C. Jones, Garden City, N.Y.. U.S.A. Eng. Pat. 103,820, Dec. 21, 1916. (Appl. No. 18,342 of 1916.) Under Int. Conv., Feb. 1, 1916.

A MULTI-COIL evaporator has a perforated baffle-plate arranged below the surface of the liquid and just above the coils, so that the vapour given off is directed to one side of the vessel and carries only a little entrained liquid with it. The vapour passes into a pipe extending upwards through the evaporator-head above the evaporator, and is discharged from the pipe through a nozzle against a ridge by which the vapour is divided into two converging streams which sweep round the evaporator-head to the outlet. The deposited liquid is returned by a pipe to the evaporator proper.

—W. H. C.

Concentration, evaporation, or distillation of liquids. J. Harvey, Roek Ferry, F. A. Hulme, Fornby, and The Chemical and Mechanical Processes Co., Ltd., Liverpool. Eng. Pat. 108,555, Aug. 30, 1916. (Appl. No. 12,255 of 1916.)

An ordinary evaporating apparatus has on its

outlet pipe a long continuation pipe and in it a length of piping or coil, the lower end of which is connected with the feed tank and the upper with the evaporator. The liquid in the feed tank passes through this pipe and is heated by the vapours from the evaporator, acting as a condenser at the same time. Any uncondensed vapour is condensed by means of a water spray placed below the preheating coil.—J. H. P.

Dust separator for pulverising mills. The Raymond Brothers Impact Pulveriser Co., Chicago, Ill. Assignees of R. A. Lechmann and W. B. Senseman, Chicago, and A. W. Raymond, Evanston, Ill., U.S.A. Eng. Pat. 105,763, July 24, 1916. (Appl. No. 5517 of 1917.) Under Int. Conv., Oct. 23, 1915.

A DUST separator for pulverising apparatus of the type in which the pulverised material is discharged by means of an air current, consists of a funnel-shaped separating chamber open at the top and having a discharge opening at the bottom which can be closed by a slide. A conical partition, having a central opening, is disposed across the separating chamber, to the upper open end of which a bag, formed of material pervious to air, and supported by a framework, is fixed. The pulverised material is led tangentially into the separating chamber, below the partition, and the space above the partition is connected by a pipe with the feed passage leading to the pulverising machine.

—W. H. C.

Waste heat of gas engines, incandescent slag, coke, and the like; Method for utilisation of the—. C. Semmler, Wiesbaden, Germany. Eng. Pat. 107,443, July 24, 1916. (Appl. No. 10,403 of 1916.)

A CIRCULATING medium which does not readily boil, for instance glycerin, calcium chloride solution, etc., is used to take up the waste heat and to give it up again to water or air in a suitable heat-exchanging apparatus. The circulating medium is heated only to a temperature below its boiling-point, so that it can be used under atmospheric pressure. Heat storing or dissipating devices are interposed in the system to deal with an irregular supply of waste heat. (See also Eng. Pat. Appl. 10,074 of 1916.)

—W. H. C.

Boiler gases; Apparatus for washing and utilising waste—. F. Sargent and H. C. Heaton, Chicago. Assignors to Babcock and Wilcox Co., Bayonne, N.J. U.S. Pat. 1,235,928, Aug. 7, 1917. Date of appl., Apr. 21, 1916.

THE waste gases are sprayed with water which then passes to the feed water heater, through which it travels in the opposite direction to the feed water. After leaving the feed water heater, the spray liquid is used to moisten the air for combustion.—J. H. P.

Vacuum drying apparatus. J. D. Taylor, London, and F. Shaw and Co., Ltd., Manchester. Eng. Pat. 108,130, Mar. 6, 1917. (Appl. No. 3325 of 1917.)

THE material is fed from a hopper by a rotary vacuum-tight plug into a steam-jacketed vacuum drying chamber. Within the chamber a screw conveyor passes the material to the smaller end of a tapering horizontal conveyor drum, from the wider end of which the dried material is discharged

to the atmosphere through an air-lock. Several tapering drums may be placed in series, one above the other, within the chamber.—W. H. C.

Drying apparatus for cattle bark, maize, or other like commodity. A. Mitchell, London, Eng. Pat. 108,132, Mar. 15, 1917. (Appl. No. 3805 of 1917.)

THE material is supported on a series of superposed endless bands which convey it through the drying chamber. The latter is formed by a collapsible frame covered on the inside and outside with asbestos sheets, with a layer of insulating material between the sheets. Air is drawn from the atmosphere through a dust filter by a fan and delivered through a refrigerating chamber, where it is dried, to a tubular air heater. The air is heated by the products of combustion from a furnace placed below, which pass round the tubes, and the warm air is delivered into the drying chamber through flues which pass below the floor, and are provided with a number of discharge nozzles.—W. H. C.

Drying and aerating machines. J. A. Sparks, C. E. and W. M. Clark, Elk, Kans., U.S.A. Eng. Pat. 108,520, Aug. 8, 1916. (Appl. No. 11,190 of 1916.)

THE apparatus consists of a hydro-extractor provided with a lid containing an air inlet in the form of a spout. The revolving basket sets up an inflowing current of air through the spout and through the material in the basket.—J. H. P.

Centrifugal dryer. G. H. Elmore, Swarthmore, Pa. U.S. Pat. 1,235,193, July 31, 1917. Date of appl., Sept. 6, 1912.

THE material is fed to the small upper end of a revolving conical screen by means of a hopper. Within the screen is a bell distributor mounted with a number of quick pitch conveyor flights; the distributor revolves in the same direction as the screen, but at a slightly different speed, thus tending to feed the material down the screen.—J. H. P.

Regenerative furnaces; Reversing valves and flues for —. B. Percival, Sheffield, Eng. Pat. 108,205, July 31, 1916. (Appl. No. 10,776 of 1916.)

SEPARATE water-sealed valve-boxes, separated by a considerable length of flue, are used for the gas and waste products of combustion respectively.—W. H. C.

Furnaces. P. Southwick, Birmingham, Eng. Pat. 108,566, Sept. 16, 1916. (Appl. No. 13,174 of 1916.)

A FRAME, formed from cast iron bars with mitred ends and secured by dovetail connections, is placed above the usual fire-bar frame, and passages are formed at the sides of both frames in the brickwork to admit air to the back of the upper frame. The air passes through slots in the vertical bars of the frame to the upper side of the fire-bars.—J. H. P.

Viscid material; Apparatus for reducing more or less — in bulk to the condition of a layer or film. A. Sonsthagen, West Ealing, and E. H. Bernhard, Ashurst, Kent, Eng. Pat. 108,504, Aug. 3, 1916. (Appl. No. 10,982 of 1916.)

THE material is supplied by a feed roller to a pair of oppositely moving rollers or to a roller and a fixed body or a belt. The rollers may move at the same or different speeds, and the thickness of the film is regulated by altering the space between the rollers and the speed of the feed-rollers.—J. H. P.

Centrifugal separator. T. H. Parker, San Francisco. Reissue 14,331, July 24, 1917. of U.S. Pat. 1,212,996, Jan. 16, 1917. Date of appl., June 9, 1917.

IN a separator, the rotary distributor has a central depression and is surrounded and partly covered by a shell having an opening at top and bottom. The shell is carried on a rotating sleeve and its upper part is surrounded by a receptacle with a downwardly inclined bottom and fitted with a discharge hole at the bottom and a supply pipe at the top. The material is fed through this pipe on to the revolving distributor, the light particles being discharged over the top of the shell and the heavy ones below it. The shell and distributor may be run at different speeds.—J. H. P.

Cleaning and heating air; Apparatus for —. W. F. Cox, Danville, Va. U.S. Pat. 1,233,555, July 17, 1917. Date of appl., Jan. 25, 1916.

A TANK containing liquid is supported on "staggered" guides between which "staggered" baffles formed of absorbent material are placed. The air passes between the guides and baffles, the latter being supplied with liquid from the tank above by wicks, and then through a screen or filter which is also supplied with liquid from the tank by wicks.—W. H. C.

Clarifier. O. M. Nilson, Assignor to United States Sugar Co., New Haven, Conn. U.S. Pat. 1,234,202, July 24, 1917. Date of appl., Dec. 14, 1916.

AN inner vessel serving as a heating flue is suspended within an outer vessel containing a fluid, and is partly surrounded by baffle plates. The fluid in the outer vessel is caused to flow in a tortuous path around the inner vessel and through vertical tubes extending through the inner vessel. The baffle plates are arranged so that the inner vessel can be removed without disturbing them. The outer vessel is provided with gutters and cocks for the scum and fluid contents.—J. H. P.

Dryers; Rotary —. W. E. Prindle, London, Ohio, U.S.A. Eng. Pat. 108,358, Aug. 3, 1916. (Appl. No. 10,991 of 1916.)

SEE U.S. Pat. 1,222,244 of 1917; this J., 1917, 583.

Drying-machines with rotary heating devices; Construction of —. R., W. G., and F. R. Simon, Basford, U.S. Pat. 1,237,110, Aug. 14, 1917. Date of appl., May 21, 1914.

SEE Eng. Pat. 12,237 of 1913; this J., 1914, 342.

Disintegrating machine. G. S. Higginson, London. U.S. Pat. 1,235,030, July 31, 1917. Date of appl., June 14, 1915.

SEE Eng. Pat. 14,891 of 1914; this J., 1915, 945.

Pyrometer. U.S. Pat. 1,234,203. See XXIII.

IIA.—FUEL; GAS; MINERAL OILS AND WAXES.

Alcohol as a source of power. W. T. Rowe, Bull. No. 8, Dept. of Chem., South Australia.

ALCOHOL possesses many advantages over petrol as a fuel for internal combustion engines. A greater degree of compression can be used and there is less trouble from "knocking." The Department has used a mixture of 95 volumes of pure alcohol and 5 volumes of water. Methylated spirit is more economical but would be improved by using better denaturing agents. There is a little difficulty in starting from "all cold" with alcohol, and it is advantageous to add a little petrol or ether. With engines specially designed

for alcohol, this fuel has an advantage over petrol, relative efficiencies of 28 and 16.5% respectively being quoted (see also this J., 1915, 336). Petrol and alcohol do not mix in all proportions, but petrol may be added to 95% alcohol up to equal volumes. Benzol will mix with alcohol in all proportions, and in some cases a solution of naphthalene in benzol is used. With regard to the Excise restrictions it would be an advantage to provide a system of methylation more adapted to a motor spirit: benzol, petrol or redistilled condensate from Pintsch gas are suggested as admirable denaturants for this purpose. The use of wheat for alcohol production renders the cost prohibitive, and the price of potatoes would require to be not higher than 23s. per ton. A good source of alcohol is found in molasses, of which in Australia fully a third is put to no use. Wood, according to the variety, will give 16 to 20 galls. of alcohol per ton. As regards the cost of alcohol, the working expenses, apart from the restrictions of the Revenue authorities, would appear to average about 5d. per gallon.—J. E. C.

Ammonium sulphate; Direct process for manufacturing — II. 53rd Report on Alkali, etc., Works, 1916, 21—50. (See this J., 1915, 1001.)

THIS process was kept under observation in two works. In these works the make of gas has on occasions reached 1200 cub. ft. per sq. ft. of box surface per 24 hours, and the volume of oxide in relation to gas has been 8.0 and 6.7 cub. ft. of oxide respectively per 1000 cub. ft. of gas; the crude gas is very imperfectly cooled before reaching the purifiers, and where cooling is more efficient the condensed moisture removes much of the ammonia. Under these conditions, moisture tends to condense within the system, and the use of a relatively dry oxide, as previously recommended, is considered fully justified. Observations of temperatures in the process indicate that satisfactory results are obtainable with temperatures considerably in excess of the limits previously laid down (about 0° F. both in the sulphiding and oxidation zones) under the existing conditions. Experience has confirmed the view that the activity of the oxide is markedly higher when sufficient ammonia is present in the crude coal gas to keep the oxide neutral or slightly alkaline, and in some works the life of the oxide has been considerably extended by supplying a controlled amount of ammonia to the boxes. The results of experiments suggest that the amount of ammonia required to maintain the oxide in a state of neutrality bears a direct relation to the amount of ferrous sulphate formed, and that the formation of ferrous sulphate is favoured by excessive moisture and possibly by low temperature. The bulk of the ammonia should be introduced to the first purifier, but it is considered desirable to admit a certain proportion to the second box in place of supplying an excess to the first box. Cyanogen recovery, by scrubbing the crude gas with ferrous sulphate, is regularly practised at one works, but removal of the hydrocyanic acid has not obviated purifier troubles. Notwithstanding the elimination of losses due to inefficient working, the recovery of ammonia in the process was only 18½ lb. (sulphate) per ton of coal carbonised in 1916, compared with 17 lb. in 1915. These figures raise doubt as to whether the amount of ammonia leaving the retorts is really so high as has been supposed, and preliminary tests tend to confirm this, but the subject requires further investigation.

Sulphiding of hydrated oxide; Experiments on the — 53rd Report on Alkali, etc., Works, 1916, 50—52.

CRUDE coal gas leaving a scrubber fed with gas

liquor containing about 1.95% of free ammonia (ammonia content of gas in one experiment 6.3 grs. per 100 cub. ft.) was passed downwards through Dutch bog ore contained in a model purifier. Samples of the oxide were dried at various temperatures and their efficiency compared with that of an equal volume of undried material at different temperatures and rates of flow. Oxide containing 16% of moisture (corresponding approximately to $\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$) was markedly more efficient than an equal volume of oxide containing 37% of moisture ($\text{Fe}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$), or of oxide dried at 100° C. (Fe_2O_3), at both high and low temperatures. Under all conditions of hydration, the oxide showed a marked increase in efficiency at high temperatures: e.g., the relative efficiencies of air-dried oxide were 100 at 36° C. and 39 at 5° C.

Tar; Increasing the yield of — by lower temperature carbonisation. J. West. Gas J., 1917, 139, 379.

THE author gives details of tests relating to the effect of high and low temperature on the yield of tar. A four days' test with a coal of poor quality at temperatures of 1400° C. (2552° F.) and 978° C. (1793° F.) gave the following respective results:—Coal carbonised, 43.1 tons and 12.97 tons; gas made per ton, 11,491 cub. ft. and 7272 cub. ft.; total yield of tar (dehydrated), 259 galls. and 140 galls.; reduction in output of tar due to low temperature carbonisation, 46%. Tests on coal of good quality carbonised at temperatures of 1404° C. (2559° F.) and 1160° C. (2120° F.) gave the following results respectively:—Coal carbonised, 34.32 and 17.73 tons; gas per ton, 13,899 and 13,387 cub. ft.; yield of tar, 447 and 292 galls.; reduction in output of tar 34.7%. Tests on coal carbonised at high temperatures with the addition of steam to make blue water-gas gave a gas yield of 16,603 cub. ft. per ton and a tar yield of 20 gallons per ton, the latter figure being higher than any of the yields quoted at low temperatures. The low temperature tar is of very poor quality, and is made at a very great sacrifice of volume of gas, time taken up, and excessive costs, while the total output per day is materially decreased. Analysis shows that low temperature tar does not produce as good results in content of toluol and benzol as the high temperature product.—J. E. C.

Mineral oils; Oxidation of — by air. I. Effect of sulphur on the oxidation of hydrocarbons, with particular reference to asphalt. B. T. Brooks and I. W. Humphrey. J. Ind. Eng. Chem., 1917, 9, 746—748.

PETROLEUM oils, whether saturated, such as natural gasoline, or of the unsaturated type, like "cracked" gasoline, deteriorate much more rapidly by oxidation on exposure to the air than portions of the same oils which have been freed from sulphur by treatment with lead or copper oxides or metallic sodium. It is possible that oxidation of the sulphur compounds causes a simultaneous oxidation of other constituents. This view is supported by the fact that on heating petroleum residues with small amounts of sulphur, and shaking the mixture with natural gas, the product is much more fluid than that obtained by blowing air into the mixture. Asphalts of exceptional hardness may be made by the combined action of air and sulphur. For example, on air-blowing a sample of residue from a Mexican oil, to which 8% of sulphur had been added, for 31 hours at 220° to 230° C., the resulting product had a flowing point of 185° C., and a penetration of 7 mm. at 25° C. Another product made from the same residue, with the addition of 12% of sulphur, had a flowing point of 200° C., and a penetration at 25° C. of 5 mm. (100 gm. weight, No. 2 needle, 10 secs.). In practice, products as hard as this are seldom required, but the addition

of 3 to 5% of sulphur has a pronounced effect in producing hard asphalts in a much shorter time (e.g., 14 hours as against 96 hours) than can be obtained by air-blowing residues to which sulphur has not been added. Hence, too, residues relatively rich in sulphur will yield hard asphalts in less time, when blown with air, than those poor in sulphur.—C. A. M.

Bitumens; Effects of exposure on some fluid —. C. S. Reeve and R. H. Lewis. J. Ind. Eng. Chem., 1917, 9, 743–748.

EXPOSURE tests were made in a shallow box designed to exclude dust (J. Ind. Eng. Chem., 1913, 5, 15) upon samples of crude petroleum, oil asphalt, petroleum residue, and a water-gas tar preparation, and the results were compared with the behaviour of the same materials when used for the surface treatment of a limestone macadam road. At the end of two months the crude petroleum had lost 12.47% and 14.57% in weight respectively, the oil asphalts showed a slight increase in weight, whilst the Texas petroleum residue had increased 2.16% in weight, and showed a slight softening of the material, as indicated by the float test at 10° C. The tar preparation, which yielded only 2.1% of distillate up to 170° C., lost 7.29% in weight in the exposure test. The behaviour of the four products under service conditions was in general agreement with their relative behaviour in the exposure tests. The crude petroleum and the tar preparation developed a firm crust which was not displaced by traffic in rain and snow, whilst the Texas petroleum residue became soft during rainy periods throughout the year. On continuing the exposure tests for 12 months, all the samples excepting the petroleum residue showed a lower loss than during the previous period, whilst the residue showed a slight increase in fluidity. The amounts of fixed carbon and of bitumen insoluble in naphtha showed much greater increases than corresponded with the loss of volatile constituents. For example, in the case of a Trinidad crude petroleum, the loss on heating the sample for 10 hours at 163° C. was 28.31%, whilst the loss on exposure for 10 months was 26.60%, but the actual increases in fixed carbon for the same periods were 4.30 and 5.80% respectively. It is probable that polymerisation and intermolecular reactions have as much effect as evaporation in causing these changes.—C. A. M.

Action of illuminating gas on plants. Action of the gas on the germination of spores and seeds. Wehmer. See XVI.

PATENTS.

Peat; Apparatus for expressing liquid from —. J. W. Hinchley, London. Eng. Pat. 108,503, Aug. 3, 1916. (Appl. No. 10,976 of 1916.)

IN using the apparatus described in Eng. Pat. 101,782 of 1915 (this J., 1916, 1254), water, or the filtered expressed liquid, is pumped down through the grooves at the back of the strainers to prevent choking of the grooves or strainers.—J. E. C.

Fuel; Burning pulverised —. V. Z. Caracristi, Albany, N.Y., Assignor to Locomotive Pulverised Fuel Co. U.S. Pat. 1,234,870, July 31, 1917. Date of appl., May 25, 1914. Renewed Dec. 27, 1916.

A SERIES of columns of the fuel is delivered in a furnace, upwards and at different relative angles, towards a central combustion zone, and the flame is deflected, above the combustion zone, towards the rear and top of the furnace. Combustion is effected by means of preheated air delivered in the direction of the zone of combustion and of the deflected flame. Incombustible residuum is separated by impingement and gravity.—J. E. C.

Hydraulic mains used in connection with gas retorts and other carbonising plant. H. E. Bloer and J. B. Fenwick, York. Eng. Pat. 108,049, Aug. 15, 1916. (Appl. No. 11,510 of 1916.)

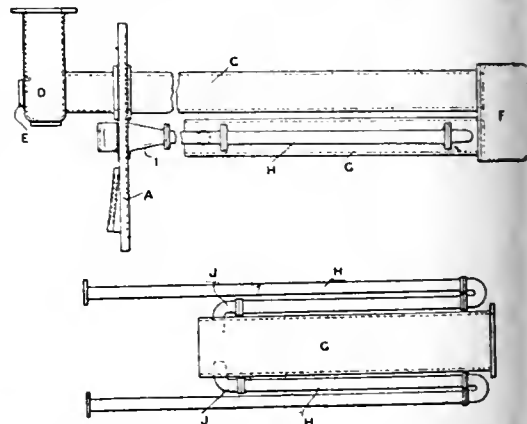
THE bottom of a hydraulic main is inclined towards one end, whereby the tar produced in any number of settings may be drawn off as produced. Division plates dipping into the tar and liquor are provided between the settings to form seals and thus allow of the isolation of any particular setting.—J. E. C.

Producing gas; Process and apparatus for —. H. L. Doherty, Assignor to The Improved Equipment Co., New York. U.S. Pat. 1,235,774, Aug. 7, 1917. Date of appl., Sept. 5, 1913.

AN automatically proportioned mixture of steam and air is forced through a deep bed of ignited fuel, the temperature being thereby maintained below the clinkering point. The steam is supplied by the exhaust from the engine driving a positive air blower and is introduced into the air blast main, a siphon being provided to remove condensed water.—J. E. C.

Burners [for blast-furnace gas, etc.] for boilers, stoves, and like heating appliances. J. J. H. Mackinlay, Shifnal, Salop. Eng. Pat. 108,185, July 25, 1916. (Appl. No. 10,139 of 1916.)

THE gas enters through the box, D, provided with a sight glass, E, into two upper gas tubes, C, which pass through the flue-plate, A, into the boiler



flue. The two tubes, C, end in a gas-box, F, from which the gas flows back through a common tube, G, mingles with the air which enters at I, and flows through the two tubes, H, J. The mixture burns at the open end of G, and the flame travels back over the tube, G, and around the two tubes, C.—W. H. C.

Oils; Apparatus for vaporising — for enriching coal and other gases. N. Swindin, London. Eng. Pat. 108,579, Oct. 4, 1916. (Appl. No. 14,003 of 1916.)

A SERIES of connected gas pipes are arranged one above the other. Each gas pipe contains a closed steam pipe provided with gills or helical fins. Oil is distributed by means of a tray fitted in notches in the gills or fins and having overflow lips and spreading devices. The oil may pass from gas main to gas main, by way of sealed overflows, in the opposite direction to the flow of gas.—J. E. C.

Oil gases; Purification of —. F. Tinker, Birmingham. Eng. Pat. 108,602, Nov. 4, 1916. (Appl. No. 15,785 of 1916.)

IN the purification of oil gases by the removal

of unsaturated gaseous hydrocarbons under the action of chlorine, the reacting mixture is cooled throughout its bulk by means of a cold inert liquid introduced as a spray or in thin films. The product of the reaction is preferably used as cooling liquid.—J. E. C.

Mineral oils; Treatment of — [to remove sulphur, etc.]. O. D. Lucas, London, T. C. Palmer, Dagenham, and F. M. Perkin, London, Eng. Pat. 108,019, July 17, 1916. (Appl. No. 10,039 of 1916.)

SULPHUR or other undesirable ingredient is removed from mineral oils by subjecting the latter, whilst heated, to the action of ammonia. The ammonia reacts with the sulphur and converts it into hydrogen sulphide and other compounds readily removable by subsequent chemical treatment. The oil may be forced at a high velocity and pressure through tubes in which it is heated above its normal boiling point and then allowed to expand suddenly, ammonia being previously dissolved in the oil or forced in as a gas.—J. E. C.

Hydrocarbons; Apparatus and method for the conversion of — F. B. Dehn, London. From Synthetic Hydro-Carbon Co., Pittsburgh, U.S.A. Eng. Pat. 108,333, June 29, 1916. (Appl. No. 9186 of 1916.)

THE hydrocarbons are passed on to heated pieces of metal contained in a perforated basket in order to convert them completely into the gaseous state. The gases pass down under pressure into a vertical cracking tube, heated to a suitable temperature, and containing a central shaft with a series of lateral vanes, to the ends of which short chains are attached. The shaft is kept in rotation, thus deflecting the gases and ensuring effective contact with the heating surface; at the same time the chains remove the carbon deposited on the outer wall. Underneath the cracking tube is a chamber in which the carbon collects, through which the gases pass on their way to the condensing apparatus. A baffle wall or curtain prevents the carbon from passing on with the gases, and by closing a valve the carbon can be removed during the operation. A by-pass connects the receiver of the condensed liquid with the supply tank to supply the necessary pressure to force the hydrocarbons into the cracking tube, or, if preferred, a force pump may be attached for this purpose. By controlling the temperature, pressure, and time of cracking, different products, such as gasoline, benzene, toluene, may be obtained as desired.—L. A. C.

Petroleum; Transforming crude — into petroleum of less density. F. B. Deakin, London. From M. E. Venturino, Buenos Ayres, Argentine. Eng. Pat. 108,496, Aug. 16, 1916. (Appl. No. 3251 of 1916.)

THE crude petroleum is heated in a retort cooled at the top by the controlled application of water or other liquid, thereby causing the vapours of higher boiling points than that of the required product to be condensed and again exposed to the cracking action at the bottom of the retort. The lighter vapours pass out at the top of the retort and are condensed. A mechanical scraper, operated at intervals from the outside, prevents the formation of a layer of non-conducting coke at the bottom of the retort. A chamber inside the retort, open at the bottom and closed at the top, enables the denser portions of the liquid to be drawn off and either stored, or burnt as fuel for heating the retort. The top half of the retort is separated from the bottom half by asbestos sheets to lessen the conduction of heat.—L. A. C.

[Oil] distilling apparatus. L. S. Flatau, St. Louis, Mo. U.S. Pat. 1,233,771, July 17, 1917. Date of appl., Oct. 1, 1915.

A DISTILLING apparatus comprises an inner oil

receptacle provided with a vapour dome, and an outer shell, the annular space between the two forming a steam boiler. The products of combustion from a heating chamber beneath the still pass upwards by way of a series of tubes passing through the annular boiler portion into a hood enclosing the dome.—J. E. C.

Petroleum distilling apparatus. S. Boru, Bartlesville, Okla. U.S. Pat. 1,234,124, July 24, 1917. Date of appl., Jan. 25, 1917.

PARALLEL lengths of chain extend along the still bottom from end to end, covering its entire bottom. An opening is provided through which the chain may be inserted and removed.—L. A. C.

Still. B. Gallsworthy, Port Arthur, Tex. U.S. Pat. 1,234,327, July 24, 1917. Date of appl., Apr. 12, 1915.

THE still is domed and fitted with a coiled oil inlet nozzle at the top and a similar one for steam at the bottom. It is divided into compartments by perforated partitions with alternate central and marginal perforations. Each compartment is provided with a cock, and the dome has diaphragms projecting upwards from opposite sides at an angle.—J. H. P.

Hydrocarbon oils; Treatment of — A. L. Brown, Wilkinsburg, Pa., Assignor to Westinghouse Electric and Manufacturing Co. U.S. Pat. 1,234,862, July 31, 1917. Date of appl., Aug. 6, 1915.

HYDROCARBON oil is treated with 0.1 to 0.2% of red phosphorus to prevent the formation of sediment.—L. A. C.

Unsaturated hydrocarbons; Process of making — B. E. Eldred and G. Mersereau, New York, Assignors to Chemical Development Co. U.S. Pat. 1,234,886, July 31, 1917. Date of appl., Aug. 6, 1912.

HYDROCARBON oil vapours are exposed for a brief period to a temperature of about 700° C., but not reaching 800° C., the reaction products immediately removed and quickly cooled. The issuing mixture is white and foggy, consisting of a permanent gas and unchanged oil.—L. A. C.

Gas; Cold-proof — and method of making the same. B. E. Eldred and G. Mersereau, New York. U.S. Pat. 1,235,777, Aug. 7, 1917. Date of appl., Aug. 6, 1912. Renewed Dec. 14, 1916.

HEAVY oil vapours are exposed for a short time, in narrow tubing free from coky carbon, to a temperature of about 700° C., and then cooled to from 0° to -8° C. to condense residual oil vapours, which should amount to not less than 10% of the original oil. The remaining gas is added in an "unfixed" condition to "permanent lean gas" to make a compound cold-proof illuminating gas.—J. E. C.

Hydrocarbon oils; Apparatus for treating — G. L. Rowsey, Assignor to The Illinois Refining Machinery Co., Quincy, Ill. U.S. Pat. 1,235,384, July 31, 1917. Date of appl., July 1, 1916.

THE apparatus comprises a still, and primary and secondary condensers arranged in series. The distillate from the primary condenser passes back to the conduit leading from the still. This conduit is heated in order to crack the returning heavy hydrocarbons, and is arranged so that it is in part beneath the point of its connection to the still, to prevent the return of the condensed liquid into the still.—L. A. C.

[Gasoline] filter. A. Storm, Thompson, Iowa. U.S. Pat. 1,235,395, July 31, 1917. Date of appl., Oct. 11, 1916.

A GASOLINE filter consists of a thin-walled receptacle

with a filtering medium stretching in an inclined plane entirely across it. The inlet pipe is beneath the filtering medium, and the outlet pipe above it, and each has its mouth pointing downwards. These pipes extend across the receptacle and serve to brace its sides.—L. A. C.

Waste liquor [from refining of mineral oils]; Process for treating —. E. H. Wright and J. F. Oakleaf, Olean, N.Y., Assignors to Vacuum Oil Co., Rochester, N.Y. U.S. Pat. 1,236,031, Aug. 7, 1917. Date of appl., June 11, 1914.

WASTE liquor from the acid and alkali treatment of mineral oils, containing sodium sulphonates and sodium sulphates in solution and a small quantity of suspended oil, is treated with a reagent capable of producing with the sodium salts an insoluble precipitate in which the oil is occluded. This precipitate is separated, dried, and distilled.—L. A. C.

Coke-ovens; Means for continuously operating —. J. Lütz, Essen, Germany. U.S. Pat. 1,236,727, Aug. 14, 1917. Date of appl., Aug. 5, 1913. SEE Ger. Pat. 263,767 of 1912; this J., 1913, 1058.

Acetylene gas; Means for storing compressed or dissolved —. T. G. Allen, London. U.S. Pat. 1,234,600, July 24, 1917. Date of appl., Jan. 30, 1917.

SEE Eng. Pat. 100,911 of 1916; this J., 1916, 918.

[Petroleum] oils; Process of treating —. A. M. McAfee, Bayonne, N.J. U.S. Pat. 1,235,523, July 31, 1917. Date of appl., Sept. 30, 1913.

SEE Eng. Pat. 22,244 of 1914; this J., 1916, 298.

Utilisation of the waste heat of gas engines, incandescent slag, coke, and the like. Eng. Pat. 107,443. See I.

Production of toluol, benzol, and other light hydrocarbons from heavy oils. Eng. Pat. 108,508. See III.

Viscosimeter. U.S. Pat. 1,233,177. See XXIII.

Closed oil-tester. [Flash-point apparatus.] U.S. Pat. 1,236,123. See XXIII.

IIB.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

PATENTS.

Carbonising furnaces, or furnaces for reducing ores. J. G. Aarts, Dongen, Holland. Eng. Pat. 101,215, Aug. 8, 1916. (Appl. No. 11,203 of 1916.) Under Int. Conv., Aug. 13, 1915.

THE chamber walls of a carbonising or ore-reducing furnace are built of refractory material of such high specific heat and density that the heat capacity of the bricks in any horizontal plane is several times greater than that of the charge. The heating flues in the chamber wall are of such form that the heat-absorbing surface of the bricks is many times greater than the heat-imparting surface, and a number of baffles, transverse to the direction of the gas, may be introduced to increase the resistance of the flue. The radiating effect of the faces of the bricks is increased by embedding in the surface, material in crystallised form and of greater hardness than the charge. Graduated heating is brought about by insulating the various zones by asbestos, and by varying the composition of the bricks, substances such as silicon carbide, chromite, or graphite increasing the conductivity as compared with fireclay bricks. In each horizontal plane of the furnace the difference of

temperature between the heating wall and the charge is about 300° C., and the temperature of the heating flue ranges from 1500° C. to about 500° C. in the different zones.—J. E. C.

Organic refuse; Extraction of fals, ammonia, and the like from — [by destructive distillation]. Benton's Patents, Ltd., and W. A. Benton, Birmingham. Eng. Pat. 107,992, Apr. 20, 1916. (Appl. No. 5784 of 1916.)

THE organic refuse is subjected to distillation under reduced pressure, and in order that the process may be continuous the material is fed into the retort through a semi-rotary valve. The distilled substances pass from higher to lower zones of temperature and through a porous core in the material in the retort. The exit for the distillate consists of a semi-rotary valve which is cleaned, lubricated, and sealed by the issue of a sheet of steam between the valve and its casing. Suitable processes are applied to the distillate to separate the various constituents.—W. P. S.

Destructive distillation of carbonaceous substances. S. N. Wellington, London. Eng. Pat. 108,200, July 27, 1916. (Appl. No. 10,658 of 1916.)

COAL or similar carbonaceous material is heated in a vertical retort at a comparatively low temperature. Free space is allowed at the top of the retort, which is heated to a higher temperature than the lower carbonising section, and a mass of metal or other material is suspended in the heated free space to facilitate the decomposition of gases and vapours by means of radiant heat.—J. E. C.

Distillation of coal; Low temperature —. F. Lamplough, and Oil Extractors, Ltd., London. Eng. Pat. 108,343, July 28, 1916. (Appl. No. 10,726 of 1916.)

COAL is heated in a series of retorts by superheated steam admitted at the bottom. The hot gases evolved may be delivered to a gas main, or, by means of a by-pass, directed to the base of any particular retort to assist in the heating thereof.—J. E. C.

Carbonisation of coal and other carbonaceous matter. W. Anderson, Helensburgh, and J. Meikle, Glasgow. Eng. Pat. 108,509, Aug. 4, 1916. (Appl. No. 11,034 of 1916.)

VAPOURS distilled from oil are passed at a high temperature and pressure, through a retort containing carbonaceous matter, the vapours mingling with the gas evolved from the coal, etc. The apparatus comprises a still for oil distillation, a superheater communicating therewith, a retort, and a condenser.—J. E. C.

Rotary furnaces [for manufacture of carbon from vegetable matter]. R. Sumner, Cowley. Eng. Pat. 108,596, Nov. 1, 1916. (Appl. No. 15,592 of 1916.)

THE furnace comprises an inclined rotary tube, preferably ribbed or corrugated on its inner surface, and mounted between two superimposed fires.—J. E. C.

Electric incandescent lamps filled with argon. Allgem. Elektricitäts-Ges., Berlin. Eng. Pat. 102,441, Oct. 14, 1916. (Appl. No. 14,643 of 1916.) Under Int. Conv., Nov. 11, 1915.

IN an electric incandescence lamp small quantities of electro-negative gases or vapours, particularly phosphorus vapour, or substances evolving such gases or vapours, are introduced for the purpose of preventing the formation of arcs and thus permitting the use of argon free from nitrogen or containing a very small quantity thereof, as a filling for the lamp.—J. E. C.

Electric lamp; Incandescence — G. M. J. Mackay, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pat. 1,234,060, July 17, 1917. Date of appl., Apr. 30, 1913.

AN incandescence lamp comprises a bulb, a tungsten filament therein, and a filling of nitrogen at an initial pressure of 0.2–50 mm. (say 10 mm.) of mercury for each sq. cm. of filament surface. Under these conditions the progressive "clean-up" of gas during the operation of the lamp produces a progressive decrease in cooling effect on the filament, approximately counterbalancing the progressive decrease in heat generated in the filament, due to the wasting away of the filament. Special claim is made for a lamp having a tungsten filament about 5 in. long and 5 mils (0.005 in.) diam., the bulb being filled with nitrogen at an initial pressure of about 2 mm. of mercury.—J. E. C.

Furnace-setting for destructive distillation of coal or other carbonaceous substances. S. N. Wellington, Assignor to Coalite, Ltd., London. U.S. Pat. 1,234,517, July 24, 1917. Date of appl., May 17, 1916.

SEE Eng. Pat. 7769 of 1915; this J., 1916, 1006.

Destructive distillation of carbonaceous material; Apparatus for — W. L. St. J. Prioleau, London. U.S. Pat. 1,237,094, Aug. 14, 1917. Date of appl., June 20, 1916.

SEE Eng. Pat. 9375 of 1915; this J., 1915, 1082.

Electrical heating apparatus and process of making the same. U.S. Pat. 1,234,973. See XI.

III.—TAR AND TAR PRODUCTS.

Dichlorophenols; Preparation and properties of the six — [Odour of the dichlorophenols and their anisols.] A. F. Holleman. Rec. Trav. Chim. Pays-Bas, 1917, 37, 96–107.

The following methods were used for the preparation of the six dichlorophenols. 2,6-Dichlorophenol. Melted phenol was treated with one molecule of chlorine, and the product distilled. The fraction boiling above 210° C. was treated with a second molecule of chlorine, then diluted with benzene, shaken with water, dried, and distilled. From the fractions boiling from 210° to 230° C., the 2,4-compound crystallised. The 2,6-compound was separated from the fraction boiling from 215° to 220° C. by extracting with sodium carbonate and acidifying. After recrystallisation from petroleum ether it melted at 67° C. It was also prepared by chlorinating *p*-nitrophenol with hydrochloric acid and potassium chlorate, reducing the product with iron and sulphuric acid, diazotising, and boiling with alcohol and sodium acetate. 2,4-Dichlorophenol was obtained as described above in the chlorination of phenol. It was purified by repeated crystallisation from petroleum ether, and vacuum distillation, and melted at 45° C. 2,5-Dichlorophenol was prepared by diazotising the corresponding dichloroaniline. It melted at 58° C. 3-Dichlorophenol was obtained by reducing 2,3-dichloronitrobenzene and diazotising the product. Vacuum distillation and recrystallisation from petroleum ether gave a product melting at 7° C. 3,4-Dichlorophenol was prepared by diazotising the corresponding amine. After recrystallisation from a mixture of benzene and petroleum ether, it melted at 68° C. and boiled at 53.5° C. (767 mm.). 3,5-Dichlorophenol was prepared from *symm*-trichlorobenzene by treating it with sodium methoxide and decomposing the anisol produced with concentrated hydrochloric acid. It melted at 68° C. The corresponding anisols were prepared by treating the dichlorophenols with dimethyl sulphate and caustic soda,

extracting with benzene, and distilling *in vacuo*. Their melting points are as follow: 2,6-Dichloroanisol, 10.1° C.; 2,4, 28° C.; 2,5, 24° C.; 2,3, 31° C.; 3,4, –8° C.; 3,5, 68° C. The kind and intensity of the odour of the chlorophenols vary considerably. The 2-, 2,3-, 2,4-, and 2,6-chlorophenols have odours resembling that of iodoform, and the 3-, 4-, 2,5-, 3,4-, and 3,5-isomers have odours similar to that of phenol. The odour of the 2-, 2,3-, 2,4-, and 2,6-chloroanisols is similar to that of acetophenone, the odour of the 3-, 2,5-, and 3,5-isomers is similar to that of anisol, and the odour of the 4- and 3,4-isomers is similar to that of anethol.—F. Sp.

Increasing the yield of tar by lower temperature carbonisation. West. See 11A.

PATENTS.

Tar oils, carbolic acid, cresylic acid, and like substances; Distillation of — W. R. Grimwade, Toorak, Victoria, Australia. Eng. Pat. 108,004, July 11, 1916. (Appl. No. 9770 of 1916.)

THE distillation of tar oils, carbolic acid, cresylic acid, or the like from coal tar, is conducted in a current of an inert gas, *e.g.*, nitrogen or carbon dioxide, introduced under pressure at the bottom of the still. The offensive odour of the distillates (which is stated to be due to the action of oxygen) is thus avoided, the still temperature is reduced with consequent fuel economy, the distillation is accelerated, and fractional separation is facilitated. —F. W. A.

Low temperature tars; Separating — *without distillation.* R. Maclaurin, Stirling. Eng. Pats. (A) 108,339 and (B) 108,448, July 21, 1916. (Appl. Nos. 10,263 of 1916 and 8603 of 1917.)

(A) True low temperature tars, *i.e.*, those characterised by the almost entire absence of aromatic hydrocarbons of the benzene series, of naphthalene and anthracene, can be separated from resinous matter by thorough agitation with one or more portions of a hydrocarbon oil at about 40° C. The mixture is allowed to settle, the resinous matter collecting at the bottom. The top layer, on purification, gives an oil suitable for lubrication. The addition of a small quantity of water during the last agitation ensures a more complete separation. (B) By agitating low temperature tar or oil at 40–50° C., with water containing 3% by volume of sulphuric acid, and then allowing to settle, three layers are obtained. At the bottom is resinous matter; above this, an acid layer containing basic matter in solution; and, on top, an oil. These are separated and purified. A better resin may be obtained by previously treating the tar or oil as specified in (A), thus removing the bulk of the resinous matter. (See also this J., 1917, 620.)—L. A. C.

Pitch or other viscous or solid tar products; Liquid and plastic compositions containing — G. L. Davies, London. Eng. Pat. 108,368, Aug. 15, 1916. (Appl. No. 11,551 of 1916.)

SOLID or very viscous tar products obtained as described in Eng. Pat. 16,908 of 1909 (this J., 1910, 1368) are dissolved in cresols or a mixture of cresols and tar naphthas, or, preferably, commercial cresylic acid. The mixture can then be applied with less heat, or without the use of heat at all, leaving after evaporation of the volatile solvents, a hard, waterproof coating.—L. A. C.

Light hydrocarbons; Production of toluol, benzol, and other — *from heavy oils.* W. Anderson, Helensburgh, and J. Meikle, Glasgow. Eng. Pat. 108,508, Aug. 4, 1916. (Appl. No. 11,033 of 1916.)

THE heavy oil (creosote oil, blast-furnace oil) is distilled under pressure in a specially constructed

still consisting of two superposed drums separated by a combustion chamber, the lower drum, or both drums, being traversed by fire-tubes. The two drums are connected by a downcomer and return tubes, the oils being fed into the upper drum by a pipe coaxial with the downcomer. The distillate is mixed with steam, and the mixed vapours passed through a superheater and then through suitable condensing apparatus.—L. A. C.

Benzyl chloride; Process of producing —. J. B. Conant, Cambridge, Mass. U.S. Pat. 1,233,986, July 17, 1917. Date of appl., Oct. 20, 1916.

A MIXTURE of toluene and bleaching powder or other suitable chlorine compound is treated with sulphur dioxide or other suitable gas, reacting with the bleaching powder to form chlorine, and the resulting benzyl chloride separated by distillation. —B. V. S.

Process for treating waste liquors [from refining of mineral oils]. U.S. Pat. 1,236,031. See 11A.

IV.—COLOURING MATTERS AND DYES.

p-Phenylenediamine (ursol); Product of oxidation of — by hydrogen peroxide. (Bandrowski's base, tetra-aminodiphenyl-*p*-azophenylene). A. Heiduschka and E. Goldstein. Arch. Pharm., 1916, 254, 584—625. J. Chem. Soc., 1917, 112, i., 482—485.

IN view of the use of a solution of hydrogen peroxide and *p*-phenylenediamine as a hair-dye, the reaction between these two substances, which has been cursorily examined by Erdmann (thus J., 1904, 1023), has been thoroughly studied by the authors in order to ascertain the influence of varying experimental conditions on the yield of tetra-aminodiphenyl-*p*-azophenylene. In all the experiments a constant amount of 10% sodium carbonate solution, which was found to have no appreciable effect on the oxidation, was added to destroy the acidic impurities in the hydrogen peroxide. In all cases, substances other than Bandrowski's base are produced in larger or smaller amounts. The theoretical yield of Bandrowski's base was calculated in accordance with the equation: $3C_6H_4(NH_2)_2 + 3H_2O_2 = C_{18}H_{18}N_4 + 6H_2O$. The influence of the concentration of the *p*-phenylenediamine was found by allowing aqueous solutions of *p*-phenylenediamine (1—4%) to react with 2.98% hydrogen peroxide (10% in excess of the theoretical quantity) for twenty-four hours at 18°—20° C. The yields of base were 6—16.3%, nothing approaching the amounts (80—90%) claimed by Erdmann ever having been obtained. The yield does not increase proportionately to the concentration. The effect of time was found by prolonging the period of reaction. After seven days, the yield of oxidation product was 30—40%, and after three months only 60%, of the theoretical. The influence of the amount of hydrogen peroxide (2.98% solution) was found by keeping the reaction mixture containing 1.88% of *p*-phenylenediamine at 18°—20° C. for twenty-four hours. With amounts of hydrogen peroxide increasing from 0.636 mol. to 3.636 mols. (per 1 mol. of *p*-phenylenediamine), the yield of Bandrowski's base increased proportionally from 4.7% to 27.7%. With yet larger amounts of hydrogen peroxide, impure products were obtained, 5 mols. of hydrogen peroxide yielding a black non-crystalline mass. Rise of temperature accelerated the reaction at the expense of the purity of the product, but its effect was unimportant within the range of temperature which the skin can endure. *p*-Phenylenediamine in solution can be estimated by precipitation as *p*-benzoquinonedichloroimide by an excess of

calcium hypochlorite solution, and it is thus shown that in the preceding experiments, after removal of the Bandrowski's base, the filtrates contain 40—60% of unchanged *p*-phenylenediamine after twenty-four hours, about 50% after thirty days, and appreciable amounts after three months; in addition, about 20% of the diamine has been oxidised to products which could not be isolated. Despite certain differences in properties, Erdmann states (*loc. cit.*) that the base obtained by oxidising *p*-phenylenediamine with hydrogen peroxide is identical with the tetra-aminodiphenyl-*p*-azophenylene $[C_6H_4 \cdot \begin{smallmatrix} N \cdot C_6H_4(NH_2)_2 \\ | \\ N \cdot C_6H_4(NH_2)_2 \end{smallmatrix}]$ obtained

by Bandrowski by oxidising an ammoniacal solution of *p*-phenylenediamine by atmospheric oxygen or a solution of its hydrochloride by potassium ferricyanide. The authors prepared the base by oxidising an ammoniacal solution of *p*-phenylenediamine by aqueous potassium ferricyanide (whereby it is obtained rapidly and almost quantitatively), and found that after purification with pyridine it has m. pt. 239°—240° C. and no water of crystallisation. The base is obtained sometimes in very slender bronze leaflets, at other times in dark brown crystals, and yet again in large, dark red prisms according to the method of preparation. Estimations of the nitrogen by the Dumas method gave the expected results; those obtained by the Kjeldahl method were 2—3% too low. Bandrowski's base can be diazotised in the usual way, but the diazo solution does not combine with amines or phenols and does not yield characteristic products on boiling.

Separation and identification of food-colouring substances. Mathewson. See XIXA.

PATENTS.

Disazo dyestuffs; Wool —, and a process of making same. E. Anderwert and H. Schobel, Assignors to Soc. of Chem. Ind., Basle, Switzerland. U.S. Pat. 1,233,742, July 17, 1917. Date of appl., Apr. 9, 1917.

ONE molecule of the tetrazo derivative of a 3,3'-diaminodiphenylmethane compound, e.g., 3,3'-diamino-4,4'-dimethylphenylmethane, is combined with 2 mols. of an azo dyestuff component of which at least 1 mol. is a naphtholsulphonic acid, e.g., with 2 mols. of 1,4-naphtholsulphonic acid, to give a red wool dye fast to light and to fulling.—F. W. A.

Leucotriarylmethanecazo dyestuffs and a process of making same. Copper compounds of leucotriarylmethanecazo dyestuffs and a process of making same. F. Funcke and C. Jagerspacher, Assignors to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pats. 1,237,192 and 1,237,193, Aug. 14, 1917. Date of appl., Jan. 5, 1917.

SEE Eng. Pat. 104,743 of 1916; this J., 1917, 509. Special claim is made for the dyestuff obtained from the diazo derivative of aminoleuco-Patent Blue and 1-phenyl-3-methyl-5-pyrazolone and for its copper compound.

o-[Hydr]oxyazo dyestuffs; Copper compounds of — and process of making same. B. Wuth and C. Jagerspacher, Assignors to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,234,994, July 31, 1917. Date of appl., Jan. 24, 1917.

SEE Eng. Pat. 12,249 of 1915; this J., 1916, 922.

Copper compounds of ortho[hydr]aryazo dyestuffs; Process for the manufacture of —. G. Engi and C. Jagerspacher, Assignors to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,237,183, Aug. 14, 1917. Date of appl., Nov. 27, 1915.

SEE Eng. Pat. 15,127 of 1915; this J., 1916, 1104.

Colouring-matter lake and producing same. Colour lake and producing same. (A) C. Immerheiser, (B) C. Immerheiser and A. Beyer, Assignors to Badische Anilin und Soda Fabr., Ludwigshafen, Germany. U.S. Pats. 1,232,551 and 1,232,552, July 10, 1917. Date of appl., Aug. 3, 1914.

SEE Fr. Pat. 474,706 of 1914; this J., 1915, 1085.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Fibres from various sources. Bull. Imp. Inst., 1917, 15, 7—23.

Jute from Egypt. The sample was grown at Cairo from Indian seed and had been prepared by a special (alkaline) process; it was inferior in colour and lustre to Indian jute of fair quality prepared by retting. Owing to the method of preparation the loss on hydrolysis was abnormally low; the presence of a small amount of alkali, owing to insufficient washing, was detrimental to quality. The sample was valued at £36—£37 per ton, as compared with Calcutta jute at £41.

Sida rhombifolia fibre, known as "vivane," was received from Swaziland. The sample was clean, well prepared but somewhat harsh; it was of good strength and about 2 ft. in length. Fibre of this quality but 4 ft. in length would be worth £3 to £4 less than Calcutta jute. A larger sample received later was not well prepared; it was harsh, mostly matted and gummy, and poor in lustre; the cellulose content (70.5%) was low and the hydrolysis losses abnormally high on this account. The fibre was valued at only £17—£18 per ton with Calcutta jute at £28; such a fibre would be saleable for mixing with jute when the price of the latter is high. Better results should be obtainable by improved methods of retting.

Hibiscus cammabinus fibre from Rhodesia. This fibre had not been well prepared and the retting appeared to be uneven; the strength was irregular and the length varied from 4 to 6 ft. The hydrolysis results were high and the cellulose content low. The sample was inferior in colour, softness, and general appearance to Bimlipatam jute prepared in India from the same plant. The fibre was valued at £27 per ton, as compared with Calcutta jute at £32; the low quality is attributed to inexperience in the retting process. *Hibiscus* fibres of the same species were obtained from Egypt and from Nyasaland. The Egyptian fibre had been prepared by a special treatment and had not been washed free from alkali; it was consequently inferior in appearance and deficient in lustre. Two samples from Nyasaland gave high hydrolysis losses and low cellulose content; one was of moderate quality and the other distinctly inferior.

Nettle fibre from India. The sample consisted of uneven, very tangled fibre, brown to pale buff in colour, with many green portions. It had apparently been prepared merely by mechanical treatment and contained most of the gum and was coated with bark. The length of staple was mainly about 3 ft. 6 in., composed of extremely fine ultimate fibres 4—5 in. in length. In the rude state the fibre would have little value but might be used in coarse jute goods. The de-gummed fibre would hardly be a suitable substitute for flax or ramie, being deficient in strength and spinning qualities. The fibre might be obtained sufficiently clean and free from gum and bark by retting to be used in admixture with jute or hemp, but if retting were not practicable in India, it might be saleable in the form of clean bark ribbons prepared by scraping away the outer bark as in the preparation of China grass.

Sisal hemp from Rhodesia. A sample of sisal

hemp grown under experimental conditions was found to be exceptionally well prepared. The length of staple was mainly 2 ft. 6 in. to 3 ft. and if this had been slightly greater the sample would have ranked among the first-class materials of this species.

Furcraea fibre from Southern Rhodesia. This fibre was fairly clean and well prepared but inferior to previous samples from the same source; the cellulose content (72%) was lower and loss on acid purification higher, indicating insufficient washing. The length varied from 3 ft. to 8 ft., mostly 5 ft. to 5 ft. 6 in. Better removal of the pith by brushing and sorting of the fibres into more uniform lengths would increase the value. Another sample of *Furcraea gigantea* fibre from S. Africa was insufficiently cleaned but of good length and strength; it was estimated at a value of £20—£21 (Oct., 1915) but would be readily saleable at a much higher price if properly prepared.

Asclepias fruticosa fibre from S. Africa. This is locally known as "melkbosch" and is widely distributed. Two samples were examined which, however, were not well prepared and contained a good deal of bark. The staple was not sufficiently long (mostly 20—22 in.) to compare favourably with sisal. The fibre was harsh and of poor lustre, but exceptionally rich in cellulose (52%) and might possibly be found useful as a basis for nitrated explosives. In comparison with sisal hemp at £50, the samples were valued at £32—£38 per ton.

Kapok from the Sudan and Togoland. The Sudanese sample was not quite free from pod residues, but after cleaning it yielded a floss of excellent quality equal in resiliency to Java kapok. In Togoland a trade in kapok has been developed by the Germans, 9 tons having been exported in 1913. The quality of the sample bale received may be regarded as normal, and it is considered that encouragement should be given to the development of the industry.

Asclepias fruticosa floss from S. Africa. This floss is somewhat brittle and inferior in resiliency to kapok, and corresponds to the material known in the trade as "Akund." Its value in this country is considerably lower than that of kapok and it is not so suitable for the manufacture of life-saving appliances.

Seed hairs of Ipomoea albivenia from S. Africa. This material is known locally as Kafir or Natal cotton and resembles harsh unginned cotton of dark cream colour. The fibres are triangular in section, untwisted, and much thinner in the walls than cotton fibre, and only about 0.3 in. long. The raw fibre is much more absorbent than raw cotton, but it lacks the strength and spinning qualities of the cotton fibre. The material contains only 77.3% of cellulose and does not appear to be a very promising commercial article, though it might fetch a low price as a stuffing material considerably inferior to kapok.—J. F. B.

Wood; Chemistry of.—III. Mannan content of the gymnosperms. A. W. Schorger. J. Ind. Eng. Chem., 1917, 9, 748—750.

The method of determining mannan in various woods was to digest the sawdust with hydrochloric acid, precipitate the resulting mannose by phenylhydrazine, and calculate the mannan from the weight of the mannose phenylhydrazone. There was a pronounced difference in the results obtained with the conifers (*Gymnospermæ*) and hard-woods (*Angiospermæ*). The amounts of mannan found in 22 species of conifers, including firs, spruces, and pines, ranged from 1.44% (*Arbor vitæ*) to 9.22% (Cuban pine), but no mannan was present in the six hard-woods examined, including basswood, sugar maple, yellow birch, ash, and aspen. The proportion of mannan is usually greater in the

sap wood than in the heart wood; it decreases from the base upwards, but is fairly constant in transverse sections of the heart wood.—C. A. M.

Paper-making materials; Some new —. Bull. Imp. Inst., 1917, 15, 1-7.

Ecdeicola manostachya is a rush-like plant found only in Western Australia; the stems or so-called "leaves" are erect, rigid, rather slender, and vary in length from 2 to 5 ft. Treated in the same way as esparto grass (Oran) they gave approximately the same yield of pulp, 44% on the air-dry material, but the pulp was inferior in appearance, darker, and more difficult to bleach; it was also contaminated with yellow specks of a wax or resin, which could be removed by a more severe treatment, at the expense, however, of the yield of cellulose. This plant is regarded as a practicable material for the manufacture of paper pulp in the country of origin.

Neoboutonia macrocalyx is a tree growing to a height of 50-60 ft. and a diameter of 15-20 ins. in the East African Protectorate. It is extremely abundant and grows rapidly. The timber is of little value on account of its "woolly" nature, being very soft and light. Treated by the soda process under the same conditions as spruce, it yielded 46% of pulp of good quality as compared with 42% from spruce wood. The fibres are shorter than those of spruce, but the pulp bleaches well and yields a strong paper.

Brachystegia Randii is a tree which forms extensive forests in Mashonaland. The timber is of little value, though it is used for hut building. Ribbons of the inner bark have been examined, and a cordage fibre of inferior quality prepared, but being much interlaced it was not suitable for spinning. On digestion with 20% of caustic soda the bark yielded 33-34% of pulp of a dark colour, giving a strong brown paper. The pulp bleached easily and yielded a white opaque paper of good quality. The bark might be considered as a substitute for *Adansonia* bark but of lower commercial value from the point of view of yield; the economic difficulties of its transport from Rhodesia, however, would be considerable.—J. F. B.

Paper; Photomicrography of the structure of —. M. B. Hodgson. J. Ind. Eng. Chem., 1917, 9, 782-784.

Cross sections of paper stocks will afford information of the structure, and especially of the penetration of materials such as Indian ink into the paper. The sections are best prepared by mounting the paper between two pieces of gelatin-coated film the surfaces of which have been moistened to adhere to the paper. Outside the films are placed two pieces of moderately dry Castille soap, and the whole is fixed in the microtome with the paper edge normal to the edge of the blade.

—C. A. M.

Paper; Photometer for the measurement of the translucent effect of —. C. F. Sammet. J. Ind. Eng. Chem., 1917, 9, 784-785.

Two movable, standard, white backgrounds, inclined at an angle of 30° towards the source of light, are mounted on a track, with the light between and slightly below them. Above the zero point on the track there is a prism and eyepiece placed so as to reflect the light from the backgrounds into adjacent fields. After adjusting the blocks so that the fields match in luminosity, a sheet of paper is placed over the left-hand block, whilst a second piece is placed over the other block, with black velvet between. This block is now moved towards the light until the luminosity of the fields again appears the same, and the distance moved is an expression of the amount of light transmitted by the paper to the velvet and

then absorbed. The reading obtained with a given paper substituted in the formula— $100(1 - b^2/a^2)$ —gives a value for the comparison of the approximate percentage loss of light due to the absorption by the velvet. In this formula a represents the total scale reading, and b the distance which the block is removed from zero.

—C. A. M.

PATENTS.

Hemp-stalks; Method of exsiccating unretted —. C. Colahan, Stockton, Cal. U.S. Pat. 1,233,449, July 17, 1917. Date of appl., Aug. 12, 1915.

UNRETTED fibrous stalks are suspended in bundles which are exposed to the action of dry cool air in an enclosed chamber, so that a relative movement is effected between the stalks and the drying atmosphere. The binding gums uniting the fibres to the wood are thereby rendered brittle and the stems are then subjected to a mechanical breaking and decorticating treatment.—J. F. B.

Pyroxylin compounds; Process of making —. W. G. Lindsay, Newark, N.J., Assignor to The Celluloid Co. U.S. Pat. 1,233,374, July 17, 1917. Date of appl., May 11, 1916.

HYDRATED pyroxylin is mixed with a non-volatile liquid menstruum, e.g., liquid tricresyl phosphate, which is substantially insoluble in water, and the water is removed from the mixture by pressing.—J. F. B.

Paper, fabric or the like, not sensitive to acids or alkalis. M. Fehring, New York. U.S. Pat. 1,233,334, July 17, 1917. Date of appl., Mar. 1, 1915. Renewed Dec. 12, 1916.

PAPER, fabric or the like is coated or impregnated with coumarone-resin.—J. F. B.

Writing paper for metallic styli; Waterproof —. S. Kuroki, Assignor to Kumpitsu Seishi Kabushiki Kaisha, Ltd., Tokyo, Japan. U.S. Pat. 1,234,045, July 17, 1917. Date of appl., Jan. 23, 1917.

PAPER material is treated with a mixture of powdered clay and zinc oxide and subsequently coated with a mixture composed of castor oil or other non-drying oil, benzene, vaseline, and a deodorising substance.—J. F. B.

Yarn; Apparatus for testing —. Fine Cotton Spinners and Doublers Association, Ltd., and W. L. Balls, Manchester. Eng. Pat. 108,552, Aug. 28, 1916. (Appl. No. 12,127 of 1916.)

Conditioning and dehydrating wool or other bodies; Apparatus for —. G. H. Benjamin, New York. Eng. Pat. 108,441, Apr. 11, 1917. (Appl. No. 5106 of 1917.)

SEE U.S. Pat. 1,225,211 of 1917; this J., 1917, 640.

Vulcanised fibres; Treatment of —. T. Oye, Christiania, Norway. U.S. Pat. 1,234,377, July 24, 1917. Date of appl., Nov. 21, 1916.

SEE Eng. Pat. 105,033 of 1916; this J., 1917, 544.

Cellulose acetates and process of making same. H. Dreyfus, Basle, Switzerland. Reissue No. 14,338, July 31, 1917, of U.S. Pat. 1,181,857, May 2, 1916. Date of appl., Oct. 19, 1916.

SEE Fr. Pat. 432,046 of 1911 and third Addition thereto; this J., 1912, 24, 329.

Porous materials [for grinding wood pulp]; Method for producing —. C. F. Södervall, Kilsmo, and H. Heliu, Skärblacka, Sweden. U.S. Pat. 1,235,071, July 31, 1917. Date of appl., Aug. 2, 1912.

SEE Fr. Pat. 447,558 of 1912; this J., 1913, 284.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

PATENTS.

Foam for treating textile materials; Process for producing —. R. Clavel, Basle, Switzerland. U.S. Pat. 1,234,732, July 31, 1917. Date of appl., Apr. 21, 1916.

SEE Eng. Pat. 102,310 of 1916; this J., 1917, 80.

Bleaching textile fibres; Process for —. A. Schaidhauf, Frankfort, Germany, Assignor to The Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,235,929, Aug. 7, 1917. Date of appl., Oct. 2, 1913.

SEE Fr. Pat. 460,959 of 1913; this J., 1914, 76.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Nitric acid; Possible adulteration of —. J. R. Withrow. J. Ind. Eng. Chem., 1917, 9, 771—776.

ATTENTION is drawn to the possibility of nitric acid being adulterated by the addition of sodium nitrate or other sodium salts, and dilution of the solution to the required sp. gr. with water. Nitric acid of sp. gr. 1.381, when saturated at 15° C. with sodium nitrate, contains 3.24% of the salt, and has a sp. gr. of 1.399. A saturated mixture of sp. gr. 1.380 will contain 4.83% of sodium nitrate and 8.30% of water. In like manner, nitric acid of sp. gr. 1.381 will dissolve 12.62% of sodium sulphate, giving a sp. gr. of 1.416, whilst a saturated mixture of sp. gr. 1.374 will contain 12.62% of sodium sulphate and 15.15% of water. Hence, the determination of the sp. gr. and of the NO_3 content of nitric acid ought always to be accompanied by an evaporation test for dissolved salts.

—C. A. M.

Ammonia oxidation; Chemical control of —. P. J. Fox. J. Ind. Eng. Chem., 1917, 9, 737—743.

For the determination of the ammonia in the entering gas, the Cumming absorber, described by Edwards (Bureau of Standards, Techn. Paper 34, 1914), effects complete absorption, and by its use it is possible to determine the ammonia without making a titration. A measured quantity of standard acid is placed in the absorber and coloured with an indicator, and the gas is made to bubble through the liquid until the colour changes. The theoretical dry air-ammonia mixture should contain 14.33% of ammonia. The method of absorption by means of standard alkali of the acid formed from the nitrogen peroxide (NO_2) is not applicable to the exit gas from the oxidation, owing to the large amount of condensed water from the hot gas interfering with the measurement of the volume, and also to the possibility that sufficient oxygen may not be present to oxidise all the nitric oxide to nitrogen peroxide. To obviate these difficulties the following method is suggested:—The gas is aspirated from the outlet pipe, but before reaching the absorption apparatus it is mixed with a measured quantity of oxygen or air in sufficient quantity to convert all the nitric oxide into nitrogen peroxide. The mixture is drawn through two absorption vessels, the first of which contains standard alkali solution, and the second standard alkali solution containing 1% of hydrogen peroxide. By this arrangement ammonium nitrite remains in the first vessel, where there is no hydrogen

peroxide to oxidise it. To prevent condensation of water, the sample of gas should be taken through a capillary tube as close to the catalyst as possible. Test experiments showed that the alkaline 1% hydrogen peroxide yielded about 6 c.c. of oxygen in the determination, and it is therefore advisable to make a correction for this amount. As an alternative efficient absorbent agent sulphuric acid may be used, the gases being previously mixed with oxygen as described above. For the determination of very small amounts of ammonia in the exit gases, the best method is that of oxidation by means of sodium hypobromite, and measurement of the resulting nitrogen in a gas burette. The author has worked out the following formula for calculating the efficiency of the process:—

$$\text{Efficiency} = \frac{V_{no}}{V_{nh_3}} = \frac{V_{no} (1/b - 1.25)}{fc + V_{no}}$$

where V_{no} is the volume of nitric oxide, V_{nh_3} is the volume of ammonia in the entering gas mixture, b is ratio of ammonia to the volume of the entering gas mixture, and fc is the volume of residual gas collected in the aspirator bottle of the testing apparatus, corrected as described below. If the hypobromite test shows that ammonia has passed through the catalyst unchanged, the equation must be modified as follows:

$$\text{Efficiency} = \frac{V_{no} + V_1}{V_{nh_3}} = \frac{(V_{no} + V_1) (1/b - 1.25)}{V_{no} + 0.75 V_1 + fc}$$

where V_1 is the volume of the unoxidised ammonia. The correction to be applied to the volume of gas in the aspirator bottle reduced to standard pressure and temperature, f , is

$$fc = f + 0.5 (V_{no} + V_1) - V_{ox},$$

where V_{ox} represents the vol. of oxygen added.

—C. A. M.

Pyrites; Determination of the "explosibility" of — as well as of the available sulphur and the sulphur content of its cinders. C. R. Gyzander. J. Ind. Eng. Chem., 1917, 9, 776—780.

THE explosive property of certain varieties of pyrites interferes with the burning of the ore in lumps, since the dust produced by the bursting of the lumps fills up interstices and prevents free access of air. The "explosibility" or crumbling quality of an ore may be quantitatively determined by heating the sample in a covered dish at a high temperature until no further change is observed, and then cooling, screening, and weighing the material which remains on a screen of a certain size, whilst passing through a next larger size. It has been claimed that a gradual pre-heating of the ore will minimise the effect of "explosion," but in the author's experiments 24 hours' pre-heating at 120° to 340° C., had no apparent effect in diminishing the "explosive" quality. But even in the case of non-crumbling ores, the sulphur may be given up slowly during the combustion, so that to find the available sulphur content of an ore it is necessary to determine the rate of change compared with that of some other ore which behaves normally and contains a known amount of available sulphur. For this purpose, 2 grms. of the ore, crushed to pass a 50-mesh sieve, is placed in a thin-walled electro-quartz dish. Three such dishes of uniform size and thickness of wall, each containing a charge of ore, are heated at 1000° F. (538° C.) in a sheet-iron rack in an electric furnace. After successive intervals of 15 mins., or longer if necessary, the dishes are separately withdrawn, and the reaction stopped by placing 5 grms. of sodium carbonate on the top of the ore. The sulphur in each is then determined by breaking up the mass, fusing it

with 5 grms. of sodium nitrate, dissolving the melt in hydrochloric acid, separating the silica, and precipitating with barium chloride. From the amounts of sulphur found the rate of change may be calculated.—C. A. M.

Potash ; [Blast-furnace flue dust,] a new source of —. H. T. Cranfield. J. Bd. Agric., 1917, 24, 526—530.

THE fine dust deposited in or around the flues, ovens, boilers, etc., in which the waste gases from iron blast-furnaces are utilised, contains appreciable quantities of potassium, mainly as sulphate and chloride. Twelve typical samples were found to contain from 2.97 to 15.89% of total (acid-soluble) and from 1.23 to 9.25% of water-soluble potash (K_2O); while the salt obtained by extracting other samples with hot water contained from 39.74 to 41.84% K_2O . In view of the number of furnaces in operation and the quantity of dust produced, the author considers this to be the most important source of potash yet discovered in this country.—W. E. F. P.

Reh or saji mitti for the manufacture of commercial alkalis ; Possibility of utilising —. A. H. Silver. Indian Trade J., Jan. 26, 1917. Agric. J. India, 1917, 12, 477—480.

THE deposits of *reh* or *saji mitti*, occurring as efflorescences on *usar* lands, are composed mainly of sodium carbonate, sulphate, and chloride, and may be divided into two main classes according as the carbonate or sulphate predominates. The soluble salts from deposits of both classes contain Na_2CO_3 , 70—90 and 1—10, Na_2SO_4 , 1—10 and 60—85, and $NaCl$ 5—20 and 5—20%, respectively ; by fractional crystallisation it was found possible to eliminate practically all the sodium chloride in each case, and thus to obtain crude sodium carbonate and crude sodium sulphate for use as such or in the manufacture of caustic soda and soda ash respectively.—W. E. F. P.

Chlorine in chlorides ; Iodometric determination of —. G. Torossian. J. Ind. Eng. Chem., 1917, 9, 751—752.

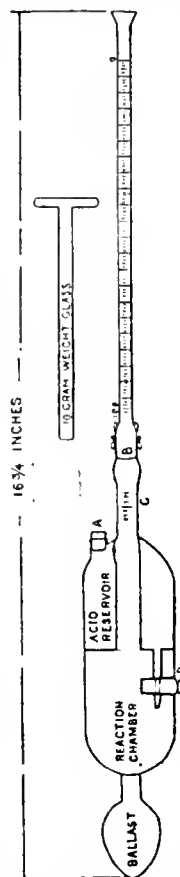
FROM 0.12 to 0.5 gram. of the chloride is thoroughly mixed with about 2 grms. of finely powdered manganese dioxide, and the mixture is introduced into a round-bottomed flask. The delivery tube from the flask passes through the cork of a long tube, which is immersed in a cylinder of cold water, and contains 100 c.c. of potassium iodide solution (25 grms. per litre). After the addition of 50 c.c. of dilute sulphuric acid (1:1), the delivery tube is attached, and the flask is slowly heated, with constant shaking, until the contents boil, when the heating is continued intermittently, with occasional agitation, for about 5 minutes, until all chlorine has distilled into the iodide solution. The glass tubing is then rinsed into the absorption tube, and the contents of the latter made up to 200 c.c., and titrated with $N/10$ sodium thiosulphate solution which has previously been standardised against pure iodine. The method is also applicable to the determination of chlorine in fluorides, any hydrogen fluoride liberated having no influence upon the final results.—C. A. M.

Ferricyanides ; Determination of — by titration with permanganate. C. de Coquet. Bull. Soc. Pharm. Bordeaux, 1917, No. 3. Ann. Chim. Analyt., 1917, 22, 160—161.

A SOLUTION containing about 0.5 gram. of ferricyanide, is heated to boiling and then treated with a few fragments of aluminium and a small quantity of sodium hydroxide solution. The

reduction of the ferricyanide is complete in about 20 mins.; the solution is then diluted, filtered, slightly acidified with sulphuric acid, and titrated with $N/10$ permanganate solution. Each c.c. of $N/10$ permanganate solution is equivalent to 0.033 gram. of potassium ferricyanide. The method may be used to determine ferricyanide in mixtures, such as certain compounds used in photography, which contain uranium nitrate, iron-ammonium citrate, and copper chloride. The mixture is dissolved in water, and sodium hydroxide solution is added as long as a precipitate forms; the mixture is then filtered and the filtrate treated with aluminium as described.—W. P. S.

Carbonates in limestone and other materials ; Determination of —. J. F. Barker. J. Ind. Eng. Chem., 1917, 9, 786—787.



THE following rapid method of determining carbonates in limestone, etc., gives results agreeing within 0.25% with those obtained by standard methods:—The acid reservoir is charged with 40 c.c. of hydrochloric acid (sp. gr. 1.15), the graduated stem of the hydrometer is disconnected, and a 10 gram. weight is attached at B. The hydrometer is then placed in a cylinder of water, and the depth of immersion on the scale, C, noted, after which the weight is removed, and powdered limestone is introduced into the reaction chamber until the instrument is immersed to exactly the same point. The graduated stem is now attached, and water is introduced, drop by drop, until the hydrometer is immersed to the zero mark. The instrument is now raised, and the stop-cock, D, is turned, so that acid runs into the reaction chamber. As the carbon dioxide escapes the hydrometer rises, until at the end of the reaction, the reading on the stem at the surface of the water gives the percentage of calcium carbonate equivalent to the carbon dioxide in the sample. A correction of + or - 0.5 is made for each 1° C. rise or fall in the temperature between the two readings. The weight of carbon dioxide left in the

flask is counterbalanced by the loss of moisture escaping with the gas.—C. A. M.

Silver and sulphides ; Course of the reaction between —. (Hepar test.) F. L. Hahn. Z. anorg. Chem., 1917, 99, 118—122. J. Chem. Soc., 1917, 112, ii., 371.

THE blackening of metallic silver by hydrogen sulphide or soluble sulphides, used as a qualitative test for sulphur, is sometimes represented as taking place in the absence of air, with liberation of hydrogen, and sometimes as a reaction with oxygen, the former hypothesis being adopted in most recent text-books. When precautions are taken, to exclude air, silver may be boiled for hours with sodium sulphide solution without evolution of hydrogen, the metal being unchanged, blackening taking

place immediately air is admitted. Hydrogen sulphide may also be passed through water in which silver is placed without any blackening. The presence of oxygen or hydrogen peroxide causes immediate blackening.

Cerous oxalate; Decomposition of — in a reducing or inert atmosphere, and a new property of the higher oxides of cerium. W. S. Chase. J. Amer. Chem. Soc., 1917, 39, 1576—1582.

CEROUS oxalate was very carefully purified and then decomposed by heat in a Hoskins combustion furnace fitted with a Pt—Pt Rh thermocouple. A temperature of 550° C. was found to be the lowest at which the carbonate resulting from the decomposition of the oxalate was completely decomposed. The residue obtained in hydrogen or nitrogen atmospheres is a very dark, blue-black, amorphous powder. At ordinary temperatures, if drawn directly into the air from a hydrogen atmosphere, it fires and burns vigorously to cerium dioxide. This phenomenon does not occur when a nitrogen atmosphere is used; it is due to absorbed hydrogen. The residues from the hydrogen and nitrogen atmospheres gave the same analytical results, indicating that the product is a mixture of ceric oxide, a lower oxide or oxides, free carbon, and adsorbed air. When heated in air to 400°—500° C., it fires, forming the dioxide. At lower temperatures it is stable, though at 200° C. oxidation of the carbon takes place, causing a rise in temperature. The hydrogen absorbed in the residue prepared in a hydrogen atmosphere amounted to 10—11 c.c. per grm. of residue. A stream of nitrogen passed over the residue at 550° C. removes the hydrogen, but in no case was the formation of ammonia detected, thus indicating that the hydrogen is held mechanically.—J. H. P.

Tantalum chloride; Study of — with reference to its use in the determination of the atomic weight of tantalum. G. W. Sears. J. Amer. Chem. Soc., 1917, 39, 1582—1587.

TANTALUM pentachloride exists as a stable compound in an atmosphere of dry nitrogen or dry air, but a trace of moisture is sufficient to hydrolyse it. It does not occlude chlorine. It was found that a high degree of accuracy could not be obtained when tantalum chloride was weighed in a vessel with a ground joint, owing to diffusion of moisture through the joint, and when weighed in sealed tubes volatilisation of the glass during the sealing operation affected the accuracy of the results. It seems that tantalum chloride is unsuitable for use in work where a high degree of accuracy in analysis is desired.—J. H. P.

Hydrogen peroxide; New method for the determination of —. G. S. Jamieson. Amer. J. Sci., 1917, 44, 150—152.

A KNOWN volume of hydrogen peroxide suitably diluted with distilled water (e.g., 50 c.c. of commercial peroxide to 500 c.c.) is measured into a 500 c.c. glass-stoppered flask containing 10 c.c. of a 10% solution of sodium hydroxide and a measured volume of standard sodium arsenite solution in excess of that required by the hydrogen peroxide. The flask is gently agitated as the solution is run in and then allowed to stand for two minutes. Forty c.c. of concentrated hydrochloric acid is then cautiously added, the stopper inserted, and the flask violently shaken. Six or seven c.c. of chloroform is then added and the unoxidised sodium arsenite is titrated with standard potassium iodate solution, the contents of the flask being well shaken after each addition. The end point is marked by the disappearance of the iodine colour from the chloroform. The original amount of sodium arsenite, less that determined by the iodate titration, gives the amount oxidised by the hydrogen peroxide. N/5 Sodium arsenite solution

and an equivalent sodium iodate solution are found most suitable for use. This method gives accurate results, and is not influenced by the presence of organic preservatives.—I. A. C.

Fifty-third report on alkali works. See p. 990.

Direct process of manufacturing ammonium sulphate. See 11A.

Evaluation of pyrolusite. Rupp. See X.

Preparation in a pure state of highly reactive metals and metalloids [titanium, zirconium, and boron]. Podszus. See X.

Astringent action of aluminium salts, especially of the formate. Loewy and Wolfenstein. See XX.

PATENTS.

Nitric acid from ammonia; Process of making —. C. Ellis, Montclair, N.J., Assignor to Ellis-Foster Co. U.S. Pat. 1,233,564, July 17, 1917. Date of appl., Oct. 12, 1916.

A HOT mixture of ammonia and air is passed upwards through a mass of coarse particles of a suitable catalyst, the temperature of which is adjusted by passing a cooler mixture of air and ammonia through a conduit embedded in the catalyst. Spent catalyst is withdrawn from the bottom of the chamber and fresh material supplied at the top.—B. V. S.

Ammonium nitrate; Manufacture of —. F. W. Howorth, London. From Norsk Hydro-Elektrisk Kvaestof Aktieselskab, Christiania. Eng. Pat. 101,090, July 24, 1916. (Appl. No. 10,422 of 1916.)

SOLUTIONS of ammonium nitrate act as absorbents for both ammonia and nitrous gases. One part of a dilute solution of ammonium nitrate is saturated with ammonia and the other part with nitrous gases, and the two liquids are mixed to obtain a stronger neutral solution. The operations may be repeated at will until a concentrated solution is obtained or the solid salt separates.—B. V. S.

Ammonium sulphate; Manufacture of —. W. G. Adam, London. Eng. Pat. 108,698, Dec. 13, 1916. (Appl. No. 17,940 of 1916.)

COMMERCIAL ammonium sulphate, which usually contains from $\frac{1}{2}$ % to 2% excess acid, is neutralised by passing ammonia gas through it in any convenient way.—B. V. S.

Soluble glass; Manufacture of —. R. M. Caven, Nottingham. Eng. Pat. 108,372, Aug. 21, 1916. (Appl. No. 11,848 of 1916.)

A FINELY-SUBDIVIDED neutral silicate which has been ground in the dry state is mixed with 25 to 38% of its weight of water, and the mixture is heated to a temperature between 70° and 100° C., under atmospheric pressure, until the mass becomes vitreous in structure. Over 95% of the solid product is readily soluble in water.—J. B. C. K.

Silicate-glasses; Treatment of — and preparation of useful products [soluble silicates] therefrom. J. W. Spensley, J. W. Battersby, and E. S. Holmes, Manchester. Eng. Pat. 108,576, Sept. 29, 1916. (Appl. No. 13,882 of 1916.) Addition to Eng. Pat. 11,959, May 14, 1914 (this J., 1915, 834).

IN the manufacture of soluble silicates by the method described in the earlier patent, the hydrated silicate, as it leaves the wet-grinding drum of the apparatus, is subjected to a further heat-treatment, in order to facilitate or render more complete the formation of a solid and uniformly hydrated product. The temperature limits named in the patent are 100° and 170° F.

(38°—77° C.) and the heating should be sufficiently gradual to ensure that the whole mass is uniformly affected and that no local overheating occurs. The cooling should also be gradual.—J. B. C. K.

Felspar; Method of utilising —. J. Rhodin. Chiswick. U.S. Pat. 1,232,977, July 10, 1917. Date of appl., Dec. 4, 1914.

FELSPAR is ground, and is mixed with a small quantity of a sodium salt, such as sodium chloride. A mixture of sulphur dioxide, steam, and air is then passed over the heated material, and the sulphuric acid produced is condensed. The residue is leached to extract the soluble potassium sulphate, and the insoluble matter that remains is utilised for the manufacture of Roman or Portland cement.—J. B. C. K.

Silicates; Process of decomposing —. L. L. Jackson, Assignor to O. C. Horney, New York. U.S. Pat. 1,233,273, July 10, 1917. Date of appl., June 16, 1916.

SILICATES are decomposed by mixing with 1 part by weight of lime (CaO) and 5 parts of water, and heating under pressure.—J. B. C. K.

Silicates; Process of decomposing —. H. W. Charlton, Jones Point, N.Y., Assignor to Kaolin Products Corporation. U.S. Pat. 1,234,626, July 24, 1917. Date of appl., Dec. 8, 1916.

AN alkali-bearing silicious material, such as glauconite (green-sand), is digested with a solution of calcium chloride and milk of lime, below 190° C. and at a pressure below 200 lb., for 2 to 4 hours, whereby a solution containing potassium chloride is obtained.—J. B. C. K.

Nepheline-syenite; Process of treating —. H. T. Kalmus, Brookline, Assignor to The Exolon Co., Cambridge, Mass. U.S. Pat. 1,234,905, July 31, 1917. Date of appl., June 28, 1915.

NEPHELINE-SYENITE is dissolved in an acid and the silicon and aluminium are separately precipitated and removed from the solution. The aluminium compound is then fused in an electric furnace, in order to obtain on cooling a crystalline product. The solution of the syenite may be effected by sulphitation, and aluminium and silicon separated from the solution by fractional desulphitation.—J. B. C. K.

Alunite; Method of treating —. F. K. Cameron, Washington, D.C. U.S. Pat. 1,233,977, July 17, 1917. Date of appl., Jan. 8, 1916.

ALUNITE is calcined at 500°—550° C. to obtain maximum formation of soluble aluminium salts and minimum evolution of oxides of sulphur. The calcined material is extracted with water, the dissolved alum separated and calcined with the formation of potassium sulphate, alumina, and oxides of sulphur, chiefly the trioxide. The potassium sulphate and the alumina are recovered, and the sulphur trioxide is used for treatment of the residue from the first calcination with the formation of aluminium sulphate.—B. V. S.

Salt-brine; Process for purifying —. B. Harlsuch, East Lansing, Mich., Assignor to The Buckley and Douglas Lumber Co. U.S. Pat. 1,235,202, July 31, 1917. Date of appl., Apr. 26, 1916.

A PURIFYING agent is generated within the brine by aid of an electric current passed through the brine by means of spaced electrodes. Precautions are taken to maintain the purifying agent in a pure condition by preventing the chlorine gas, set free by the action of the current, from acting upon it.—J. B. C. K.

Hydrogen peroxide; Method of manufacturing —. J. Pattek, Karlsruh, Germany. U.S. Pat. 1,234,380, July 24, 1917. Date of appl., Mar. 4, 1914.

A SOLUTION of ammonium persulphate is treated with sulphuric acid, and the hydrogen peroxide formed is separated rapidly from the resulting solution.—J. B. C. K.

Hydrogen peroxide; Method of producing —. H. A. Doerner, Assignor to The Chemical Products Co., Denver, Colo. U.S. Pat. 1,235,664, Aug. 7, 1917. Date of appl., Feb. 7, 1917.

CARBON dioxide gas under pressure is passed into water cooled to 0° C., and the mixture is agitated while at the same time barium peroxide is introduced into the mixture. An excess of carbon dioxide must be preserved during the reaction.—J. B. C. K.

Hydrogen sulphide; Production of —. R. F. Bacon, Pittsburgh, Pa., Assignor to Metals Research Co., New York. U.S. Pat. 1,235,953, Aug. 7, 1917. Date of appl., Nov. 10, 1915.

A MIXTURE of sulphide ore or concentrate with a small proportion of lime is treated with steam at a temperature which is gradually increased to about 700°.—W. E. F. P.

Hydrocyanic acid; Production of —. C. Beindl, München, Germany. Eng. Pat. 7260, May 14, 1915.

SEE Ger. Pat. 281,723 of 1911; this J., 1915, 612.

Formic acid; Production of —. G. Bredig, Karlsruhe, Assignor to R. Koepf und Co., Oestrich, Germany. U.S. Pat. 1,235,426, July 31, 1917. Date of appl., July 21, 1915.

SEE Eng. Pat. 9762 of 1915; this J., 1915, 1207.

Alkali perborates; Electrolytic process of making —. O. Liebknecht, Frankfurt, Germany, Assignor to The Roessler and Hasslacher Chemical Co., New York. U.S. Pats. 1,235,904 and 1,235,905, Aug. 7, 1917. Date of appl., Jan. 6, 1916.

SEE Eng. Pats. 160,154 and 100,153 of 1916; this J., 1917, 137 and 83.

Sodium percarbonate; Manufacture of —. W. Weber, Düsseldorf, and F. Noll, Benrath, Assignors to Henkel und Co., Düsseldorf, Germany. U.S. Pat. 1,237,128, Aug. 14, 1917. Date of appl., July 8, 1916.

SEE Eng. Pat. 100,997 of 1916; this J., 1916, 963.

Radio-active; Process for rendering liquids —. S. Saubermann, Berlin. U.S. Pat. 1,236,213, Aug. 7, 1917. Date of appl., June 14, 1915.

SEE Eng. Pat. 7385 of 1915; this J., 1915, 1208.

Calcium hypochlorite; Manufacture of —. G. Pistor and H. Reitz, Griesheim, Assignors to Chem. Fabr. Griesheim-Elektron, Frankfurt, Germany. U.S. Pat. 1,236,978, Aug. 14, 1917. Date of appl., Aug. 25, 1914.

SEE Ger. Pat. 282,746 of 1913; this J., 1915, 715.

Extraction of fats, ammonia, and the like from organic refuse Eng. Pat. 107,992. See 11b.

VIII.—GLASS; CERAMICS.

Glass; Art of colouring —[by exposure to rays of short wave-length]. H. Rosenthal. J. Ind. Eng. Chem., 1917, 9, 734—736.

GLASS may be artificially coloured by exposing it to short wave lengths of light from a quartz mercury arc, X-ray tubes, or special tubes for producing negative electrons. Definite results may be obtained by the use of a Coolidge, water-cooled, self-rectifying tube, in which an anode terminal of tungsten is supported on a rod of molybdenum, whilst the cathode consists of a tungsten spiral which can be electrically heated. The vacuum in this tube remains constant under all conditions, and unless the filament is heated the tube shows no electrical conductivity in either direction. The penetration of the rays is increased by increasing the voltage of the terminals. For colouring optical lenses, using a tube giving a current of 160 milliamperes at 50 kilovolts, an exposure of 2 mins. produces a light colour, an exposure of 4 mins. a medium colour, and an exposure of 10 mins. a dark colour. Thin, colourless glass is coloured uniform tints by this treatment, but thick glass (over $\frac{1}{4}$ in.) shows a gradation of colour from the exposed side. Porcelain teeth may be coloured by this method, and, by the use of stencils, coloured designs may be printed on porcelain ware. The less valuable gems are also changed in colour. For example, kunzite was changed from an amethyst to an emerald green colour after a few minutes' exposure. If the composition of the white glass is known, it is possible to predict beforehand the resulting colour. The action is molecular and is not confined to the surface of the glass; it is also reversible. Although the colouring of purple glass thus treated is due to manganese, the colour is not identical with that produced by chemical reactions of manganese in glass.—C. A. M.

PATENTS.

Insulator; Electrical —. F. M. Locke, Victor, N.Y. U.S. Pat. 1,233,486, July 17, 1917. Date of appl., Aug. 28, 1916.

SILICA, to at least 70%, boric oxide, alumina, lithia, and an alkali are fused together to form a homogeneous body, having a coefficient of expansion of less than 0.0000056.—B. N.

Clay and kaolin; Process for the treatment of — by elutriation. B. Schwerin, Assignor to Elektro-Osmose Akt.-Ges. (Graf Schwerin Ges.), Frankfurt, Germany. U.S. Pat. 1,233,713, July 17, 1917. Date of appl., Aug. 4, 1915.

To separate clay and kaolin from slime, the material is suspended in water and the degree of dispersion then increased, so that when the material is allowed to settle a fractional sedimentation takes place. Slime substantially free from kaolin, and kaolin containing less than 30% of water are deposited.—W. F. F.

Metal and other melting furnaces. Eng. Pat. 108,084. See X.

IX.—BUILDING MATERIALS.

Oxidation of mineral oils by air. Effect of sulphur on the oxidation of hydrocarbons, with particular reference to asphalt. Brooks and Humphrey. See IIA.

Effects of exposure on some fluid bitumens. Reeve and Lewis. See IIA.

Modification of the cobaltinitrite method of determining potassium. Hoff and Schwartz. See XXIII.

PATENTS.

Cement, mortar or concrete; Method of manufacturing a compound for making watertight —. Z. Morikami, Hiogo Ken, Japan. Eng. Pat. 100,886, June 27, 1916. Under Int. Conv., July 10, 1915. (Appl. No. 9043 of 1916.)

To make waterproofing material for adding to cement, mortar, or concrete, a mixture of fat or resin, 100 parts, caustic soda of 20° B. (sp. gr. 1.16), 20—22 parts, is boiled for 5—7 hours and milk of lime, 300 parts added, and the mixture boiled for four hours. The resulting calcium soap is skimmed from the surface, dried, and mixed with powdered burnt alum, 10 parts.—W. F. F.

Mixing concrete; Machines for —. H. Thornton, Stanningley, Yorks. Eng. Pat. 108,626, Dec. 14, 1916. (Appl. No. 17,971 of 1916.)

A BATCH-MIXING machine of the revolving drum type is fitted with internal mixing blades arranged in the following order: one pair of equal-sided V-shaped blades, one unequal-sided V-shaped blade, one pair of W-shaped blades, and another unequal-sided V-shaped blade. These blades extend the full width of the drum and their apices are in line with the periphery of the drum and at right angles to its axis.—A. B. S.

Cement-burning apparatus. L. P. Basset, Montmorency, France. U.S. Pat. 1,233,166, July 10, 1917. Date of appl., June 19, 1915.

A HEATING chamber or furnace, the length of which is many times its width, is provided at the material-outlet end with an injector for air and fuel, and at the opposite end with a horizontal pipe, extending into the furnace and bent at the end. A blast of air in the same direction as the draught through the furnace is delivered through this pipe at a point in the furnace where the temperature is about 900° C.—A. B. S.

Waste gases from Portland cement, lime and other kilns; Apparatus for utilising —. F. Schott, Heidelberg, Germany. U.S. Pat. 1,234,396, July 24, 1917. Date of appl., Dec. 30, 1912.

A WATER-TUBE boiler or other steam generator is fitted into a chamber built between a cement kiln and chimney, suitable baffle-plates and deflectors being placed so as to cause the waste gases from the kiln to circulate around the boiler. Pockets are provided for collecting dust from the gases.—A. B. S.

Pavements or paving mixtures; Method of making —. G. B. McGrath, Washington, D.C. U.S. Pat. 107,549, Feb. 28, 1917. (Appl. No. 2977 of 1917.)

A MINERAL aggregate consisting of gravel and sand is graded as usual to various sizes and mixed so that the voids or spaces between the particles are filled with the next smaller size of grains. The volume of the voids in the aggregate prepared as above is then determined, and a desired percentage of this volume is filled by incorporating the aggregate with a definite quantity of a filler prepared by mixing finely pulverised material with bituminous material up to the limit of its absorbing power, the quantity of bituminous material required being determined previously. The particles of mineral aggregate, before being mixed with the hot filler, may be coated with bituminous material.—A. B. S.

Plastic surfacing material, and process of producing same. J. C. Mertens, Chicago, Ill. U.S. Pat. 1,235,989, Aug. 7, 1917. Date of appl., May 8, 1916.

A SURFACING material for roads is made by mixing preheated, pulverised limestone and shale and hot liquefied bitumen in the proportion of 84% limestone and shale, and 16% bitumen.—A. B. S.

Artificial-stone slabs; Manufacture of —. M. I. Poznanski, Geneva, Switzerland. U.S. Pat. 1,234,692, July 24, 1917. Date of appl., Mar. 11, 1916.

FIBROUS vegetable matter is treated with a cold alkaline solution and then mixed with cement water.—A. B. S.

Sand-lime bricks; Manufacture of —. H. W. Charlton, Jones Point, N.Y. U.S. Pat. 1,235,766, Aug. 7, 1917. Date of appl., Apr. 13, 1917.

ONE part of lime is digested with five parts of water under a steam pressure of 225 lb. per sq. in. for 1–3 hrs., so as to form a hydrate with less than one molecule of water of hydration for each molecule of calcium oxide present. The product is mixed with sand and made into bricks which are then kept for 8–12 hrs. under a steam pressure of 100–135 lb. per sq. in.—A. B. S.

Cement; Acid- and waterproof — and method of making the same. C. C. Meigs, Assignor to Electro-Chemical Supply and Engineering Co., Philadelphia, Pa. U.S. Pat. 1,237,078, Aug. 14, 1917. Date of appl., Nov. 6, 1916.

SEE Eng. Pat. 108,278 of 1917; this J., 1917, 965

Method of utilising felspar. U.S. Pat. 1,232,977. See VII.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

γ-Iron; Determination of the curve of transformation of — into α- and β-iron and of the curve of saturation of γ-iron by cementite by means of the methods of quenching and hardness. P. Saldau and P. Goerens. Rev. Soc. Russe de Métall., 1914, 1, 789–824. Rev. Mét., 1917, 14, Extraits, 65–74.

AFTER an historical account of the determination of these transformation curves, experiments are described which have been made with a series of pure Krupp steels, with carbon ranging from 0.11 to 1.51%. The specimens were in the form of discs 5 mm. thick, cut from rods 20 mm. in diameter, and pierced with a hole 4 mm. in diameter, in order to increase the cooling surface. They were heated in an electrically heated salt bath to 1050° C., cooled slowly in the bath to the required temperature, kept constant for 15 minutes, and then rapidly quenched in ice water. Four similar specimens were always treated at once. After grinding off a layer 1 mm. thick, the steels were examined micrographically and tested for hardness both by the Shore and Brinell methods. The micrographic results are represented graphically, and show that the γβ transformation follows a curve (GO) whilst the γα transformation follows a straight line (OS), the point O being at 780° C. and 0.35% C. The cementite line (SE) is straight. These lines all lie somewhat above those found by Carpenter and Keeling by the thermal method. The curves determined by means of hardness tests are in very good agreement with those determined micrographically. By plotting the hardness against the carbon content at each temperature, hardness isotherms are obtained which clearly mark the limits of solid solution. The maximum hardness, both by the Shore and Brinell methods, occurs at 0.63% C after quenching at 780°, 880°, or 1000° C. The maximum hardness of a steel containing 1.54% C occurs after quenching from 830° C., which is below the saturation curve, the steel then being a mechanical mixture of martensite and cementite.—C. H. D.

Iron and steel; Apparatus for measuring the electrical resistance of bodies at high temperatures, and the use of this apparatus in determining the critical points of —. P. I. Saldau. Rev. Soc. Russe de Métall., 1915, 1, 655–690. Rev. Mét., 1917, 14, Extraits, 76–81.

THE metals to be tested are used in the form of rods 50 mm. long and of 5 mm. diameter, which are polished and then annealed under a layer of two parts of barium chloride and one of potassium chloride at 1050° C., and slowly cooled. The specimens are then tested in a vertical electric furnace in a current of coal gas free from oxygen, the temperature and resistance being measured simultaneously (see Eng. Pat. 12,993 of 1915; this J., 1916, 1116).

The values of Ar, and Ac, were found to be the same, whilst the other critical points are different on heating and on cooling. The position of the curves of transformation in the iron-carbon system obtained by this method are in close agreement with those found by the thermal method (see preceding abstract). A new critical point is clearly indicated at 980° C. in all the steels examined. This is taken to indicate that, starting from this temperature, the growth of the austenite crystals is no longer proportional to, but is more rapid than the increase of temperature; hence the ratio of surface to volume diminishes rapidly, and the conductivity consequently increases. Benedicks' linear formula for the influence of dissolved elements on the resistance of austenite does not hold good, the resistance following a curve, as in the case of other solid solutions. Evidence is given from the form of the curves for the existence of a new allotropic form of iron above 900° C. Eutectoid steel has a higher resistance than steels of neighbouring composition. The resistance of quenched steels is not a linear function of the composition, but follows a curve.—C. H. D.

Cementation of iron. I. A. Fechtchenko-Tchopovsky. Rev. Soc. Russe de Métall., 1915, 1, 480–510. Rev. Mét., 1917, 14, Extraits, 91–95. (Compare this J., 1916, 892.)

CYLINDERS of mild steel, containing C 0.13, Si 0.015, Mn 0.60, P 0.05, S 0.04, and N 0.012%, were hardened in mixtures of wood charcoal with varying proportions of potassium ferrocyanide. Heating was continued for 4 hours at each of the temperatures selected. The nitrogen content of the case-hardened layer is insignificant at high temperatures, but increases as the temperature of hardening falls, being greatest at 700° C. Penetration of nitrogen at 700° C. continues for some hours at a diminishing rate. It does not occur in the absence of ferrocyanide. Nitrogen increases the hardness (Brinell) of the superficial layer by about 17 kilos. per sq. mm. for each 0.1% N. At the ordinary case-hardening temperatures nitrogen has no influence on the hardness. The effect of barium carbonate on cementation has also been studied quantitatively. At a given temperature, the actual quantity of barium carbonate which remains unchanged is greater, the higher the proportion in the original mixture, the ratio of the two being constant for the same temperature and time of cementation, but diminishing either with increasing duration or increasing temperature. The ratio BaCO₃:BaO is also constant for a given temperature and time. The diminution of carburising power is proportional to the barium oxide content. Barium oxide in small quantity renders the case-hardened layer irregular, and in large quantity destroys the layer. The best results are obtained with a mixture of 70% of wood charcoal and 30% of anhydrous sodium carbonate, which gives a rapid, vigorous, and uniform cementation. The depth of penetration is independent of the volume of carburising mixture used, but the hypereutectic

layer is less marked, the smaller the volume in proportion to the size of the object being hardened. This layer is less developed when a gas furnace is used than when the heating is electrical.—C. H. D.

Mild steel; Formation of free cementite in—. A. L. Babochine. Rev. Soc. Russe de Métall., 1915, 8, 561—571. Rev. Mét., 1917, 14, Extraits, 81—83.

Using small specimens of a mild steel containing C 0.17, Mn 0.39, Si 0.026, P 0.059, and S 0.069%, heated in a salt bath to avoid decarburisation, free cementite makes its appearance in the pearlite when the cooling takes place at the rate of 17° per minute between 793° and 691° C., and at the rate of 0.3° per minute between 694° and 674° C. The temperature to which the steel is heated is of little importance, but it is essential that the cooling through A_1 be very slow. Re-solution on heating takes place much more slowly than the deposition of cementite from solid solution on cooling. Manganese hinders the formation of free cementite if present to the extent of more than 0.6%. The lower the carbon and manganese and the lower the rate of cooling, therefore, the greater should be the brittleness of the steel.

—C. H. D.

Tool steels; Forms in which cementite appears in hypereutectic—according to their thermal treatment. N. G. Iljin. Rev. Soc. Russe de Métall., 1915, 1, 488—494. Rev. Mét., 1917, 14, Extraits, 83—85.

The forms assumed by the cementite in relation to the temperature of initial heating, velocity of cooling, and time of heating at a given temperature, have been studied in a steel containing C 1.27, Mn 0.28, Si 0.21, P 0.035, and S 0.020%. The cementite network increases in coarseness with the temperature of initial heating. The slower the cooling, the less tendency for the appearance of needle forms in the pearlite. A long stay at 700° C. favours the formation of granular cementite, especially after heating to a high temperature followed by slow cooling.

—C. H. D.

Manganese; Determination of—in iron and steel according to the bismuth method. H. Kinder. Chemikerkommission des Vereins deutscher Eisenhüttenleute. Stahl u. Eisen, 1917, 37, 197—202. J. Chem. Soc., 1917, 112, ii., 389—390.

In continuation of previous work on the estimation of manganese by the permanganate (this J., 1913, 510) and chlorate or persulphate (Stahl u. Eisen, 1915, 35, 918) methods, the Commission has examined the data concerning the bismuth process, using sodium bismuthate or bismuth tetroxide. The method is not suited for purposes of investigation, and cannot be recommended for the works laboratory because of its complicated nature and the necessity of keeping the temperature below 25° C. (increase of temperature causes low results for Mn). The Volhard-Wolff permanganate method is suitable for investigations, and can be used in the examination of ores, pig iron, steel, and ferromanganese. It can be employed equally well in hydrochloric or nitric acid solution, but sulphuric acid solutions are to be avoided. The presence of chromium is immaterial if the precipitated zinc oxide is removed; molybdenum and vanadium are without influence, but cobalt, which is usually only present in small amount, causes high results. The chlorate process can only be employed in nitric acid solution, and is particularly suitable for iron and steel; it is less accurate for estimating small amounts of manganese and for ferromanganese. Considerable quantities of chromium cause slightly high results. The persulphate process is adapted to works practice because of its rapidity. The presence of

considerable quantities of chromium or cobalt makes the end-point difficult to detect, on account of the yellow or pink colorations which they impart to the solutions.

Electrometric titration; Apparatus for—depending on the change of oxidation potential, and its application to the determination of small quantities of chromium in steel. G. L. Kelley, J. R. Adams, and J. A. Wiley. J. Ind. Eng. Chem., 1917, 9, 780—782.

An apparatus is described which has been designed to give very accurate results in the method of electrometric titration devised by Hildebrand (J. Amer. Chem. Soc., 1913, 35, 869) and modified by Kelley and Conant (this J., 1916, 966). It consists essentially of a wooden box with a metal upright, which carries the motor for driving the agitator, the electrodes, and the two burettes for the oxidising and reducing solutions. By means of this apparatus it is possible to determine chromium in steel more accurately than by any other method, duplicate results agreeing within 0.001%. The permanganate solution is conveniently standardised by titration with sodium oxalate, which in turn is compared with ferrous sulphate, whilst the chromate is finally titrated by adding an excess of ferrous sulphate and titrating the excess with permanganate. In each case corrections for the end-points must be found by means of blank titrations. All these titrations, with the exception of that of the sodium oxalate, may be most accurately made by the electrometric method. Allowance must be made for characteristic differences at the end-points of the reactions. Thus, in titrating a chromate solution the addition of ferrous sulphate almost always produces an anomalous rise, whilst in titrating a permanganate solution the phenomenon is less regular and not so pronounced. In titrating chromate solutions the end-point is indicated by an abrupt change in potential, whereas in the case of permanganate solutions the addition of from 0.2 to 0.4 c.c. of ferrous sulphate solution, after disappearance of the pink colour, often causes only a gradual change in potential. This difficulty may be overcome by adding ferrous sulphate in excess until there is a pronounced change in potential, then adding permanganate solution gradually, until the addition of two or three drops causes no further change. On now adding ferrous sulphate solution, drop by drop, a sharp and definite end-point is obtained.—C. A. M.

Zinc alloys; Analysis of—. Mossbacher. Z. öffentl. Chem., 1917, 23, 113—115. J. Chem. Soc., 1917, 112, ii., 389.

DETAILS are given of a rapid method for the full analysis of zinc alloys. After dissolving in concentrated nitric acid and evaporating to one-third bulk, sulphuric acid is dropped into the middle of the liquid, and heating is continued until white fumes are evolved. Water and alcohol are added, and after several hours the lead sulphate is collected. The precipitate is ignited in a crucible which has just previously been heated with a drop of sulphuric acid. Copper is precipitated as sulphide and heated with sulphur in hydrogen in a silica crucible. Aluminium and iron are precipitated from the filtrate, after removal of hydrogen sulphide, by adding hydrogen peroxide, and then, rapidly, a large excess of ammonia. By adding a little Congo-red, that part of the colloidal precipitate which always adheres to the glass is made clearly visible. Iron is estimated volumetrically in a separate portion.

Pyrolusite; Evaluation of—. E. Rupp. Arch. Pharm., 1916, 254, 135—137. J. Chem. Soc., 1917, 112, ii., 390.

To 0.2 gm. of very finely powdered pyrolusite are

added 3 grms. of potassium iodide, 3 grms. of sodium phosphate, 10 c.c. of water, and 10 c.c. of official (25%) phosphoric acid. The mixture is well shaken for one minute, and kept for thirty to sixty minutes with occasional shaking; about 50 c.c. of water is then added, and the liberated iodine is titrated with $N/10$ -thiosulphate with starch as indicator. A reappearance of the blue coloration indicates that the pyrolusite has not been sufficiently finely ground.

Titanium ores; Distribution and uses of —.
Bull. Imp. Inst., 1917, 15, 82—98.

The more important titanium minerals (rutile and ilmenite) are briefly described, and an account is given of their occurrence and distribution throughout the world. Titanium is used chiefly in the purification of iron and steel, for which purpose the carbide or a ferro-alloy is generally employed, the high melting point (1850° C.) and low specific gravity (5.17) of titanium precluding the use of the pure metal. The carbide is prepared by reducing a mixture of the ore and carbon in the electric furnace, the product consisting of microscopic particles of titanium carbide held in a matrix similar to grey cast iron; such material, containing 15—20% Ti and known as "ferro carbon-titanium," is the principal form in which titanium is at present employed for steel purification in the United States. Ferro-titanium, containing 10—75% Ti and only 0.12—0.75% C, is produced in quantity by reduction with molten aluminium in the electric furnace; but alloys of German origin are usually obtained by the ordinary aluminothermic process. The injurious effects of dissolved nitrogen upon steel are counteracted by titanium which, at 800° C., combines with nitrogen to form titanium nitrides; titanium also prevents segregation of the sulphur, phosphorus, and carbon and has the effect of concentrating the blowholes in the pipe cavity. In the case of ferro-alloys the best results are obtained with ferrotitanium containing 10—15% Ti, and an alloy of this composition is now specified in American (U.S.) practice. The alloy is added as the steel is run into the ladle (*i.e.*, after recarburisation and the addition of the necessary ferromanganese and ferrosilicon), 0.5% of the weight of the molten charge being usually sufficient. Although chiefly employed for treating rail steel, the use of titanium for other steels is steadily increasing. The quantity of titanium-treated steel rail produced in the United States has decreased considerably during recent years, owing to the substitution of open-hearth for the Bessemer steel formerly employed; titanium appears to be generally less beneficial to the former than to the latter. Alloys of titanium and silicon containing 5—70% Ti and 20—75% Si are also used in the iron and steel industry, while cupro-titanium containing 5—12% Ti is employed for degasifying copper and its alloys. To a limited extent titanium compounds are employed in various non-metallurgical industries. Thus, the carbide is used as a constituent of electrodes for arc lighting; the oxalate and various double oxalates are employed as mordants and for dyeing leather; while titanous chloride and sulphate find uses in the textile industry by reason of their powerful acid-reducing properties.—W. E. F. P.

Metals and metalloids [titanium, zirconium, and boron]; Preparation in a pure state of highly reactive —. E. Podszus, Z. anorg. Chem., 1917, 99, 123—131. J. Chem. Soc., 1917, 112, ii., 373—374.

For the preparation of titanium and zirconium, a steel bomb is used, closed by a strong screw and sealed with molten lead. The reduction mixture, consisting of sodium and titanium chloride or

potassium zirconium fluoride, is introduced in an atmosphere of hydrogen or carbon monoxide, several clean iron balls being added. The bomb having been closed, the whole is revolved for twenty to forty hours at about 200° C. to bring about an intimate mixture. Heating strongly for a few minutes starts the reaction. When a large excess of sodium is used, vapour may escape through the lead seal. The bomb is cooled from the top downwards, so that the lead may be solid before the pressure falls. The element is obtained in a minutely crystalline, highly reactive form. Titanium of 99.7% purity, and zirconium of 99.3% purity have been thus obtained, but the method fails to give pure boron.

Apparatus is described for the preparation and purification of boron trichloride. Reduction of the chloride with sodium, even in a vessel of pure boron nitride electrically heated by a resistance spiral of boron and boron carbide, yields only a black powder which will not weld to a compact mass. Iron is found to give the best results. Wire, prepared by drawing down Kahlbaum's pure iron, is wound on a frame made of boron nitride, and heated by means of a resistance tube of boron and boron carbide enclosed in a large glass vessel with mercury seals. The leading-in wires are of tungsten. After filling with hydrogen, the furnace is heated to redness to remove traces of oxygen. Hydrogen is then expelled by filling with boron trichloride. Most of the reduction takes place at about 800° C., and the temperature is then raised gradually to 1700° C. A porous mass of pure boron is thus obtained, which becomes denser on prolonged heating in boron trichloride. Compact boron thus prepared has an appreciable conductivity and is very infusible, an arc struck between boron poles showing no trace of fusion unless iron is present. The wires may be heated electrically to bright whiteness without injury.

Determination of the "explosibility" of pyrites as well as the available sulphur and the sulphur content of its cinders. Gyzander. See VII.

[Blast-furnace flue dust,] a new source of potash. Cranfield. See VII.

Course of the reaction between silver and sulphides. (Hepar test.) Hahn. See VII.

PATENTS.

Tool-steel; Alloy —. J. H. Parker, Reading, and B. H. de Long, Springmont, Pa., Assignors to Carpenter Steel Co., Reading, Pa. U.S. Pat. 1,233,118, July 10, 1917. Date of appl., June 26, 1916.

A TOOL-STEEL alloy is composed of approximately two parts of iron to one of cobalt, with 8 to 20% tungsten, 0.5% to 2.5% vanadium, and 1% to 6% of chromium.—T. H. B.

High-speed-tool-steel alloy. R. Furness, Jenkintown, Pa., Assignor to The Midvale Steel Co., Philadelphia, Pa. U.S. Pat. 1,233,862, July 17, 1917. Date of appl., Mar. 12, 1917.

A TOOL-STEEL alloy contains uranium 0.10% to 2.0%, cobalt 3% to 20%, tungsten 9% to 20%, and chromium 2% to 6%.—W. F. F.

[Iron ore briquettes;] Binding material [for], and the method of preparing —. W. Mathesius, Berlin. U.S. Pat. 1,233,384, July 17, 1917. Date of appl., May 21, 1915.

AN intimate mixture of finely-divided iron ore and dry slaked lime is heated to a temperature just below that of sintering, a further quantity of ore is added, and the mixture finely ground and moulded.—W. F. F.

Iron and steel; Process of manufacturing —. J. I. Bronn, Assignor to Rombacher Hüttenwerke, Rombach, Germany. U.S. Pat. 1,233,970, July 17, 1917. Date of appl., Apr. 24, 1917.

MOLTEN pig iron containing phosphorus is blown in a converter to oxidise and then remove the phosphorus. The slag is then removed and molten Thomas pig iron containing phosphorus is added in quantity slightly greater than that necessary to deoxidise the charge. The blowing is then renewed for a few seconds to oxidise the small amount of phosphorus present. —W. F. F.

Cementation process. F. A. Kaufmann, Perth Amboy, N.J., Assignor to The Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,235,901, Aug. 7, 1917. Date of appl., Aug. 11, 1915.

IRON and steel are carburised by the nascent carbon resulting from the decomposition of gaseous hydrocyanic acid at about 700° C., in the presence of the ammonia also produced. —T. H. B.

Tinning sheet metals; Method of —. C. Paetow and H. Lippmann, Berlin. Eng. Pat. 104,510, Mar. 1, 1917. Under Int. Conv., Feb. 26, 1916. (Appl. No. 3043 of 1917.)

SHEET metal is tinned on one face only by placing two sheets face to face and connecting them preferably at the edges by autogenous or electric soldering or welding, and then passing them through the tinning bath. The connected sheets may be left open at one side which is kept out of the bath during the tinning operation. —W. F. F.

Ores and other materials; Apparatus for treating —. H. B. Hovland, Duluth, Minn., U.S.A. Eng. Pat. 105,571, May 30, 1916. (Appl. No. 5174 of 1917.) Under Int. Conv., June 17, 1915.

IN an apparatus for successively sulphating and sulphidising ore-pulp and recovering the sulphides by flotation, the pulp is treated under pressure with sulphur dioxide and air, or with smelter smoke, etc., in a series of containers enclosed by a horizontal, cylindrical casing and provided with hollow, rotary agitators through which the gases are passed into the charge continuously. The sulphated charge emerging from the last container of the series is passed into a vertical conduit, the lower end of which communicates with the charging bin of the sulphidising unit, and the upper end with a closed receptacle having a bottom discharge outlet also connected with the bin; the arrangement being such that while the solid portion of the charge gravitates to the bin, the liquid portion is forced, by the pressure within the casing, into the closed receptacle above, and is therein treated with ferric sulphate (as a preliminary to the sulphide treatment) before readmixture with the solid material. —W. E. F. P.

Metal and other melting furnaces. I. Hall, Birmingham. Eng. Pat. 108,084, Oct. 31, 1916. (Appl. No. 15,504 of 1916.)

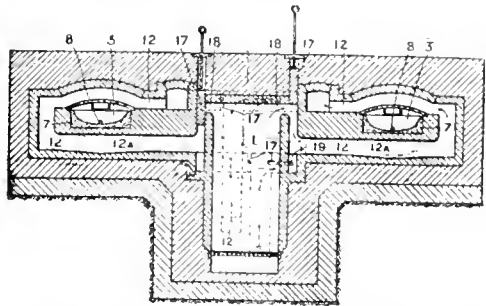
IN a furnace for melting metal or glass, heat treatment of residues, recovery of metals, etc., the lining of the extension of the crucible which forms a preheater comprises two annuli of different diameters integrally connected together. The annuli are composed of sections each having an outer and inner wall connected by radial ribs forming a combustion flue of quadrilateral cross-section. The sections are connected together by means of projecting tongues fitting into grooves in the adjoining sections. —W. F. F.

Converter bottoms, furnace hearths and the like for metallurgical purposes; Process for the manufacture of —. W. P. Thompson, London. From A. Bosshard, Zürich, Switzerland. Eng. Pat. 108,412, Nov. 16, 1916. (Appl. No. 16,399 of 1916.)

THE materials, preferably dolomite and coal tar, of which the bottoms, etc., are composed, are mixed and the mixture shaken into position instead of being rammed or stamped. —W. E. F. P.

Smelting furnaces. E. K. H. Lundberg, Bruzaholm, Sweden. Eng. Pat. 108,498, June 23, 1916. (Appl. No. 8871 of 1916.)

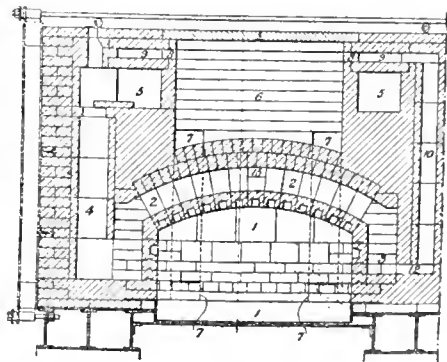
GAS is generated in the producer, 1, and passes by the openings, 18, controlled by dampers, 17, to the heating flues, 12, of the smelting chambers,



3. A regenerator is provided to heat the secondary air which meets the gas at the ignition point, 19. Receptacles, 7, are placed in the chambers, 3, in an unburnt condition, and are burnt previous to the smelting operation. Lateral openings are provided in the chambers, 3, for the introduction of metal and removal of dross, and a tapping hole, 8, is provided in each receptacle. The bottom of each smelting chamber is inclined and provided with a channel to conduct the molten metal away in the event of breakage of the receptacles, 7. Transverse flutes, 12a, are also provided in the flues to receive molten metal in the event of breakage of the chamber floor. —W. F. F.

Annealing ovens, [muffle furnaces,] and the like. A. McD. Duckham, Ashted, Surrey. Eng. Pat. 108,573, Sept. 25, 1916. (Appl. No. 13,587 of 1916.)

THE top of the muffle, 1, is traversed by cross flues, 2, leading from combustion chambers, 3, to vertical flues, 4, which communicate with



common longitudinal outlet flues, 5. Air enters the common chamber, 6, through openings, 7, and is heated by passing through the passages, 8, 9, 10, 12, to the combustion chambers, 3.

Producer gas passes down through vertical heated passages parallel to the passages, 10, and thence to the combustion chambers, 3. The combustion chambers, 3, alternate with the outlet flues, 4. The middle points of the cross flues, 2, are connected by passages, 15.—W. F. F.

Furnaces of the kind used for heating crucibles [for melting metals]. F. J. Grocott, Birmingham, Eng. Pat. 108,615, Nov. 21, 1916. (Appl. No. 16,831 of 1916.)

THE crucible is supported on firebars, and one of the bars at each side comprises an open-topped water channel extending outside the furnace, into which water drips to supply steam for the production of gas. Air is delivered to the ashpit through the front, and also if desired through parallel flues in the walls on each side opening into the sides of the ashpit. Steam may also be supplied through the latter flues to supplement the supply from the firebars. Additional heated air may be supplied through a flue which extends from the front wall of the furnace in a tortuous path round the ashpit and opens into the side walls of the heating chamber at points about midway of the height of the crucible.—W. F. F.

Furnace; Open-hearth —. T. S. Blair, jun., Chicago, Ill., Assignor to Blair Engineering Co., New York. U.S. Pat. 1,236,140, Aug. 7, 1917. Date of appl., Sept. 12, 1916.

IN an open-hearth furnace having a basic bottom, a gas port, and a gas down-take, a water-cooled bulkhead is provided in the upper end of the outer wall of the down-take, immediately below the entrance to the port, the bulkhead having an inclined surface to collect and retain slag particles.—W. E. F. P.

Zinc and other volatile metals; Method for extracting — from their ores, and apparatus therefor. F. Tharaldsen, Christiania, Norway. Eng. Pat. 108,363, Aug. 7, 1916. (Appl. No. 11,143 of 1916.)

ORES of zinc and other volatile metals are introduced into an electric radiation furnace in the form of a layer having a horizontal or slightly curved surface; volatile constituents are conducted through a separate outlet to a condenser. A movable table constitutes the bottom of the furnace; it is charged with the materials to be treated outside the furnace on one side, and the residue is removed outside the furnace on the other side. The surface of the charge is shaped by the lower edge of the wall of the furnace on the charging side, as the charge is passing into the furnace. The table is provided with side ribs and the walls of the furnace have projections overlapping the ribs to form tight joints, the charge serving as packing material.—T. H. B.

Recovering metalliferous minerals by flotation; Method of and means for —. G. Crerar, Spokane, Wash., Assignor to J. L. Boyle, Los Angeles, Cal. U.S. Pat. 1,232,772, July 10, 1917. Date of appl., Mar. 9, 1915. Renewed Nov. 27, 1916.

A MIXTURE of ore pulp and frothing agent is fed on to the upper end of an inclined, porous table the lower end of which terminates in a receptacle provided with a peripheral overflow for concentrate and a bottom discharge for tailing. During operation, air is forced through the table and produces a froth in the flowing pulp; the froth accumulates in the receptacle to a considerable depth and is therein subjected to the action of upward currents of air.—W. E. F. P.

Oil-flotation concentration process. E. Wagner, New York. U.S. Pat. 1,235,683, July 31, 1917. Date of appl., May 7, 1913.

A MIXTURE of ore pulp and oil is caused to ascend

in a vertical stream or column through which air bubbles of definite size are forced continuously and vertically from below. The concentrate is discharged by peripheral overflow at the top of the apparatus and the tailing at a point between the overflow and the air inlet.—W. E. F. P.

Ores; Flotation of —. R. F. Bacon, Pittsburgh, Pa., Assignor to Metals Research Co., New York. U.S. Pat. 1,235,954, Aug. 7, 1917. Date of appl., Jan. 4, 1916.

ORE containing metals forming acid-soluble and acid-insoluble sulphides is treated with hydrogen sulphide and sufficient acid to dissolve the constituents of the former class. The mixture is then subjected to flotation treatment to recover the acid-insoluble sulphides, and afterwards neutralised, treated with alkali sulphide, and re-treated by flotation to recover the acid-soluble sulphides. To effect separation of acid-insoluble sulphides from ore containing iron pyrites, the latter is subjected to a preliminary roast (to convert the pyrites into an acid-soluble form) before the application of acid and hydrogen sulphide.

—W. E. F. P.

Metals; Apparatus for electrolytically recovering —. G. A. James, Assignor to J. H. Alling and F. M. Wright, San Francisco, Cal. U.S. Pat. 1,233,363, July 17, 1917. Date of appl., Apr. 15, 1913. Renewed Oct. 14, 1916.

ELECTROLYTIC cells, used in series for the treatment of metalliferous pulp, are provided with insoluble anodes and mercury cathodes over which the pulp can flow in succession, means being provided for feeding an electrolyte with the pulp to the first of the series. A rotary reverser with four poles is arranged in the circuit, two of the poles being connected by a pair of conductors with the poles of the source of the supply, and the other two poles by a second pair of conductors with opposite sides of each of the cells. The reverser is so arranged that once in each rotation it successively connects electrically, during equal portions of time, each conductor of the first-named pair with conductors of the second-named pair. The current, thus automatically reversed, flows for a shorter period than the direct current, and means are further provided for automatically reducing the intensity of the reversed current.

—B. N.

[Molybdenum and vanadium;] Process of treating ores [containing —]. A. L. Pellegrin, Tucson, Ariz. U.S. Pat. 1,233,398, July 17, 1917. Date of appl., Nov. 13, 1916.

IN the separation of lead molybdate and vanadate from other lead minerals in complex lead ores, the ore is treated with a sulphidising material. The treatment is discontinued before the particles of molybdate and vanadate are attacked, and the attacked portion of the ore is then removed by flotation. The residue is subjected to similar sulphidising treatment until the molybdate is attacked but not the vanadate, and the two are then separated by flotation.—W. F. F.

Copper; Process of extracting — from oxidised ores. N. V. Hybinette, Christiania, Norway. U.S. Pat. 1,233,580, July 17, 1917. Date of appl., May 22, 1913.

A PORTION of the oxidised ore, containing iron which dissolves with the copper, is leached with sulphuric acid, and the solution is passed over a second portion of the ore which has been reduced by heating with carbonaceous matter at a low temperature. The ferric compounds are thus reduced to the ferrous condition, and the copper is then deposited electrolytically from the solution.

—B. N.

Copper-bearing substances; Method of treating ——. C. S. Bradley, New York. U.S. Pat. 1,236,046. Aug. 7, 1917. Date of appl., Dec. 9, 1911. Renewed Jan. 4, 1917.

THE copper is obtained in solution as cupric chloride, and then precipitated as the trioxycupride, which is subsequently converted into cupric oxide.—T. H. B.

Metal; [Electrolytic] process for coating ——. B. P. Allen, Great Neck Station, N.Y. U.S. Pat. 1,233,633, July 17, 1917. Date of appl., Feb. 19, 1917.

THE metal article is first immersed in a bath containing 80 c.c. of water, 10 c.c. of acetic acid, and 40 grains of lead chromate, and a current of electricity is passed through the article and the bath to produce a yellow deposit upon the article.—B. N.

Heat-treating apparatus; Continuous ——. T. F. Baily and F. T. Cope, Assignors to The Electric Furnace Co., Alliance, Ohio. U.S. Pat. 1,234,257, July 24, 1917. Date of appl., Feb. 3, 1917.

THE articles to be treated are passed through a heating furnace and then through a quenching bath to a reheating furnace. The means for moving the articles through the furnaces are controlled by the temperatures of the furnaces by means of a thermal device operating electric controlling means which are connected with the moving gear.—W. F. F.

[Manganiferous silver] ores; Process of treating refractory ——. S. J. Vermaes, Delft, Assignor to Mijnbouwmaatschappij Aequator, The Hague, Netherlands. U.S. Pat. 1,234,426, July 24, 1917. Date of appl., Aug. 7, 1916.

SILVER ore containing manganese dioxide is mixed with a reducing agent and a chlorinating agent, and the mixture roasted at a temperature insufficient to volatilise silver chloride. The product is then leached with cyanide solution.—W. E. F. P.

Bearing metals; Process of making ——. W. H. Kelly, Los Angeles, Cal. U.S. Pat. 1,234,547, July 24, 1917. Date of appl., Dec. 26, 1914.

METALLIC lead in the molten condition is purified by the action of oxygen and hydrogen, and then mixed with commercially pure copper.—T. H. B.

Ore-pulverising ball-mill. H. Eggers, Denver, Colo. U.S. Pat. 1,235,449, July 31, 1917. Date of appl., Feb. 24, 1917.

A ROTATING horizontal cylindrical casing, provided with a metal lining and containing grinding balls, is supported on hollow trunnions communicating with the interior and forming an inlet and outlet for the ore. A pair of transverse partitions, with lots arranged concentrically, are mounted near the outlet end of the casing, spaced apart by lugs and bearing against a flange on the casing projecting inwards. The perforated partitions are maintained in position by a hood forming the end of the casing and containing the hollow trunnion. The outer partition is also provided with a central rooved projection extending to the entrance of the hollow trunnion. The space between the partitions is partly filled with small hard metal grinding balls which are inserted through openings in the casing provided with screwed plugs. The ore thus passes through the main grinding chamber provided with balls of varying sizes, and then through the supplementary grinding chamber between the perforated partitions containing smaller balls, to the outlet.—W. F. F.

[Welding] uniting metals; Apparatus for ——. A. K. Sloan, Brooklyn, N.Y. U.S. Pat. 1,235,608, Aug. 7, 1917. Date of appl., Dec. 5, 1913.

A CARTRIDGE for welding copper wires comprises a cylinder having an insulating lining and containing the welding compound. The wires are inserted through opposite ends of the cartridge but are separated by a thin web of non-conducting material, so that when a current is passed through, an arc is formed which ignites the welding material. The material contains copper which melts and unites the two wires, and a gas absorbent is provided at the outer ends of the cartridge.—W. F. F.

Alloys; Process of treating ——. H. E. Cleaves, Washington, D.C. U.S. Pat. 1,235,655, Aug. 7, 1917. Date of appl., May 23, 1917.

IRON is removed from ferrotungsten containing more tungsten than iron, or from ferrovanadium or ferromolybdenum, by subjecting the alloy, in a finely divided condition, at a high temperature (1000° to 1100° C., for ferrotungsten), to the action of hydrogen chloride, iron chloride being formed and volatilised.—T. H. B.

Alloying metals; Process of ——. C. C. Baldwin, Perth Amboy, N.J., Assignor to Standard Underground Cable Co., Pittsburgh, Pa. U.S. Pat. 1,235,872, Aug. 7, 1917. Date of appl., Aug. 4, 1916.

COPPER is melted, and a specific quantity of it is added to a specific quantity of solid alloying metal, such as lead, zinc, and tin. A specific quantity of a suitable deoxidising agent is added to the copper, with which it is thoroughly mixed before coming in contact with the alloying metal.—T. H. B.

Gold-separator [amalgamator]. B. P. Tuggle, Portland, Oreg., Assignor to Redemption Gold Co., Seattle, Wash. U.S. Pat. 1,235,945, Aug. 7, 1917. Date of appl., Feb. 24, 1916.

A NUMBER of concentric vertical cylindrical containers are mounted on a frame so that they can be rapidly rotated. A concentric feed pipe is divided into as many longitudinal passages as there are containers, each passage communicating with one of the annular chambers. Pulverised ore suspended in water is fed by the central pipe to the annular separating chambers, and the particles are projected by centrifugal force on to the outer walls of the chambers, which are coated with mercury. Series of rings are provided upon the inner and outer walls of the separating chambers, the outer rings having apertures through them parallel to the axis of rotation, so that the layer of mercury is maintained at a predetermined and uniform thickness. The upper ends of the containers are maintained concentric by a number of glands, each of which has an annular overflow chamber connected by ports to the separating chambers.—W. F. F.

Metals [manganese, zinc, lead] from ores and the like; Process for the recovery of ——. C. S. Vadner, Humboldt County, via Battle Mountain, Nev. U.S. Pat. 1,236,236, Aug. 7, 1917. Date of appl., Nov. 27, 1916.

THE ore is treated with sulphur dioxide (roaster gases) in the presence of water, and the solution nearly neutralised and then oxidised by being passed over manganese dioxide or ore containing it, whereby lead and iron are precipitated. The liquid is then treated with a metallic oxide and chlorine to precipitate the manganese as peroxide in a slightly acid solution, the precipitate being filtered off and the filtrate treated for the recovery of zinc by known methods. Lead is recovered from the manganese-ore residue by leaching with a solution of sodium chloride.—W. E. F. P.

Tungsten or molybdenum; Process of coating — with noble metals. F. A. Fahrenwald, Cleveland, Ohio. Dedicated to the Government and people of U.S.A. (Dedicated to the public.) U.S. Pat. 1,236,383, Aug. 7, 1917. Date of appl., May 31, 1916.

AN oxidisable metal, such as tungsten or molybdenum, is heated in contact with an oxygen-containing alkali salt to which is added the haloid salt or salts of the coating metal desired. The process may be applied to the soldering or brazing of tungsten or molybdenum.—T. H. B.

Tungsten and molybdenum; Alloy of —. F. A. Fahrenwald, Cleveland, Ohio. Dedicated to the Government and people of the U.S.A. (Dedicated to the public.) U.S. Pat. 1,236,384, Aug. 7, 1917. Date of appl., June 3, 1916.

A FINELY powdered mixture of tungsten and molybdenum in the desired proportions is compacted under great pressure, and sintered, according to the proportions, for from ten minutes at 2600° C. for tungsten, and at 2300° C. for one minute for molybdenum. The mass is forged at about 1700° C. for an alloy of equal parts, downwards to about 1300° C. for tungsten or about 1000° C. for molybdenum, and is finally cold-worked.—T. H. B.

Ores and other materials; Apparatus for treating — under pressure. H. B. Hovland, Duluth, Minn., U.S.A. Eng. Pat. 100,545, May 29, 1916. (Appl. No. 7601 of 1916.) Under Int. Conv., May 27, 1915.

SEE U.S. Pat. 1,164,187 of 1915; this J., 1916, 185. A subterranean cavity may be used as the pressure-withstanding enclosure.

Ores and other materials; Apparatus for treating —. H. B. Hovland, Duluth, Minn., U.S.A. Eng. Pat. 100,681, May 30, 1916. (Appl. No. 7661 of 1916.) Under Int. Conv., June 17, 1915.

SEE U.S. Pat. 1,164,189 of 1915; this J., 1916, 185.

Smelling process [with wet-carbonised peat]. N. Testrup, London, and T. Rigby, Dumfries, Assignors to Wetcarbonizing, Ltd., London. U.S. Pat. 1,233,144, July 10, 1917. Date of appl., Feb. 9, 1914.

SEE Eng. Pat. 27,150 of 1911; this J., 1913, 93.

Aluminium or aluminium alloys; Soldering of —. W. Overend, Finsbury Park, Assignor to Overend Aluminium Soldering Processes, Ltd., Auckland, N.Z. U.S. Pat. 1,233,803, July 17, 1917. Date of appl., Apr. 24, 1916.

SEE Eng. Pat. 17,118 of 1915; this J., 1916, 1161.

Ore concentration. G. A. Chapman, Anaconda, Mont., Assignor to Minerals Separation North American Corporation. U.S. Pat. 1,234,288, July 24, 1917. Date of appl., Sept. 30, 1914. Renewed June 20, 1917.

SEE Eng. Pat. 17,327 of 1914; this J., 1915, 910.

Ores; Concentration of —. A. H. Higgins, London, Assignor to Minerals Separation North American Corporation. U.S. Pats. (A) 1,236,933 and (B) 1,236,934, Aug. 11, 1917. Date of appl., Sept. 23, 1914. (A) Renewed June 2, 1916.

SEE Eng. Pat. 1368 of 1914; this J., 1915, 233.

Electric smelling furnaces; Cooled bottom electrode for —. M. Sperling, Assignor to F. Krupp A.-G., Essen, Germany. U.S. Pat. 1,231,917, July 31, 1917. Date of appl., Nov. 13, 1911.

SEE Eng. Pat. 6731 of 1914; this J., 1914, 869.

Ores; Method for treating roasted — with liquids. A. Ramén, Olympia, Sweden. U.S. Pat. 1,235,598, Aug. 7, 1917. Date of appl., Mar. 4, 1915.

SEE Eng. Pat. 15,254 of 1914; this J., 1915, 838.

Zinc, copper, or other metals; Apparatus for production of — by electrolysis. M. Perreux-Lloyd, Boulogne-sur-Seine, Assignor to M. V. Bailly, Paris. U.S. Pat. 1,235,723, Aug. 7, 1917. Date of appl., May 24, 1915.

SEE Fr. Pat. 472,764 of 1914; this J., 1915, 497.

Zinc, copper, or other metals; Apparatus for electrolytic production of —. M. Perreux-Lloyd, Boulogne-sur-Seine, Assignor to M. V. Bailly, Paris. U.S. Pat. 1,235,724, Aug. 7, 1917. Date of appl., Dec. 14, 1915.

SEE First Addition of Sept. 24, 1915, to Fr. Pat. 472,764 of 1914; this J., 1917, 143.

Zinc; Method and apparatus for extracting —. E. S. Berglund, Trollhättan, Sweden. U.S. Pat. 1,236,395, Aug. 14, 1917. Date of appl., Feb. 15, 1916.

SEE Fr. Pat. 480,633 of 1916; this J., 1917, 115.

Tungsten alloys; Process of forming high-percentage —. H. Goldschmidt and O. Weil, Essen, Germany, Assignors to Goldschmidt Thernit Co., New York. U.S. Pat. 1,235,969, Aug. 7, 1917. Date of appl., Jan. 20, 1912.

SEE Fr. Pat. 427,774 of 1911; this J., 1911, 1069. A relatively large quantity of flux is used.

Blast-furnaces; Hearth of —. R. Kunz, Georgsmarienhütte, Germany. U.S. Pat. 1,236,721, Aug. 14, 1917. Date of appl., Nov. 30, 1912.

SEE Eng. Pat. 26,806 of 1912; this J., 1913, 755.

Utilisation of the waste heat of gas engines, incandescent slag, coke and the like. Eng. Pat. 107,443. See I.

Carbonising furnaces or furnaces for reducing ores. Eng. Pat. 101,215. See IIb.

XI.—ELECTRO-CHEMISTRY.

PATENTS.

Furnace; Electric —. I. Rennerfelt, Djursholm, Sweden. Eng. Pat. 101,412, Sept. 1, 1916. Under Int. Conv., Sept. 8, 1915. (Appl. No. 12,396 of 1916.)

A FURNACE, of the type in which the heating is by the combined effect of arcs and resistances, is divided into two or several chambers, one of which is the arc chamber for the generation of heat, and the others are adapted for receiving the material to be treated. The latter chamber, or chambers, are partially or wholly surrounded or covered by a refractory resistance, which serves for receiving the arcs from the electrodes in the electric arc chamber, and also for conducting the heat, generated by the arcs and in the resistance, to the furnace or retort chamber or chambers. Three electrodes, connected to a three-phase circuit, may be provided in the arc chamber, each of which generates an arc contacting with a resistance, preferably finely-divided, or three or four electrodes may be connected to a two-phase circuit. In an alternative form, one or several electrodes may be provided in a chamber for electric arcs, and an electrode or contact may be embedded in a resistance beneath the arc chamber. Several cupel furnaces may be arranged above or adjacent one another in the resistance.—B. N.

Ozonisers. W. S. Graft-Baker, London. Eng. Pat. 108,293, Apr. 26, 1917. (Appl. No. 5929 of 1917.)

THE ozoniser comprises a frame, formed from side plates held together by transverse rods; other rods for supporting the metal ozonising plates are supported at their ends by resting on battens on the inner faces of the side plates. Two sets of

supporting rods are arranged at the top and bottom respectively of the frame, and the rods pass through perforations in the top and bottom respectively of the two sets of ozonising plates. The metal plates are provided with spacing-projections embossed thereon, and the projections of one plate are arranged in register with the recessed side of the corresponding projections of the next plate, so that the plates at all parts are equidistant from each other. The dielectric plates, which may or may not be supported from the rods, are placed between the plates, the embossed projections taking the place of insulators.—B. N.

Electrical contact members. H. V. S. Taylor, Pittsburgh, Pa., Assignor to Westinghouse Electric and Manufacturing Co. U.S. Pats. (A) 1,232,624 and (B) 1,232,625, July 10, 1917. Dates of appl., Jan. 21 and Aug. 30, 1916.

(A) A PAIR of make-and-break contact members is composed of two metals, one having a high melting point relatively to the other, such as a cathode of tungsten and an anode of silver. (B) The silver in (A) is replaced by a non-arcing metal, such as platinum.—W. F. F.

Electrical resistance element and process of making the same. M. H. Rice, New Rochelle, N.Y., Assignor to National Electric Utilities Corporation, New York. U.S. Pat. 1,232,843, July 10, 1917. Date of appl., Apr. 8, 1913.

AN electrical resistance element is made by coating a carbon base with a mixture of water glass, 1 part, clay, 2 parts, and graphite, 5 parts, and then heating to fuse the coating to the base.—W. F. F.

Insulation; Electrical.—. Electrical insulating composition and process of making the same. W. H. Steinberg, Assignor to The Cutler-Hammer Mfg. Co., Milwaukee, Wis. U.S. Pats. (A) 1,233,415 and (B) 1,233,416, July 17, 1917. Dates of appl., (A) Mar. 1, and (B) Aug. 23, 1915.

(A) A BINDER, for cementing purposes, is composed of approximately equal parts of coal tar pitch and stearin pitch, with a solvent comprising a volatile oil and a non-volatile oil, such as castor oil. (B) An electrical insulating composition is formed from a base of finely-divided asbestos and sulphur, which is mixed with a binder. The latter is formed by the action of heat upon a mixture of coal tar pitch, stearin pitch, and an oil capable of vulcanisation or polymerisation, mixed with a volatile solvent.—B. N.

Insulated wires; Method of making —. Sheathed heater-wire and method of making same. R. H. Read, Washington, D.C., Assignor to General Electric Co. U.S. Pats. (A) 1,233,807 and (B) 1,233,808, July 17, 1917. Dates of appl., (A) Jan. 3, 1914, and (B) July 30, 1914. (B) Renewed June 9, 1917.

(A) FIREPROOF armoured conductors, for electric heating or for transmitting devices which become hot when used, are prepared by covering a core wire with a medium formed from an insulating powder, refractory to heat, and a destructible organic binder containing a low percentage of a fusible binder. The medium is shrunk and the binder destroyed by heat, whilst finally, at a red heat, an infusible compound is formed. The medium is then enclosed in a seamless metallic armour, which is hammered by radial blows, so as to crush the medium to fine powder, and simultaneously make it compact on the core. (B) The conductor is surrounded by a bed of asbestos, and finely powdered mineral insulation is introduced into the pores of the asbestos. The asbestos-covered wire is led through rotating semi-circular walls, in which molten metal is supplied, and the walls are chilled continuously whilst the conductor

passes, thereby solidifying a seamless metallic sheath around the conductor. A terminal joint is arranged within the insulation, consisting of a metal tube, mechanically interlocked with the conductor and a good conducting lead wire, whilst a metallic cap of good heat-radiating capacity surrounds the joint and is secured to the sheath.—B. N.

Refractory substances; Method and apparatus for electrically reducing [melting] —. J. G. Webb, Richmond, Va. U.S. Pat. 1,231,836, July 31, 1917. Date of appl., Mar. 16, 1917.

THE charge to be melted is contained in a crucible provided with a number of electrodes converging downward toward the centre. Craters are formed by an electric arc between each electrode and the material, and are made to coalesce as the material melts, by advancing the electrodes inward. The angle between the electrodes is less than the angle between any electrode and the wall of the crater, so that contact with the material is avoided as the electrodes are moved forward.—W. F. F.

Electrical heating apparatus and process of making the same. S. Trood, Wilkesburg, Pa., Assignor to Westinghouse Electric and Manufacturing Co., U.S. Pat. 1,234,973, July 31, 1917. Date of appl., Jan. 7, 1914.

A RESISTANCE unit for an electric heater is made by embedding a conductor, e.g., tungsten, between layers of insulating material, e.g., silica. An electric current is then passed through the conductor till the silica is partly fused, the melting point of the conductor being above that of the insulating medium.—W. F. F.

Electro-osmotic process of treating liquid mixtures. B. Schwerin, Assignor to Electro-Omose A.-G. (Graf Schwerin Ges.), Frankfurt, Germany. U.S. Pat. 1,235,063, July 31, 1917. Date of appl., Feb. 16, 1915.

SEE Eng. Pat. 11,823 of 1914; this J., 1915, 877.

Process for purifying salt brine. U.S. Pat. 1,235,202. See VII.

Electrical insulator. U.S. Pat. 1,233,486. See VIII.

XII.—FATS; OILS; WAXES.

African palm oil industry. III. Machinery. Bull. Imp. Inst., 1917, 15, 57—78.

AN account of the distribution, varieties, and method of preparing the oil and kernels has already been given (this J., 1910, 287; 1913, 797). The original difficulty of obtaining a yield of "soft" oil, i.e., oil of comparatively low acid value, has now been surmounted by a process of rendering the enzymes or micro-organisms inactive by heat and rapidly expressing and purifying the oil. The inferiority of "hard" oils containing a high percentage of free fatty acids and lower glycerin content is shown by the relative prices of hard and soft oils at normal times, viz., Lagos (soft) oil £31 per ton, Congo (hard) oil £26 per ton. It is stated that none but the soft or neutral palm oil containing less than 1% of dirt and moisture and not more than 8% of free acid can be employed in the manufacture of edible fat. A fairly detailed account of the plant employed in the several processes of working up the fruit of the oil palm, together with names of manufacturers of the same, yields, etc., is given. In the hand-power plant the oil is extracted by boiling with hot water under agitation; yields of 15.75% to 16.25% on fruit containing 22% of oil are obtained. The power-driven machines deal with the removal of fruit from bunches, separation of pulp, shelling, etc.

In these the oil is extracted by pressure in hydraulic presses, with or without previous removal of the nut. The kernel is removed from the nut by cracking the latter by centrifugal force against the walls of the centrifugal. A power-driven machine is described giving a yield of 20% of oil of sufficient purity to realise £2 per ton more than palm oil obtained in the usual way. It is concluded that development of the oil palm in the British Colonies and Protectorates will take place along the lines of establishment of a central factory situated in a centre where considerable planting will be necessary, thus diverting the native labour from individual extracting to the requirements of the factory. Such a system will necessitate the putting down of heavy power-driven plant, the hand-driven portable plant being more fitted to working up the fruits *in situ* over sparsely planted districts.

—A. DE W.

Manketti nuts from South West Africa. Bull. Imp. Inst., 1917, 15, 35—38.

MANKETTI or munkuetti nuts are obtained from the euphorbiaceous tree (*Ricinodendron Raudaninii*, Schinz.) found in the South African veldt. The sample examined consisted of fruits $\frac{3}{4}$ in. to 1 in. in diameter and 1 in. to $1\frac{1}{2}$ in. in length, composed of husks (13%), mesocarp (20%), and nuts (67%). The kernel of the nut formed about 10% of the entire fruit. The kernels contained 4.1% of moisture and 57.2% of a bright yellow liquid oil giving the following values: Sp. gr. at 15° C. 15° C., 0.9281; acid value, 1.9; saponification value, 191.5; iodine value, 133.6. From a consideration of its iodine value, insolubility in alcohol, and solubility in light petroleum, it is concluded that the oil belongs to the semi-drying oil group and not, as previously supposed, to that of castor oil. It is not considered to be particularly suited for use in paint or varnish manufacture, whilst many cheap vegetable oils are already available for the manufacture of soft soap. Its suitability as an edible oil has been shown by experiments of some German investigators a few years ago. Examination of the pulpy mesocarp of the fruit showed it to possess only a moderate percentage of proteins. In view of the small proportion of kernel and difficulty of extraction of the oil therefrom, it is considered that the exportation of the nuts to Europe would not be remunerative.—A. DE W.

Human adipocere. R. F. Ruttan. Trans. Roy. Soc. Canada, 1917, [iii.], 10, 169—170. J. Chem. Soc., 1917, 112, i., 495. (Compare Ruttan and Marshall, this J., 1916, 477.)

THE author has analysed specimens of adipocere of human origin, some of which were dry and firm and others soft and oily. The latter consist of immature adipocere and differ from the waxy variety in containing more oleic acid, proteins (soft connective-tissue and hyaline muscular fibres), and calcium soaps. Human adipocere, whether mature or immature, shows a remarkable similarity in composition to the adipocere from the pig. It is essentially composed of saturated fatty acids, glycerides being present in traces only. The two isomeric monohydroxystearic acids derived from oleic acid are invariably present, and the disappearance of unaltered oleic acid marks the final stage in the formation of mature adipocere. Adipocere is regarded as the product of the hydrolysis of fats by water where the time factor and the concentration of the reacting water are almost indefinitely great and where the soluble product, glycerol, is rapidly removed. Bacterial and enzymic actions play a quite secondary part in the production of adipocere. The hard, waxy character of the mature substance is largely due to the presence of the two hydroxystearic acids.

Yield and nitrogen content of soya beans as influenced by lime. Lipman and Blair. See XVI.

Composition and digestive activity of different fractions of the pancreas. Nelson and Long. See XVIII.

PATENTS.

Oils, fats, and greases; Apparatus for the extraction of — and of gelatin. H. Engel, Cricklewood. Eng. Pat. 108,014, July 17, 1916. (Appl. No. 10,017 of 1916.)

THE material from which oil, fat, grease, or gelatin is to be extracted, is placed in a long inclined extraction vessel, provided with heating coils and with agitating blades, and communicating through a metal grid at its lower end with a chamber into which the extracted oil, etc., may pass, and where the solution is heated before passage, by gravity or otherwise, into a still for recovery of the solvent.—E. W. L.

Oil-extracting apparatus. F. Strickland, Anderson, S.C. U.S. Pat. 1,233,930, July 17, 1917. Date of appl., Sept. 18, 1916.

AN oil-extracting press comprises a rotary compressor, formed of two lengthwise cylindrical portions differing in diameter, and connected by a taper portion which, together with the larger end of the compressor, is provided with a spiral feed groove. Around the compressor is a series of parallel plates, arranged perpendicular to its length. The central or hub portions of the plates are provided with ducts leading to the spaces between the thinner outer portions of the plates, and there is a narrow annular space between the smooth end of the compressor and the surrounding plate hubs.—E. W. L.

Extraction of fats, ammonia, and the like from organic refuse. Eng. Pat. 107,092. See IIb.

Viscosimeter. U.S. Pat. 1,233,177. See XXIII.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Burmese black varnish or lacquer. II. Bull. Imp. Inst., 1917, 15, 42—46. (See also Sing, this J., 1909, 993.)

AN earlier article (Bull. Imp. Inst., 1910, 8, 273) described the preparation and characteristics of Burmese lacquer together with the manufacture of Burmese lacquer ware. The present article gives the results of inquiries instituted at the request of the Forest Department in India to induce users of varnishes in this country to experiment with the material with a view to utilisation in European industries. Burmese lacquer is similar to Chinese lacquer and is likewise used in a liquid state as a varnish for woodwork and for waterproofing paper and cloth. Mixed with pigments as a decorative paint, or with ashes or teak sawdust it is used as a putty basis on woodwork or basket ware preparatory to application of finishing coats of the varnish. It is also used as a cement for glass mosaics in Buddhist temples. Figures are given showing the yield and value of "thitsi" (its native name) from different Forest Circles in Burma. Samples of three grades sent to the Imperial Institute for examination showed that the grading was dependent on moisture content only, the dried product being identical in each case. After application the varnish becomes hard in three days at 30°—35° C. in an atmosphere saturated with moisture, but remains sticky for several days when exposed in dry air at the normal temperature. In submitting samples of thitsi for trial to varnish chemists, manu-

facturers, and firms specialising in lacquer ware, reports on the material were obtained from which the following may be summarised; "Thitsi" appears to be quite equal to Chinese lacquer, although slower drying. It shows advantages over Japanese lacquer, but owing to the conditions required for its hardening, it does not seem to find favour as a substitute for other materials drying more quickly at ordinary temperatures. In view, however, of its special resistance to chemical and physical influences and its great elasticity, it would appear desirable, according to one report, to ascertain if the disadvantages accruing from the special conditions required for hardening it could be overcome without much difficulty. There appears to be little prospect of thitsi being exported extensively for use in Europe, but there should be a large demand for articles lacquered with the material locally.—A. DE W.

PATENTS.

Titanic oxide products [pigments]: Method of producing composite—L. E. Barton, Niagara Falls, N.Y., Assignor to The Titanium Alloy Manufacturing Co., New York. U.S. Pat. 1,234,260, July 24, 1917. Date of appl. July 19, 1915.

A COMPOSITE pigment is obtained from impure titanic sulphate solutions by precipitation with hydrogen sulphide, filtering off the precipitated sulphides, and treating the filtrate with calcium hydroxide, the calcium sulphate and orthotitanic acid precipitate being afterwards calcined.

—A. DE W.

Resin and analogous substances: Apparatus for melting—A. Thomson, Manchester. Eng. Pat. 198,604, Nov. 8, 1916. (Appl. No. 15,987 of 1916.)

A COPPER boiler is fitted with a jacketed casing, which is provided with electrical heating elements and with internal heat reflectors. The boiler is provided with a screen for straining melted resin on its way to the outlet and a chimney for escape of fumes. The apparatus is specially designed to prevent ignition of evolved gases by the heating elements.—A. DE W.

Coaling composition and process of making same. H. K. Kiso, New York. U.S. Pat. 1,236,183, Aug. 7, 1917. Date of appl. Feb. 2, 1917.

THE root of a plant of the *Conopholis* family e.g., of the Konjak plant, is finely divided, crushed, and heated, the upper layer of juice is removed, and used as a waterproofing material.—A. DE W.

Paint and varnish solvent. J. S. Patty, Chicago, Ill., Assignor to Chadeloid Chemical Co., New York. U.S. Pat. 1,235,721, Aug. 7, 1917. Date of appl. June 13, 1912. Renewed June 11, 1917.

A SOLVENT consisting of a mixture of benzol, alcohol, an alkyl palmitate, an oil, and a phenol compound.—A. DE W.

Phenols with formaldehyde and the like; Manufacture of products of condensation of—K. Tarassoff, Moscow. U.S. Pat. 1,235,597, July 31, 1917. Date of appl. May 1, 1914.

CONDENSATION products are prepared by the interaction of phenol, formaldehyde, sulphonated resin oil, and petroleum sulpho acids obtained by treating crude petroleum with sulphuric acid.

—A. DE W.

Linoleum; Manufacture of—L. E. Barton, Niagara Falls, N.Y., and H. A. Gardner, Washington, D.C., Assignors to The Titanium Alloy Manufacturing Co., New York. U.S. Pat. 1,236,367, Aug. 7, 1917. Date of appl. Feb. 7, 1917.

LINOLEUM material is incorporated with a titanic substance.—A. DE W.

Resin; Esterified fossil—and process of making same. H. Terrisse, Geneva, Switzerland, Assignor to Indestructible Paint Co., Ltd., London, and Ellis-Foster Co., Montclair, N.J. U.S. Pat. 1,236,993, Aug. 11, 1917. Date of appl. Apr. 22, 1915.

SEE Eng. Pat. 23,055 of 1911; this J., 1913, 57.

Liquid and plastic compositions containing pitch or other viscous or solid tar product. Eng. Pat. 108,368. See 111.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

PATENTS.

Rubber; Process of and apparatus for separating—from the fabrics of used pneumatic tyres. H. Delange, Paris. Eng. Pat. 190,961, July 19, 1916. (Appl. No. 10,201 of 1916.) Under Int. Conv., July 20, 1915.

USED pneumatic tyre fabric is washed with a cold rubber solvent, and is then heated at 100°–110° C., *in vacuo*, with xylene or other solvent of vulcanised rubber. The solvent is kept in vigorous circulation by means of a cone and tube device. After this treatment the fabric is further treated with solvent at 150° C. under pressure, and finally washed centrifugally in cold solvent, and dried in a current of hot inert gas.—E. W. L.

Rubber substitute. J. Flint, Emu Plains, N.S.W. U.S. Pat. 1,233,159, July 17, 1917. Date of appl. Mar. 27, 1917.

A VULCANISABLE composition is composed of gelatin, 24; glycerin, 28; water, 10; rubber, 8; diatomaceous earth, 8; zinc white, 8; sulphur, 5; calcined magnesia, 3½; litharge, 2½; formaldehyde, 2; and colouring matter, 1%.—E. W. L.

Plastic material [from rubber] and process of producing same. S. J. Peachey, Heaton Mersey. U.S. Pat. 1,234,381, July 24, 1917. Date of appl. Sept. 10, 1915.

SEE Eng. Pat. 1894 of 1915; this J., 1916, 479.

XV.—LEATHER; BONE; HORN; GLUE.

PATENTS.

Tanning agents. G. Calvert, London. Eng. Pat. 108,262, Nov. 28, 1916. (Appl. No. 17,052 of 1916.)

A TANNING agent for use either alone or as an accelerator in conjunction with natural tanning agents, is obtained by the interaction of a phenolic body and formaldehyde in the presence of a saponaceous solution. For example, dried soap (1 lb.) is dissolved in water (1 lb.), and phenol or a phenolic body (1 lb.) and 40% formaldehyde (1 lb.) are added to the cold soap solution. The stock, or diluted stock, may be used alone, or may be added to, e.g., standard oak bark extract in the proportion 1:9. Softening or delining agents such as alkali sulphates or sulphides, or a weak acid, such as boric acid, may be added.—E. W. L.

Tanning. E. Stiasny, Leeds, Assignor to Badische Anilin und Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,232,620, July 10, 1917. Date of appl. Dec. 13, 1912.

SEE Fr. Pat. 443,730 of 1912; this J., 1912, 1015. The tanning agent is a compound containing at least one hydroxyl group in the molecule, but not more than one hydroxyl group in each nucleus.

Tanning: Apparatus for ——. A. Vandenweghe, New York, and A. D. Huyvetters, Ridgefield Park, N.J., Assignors to Ideal Cooney Dressing and Dyeing Co., Inc., Paterson, N.J. U.S. Pat. 1,233,730, July 17, 1917. Date of appl., Jan. 5, 1917.

THE hides or other materials are treated with tanning liquor in an upper series of vats, from which the liquor can be run off into a lower series in which it can be heated and then returned to the upper series. Means are provided for the introduction of trolleys or other devices beneath the upper vats and above the lower, in order to receive the tanned materials through outlets in the bottoms of the vats.—E. W. L.

Tanning material. W. Moeller, Assignor to Gerh. und Fabstoffwerke H. Renner und Co., Hamburg, Germany. U.S. Pat. 1,236,168, Aug. 14, 1917. Date of appl., July 19, 1913.

SEE Ger. Pat. 262,333 of 1912; this J., 1913, 878.

Tanning apparatus: Drum ——. E. Wilson, Liverpool. U.S. Pat. 1,236,803, Aug. 14, 1917. Date of appl., Mar. 24, 1915.

SEE Eng. Pat. 7762 of 1914; this J., 1915, 437.

Gelatinous substances; Electro-osmotic purification of ——. B. Schwerin, Assignor to Elektro-Osmose A.-G. (Graf Schwerin Ges.), Frankfurt, Germany. U.S. Pat. 1,235,061, July 31, 1917. Date of appl., Feb. 16, 1915.

SEE Eng. Pats. 21,418 and 21,484 of 1914; this J., 1915, 971, 1072.

Drying apparatus for wattle bark, maize, or other like commodity Eng. Pat. 108,132. See I.

Apparatus for the extraction of oils, fats, and greases and of gelatin. Eng. Pat. 108,014. See XII.

XVI.—SOILS; FERTILISERS.

Soil flora studies. F. Actinomyces in soil. H. J. Conn. Tech. Bull. No. 60. New York Agric. Exper. Stat., March, 1917, 25 pages. (See also this J., 1917, 971.)

THE third large group of soil micro-organisms comprises the actinomyces, which, as a rule, form from 12 to 50% of the colonies on plate cultures made from the soil. About 70 different types of these organisms were found in the soils examined, three being of fairly common occurrence. One of these, hitherto undescribed, has been termed *A. pleochromogenus*. It is characterised by forming thick white mycelia and producing a deep brown pigment, which colours both the growth itself and the culture medium. One of the other two types has the same cultural characters as the potato scab organism, although it has not yet been proved to be pathogenic, whilst the third common type, which produces pink spores, is probably not a distinct species. The development of actinomyces in plate cultivations was not appreciably affected by the addition of manure to the soil, but the number of colonies tended to increase the longer grass was grown on the soil. Mixing dead grass roots with the soil had a similar stimulating influence upon the growth, but it could not be proved definitely that actinomyces played a part in the decomposition of grass roots in the soil.

—C. A. M.

Parahydroxybenzoic acid from soil; Isolation of ——. E. H. Walters. J. Amer. Chem. Soc., 1917, 39, 1778—1784.

IN an investigation of a sandy soil from Florida, 23 kilos. was extracted with 75 litres of dilute caustic soda at ordinary temperature for 24 hrs.,

the extract acidified and filtered, and the filtrate extracted with ether. The ethereal extract was purified and evaporated on the surface of warm water. When the water cooled, a crystalline compound separated, which was recrystallised from water and distilled with steam. From the distillate and residue crystalline substances were obtained; that from the residue amounted to 0.5 gm. and proved to be identical with *p*-hydroxybenzoic acid, while that from the distillate amounted to 40 mgrms. and was identified as benzoic acid.

—J. H. J.

Ammonia in the soil and in liquid manure; Determination of ——. W. I. Baragiola and O. Schuppli. Landw. Versuchs-Stat., 1917, 90, 123—137. J. Chem. Soc., 1917, 112, ii., 380—382.

THE ammonia present in the soil may be estimated as follows: 50—100 grms. of the soil is mixed with 5—7 grms. of magnesia, and at once introduced into a (Claisen) (two-necked) fractionating flask holding about three-quarters of a litre, together with about 100 c.c. of water. The flask is connected with a bulb tube passing tightly through the stopper of a pump flask which contains 10—20 c.c. of *N*/5-sulphuric acid, and is surrounded by ice-water. The side-tube of the pump flask is connected with that of a second, which serves as a safety flask, and is joined to a water-pump and also carries a manometer. A tube, drawn out at the bottom to a capillary and connected above with a sulphuric acid washing bottle, passes almost to the bottom of the distillation flask. The pressure is lowered to about 15 mm. and the water-bath in which the distillation flask is immersed is heated to about 35° C. The distillation is continued until the residue is dry, this requiring about two hours. A slow current of ammonia-free air is then passed for a time through the flask. The contents of the receiver are finally washed out into an Erlenmeyer flask, boiled to expel carbon dioxide, and when cold titrated with *N*/10-sodium hydroxide in presence of Congo-red; the titration is carried on until the colour matches that given by a mixture of the same volume of *N*/5-sulphuric acid as is used in the test with an equivalent volume of *N*/10-sodium hydroxide. Under the above conditions, not only ammonia, but also volatile amines and other bases, may pass over, and details are given of the separation of ammonia from the distillate as magnesium ammonium phosphate. Direct titration of the distillate obtained as above and that from the magnesium ammonium phosphate, however, gives virtually identical values, so that amines and volatile bases other than ammonia pass over only in negligible quantity. The ammonia which passes over when soil is distilled with magnesia seems to be that actually existing as ammonium salts in the soil, since after some time it disappears, having undergone complete conversion into nitrate.

The above method is applicable also to liquid manure, 50 c.c. of the latter and 10 grms. of magnesia being taken, and the distillate made up to a definite volume and aliquot portions used for the direct titration of the volatile basic nitrogen and for the precipitation of the ammonia as magnesium ammonium phosphate.

Manure treated with sulphur and sulphates; Fermentation of ——. Changes in nitrogen and phosphorus content. J. W. Ames and T. E. Richmond. Soil Sci., 1917, 4, 79—89.

THE loss of dry substance from manure (horse manure and fine straw litter) after fermenting for 250 days was 32.5% in untreated manure and 21.8% from manures treated with acid phosphate (342 grms. per 30 lb.) and calcium sulphate (407 grms. per 30 lb.), whilst manure treated with sulphur (90 grms. per 30 lb.) lost 18%. Manures

treated with acid phosphate (superphosphate), calcium sulphate, or sulphur lost 3.5% of their total nitrogen, and untreated manure lost 10.5%. The water-soluble and citrate-soluble phosphoric acid decreased in all the samples of manure. During fermentation the manure treated with sulphur increased in acidity whilst the untreated manure became alkaline. Sulphur, calcium sulphate, and acid phosphate were very effective in preventing loss of nitrogen from urine. In about 5 weeks untreated urine lost 80% of its total nitrogen; that treated with sulphur, 10%, with calcium sulphate, 9.7%, whilst the urine treated with acid phosphate lost only 5% of its nitrogen. —W. P. S.

Nitrogen fixation; Relation of green manures to —. H. L. Fuhrer. *Soil Sci.*, 1917, 4, 1—17.

GREEN manures, such as clover, wheat, or oats, when added to soil favour the fixation of free nitrogen; the gain in nitrogen content appears to be greatest in field soils, probably due to the presence of a greater number of nitrogen-fixing organisms. The non-legume tissue stimulates the fixation more than does the legume, possibly because of the nature of its carbohydrate content. The plants (non-legume) giving the best results are the lowest in nitrogen-content. —W. P. S.

Crop yield: Influence of the fineness of division of pulverised limestone on — as well as the chemical and bacteriological factors in soil-fertility. N. Kopeloff. *Soil Sci.*, 1917, 4, 19—71.

AN increase in the fineness of division of powdered limestone, added to soil, from 20- to 40-mesh, 60- to 80-mesh, 100- to 200-mesh, to finer than 200-mesh produces a proportional increase in the yield and total nitrogen content of crimson clover on several types of soil. The finer the division of the limestone the more rapid is the neutralisation of the soil acidity and the greater the increase in the activity of the bacteriological processes of ammonification, nitrification, and nitrogen-fixation. In the case of barley, buckwheat, and rape, fine limestone without supplementary addition of nitrogen fertilisers, gives as high a yield as coarse limestone with an application of 600 lb. of ammonium sulphate per acre; 200-mesh limestone may be regarded as being as effective as burnt lime. —W. P. S.

Soya beans; Yield and nitrogen content of — as influenced by lime. J. G. Lipman and A. W. Blair. *Soil Sci.*, 1917, 4, 71—77.

LIMING the soil increases the yield of soya beans and also the nitrogen content of the beans. When the crop is harvested as hay or as dry stalks, the yield and nitrogen content are also greater on limed soil. An acre of limed soil yielded an average of 19.3 bushels of beans containing 6.15% of nitrogen, whilst an acre of unlimed soil yielded 13.2 bushels of beans with 5.73% of nitrogen. —W. P. S.

Iron: Use of — in agriculture. A. Monmer and L. Kuczyaski. *Arch. Sci. phys. et nat.*, Geneva, 1917, 43, 66—68. *Bull. Agr. Intell.*, 1917, 8, 693—694.

SOME years ago the authors and Chodat found that plant growth was favourably affected by applying to the soil a dilute solution of a ferric salt at the beginning of vegetation, but application at a later stage had no such effect. It is now shown that the iron present in soils of normal composition is in a form very difficult to assimilate, being insoluble in water and dilute alkalis though slightly soluble in some dilute acids, e.g., 1% citric acid. Certain silicious soils entirely lacking in lime contain a considerable amount of water-soluble iron, and in such a soil pink hydrangeas give blue flowers;

but if a small quantity of calcium carbonate or magnesia is mixed with the soil the iron becomes insoluble and pink flowers are produced. When a dilute solution of an iron salt is filtered through soil of normal composition, the iron is completely precipitated as hydroxide or carbonate and retained by the superficial layers of soil, e.g., by the top 2 cm. if the soil contains about 5% of lime. Hence treatment with ferric solutions does not affect plants of which the roots have penetrated some distance into the soil. Potassium ferrocyanide applied in the same way to soils is not rendered insoluble, but part of the potash is retained by the soil and some oxidation to ferricyanide occurs. —J. H. L.

Illuminating gas: Action of — on plants. I. Action of the gas on the germination of spores and seeds. C. Wehmer. *Ber. Deut. bot. Ges.*, 1917, 35, 135—154. *J. Chem. Soc.*, 1917, 112, i., 507.

ILLUMINATING gas exhibits no general poisonous character towards plants. Anaerobic fungi grow even in the undiluted gas, and cross seeds (*Lepidium sativum*) remain alive in it for weeks. It retards the growth of the embryo, but this proceeds uninterrupted if the gas is diluted with about five times its volume of air. Gas is thus not an acute plant poison, but if it is passed for some time through soil, the latter becomes incapable of permitting seeds to germinate and grow in it; after such soil has been extracted with cold water, it behaves normally towards seeds, the injurious properties being transferred to the water. The principal constituents of coal-gas to which its action on plants is due are sulphur compounds, benzene and its homologues, and, to a less extent, ethylene. Carbon monoxide is without effect on plants.

PATENTS.

Peat for agricultural and horticultural purposes: Treating —. A. Nightingale, Bedford. Eng. Pat. 108,543, Aug. 18, 1916. (Appl. No. 11,708 of 1916.)

RAW peat, containing 50—70% of moisture, is mixed rapidly with 20% by weight of calcium oxide and the temperature of the mass allowed to rise to 220° F. (104° C.). The material is ready for use on cooling. —W. E. F. P.

Fertilisers from silicates; Process of producing —. L. L. Jackson, Assignor to O. C. Horney, New York. U.S. Pat. 1,232,553, July 10, 1917. Date of appl., June 16, 1916.

SILICATES containing alkali metals and aluminium are decomposed by heating with calcium hydroxide and water under pressure. The resulting mixture is filtered and the solution neutralised with acid and evaporated to dryness for the recovery of alkali salts. The residue is treated, first with sufficient acid to convert all the calcium present into a calcium salt, without dissolving the aluminium hydroxide, and then with sufficient acid to dissolve the latter, the two solutions being collected separately. The final insoluble residue is mixed with the dry alkali salts previously obtained to form a fertiliser. —W. E. F. P.

Dicalcium phosphate; Process of making —. W. Glaeser, Brooklyn, N.Y. U.S. Pat. 1,235,025, July 31, 1917. Date of appl., May 1, 1916.

PHOSPHATE rock is heated with hydrochloric acid and the solution treated, at about 30° C., with calcium hydroxide to precipitate amorphous dicalcium phosphate (soluble in ammonium citrate) which is filtered off and dried. —W. E. F. P.

Fertiliser composition. J. G. Lipman, New Brunswick, N.J. U.S. Pat. 1,235,906, Aug. 7, 1917. Date of appl., Sept. 6, 1916.

A MIXTURE of finely divided sulphur, 1; bacterially

active material capable of promoting the oxidation of sulphur, 1; and ground phosphate rock, 2—10 parts.—W. E. F. P.

XVII.—SUGARS ; STARCHES ; GUMS.

Clarification: Increase of the coefficient of purity caused by— in the cane sugar factory. 11. Pellet. Intern. Sugar J., 1917, 19, 367—368.

COMMENTING upon a statement that by merely liming and heating raw cane juice, an increase of 2.6 in the purity value had been produced, the author points out that the normal increase under the best possible conditions is about 1.8, and quite frequently is less. In carrying out the determination, it is important to free the juice from suspended matter, such as particles of bagasse and fine clay. An error may also be introduced by delaying the analysis of the sample representing the unclarified juice until that of the clarified product is available, since the former deteriorates very rapidly, much more so than the latter, the sucrose being converted to reducing sugars by invertase even in the presence of preservative substances as chloroform, salicylic acid, thymol, or formaldehyde. It has been stated that between the juice entering and that leaving the evaporators there occurs a loss of reducing sugars, but investigations on this point carried out by Geerligs in sugar factories in Java have conclusively proved this to be untrue, so that in fact there may be an increase in the syrup, even under proper working conditions.—J. P. O.

Date palm sugar industry; Some experiments on the improvement of the—. H. E. Annett. Agric. J. India, 1917, 12, 412—445.

IN India about 16% of the home-grown sugar is produced from palms, mostly from the wild date variety, *Phoenix sylvestris*, which is the common sugar palm of Bengal, and from the palmyra, the chief producer in Madras. Experiments conducted upon the best method of raw juice collection in earthenware pots showed that the Bengal method of previously smoking the pots over a fire has a distinct effect in preserving the juice. Formalin has a similar effect, but the results are very variable. The use of pots coated inside with lime is, however, by far the most satisfactory procedure, and is strongly to be recommended. Metal buckets, for an undetermined reason, give very unsatisfactory results. Hitherto the juice dripping from the trees during the day has fermented to such a degree as not to be worth working up for sugar, but the author has shown that if the practice of previously liming the pot be followed, excellent crystalline *gur* may be obtained from this juice, and the total yield per 24 hours may thus at the same time be increased at least 20%. Palm *gur* is appreciably darker than the native product from the cane, due to the fact that the juice being alkaline, black decomposition products of the reducing sugars, notably levulose, are formed during boiling; but this trouble is readily overcome by previously neutralising the juice, for example, with citric acid. Tests on evaporation in native furnaces showed that a considerable economy of fuel may be effected by the use of a number of pans, for example, four, with a good underdraught, in place of the single pans at present employed.—J. P. O.

Dextrose; Determination of—. G. Frerichs and E. Mannheim. Arch. Pharm., 1916, 254, 138—148. J. Chem. Soc., 1917, 112, ii., 393—394.

THE authors prefer Rupp and Lehmann's iodometric method of estimating reducing sugars to the

Fehling-Soxhlet method, and deny Ruoss's statement that the iodometric estimation of the excess of the cupric salt remaining after Fehling's solution has been partly reduced by a sugar solution yields untrustworthy results, owing to the action of oxidised sugar compounds on the liberated iodine. They find that the substances produced from the sugar by the action of the alkaline copper solution have no action on iodine. The table published by Rupp and Lehmann giving the number of mgrms. of dextrose corresponding with a given consumption of N/10-thiosulphate has been incorrectly calculated, and the authors give a list of corrected values. Details are given of the application of the method to the determination of dextrose in urine.

d-Galactose; o-Tolylhydrazine, a sensitive reagent for—. A. W. Van der Haar. Rec. Trav. Chim. Pays-Bas, 1917, 37, 108—110.

THE formation of the *o*-tolylhydrazone is a sensitive test for *d*-galactose, even in the presence of other monosaccharides. One part of *d*-galactose dissolved in one part of water is heated on the water-bath for half an hour with one part of *o*-tolylhydrazine dissolved in 20 parts of absolute alcohol. After 21 hours, the hydrazone is filtered, with the aid of the pump, washed with alcohol and ether, and recrystallised from 95% alcohol. It forms colourless shining needles which melt at 176° C. It is practically insoluble in cold water, slightly soluble in cold alcohol, more soluble in hot water or hot alcohol, and easily soluble in pyridine. 100 mgrms. of *d*-galactose can be detected in the presence of a mixture of 50 mgrms. each of arabinose, xylose, rhamnose, dextrose, mannose, and levulose, since none of these forms an *o*-tolylhydrazone.—F. Sr.

l-Arabinose and l-xylose; Method of oxidation and the oxidation products of— in alkaline solutions with air and with cupric hydroxide. J. U. Nef, O. F. Hedenburg, and J. W. E. Glattfeld. J. Amer. Chem. Soc., 1917, 39, 1638—1652. (See this J., 1908, 31; 1910, 1264; 1913, 366.)

BY aerating 50 grms of *l*-arabinose in dilute potassium hydroxide solution (5 equivalents) at 38°—41° C., and working up the products, the authors obtained 15.35 grms. of formic acid, 3.73 grms. of calcium glycolate, 14.12 grms. of *l*-erythronic- γ -lactone, and less than 1 gm. each of *d*-threonic phenylhydrazide, quinine-*l*-glycerate, and calcium *d*-glycerate. *l*-Xylose under similar conditions yielded 13.17 grms. of formic acid, 18.09 grms. of *l*-threonic phenylhydrazide, 4.94 grms. of calcium glycolate, and less than 1 gm. each of *d*-erythronic- γ -lactone and calcium *l*-glycerate. The two pentoses were also oxidised in alkaline solution, by cupric hydroxide, at 100° C., and small quantities of some of the products were isolated.—J. H. L.

Lactose, maltose, and sucrose; Action of formaldehyde on—. A. Heiduschka and H. Zirkel. Arch. Pharm., 1916, 254, 456—487. J. Chem. Soc., 1917, 112, i., 446—447.

IN view of the contradictory observations recorded in the literature of the action of formaldehyde on different kinds of sugars, the authors have examined the substances obtained from formaldehyde and lactose, maltose, or sucrose in aqueous solution. Formaldehyde and the bioses yield products the compositions of which vary with the relative proportions of the sugar and formaldehyde used in the preparation, and any one product does not differ in essential chemical characteristics from any other product or from its components. The products therefore are not to be regarded as definite chemical compounds. Products containing up to 39% of formaldehyde have been

prepared; from products containing a higher percentage paraformaldehyde separates. Products containing a high percentage of formaldehyde yield products containing a lower percentage by evaporating their aqueous solution in a vacuum. The capacity to take up formaldehyde is different in the three bioeses, being greatest in sucrose and least in maltose. The formaldehyde in the products can be estimated by the sulphite method and the sugar polarimetrically, the sum of the two percentages being 100.

Following the directions of Oppermann and Goehde (Eng. Pat. 6653 of 1897; this J., 1898, 263) and of Rosenberg (Eng. Pat. 2682 of 1906; this J., 1906, 1067) the authors have been unable to obtain from lactose and formaldehyde substances having the compositions recorded by these investigators. The products lose all their formaldehyde at 190° C. and leave pure lactose. The products are soluble in alcohol. This is noteworthy since lactose is practically insoluble in this solvent. The authors now find, however, that lactose is more soluble in alcohol containing formaldehyde than in alcohol alone, and that the products mentioned above are more soluble in alcohol the greater is their formaldehyde content; from such solutions lactose is deposited almost quantitatively as the formaldehyde progressively reacts with the solvent.

Other properties of sugar and formaldehyde solutions, such as the density and the viscosity, have been examined, and the authors are of opinion that the products obtained from formaldehyde and a bioese are solid solutions of formaldehyde in the sugar. The sugar takes up relatively more formaldehyde from dilute solutions of formaldehyde than from concentrated solutions.

Honey; Biological examination of—J. Gadammer and K. Laske. Arch. Pharm., 1916, 254, 306—345. J. Chem. Soc., 1917, 112, ii., 395—397.

ONE of the most difficult tasks of the food analyst is to prove the genuineness of bee-honey by chemical analysis, especially since solutions of very pure invert-sugar with or without raffinose, which can be used to adulterate natural honey or to prepare artificial honey, have become easily obtainable. Fiehe's reaction, which detects hydroxymethylfurfural in commercial invert-sugar, is not conclusive, and methods based on the estimation of the nitrogen and albumin in natural honey are easily evaded. Langer has shown that the honey albumin is quite independent of the plant visited by the bee, and the authors investigated the precipitin method of testing honey. Suitable anti-sera (0.2—0.5 c.c.), the preparation of which is described in detail, were mixed with 1 c.c. of 1—10% honey solutions, of 10% artificial honey solution, of 10% starch syrup solution, also 0.5 c.c. of normal dog serum was mixed with 1 c.c. of 10% honey solution; each mixture, after the addition of one drop of toluene, was vigorously shaken and kept at 37° C. for five hours, the tubes were centrifuged (1500 rev. per minute) for five minutes, and the volume of the precipitate (if any) read off in mm. It was found that: (1) Preservation of the liquid during the time of the experiment is unnecessary. The presence of toluene causes the formation of emulsions and renders a quantitative separation of the precipitate by centrifuging impossible. In the absence of toluene, quantitative results are obtained. (2) An absolute constancy in the activity of the precipitating serum cannot be claimed. Different anti-sera give approximately equal amounts of precipitate, and the variations are not so great as to render the method inapplicable for quantitative purposes. (3) With a given anti-serum, the amounts of precipitate obtained from 2% and 1% solutions of a honey are by no means comparable;

therefore, in examining a honey by the biological method, only the values obtained with a 10% solution should be utilised. (4) The amount of precipitate obtained from a given honey and the same anti-serum is the same during the period of one year. A specimen of genuine honey which had been kept for eleven years gave, however, only a very small precipitate. The authors are of opinion that the precipitin reaction has a real quantitative value. All honeys which fail to give a precipitate with honey albumin anti-serum are to be regarded as not genuine bee-honeys. If a precipitate is obtained and its amount corresponds with that obtained from the control honey, the honey under examination is genuine. If the amount of the precipitate is smaller than that given by the control, the honey under examination is either genuine honey which has been heated or honey which has been adulterated.

Formation of starch-like substances by moulds. Welmer. See XVIII.

PATENT.

[Sugar] cane juice; Process for clarification of —. D. B. Rogan, New Orleans, La. U.S. Pat. 1,233,919, July 17, 1917. Date of appl. Sept. 30, 1916.

EXCESS of lime is added to the juice, which is afterwards aerated, slightly acidified with sulphur dioxide or carbon dioxide, and again limed, this time almost to neutrality, all of these operations being conducted at a temperature not higher than 40° C. Finally, the treated juice is heated almost to 100° C.—J. P. O.

XVIII.—FERMENTATION INDUSTRIES.

Proteoclastic enzymes of yeast and their relationship to autolysis. K. G. Denby. Biochem. Zeits., 1917, 81, 109—208. J. Chem. Soc., 1917, 112, i., 500—501.

THE author has succeeded in demonstrating the presence in yeast of three proteoclastic enzymes, which are analogous to, but differ in certain particulars from, the proteoclastic enzymes of the animal organism. These enzymes are: I. Yeast pepsin, which can degrade genuine proteins to peptones (but not further). Its optimal action is in a medium of $pH=4-4.5$, whereas animal pepsin acts best in a medium of $pH=1.5$ (Sørensen). II. A yeast tryptase, which does not act on the proteins of yeast, but can degrade certain proteins, such as acid albumin, gelatin, caseinogen, into peptides and amino-acids. Its optimal action is in a medium of $pH=7$, as compared with that of $pH=8$ which is optimal for animal tryptase. III. A yeast creptase, which readily degrades peptones and polypeptides into amino-acids and has an optimal action in a medium of $pH=7.8$, which is very nearly the same as that of animal creptase. It differs, however, from the latter in that its action is not markedly inhibited by neutral salts, whereas that of the animal creptase is. A concentration of 0.5N-salt solution has little action on yeast creptase, whereas the animal creptase is inhibited by a concentration of 0.02N. The individual ions have apparently little action, as they act more or less alike, the diminution of the action of the enzyme being controlled by the salt molecules as a whole. The autolysis of yeast is due to the successive action of the various enzymes, and the maximal action takes place in a medium of $pH=6.0$. Deamidases play only a subordinate rôle in the autolysis. The method of investigation employed by the author consisted in following the course of degradation of yeast and other products in media with varying hydrogen-ion concentrations, both in the presence

and absence of buffer solutions. In the absence of such solutions, the hydron concentration changed during the course of the enzyme action. The chief indication as to the presence of various enzymes was afforded in this case by estimating the total nitrogen, amino-peptide, and protein nitrogen in solutions of the autolysis mixture after varying intervals of autolysis. When no buffer mixture was present, the total nitrogen and amino-nitrogen continually increased, especially towards the end, whereas the peptide nitrogen first increased and then diminished, and the protein nitrogen first diminished slightly and then increased slightly. The p_H changed during the reaction from 6.0 to 6.8. The results indicate that at the commencement the pepsin was chiefly active, whereas towards the end, in the more alkaline medium, the erepsin was most active. The detailed action of the various enzymes was also investigated, the enzymes being isolated by extracting them from yeast plasmolysed by chloroform in presence of calcium carbonate and submitting the extracts to dialysis against diminished pressure by a method recently described by Sørensen.

Emulsin-like enzymes separable from the cells of bottom yeast; Presence of — and the absence of myrosin in Berlin top and bottom yeast. C. Neuberg and E. Färber. *Biochem. Zeits.*, 1916, 78, 264—272. *J. Chem. Soc.*, 1917, 112, i, 501.

THE maceration juice of bottom yeast contains all three enzymes which act on amygdalin (amygdalase, prunase, and oxynitrilase). β -Glucosides are also hydrolysed by the maceration juice of Munich bottom yeast. The myrosin enzyme has been found neither in top nor bottom yeasts (free yeast and maceration juice of dried cells) of Berlin, and is also not present in dried Munich bottom yeast.

Lactic acid, acetic acid, and acetone; Use of sucrose-inverting bacteria for the manufacture of —. G. Mezzadrol. *Boll. Assoc. Ind. Zucch. e Alcool.* Bologna, 1917, 9, 142—145. *Bull. Agric. Intell.*, 1917, 8, 787—789.

IN experiments at the R. Stazione de Bieticoltura, Rovigo, on the direct production of lactic acid from beet-juice, certain bacteria capable of inverting sucrose before subjecting it to lactic fermentation have been isolated from sour milk and beet-juice. They are termed provisionally *Bacilli succaro-invertenti*, and subdivided into inverting lactic bacilli (*B. invertenti latici*), and inverting acetic bacilli (*B. invertenti-acetici*). Pure cultures of the former, grown in sterilised beet-juice containing 10% of sucrose, at 36°—38° C., yield per 100 parts of sucrose:—60—80 parts of lactic acid, 10—20 parts of acetic acid, 1—7 parts of alcohol, and traces of acetone and higher alcohols. The other sub-class, inverting acetic bacilli, produce a more rapid fermentation, with copious evolution of gas consisting of carbon dioxide, hydrogen, and small amounts of methane; yields of 40—50 parts of acetic acid, 10—20 parts of lactic acid, 10—20 parts of alcohol, and 1—2 parts of acetone have been obtained per 100 parts of sucrose, and it appears probable that acetic acid may soon be profitably produced directly from sugar. None of the organisms studied formed sufficient amounts of acetone to warrant industrial application for this purpose: lactic acid can be oxidised by hydrogen peroxide to acetic acid, and from the latter acetone can be produced more easily and at less cost than directly.—J. H. L.

Starch-like substances; Formation of — by moulds. F. Boas. *Biochem. Zeits.*, 1917, 81, 80—86. *J. Chem. Soc.*, 1917, 112, i, 503.

IN the presence of mineral acids, *Aspergillus niger*

can produce in the culture medium, from glycerol and mannitol, a substance giving the blue iodine reaction. It can also produce such a substance in fairly high concentrations from the following organic acids (the reaction being the most intense in the first-named acids) when they are used as the source of carbon in the medium: tartaric, citric, malic, succinic, and oxalic acids. The substance producing the iodine reaction tends to disappear after a certain interval.

Vinegar; Changes undergone by cider during fermentation, prolonged storage, and conversion into — in rotating generators. B. G. Hartman and L. M. Tolman. *J. Ind. Eng. Chem.*, 1917, 9, 759—762.

THE juice was expressed from New York apples as commonly used for the manufacture of vinegar, the yield being about 170 galls. per ton. It was allowed to ferment spontaneously, and yielded a wash containing 7.0% (by vol.) of alcohol. The average composition of the resulting vinegar was:—Total solids, 1.24; alcohol (by vol.), 0.25; ash, 0.32; acetic acid, 0.57%. The loss of acid during acetification was 17%, and there was a further loss of 1% during clarification and storing of the vinegar. The glycerin (0.23%) remained fairly constant throughout the process. During fermentation of the juice a large part of the malic acid (0.72%) was destroyed to form lactic acid, whilst the remainder was almost entirely oxidised during acetification. The fixed acid in the finished vinegar was mainly lactic acid (0.07%). The phosphoric acid (as P_2O_5) showed only a slight decrease during the fermentation, but fell by about 12% in the acetification. Pentosans, or their equivalent, increased by about 100% during acetification (to 0.08%). The vinegar contained traces of acetates and of formic acid.—C. A. M.

Oxidation and reduction; Biochemical phenomena of simultaneous —. Abelous and Aloy. *Comptes rend.*, 1917, 165, 270—272.

BACH has shown that milk contains an enzyme capable of reducing alkali nitrate to nitrite, but only when a substance capable of acting as a co-enzyme is present. According to Bach, such co-enzymes are aldehydes or substances yielding aldehydes on oxidation (see this J., 1911, 917). These aldehydes decompose water and are themselves oxidised, while the liberated hydrogen reduces nitrates or similar substances present. The authors have found that many other substances besides aldehydes may act as co-enzyme, e.g., amines, heterocyclic compounds, terpenes, and manganese salts. In one experiment, sodium fluoride, sodium chlorate, and salicylic aldehyde were added to milk which was then heated at 60° C. for 1 hr. out of contact with air, and afterwards incubated at 40° C. The chlorate was gradually reduced to chloride and the aldehyde oxidised to acid. Exothermic reactions also make endothermic reactions possible. For instance, the precipitate obtained from apple juice by addition of alcohol was dissolved in dilute sodium carbonate and filtered. The filtrate was divided into two parts: to both were added potassium chlorate, salicylic aldehyde, and sodium fluoride, while to one was added starch and amylase, and to the other, starch and boiled amylase. After 24 hours' incubation in absence of air, it was found that there was a large reduction of chlorate to chloride and a formation of salicylic acid in the solution containing the unheated amylase, while there was no change in the other solution. Probably in the living body, reactions of this character take place.

—J. H. J.

Pancreas; Composition and digestive activity of different fractions of the—. R. A. Nelson and J. H. Long. J. Amer. Chem. Soc., 1917, 39, 1766—1778.

FINELY minced pancreas can be separated into three layers in a centrifuge. The top layer contains fat, the middle layer is a liquid containing solids in suspension, and the bottom layer is a solid, mostly protein. The liquid layer yields a clear filtrate, containing phosphates and protein. The amylolytic activity resided in the middle layer, which was very active in the case of hog pancreas and only slightly so in the case of pancreas from the ox and sheep. The tryptic activity of the layers was determined by the amount of amino-acid produced from fibrin. All the layers showed tryptic digestion in the different pancreases, the top and bottom layers being especially active. The lipolytic activity was determined upon an olive oil emulsion, the free fatty acid formed being titrated after $\frac{1}{2}$, 1, and 2 hr. periods. Hog pancreas surpassed ox and sheep pancreases; the middle layer was nearly inactive in each case. The esterase activity was determined on a saturated solution of ethyl butyrate. The results were on the same lines as those for lipase; but in the hog pancreas the lipase was more active than the esterase, while in pancreas from the ox and sheep the esterase was the more active. This indicates that different enzymes are involved.—J. H. J.

Alcohol as a source of power. Rowe. See IIA.

Similarity between lactic organisms and streptococci from the point of view of the action of antiseptics. Cardot. See XIXB.

Detection of methyl alcohol by catalytic dehydrogenation. Mannich and Geilmann. See XX.

PATENT.

Distillation; Apparatus for continuous—. E. A. Chenard, Cognac, France. Eng. Pat. 102,966, Dec. 20, 1916. (Appl. No. 18,273 of 1916.) Under Int. Conv., Dec. 24, 1915.

SEE Fr. Pat. 480,558 of 1915; this J., 1917, 157.

XIXA.—FOODS.

Milk; Analysis of—. E. Ackermann. Ann. Chim. Analyt., 1917, 22, 152—158.

To distinguish between watered milk and abnormal milk, the author proposes to determine the percentage of lactose in the sample and to deduct this quantity from the percentage of non-fatty solids of the sample. In the case of normal milk the result obtained is always above 4. If the milk is abnormal, due to unhealthy condition of the cows, the result will still be above 4, but the quantity of lactose will be low. Addition of water decreases all the results correspondingly. Further work, however, is required before the usefulness of the method can be definitely established. The quantity of lactose may be calculated from the refraction of the milk serum and tables are given for this purpose.—W. P. S.

Fruits; Acid content of—. W. D. Bigelow and P. B. Dunbar. J. Ind. Eng. Chem., 1917, 9, 762—767.

THE acidity of plums, apples, and cherries appears to be due entirely to malic acid, which is present only in the free condition. Currants always contain citric acid, and, in some cases, also malic acid, whilst gooseberries contain a large proportion of malic acid, and also give strong reactions for citric acid. In some varieties of pear the acidity is

entirely due to malic acid, whilst in others citric acid predominates, and only traces of malic acid are present. In the cranberry and red raspberry, citric acid is probably the principal acid, whilst the pomegranate contains only citric acid, and the quince, peach, and banana contain malic acid and no citric acid.—C. A. M.

Food-colouring substances; Separation and identification of—. W. E. Mathewson. U.S. Dept. Agric. Bull. No. 448, Feb. 15, 1917. 56 pages.

THE scheme of analysis of dyestuffs described includes 130 chemical individuals in use or suggested for use in food products, with the eight permitted colours of the U.S. Dept. Agric., viz., Amaranth, Ponceau 3R, Erythrosin, Orange 1, Naphthol Yellow S, Tartrazin, Light Green S.F., yellowish, and Indigodisulphonic acid. The method of separation is based on the employment of immiscible solvents. For details of the separation and identification of the colouring matters the tables in the original must be consulted.

—F. W. A.

Yield and nitrogen content of soya beans as influenced by lime. Lipman and Blair. See XVI.

Biological examination of honey. Gadamer and Laske. See XVII.

Biochemical phenomena of simultaneous oxidation and reduction. Abelson and Aloy. See XVIII.

PATENTS.

Food; Process and apparatus for sterilising and preserving—. E. C. R. Marks, London. From Anchor Cap and Closure Corporation, New York. Eng. Pat. 108,146, Apr. 26, 1916. (Appl. No. 8214 of 1917.)

THE food is packed into containers and the air is then exhausted from the containers before the latter are sealed. The containers and their contents are next subjected to a sterilising temperature while an excess pressure is maintained on the exterior of the containers. This excess pressure may also be maintained while the containers are cooling.—W. P. S.

Milk; Dried— and method for producing the same. C. H. Campbell, Assignor to Borden's Condensed Milk Co., New York. U.S. Pat. 1,233,446, July 17, 1917. Date of appl., Dec. 21, 1915.

MILK is concentrated to about one sixth of its original volume, then mixed with water in quantity equal to about one half of the volume of the original milk, and the mixture is stirred, aerated, and dried. The product consists of a mass of mutually coherent milk solids with concavities filled with the aerating gas.—W. P. S.

Jelly-making product and process for producing same. R. Douglas, Rochester, N.Y. U.S. Pat. 1,235,666, Aug. 7, 1917. Date of appl., Apr. 12, 1915.

SEE Eng. Pat. 6497 of 1915; this J., 1916, 614.

Extracts; Device for preparation of—. K. Gebhardt, Berlin. U.S. Pat. 1,235,791, Aug. 7, 1917. Date of appl., Oct. 27, 1913.

SEE Eng. Pat. 2013 of 1913; this J., 1913, 1148.

Drying apparatus for wattle bark, maize, or other like commodity. Eng. Pat. 108,132. See I.

XIXB.—WATER PURIFICATION; SANITATION.

Culture media employed in the bacteriological examination of water; Studies on the ——. II. Neutral-red lactose peptone media. E. M. Chamot and C. M. Sherwood. J. Amer. Chem. Soc., 1917. 39, 1755—1766. (See this J., 1915, 730, 918, 1068.)

THE influence of the constitution of the culture medium upon the reaction produced by the growth of *B. coli* therein was investigated. The medium was placed in a fermentation tube consisting of an upright tube closed at the top and bent round at the bottom and enlarged into a wide bulb. A growth of *B. coli* in this apparatus produces gas and a change of colour in the tube to a fluorescent yellow, the colour in the bulb remaining red. It was found that the concentration of "neutral red" which gave the most decided colour change was 0.008—0.01%. The peptone could be varied from 2 to 5% without effect on the colour change. The most satisfactory acidity was + 1%. The presence of ammonium and calcium chlorides retarded the colour change, potassium and magnesium sulphates accelerated it, and potassium and sodium chlorides gave uniform results in 1% concentrations. The amount of lactose should be between 0.4 and 1.0%. The change of colour was found to arise not from the production of ammonia but from simple reduction, as the yellow compound readily changed to red again in presence of air. The yellow compound was found to be identical with that produced by the action of reducing agents on "neutral red," namely, dimethyldiaminomethylhydrophenazine. Wafers contaminated with the faeces of farm animals gave the change in this medium characteristic of *B. coli*. The authors prefer this medium to the lactose bile medium.

—J. H. J.

Nitrate in sewage; Determination of — by means of o-tolidine. E. B. Phelps and H. L. Shonb. J. Ind. Eng. Chem., 1917. 9, 767—770.

TWENTY-FIVE c.c. of the sample is boiled for about half a minute with 0.5 c.c. of a solution of sodium hydroxide and sodium chloride (5 grms. NaOH and 1.5 grms. NaCl in 100 c.c.), and the liquid cooled and made up to its original volume or weight. Of the supernatant liquid above the precipitated iron or manganese, from 1 to 10 c.c. (according to the proportion of nitrate present) is evaporated and the residue mixed with 0.2 c.c. of a solution of 0.4 gm. of o-tolidine in 100 c.c. of N/1 hydrochloric acid, and then treated with 0.5 c.c. of strong sulphuric acid, which is poured down the side of the vessel so that the liquids do not mix. After 5 mins. the sides of the basin are moistened with the liquid, and, after another half min. the liquid is diluted with about 5 c.c. of water, transferred to a colorimetric tube, and made up to 10 c.c., and the colour compared within 5 mins. with those given by standard nitrate solutions under the same conditions. Permanent standards may be prepared by diluting N/40 potassium bichromate solution to match solutions containing from 0.5 to 10.5 parts of nitric nitrogen per million after treatment with the reagent.—C. A. M.

Lactic organisms and streptococci; Similarity between — from the point of view of the action of antiseptics. C. and H. Cardot. Comptes rend., 1917. 165, 272—275.

EXPERIMENTS were made as to the antiseptic action of increasing amounts of phenol and sodium fluoride upon cultures of streptococci and lactic organisms. Results showed that small amounts of phenol had a slightly stimulating effect on both the cultures, as compared with cultures of the same organisms without the addition of the

antiseptic. Small amounts of sodium fluoride had no such effect. To produce a reduction in growth of 50% as compared with untreated cultures, 0.3 gm. of phenol per litre was required for streptococci and 0.8 gm. for lactic organisms, while 0.13 gm. of sodium fluoride per litre was required for streptococci and 0.2 gm. for lactic organisms. Streptococci are thus more sensitive to these two antiseptics than are lactic organisms. When the results are plotted, it is seen that the curves showing the action of the two antiseptics are quite different. The curve for sodium fluoride is of a hyperbolic nature, and is the same for both organisms. The curve for phenol is S-shaped, and is also almost the same for both organisms. From these results it is concluded that a rule established by experiments on a non-pathogenic organism will apply also to pathogenic organisms.

—J. H. J.

PATENT.

Extraction of fals. ammonia, and the like from organic refuse. Eng. Pat. 107,992. See 116.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

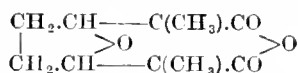
Morphine; Methyl derivatives of —. C. Mannich. Arch. Pharm., 1916. 254, 319—363. J. Chem. Soc., 1917. 112, i., 473—475.

ACCORDING to the constitution of morphine proposed by Knorr and Pschorr, the alkaloid functions as a tertiary base, as a phenol, and as a secondary alcohol. Theoretically, therefore, one trimethyl, three dimethyl, and three monomethyl derivatives should be capable of existence. Four of these are already known and the remaining three are now described. Methylcodeine methochloride, $C_{10}H_{16}O_3NCl$, colourless crystals, m.pt. 208°C., loses methyl chloride by heating under 2 mm. pressure and yields morphine OO-dimethyl ether, $C_{17}H_{17}ON(OCH_3)_2$, prismatic or tabular crystals, m.pt. 140—141°C. This method of demethylating quaternary bases is not applicable to any other morphine derivative. A second method of preparing the same dimethyl ether is the following. Morphine oxide or codeine oxide is shaken with a large excess of N/1-sodium hydroxide and methyl sulphate at 0°C., the solution is faintly acidified with hydrochloric acid and treated with concentrated aqueous potassium iodide, and the crystalline substance obtained, m.pt. about 253°C. (doubtless the hydriodide of morphine oxide dimethyl ether), is heated at about 80°C. with sulphurous acid and a little sodium bisulphite, and the solution is made alkaline and extracted with ether, whereby morphine OO-dimethyl ether, identical with that mentioned above, is obtained. Morphine methoxymethyl ether, $C_{17}H_{17}ON(OH)(OCH_2OCH_3)$, colourless needles, m.pt. 94—96°C., obtained by treating a suspension of the sodium derivative of morphine in cold chloroform with chloromethyl ether, is insoluble in alkali hydroxides, does not give a coloration with ferric chloride, but instantly develops a violet coloration (the morphine-formaldehyde reaction) with concentrated sulphuric acid. It is stable towards alkalis, but is converted by dilute acids into morphine, formaldehyde, and methyl alcohol. Heterocodeine (the monomethyl ether of morphine methylated at the secondary alcoholic group) is obtained by the following method. Morphine methoxymethyl ether is gently warmed with hydrogen peroxide, and the resulting syrup, which doubtless contains an amino-oxide, is treated with N/1-sodium hydroxide and methyl sulphate at 0°C., and the resulting solution is acidified with dilute sulphuric acid and treated with concentrated aqueous potassium

iodide solution; the precipitate is collected and warmed with sulphurous acid for two days, whereby heterocodeine, $\text{HO.C}_{17}\text{H}_{17}\text{ON}(\text{OCH}_3)$, crystals, m. pt. 242°C ., is obtained, which is isolated as the hydrochloride, prisms containing $2\text{H}_2\text{O}$, m. pt. 102°C . Heterocodeine is soluble in alkali hydroxides, develops a blue coloration with ferric chloride and a reddish-violet coloration with formaldehyde and sulphuric acid, and is shown to be a true derivative of morphine, not of *iso*- or ψ -codeine, by its conversion by diazomethane into morphine *OO*-dimethyl ether.

Cantharidin. W. Rudolph. Arch. Pharm., 1916, 254, 423—456. J. Chem. Soc., 1917, 112, i., 468—469.

The facts that the substance $\text{C}_{10}\text{H}_{14}\text{O}_3$, cantharidin, obtained by Anderlini in 1893 by reducing cantharidin by sodium and ethyl alcohol, is a neutral substance exhibiting the properties of a very stable lactone, and is not identical with the product obtained by the reduction of the "dibromide" of cantharidin, serve, in the author's opinion, to eliminate the second of Gadamer's three formulæ, *i.e.*, the one given in a previous abstract (this J., 1914, 1112). Further, the failure of the "dibromide" of cantharidin to yield a dimethyl ester is attributed to steric hindrance, and on this account, of Gadamer's remaining two formulæ for cantharidin, the preference is given to the following one:—



This preference is supported by the fact that cantharene, prepared by boiling the "dibromide" of cantharidin with 25% aqueous potassium hydroxide in an atmosphere of hydrogen, has a smaller exaltation of the molecular refraction than the values previously recorded.

Chrysarobin; Commercial. —. II. R. Eder, Arch. Pharm., 1916, 254, 1—33. J. Chem. Soc., 1917, 112, i., 464—466. (Compare this J., 1915, 681.)

In order to stabilise its reactive constituents, chrysarobin (obtained from the same consignment as that used in the oxidation experiments, *loc. cit.*) was first acetylated or benzoylated, and the reaction products were then separated and purified, and the various constituents isolated.

As the results of these experiments and of those previously recorded (*loc. cit.*), the following constituents of chrysarobin have been definitely identified: chrysophanic acid anthranol, emodin-anthranol monomethyl ether, emodin monomethyl ether, dehydroemodinanthranol monomethyl ether, and emodin (or emodinanthranol). The author has been unable to detect in his sample of chrysarobin Jowett and Potter's dichrysarobin methyl ether, dichrysarobin, and the substance $\text{C}_{17}\text{H}_{13}\text{O}_4$ (Chem. Soc. Trans., 1902, 81, 1577), Hesse's chrysarobol and chrysophanic acid anthranol methyl ether (this J., 1912, 357; 1917, 234), and Tutin and Clewer's chrysophanic acid and ararobinol (this J., 1912, 253; 1913, 1126); in other respects his results show an extensive agreement with those of the last-mentioned authors, which were attained by quite different methods.

American and oriental storax; Comparison of —. S. Jordan. J. Ind. Eng. Chem., 1917, 9, 770—771.

COMMERCIAL storax is usually derived from the "Liquidambar" tree (*Liquidambar orientalis*) of Asia Minor. The samples examined had the following characters:—Volatile matter, 20.35 to 27.64; ash, 0.28 to 4.48; insoluble in ether, 2.16 to 7.12; insoluble in alcohol, 3.25 to 7.98; cinnamene,

25.89 to 51.30; resin esters, 1.00 to 24.24; resin acids, 2.63 to 53.35; free cinnamic acid, 1.87 to 8.14%; acid value, 42.2 to 106.4; and saponif. value, 133.0 to 166.2. The liquid or semi-liquid balsam from *Liquidambar styraciflua* is known in U.S.A. as "sweet gum." A sample had the following characters:—Volatile matter, 22.37; ash, 0.32; insoluble in ether, 5.24; insoluble in alcohol, 6.64; cinnamene, 22.86; resin esters, 34.76; resin acids, 2.11; free cinnamic acid, 12.63; total cinnamic acid, 28.02%; acid value, 68.7; and saponif. value, 131.6. The experiments showed that "sweet gum" is a satisfactory substitute for commercial storax, that it contains more cinnamic acid, and has a superior odour to that of the imported article. The Southern part of the United States would be able to supply all the U.S. requirements for storax.—C. A. M.

Guanidine; Formation of—from thiourea and from cyanamide. E. Schmidt. Arch. Pharm., 1916, 254, 626—632. J. Chem. Soc., 1917, 112, i., 449.

The author finds that, contrary to the old statement of Hofmann, dicyanodiamide is not the only product obtained when thiourea in aqueous or aqueous-alcoholic ammonia solution is treated with yellow mercuric oxide for 24 hours at the ordinary temperature, guanidine also being produced, although not in large quantities. Cyanamide is first formed, which then mainly polymerises to dicyanodiamide, but also reacts with ammonia to some extent to form guanidine. The same two changes occur when a solution of cyanamide, prepared by very faintly acidifying a solution of sodium cyanamide with 98% formic acid, is treated with mercuric oxide and aqueous ammonia as above, but the quantity of guanidine formed is somewhat larger and becomes considerably greater when the reaction is effected in a sealed tube at 100°C .

Arsenic compounds (p-benzarsinic acid) and amino-acids and higher alcohols; Esters of aromatic —. E. Sieburg. Arch. Pharm., 1916, 254, 224—245. J. Chem. Soc., 1917, 112, i., 486—487.

p-BENZARSINE oxide (p-carboxyphenylarsine oxide) $\text{CO}_2\text{H.C}_6\text{H}_4\text{AsO}$, an amorphous powder which is extremely soluble in ether, is obtained by acidifying a solution of p-benzarsine iodide in aqueous sodium carbonate. When boiled with water, it is converted into p-benzarsenious acid, colourless needles, insoluble in ether. The oxide, which is at least ten times more poisonous than the hydrate, can be kept for at least eight days in a moderately concentrated aqueous solution of sodium hydroxide or carbonate at 0°C . without any appreciable diminution of its toxicity. Phenylarsine-p-carboxylic acid, $\text{CO}_2\text{H.C}_6\text{H}_4\text{AsH}_2$, colourless prisms, m.pt. $79^\circ\text{--}80^\circ\text{C}$., is prepared by reducing a methyl-alcoholic solution of p-benzarsinic acid with hydrochloric acid (sp. gr. 1.19) and zinc dust, the product being removed by distillation with steam. In the moist state it is very sensitive to atmospheric oxygen, immediately becoming yellow and changing apparently to p-arsenobenzoic acid.

In connection with the discussion (this J., 1916, 753) of the action in the organism of preparations containing arsenic, the fact that p-arsenobenzoic acid injected into the animal organism is eliminated partly in the form of benzoylglycine-p-arsinic (hippuro-arsinic) acid is important as showing that arsenic compounds are capable of reacting in the organism under certain conditions with the degradation products of the albumin molecule. The author has now prepared and examined a number of such compounds of amino-acids and aromatic arsenic compounds. p-Benzarsinic acid is produced almost quantitatively by heating p-tolylarsinic acid with nitric acid (sp. gr. 1.2)

for three hours at 170° C. in a sealed vessel. The *p*-tolylarsinic acid is conveniently prepared by the interaction of diazotised *p*-toluidine and sodium arsenite in alkaline solution. *p*-Benzarsinic acid is converted by a modification of Fournet and Oechslin's method (Fr. Pat. 441,215; this J., 1912, 844) into *p*-dichloroarsinobenzoyl chloride, which reacts with amino-acids (alanine, phenylalanine, tyrosine, leucine, aspartic acid, glutamic acid, and pentamethylenediamine) in the presence of aqueous sodium bicarbonate (sodium hydroxide in the case of tyrosine) to form, after acidification of the resulting solutions, the arsine oxide of the benzoyl derivative of the amino-acid. These arsine oxides are amorphous, white powders, which do not exhibit sharp melting points, are easily soluble in methyl or ethyl alcohol and in alkali hydroxides, carbonates, or bicarbonates, and do not dissolve in dilute hydrochloric acid; the oxygen of the AsO-group cannot be replaced by halogens or sulphur. They are oxidised to the corresponding arsenic acids by careful treatment with hydrogen peroxide in alkaline solution, and are reduced by sodium amalgam to arseno-compounds of the type



The latter are amorphous, yellow substances without definite melting points, but the arsenic acids are crystalline.

p-Dichloroarsinobenzoyl chloride reacts easily and smoothly with the higher alcohols. The reaction is effected in benzene solution in the presence of pyridine at the ordinary temperature, and finally on the water-bath. Myricyl alcohol yields myricyl benzoate *p*-arsine oxide, $\text{C}_{30}\text{H}_{47}\cdot\text{O}\cdot\text{CO}\cdot\text{C}_6\text{H}_4\cdot\text{AsO}$, which in acetone solution is oxidised to the arsenic acid, $\text{C}_{37}\text{H}_{67}\text{O}_5\text{As}$, pointed leaflets, by hydrogen peroxide, and is reduced to the arseno-compound, $\text{C}_{34}\text{H}_{110}\text{O}_4\text{As}_2$, yellow powder, by phosphorous acid. Cholesterol yields cholesteryl benzoate *p*-arsine oxide, $\text{C}_{34}\text{H}_{48}\text{O}_3\text{As}$, colourless powder; the arsenic acid, $\text{C}_{34}\text{H}_{50}\text{O}_5\text{As}$, forms pointed needles, and the arseno-compound, $\text{C}_{68}\text{H}_{96}\text{O}_4\text{As}_2$, is a yellow powder. The arsenic acid does not give Windaus's digitonin reaction.

p-Sulphomethylaminophenylarsinic acid. I. Abelin. Biochem. Zeits., 1916, 78, 191—196. J. Chem. Soc., 1917, 112, i., 487—488.

p-SULPHOMETHYLAMINOPHENYLARSINIC acid, $\text{SO}_3\text{H}\cdot\text{CH}_2\cdot\text{NH}\cdot\text{C}_6\text{H}_4\cdot\text{AsO}(\text{OH})_2$, an *N*-substituted derivative of atoxyl, is prepared by treating the sodium salt of *p*-aminophenylarsinic acid with formaldehyde sodium bisulphite in concentrated solution and precipitating from this mixture the free acid with hydrochloric acid. The free acid forms needles which decompose at 148° C. The substance is much less toxic than atoxyl, and its action on trypanosomes is apparently much weaker.

Sozoiodol-mercury preparations; Simple method of estimating mercury in —. A. Herrmann. Arch. Pharm., 1916, 254, 498—500. J. Chem. Soc., 1917, 112, ii., 399.

THE mercury in *Hydrargyrum sozoiodolicum* (mercuric salt of di-iodophenol-*p*-sulphonic acid, $\text{C}_6\text{H}_2\text{I}_2\langle\text{SO}_3\rangle\text{Hg}$) is readily estimated as follows.

The preparation, 0.5 gm., is shaken with about 10 c.c. of water in a 200-grm. glass-stoppered bottle, treated with 2 grms. of potassium iodide, and, after the liberated mercuric iodide has dissolved, treated with 10 c.c. of officinal alkali hydroxide solution. A mixture of 3 c.c. of formaldehyde solution and about 10 c.c. of water is added, and the bottle is gently shaken for about one minute. After acidifying with 25 c.c. of dilute acetic acid, 25 c.c. of *N*/10-iodine solution is added, and the

excess of the iodine is titrated with *N*/10-thio-sulphate after all the mercury has been dissolved (1 c.c. of *N*/10-iodine = 0.01003 gm. of mercury = 0.031225 gm. of the mercuric salt).

The mercury in auogen (the mercurous salt, $\text{O}(\text{Hg}\cdot\text{C}_6\text{H}_4)_2\text{SO}_3\text{Hg}$) is estimated by treating 0.5 gm. with 2 grms. of potassium iodide and 25 c.c. of *N*/10-iodine, shaking the mixture for one to three minutes, and titrating the excess of iodine with *N*/10-thio-sulphate and starch solution (1 c.c. of *N*/10-iodine = 0.02006 gm. of mercury = 0.041256 gm. of the mercurous salt).

Acetylsalicylic acid and sodium salicylate; Determination of — in powders. R. Miller. Amer. J. Pharm., 1917, 89, 347—348.

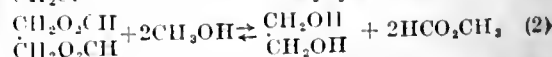
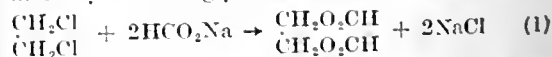
ACETYSALICYLIC acid and sodium salicylate are determined in mixtures of the two by the following method:—A finely powdered weighed sample is mixed with an equal bulk of clean sand and extracted 10 times with a small quantity of ether. The combined filtered extract is evaporated to dryness and the residue weighed. The residue of acetylsalicylic acid should give a yellow coloration, becoming gradually deeper with concentrated nitric acid, an immediate purple coloration with Froehde's reagent, and a faint red coloration after one or two minutes with formaldehyde and sulphuric acid, but no coloration with selenious sulphuric acid, or with concentrated caustic soda. Sodium salicylate is determined in the residue from the ether extraction, to which the filter paper is added, by moistening it with dilute sulphuric acid, extracting ten times with small quantities of ether, evaporating the filtered extract to dryness, and weighing the residue of salicylic acid. It is identified by the ferric chloride test, and by giving the characteristic wintergreen odour on heating with several drops of methyl alcohol and concentrated sulphuric acid.—F. SP.

[Organic] acids; Identification of —. III. E. Lyons and E. E. Reid. J. Amer. Chem. Soc., 1917, 39, 1727—1750.

IN continuation of previous work (this J., 1917, 236 and 568), the authors have studied different methods for the preparation of *p*-nitrobenzyl bromide. The best method was found to be that suggested by Wachendorf, as follows: *p*-Nitrotoluene is heated in a sealed tube for several hours at 125°—130° C. with the calculated amount of bromine. The product is treated with alcohol from which it should crystallise readily, giving nearly white crystals melting at 90° C. With careful working a 50—60% yield is obtained. Further work has been done in preparing *p*-nitrobenzyl esters and studying their properties. Satisfactory results have been obtained with many monobasic, dibasic, and polybasic acids, but it was found that sulphonic acids do not yield esters of this type. Esterification has been tried as a means of separating and identifying mixtures of acids, and has proved successful in many cases.—L. A. C.

Ethyleneglycol; Preparation of —. B. T. Brooks and I. Humphrey. J. Ind. Eng. Chem., 1917, 9, 750—751.

A CHEAP method of preparing ethyleneglycol is to heat a mixture of ethylene chloride, sodium formate, and methyl alcohol in an autoclave. An excess of 6 mols. or more of methyl alcohol is used to increase the proportion of glycol formed by the alcoholysis of the glycol formate:—



The maximum yield is obtained by heating the

mixture for about 7 hours at 165° to 170° C., the pressure varying at that temperature from 240 lb. to 290 lb. per sq. in., and remaining at about 50 lb. (owing to decomposition of sodium formate) after cooling the autoclave. After cooling, the methyl alcohol solution is separated from the crystalline salt and sodium formate mixture, the latter washed with cold methyl alcohol, and the combined alcoholic solution distilled. A small amount (8 to 10% of the weight of dichloride used) consists of glycol diformate (b. pt. 174° C.).

—C. A. M.

Methyl alcohol; Detection of — by catalytic dehydrogenation. C. Mannich and W. Geilmann. Arch. Pharm., 1916, 254, 50—64. J. Chem. Soc., 1917, 112, ii., 392—393.

THE method consists in passing the vapour of the liquid under examination over pumice impregnated with reduced copper at 280°—300° C. The course of the decomposition has been already described (this J., 1916, 943). The formaldehyde produced is detected by the violet coloration it develops with morphine and concentrated sulphuric acid. The apparatus is figured and described. An aqueous solution containing 0.1% of methyl alcohol gives a distillate which develops the coloration very faintly after one hour and faintly after twenty-four hours. The method is very effective in detecting methyl alcohol in blood or urine, 0.01 grm. of the alcohol in 100 c.c. of blood or urine giving a positive result; the liquid must first be carefully fractionated to concentrate the methyl alcohol, and the fraction containing the latter must be boiled for some time with freshly ignited animal charcoal before being passed over the catalyst, although even with these precautions the catalyst is slowly poisoned. In order to detect methyl alcohol in the presence of ethyl alcohol, the mixture, diluted if necessary so that it contains about 50% of water, is passed over the catalyst, the distillate is heated in a vacuum to remove the acetaldehyde, and the residual solution is tested for formaldehyde as above. If the original mixture contains less than 1% of methyl alcohol, the diluted solution should be repeatedly fractionated before the test is applied to the fraction in which the methyl alcohol has been concentrated. One-half per cent. of methyl alcohol in brandy can be detected by this method.

Aluminium salts; Astringent action of —, especially of the formate. A. Loewy and R. Wolfenstein. Biochem. Zeits., 1916, 78, 97—111. J. Chem. Soc., 1917, 112, i., 497.

EXPERIMENTS are described which indicate the advantages of the use of the formate of aluminium as compared with the acetate. The former preparation is less irritant. It is best employed in solution which contains some sodium sulphate. Such a solution readily precipitates proteins and also produces contraction of the blood vessels.

Action of formaldehyde on lactose, maltose, and sucrose. Heiduschka and Zirkel. See XVII.

Use of sucrose-inverting bacteria for the manufacture of lactic acid, acetic acid, and acetone. Mezzadrol. See XVIII.

PATENT.

Amyl compounds. Process of purifying —. H. Essex and I. W. Humphrey, Assignors to Gulf Refining Co., Pittsburgh, Pa. U.S. Pat. 1,233,333, July 17, 1917. Date of appl., Jan. 25, 1917.

AMYL derivatives made from petroleum are purified by heating with sodium or other alkali metal.—B. V. S.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

Determination of ferricyanides by titration with permanganate. De Coquet. See VII.

PATENTS.

Photography. [Sensitive paper for negatives.] E. B. La Rongery, Paris. Eng. Pat. 108,193, July 26, 1916. (Appl. No. 10,572 of 1916.)

A TRANSLUCENT paper base is prepared from a pure rag paper by chemical treatment to remove impurities, calendering three times under a heavy pressure, heating to about 80° C., and calendering at a lower pressure at 18° C. This base is coated with an emulsion prepared by adding a solution of potassium bromide 10 grms., ammonium bromide 30 grms., cadmium iodide 0.5 grm., and potassium iodide 0.5 grm., in distilled water 250 c.c., to a gelatin solution to which has been added 55 grms. of silver nitrate in 250 c.c. of distilled water, with sufficient ammonia to dissolve the precipitate first formed. The sensitive paper thus produced may be used instead of glass plates or celluloid films for the production of negatives.—B. V. S.

Silver from weak photographic emulsions; Process for recovery of —. F. F. Renwick, Brentwood, and B. V. Storr, Assignors to Ilford, Ltd., Ilford. U.S. Pats. 1,234,390 and 1,234,391, July 24, 1917. Date of appl., Oct. 17, 1916.

SEE Eng. Pats. 102,168 and 16,708 of 1915; this J., 1917, 47.

XXII.—EXPLOSIVES; MATCHES.

Trinitrotoluene; Inspection and testing of —. K. K. Stevens. J. Ind. Eng. Chem., 1917, 9, 801—803.

THE bulk of T.N.T. made in U.S.A. has, until recently, been shipped in the crude condition, the refined (i.e., recrystallised) grade only being made by about three plants. Quantities of about 2200 lb. are made at each operation or "run." The specifications usually require the product to be packed in cases or kegs of 50 to 100 lb. capacity, lined with oiled paper, and stating the shipment, "run," and case. *Sampling*:—Samples should represent amounts of about 4000 lb., and for convenience a composite sample representing two "runs" may be taken. The samples are taken from different parts of the case, mixed, and put into three 1 lb. bottles, for the buyer, seller, and referee respectively, the last being sealed by the buyer's inspector. *Testing—Colour*: Crude T.N.T. should be light yellow and the refined product cream-coloured, and not darken appreciably after heating for 2 hours at 100° C. *Fineness*: For crude T.N.T., 90% shall pass through a 10-mesh sieve; for refined T.N.T., 99% shall pass through a 12-mesh sieve; and for "explosders" all shall pass through a 30-mesh sieve. The crude product may frequently contain from 7 to 8% of lumps larger than specified. *Moisture* shall not exceed 0.10% for either grade (some specifications allow 0.15%), and shall be determined by drying 2 grms. for 24 hours over sulphuric acid. *Acidity*: The acidity, which should be nil, is determined by shaking 10 grms. of the melted sample with 100 c.c. of boiling water, cooling the mixture, pouring off the aqueous extract, and repeating the extraction with a fresh 50 c.c. of boiling water. The united

extract is titrated with *N*/20 caustic alkali solution, with phenolphthalein as indicator. One specification allows 0.03% of acidity as sulphuric acid. Insoluble matter must not exceed 0.15%. It is determined by boiling 10 grms. with 150 c.c. of 95% alcohol, collecting the insoluble matter on a Gooch crucible, washing it with not more than 150 c.c. of the solvent, and drying it for an hour at 95° C. In some specifications benzene is given as the solvent, and limits of 0.1% are allowed for refined, 0.15% for medium, and 0.2% for crude products. Ash is determined by slowly igniting 1 gm. in a platinum crucible. It should not exceed 0.1% in crude, or 0.05% in refined T.N.T. Nitrogen: Crude T.N.T. must contain not less than 18% of nitrogen determined by the Dumas combustion method, the minimum for refined T.N.T. being 18.2%. Diphenylamine test: Crude T.N.T. must contain no products which give the nitric acid reaction with diphenylamine and sulphuric acid. A pale blue colour is not decisive evidence of nitrates; it must be deep blue. Melting point: Crude T.N.T. should melt at 75.5° C. or higher; medium T.N.T. at 79.5° to 81.5° C.; and refined T.N.T. at 80° to 81° C. Solidification point: From 200 to 250 grms. of T.N.T. is heated below 90° C. in a dry 500 c.c. porcelain dish 15 cm. in diameter. After the sample has melted the heat is withdrawn and the liquid is stirred with the thermometer until it begins to crystallise and the temperature rises to its highest point. Stability tests:—These are not usually required for the crude material, but some specifications require it for the refined product. About 3 grms. of the substance is placed in a 6 in. test tube in which is suspended a strip of potassium iodide starch paper, on a glass hook which passes through the stopper. The tube is heated for 15 to 30 mins. at 65° C. according to the specification. No blue colour should develop.—C. A. M.

Trinitrophenylmethylnitramine (tetryl) and tetranitroaniline. C. F. Van Duin. Rec. Trav. Chim. Pays-Bas, 1917, 37, 111–117.

THE best method for the preparation of tetryl is as follows:—100 grms. of dimethylaniline is dissolved in 1 kilo. of concentrated sulphuric acid, keeping the temperature below 25° C. The solution is run, drop by drop, during 2 hours, into 500 c.c. of nitric acid (sp. gr. 1.49) previously heated to 40° C. and maintained between 38° and 42° C. The product is kept at 40°–42° C. for 3 hours, then heated slowly to 50° C. for half an hour, and finally to 55° C. for 2 hours. Next day the tetryl is filtered off, washed with water to remove acid, and finally with alcohol. Yield, 215 grms., nearly white, melting at 127° C. After recrystallisation from benzene, it melts at 130° C. and solidifies at 128.7° C. It still contains traces of sulphuric acid which can be removed by boiling it with water, but prolonged boiling causes appreciable decomposition with formation of picric acid.

(With B. C. R. van Lennep.) Tetranitroaniline is best prepared by dissolving 26 grms. of aniline in 700 c.c. of concentrated sulphuric acid, cooling to –5° C. and adding a solution of 16 c.c. of nitric acid (sp. gr. 1.49) in 80 c.c. of concentrated sulphuric acid. The mixture is kept in the cooling medium for 2 hours, after which 117 grms. of dry potassium nitrate is added, the temperature being kept below 50° C. The mass is allowed to stand for a day, is then heated to 50° C. for 1½ hours, and again left for a day. The tetranitroaniline is then filtered off, washed with 50% sulphuric acid and then with water. Yield, 26 grms., melting at 207° C. (corr.). From 25 grms. of *m*-nitroaniline, 30 grms. of tetranitroaniline is obtained. It is best recrystallised from glacial acetic acid. If acetone is used, it must be quite free from water; otherwise the tetranitroaniline is completely

converted into 2,4,6-trinitro-3-aminophenol. Tetranitroaniline begins to decompose after two months with formation of nitrous acid.—F. Sp.

PATENTS.

Blasting charges and cartridges. W. Weber. Hayingen, Germany. Eng. Pat. 15,065, Oct. 25, 1915.

A CASING made of a number of layers of paper placed loosely one upon the other so as to provide interior insulating spaces, some or all of which may be filled with straw, is charged with a mixture of one or more combustible substances—*e.g.*, sawdust, cotton wool, cork, linen—which will absorb liquid air, and one or more combustible metallic powders—*e.g.*, aluminium, antimony, magnesium, silicon. To obtain an increased disruptive effect a solid or liquid hydrocarbon is added, and the whole is saturated with liquid air by immersion immediately before use. The cartridge is fired by means of an electrical or cord fuse, wrapped in a combustible absorptive material. A diminished disruptive effect is obtained by the substitution of iron ore dust, such as minette, for the whole or a part of the metal.—E. W. L.

Powder; Apparatus for drying—W. A. Phillips. Philadelphia, Pa., Assignor to E. I. du Pont de Nemours Powder Co., Wilmington, Del. U.S. Pat. 1,232,839, July 10, 1917. Date of appl. Aug. 13, 1913.

SEE Fr. Pat. 477,343 of 1915; this J., 1916, 618.

XXIII.—ANALYSIS.

Potassium; Destruction of organic matter in the determination of—P. L. Blumenthal, A. M. Peter, D. J. Healy, and E. J. Gott. J. Ind. Eng. Chem., 1917, 9, 753–756.

Loss of potassium by volatilisation when destroying organic matter by ignition is best prevented by converting the potassium salt into sulphate. For this purpose it is not sufficient merely to moisten the material with sulphuric acid, but enough acid must be added to oxidise the carbon, and to convert the whole of the inorganic salts present into sulphates. The most uniform results are obtained by a direct evaporation of the material with nitric and sulphuric acids prior to burning off the organic matter.—C. A. M.

Potassium; Modification of the cobalti-nitrile method of determining—R. C. Haß and E. H. Schwartz. J. Ind. Eng. Chem., 1917, 9, 785–786.

THE following method, applied to cement raw materials and the dust from the cement kilns, yields results in agreement with those given by the official methods of the Amer. Offic. Agr. Chemists:—Two grms. of raw material (or clinker) or 0.5 gm. of “treater” dust is triturated with 0.5 (or 0.25) gm. of ammonium chloride, and introduced into a platinum crucible containing about 2 grms. of calcium carbonate, and the whole is heated as in the J. Lawrence Smith method. After slaking, the mass is heated to boiling, the liquid filtered, and the residue washed 3 or 4 times with boiling water. The filtrate and washings are treated with an excess (5 to 10 c.c.) of acetic acid, and evaporated on a steam-bath until no odour of the acid is perceptible.—C. A. M.

Comparison of the efficiency of some common desiccants. Dover and Marden. See I.

Photometer for measurement of the translucent effect of paper. Sammet. See V.

Chemical control of ammonia oxidation. Fox. See VII.

Determination of the "explosibility" of pyrites as well as of the available sulphur and the sulphur content of its cinders. Gyzander. See VII.

Iodometric determination of chlorine in chlorides. Torossian. See VII.

Determination of ferricyanides by titration with permanganate. De Coquet. See VII.

Determination of carbonates in limestone and other materials. Barker. See VII.

Course of the reaction between silver and sulphides. (Hepar test.) Hahn. See VII.

New method for the determination of hydrogen peroxide. Jamieson. See VII.

Determination of manganese in iron and steel according to the bismuth method. Kinder. See X.

Apparatus for electrometric titration depending on the change of oxidation potential, and its application to the determination of small quantities of chromium in steel. Kelley and others. See X.

Analysis of zinc alloys. Mossbacher. See X.

Evaluation of pyrotusile. Rupp. See X.

Determination of ammonia in the soil and in liquid manure. Baragiola and Schuppli. See XVI.

Determination of dextrose. Frerichs and Mannheim. See XVII.

o-Tolylhydrazine, a sensitive reagent for d-galactose. Van der Haar. See XVII.

Biological examination of honey. Gadamer and Laske. See XVI.

Analysis of milk. Ackermann. See XIXA.

Separation and identification of food-colouring substances. Mathewson. See XIXA.

Studies on the culture media employed in the bacteriological examination of water. IV. Neutralized lactose peptone media. Chamot and Sherwood. See XIXB.

Determination of nitrate in sewage by means of o-tolidine. Phelps and Shoub. See XIXB.

Simple method of estimating mercury in oszoidol-mercury preparations. Herrmann. See XX.

Determination of acetylsalicylic acid and sodium salicylate in powders. Miller. See XX.

Identification of organic acids. Lyons and Reid. See XX.

Detection of methyl alcohol by catalytic dehydrogenation. Mannich and Geilmann. See XX.

Inspection and testing of trinitrotoluene. Stevens. See XXII.

PATENTS.

Liquids; Instrument for measuring the turbidity of —. O. M. Smith, Little Rock, Ark. U.S. Pat. 1,232,989, July 10, 1917. Date of appl., July 28, 1916.

A VERTICAL glass tube containing the liquid is mounted in a cylinder provided with a graduated longitudinal slot through which the tube is visible. An electric lamp is placed below the bottom of the tube and the turbidity is measured by the penetration of light into the liquid as seen through the slot.—W. F. F.

Viscosimeter. C. H. Briggs, Minneapolis, Minn. U.S. Pat. 1,233,177, July 10, 1917. Date of appl., Feb. 15, 1915.

A VERTICAL graduated tube, open at the bottom, is inserted into the liquid to be tested. The upper end of the tube is connected to a chamber provided with a pressure gauge and exhausted by a pump. The tube is put into communication with the vacuum chamber by means of a valve, and the viscosity is measured by the rate at which the liquid rises in the graduated tube.

—W. F. F.

Plastic materials; Method of and apparatus for testing the consistency of —. C. M. Chapman, Assignor to Westinghouse, Church, Kerr & Co., New York. U.S. Pat. 1,233,813, July 17, 1917. Date of appl., Feb. 21, 1913.

THE material is moulded into a substantially cylindrical shape with its axis vertical, and the mould is then removed. The mass is subjected to a definite jarring, and the plasticity of the material is indicated by the increase in diameter at the base.—W. F. F.

Pyrometer. E. F. Northrup, Princeton, N.J., Assignor to Pyroelectric Instrument Co., Trenton, N.J. U.S. Pat. 1,234,203, July 24, 1917. Date of appl., Oct. 12, 1916.

A HOLLOW vessel of refractory material, such as graphite, is filled with a metal, such as tin, solid at ordinary temperatures and having a practically constant coefficient of cubical expansion when molten. The vessel communicates with a vertical stem also of graphite, and the temperature is indicated on a uniform scale by the changes in volume of the molten metal measured by electrical means. The expansion of the containing vessel is negligible.—W. F. F.

Oil-tester; Closed —. [Flash-point apparatus.] C. J. Tagliabue, Brooklyn, N.Y., Assignor to C. J. Tagliabue Manufacturing Co. U.S. Pat. 1,236,123, Aug. 7, 1917. Date of appl., Aug. 14, 1915.

AN oil cup is mounted in a heating bath and provided with a cover having an opening which may be closed by a sliding lid. A horizontal gas-supply tube is mounted above the cover and is provided with a burner projecting at right angles. The tube and sliding lid are interconnected, so that when the tube is rotated the lid uncovers the opening and the burner tip is lowered into it. The burner and lid are returned to their normal positions by a spring, and thermometers are provided in the bath and oil cup.—W. F. F.

Trade Report.

MINERAL OUTPUT OF THE UNITED KINGDOM IN 1916.

The following is a Summary of the Mines and Quarries, Gen. Rept., Part I., 1916 [Cd. 8732], Output of Minerals from Mines, Quarries, and Brine Wells in the United Kingdom :—

DESCRIPTION OF MINERAL.	Mines.		Quarries.*	Total Output 1916	Total 1915.
	Coal Mines Act.	Metalliferous Mines Act.			
	Tons.	Tons.	Tons.	Tons.	Tons.
Alum shale	6,261	—	—	6,261	7,911
Antimony ore	—	—	—	—	2½
Arsenic	—	2,534	11	2,545	2,490
Arsenical pyrites	—	—	300	300	421
Barium (compounds)	8,973	60,468	6,593	76,034	92,477
Bauxite	—	10,329	—	10,329	11,723
Bog ore	—	—	1,095	1,095	1,086
Chalk	—	160	2,786,161	2,786,321	3,233,807
Chert, flint, etc.	—	3,202	47,390	50,592	102,698
Clay† and shale	1,883,739	84,168	4,532,481	6,500,388	8,871,821
Coal	256,348,351	—	27,015	256,375,366	253,206,081
Copper ore and copper precipitate	—	937	91	1,028	822
Fluorspar	—	34,547	20,184	54,731	33,123
Gold ore	—	1,338	—	1,338	5,086
Gravel and sand	—	8,575	1,953,075	1,961,650	2,350,267
Gypsum	—	188,801	30,483	219,284	247,229
Igneous rocks	108	23,875	4,819,193	4,843,176	6,085,415
Iron ore	5,648,602	1,752,614	6,093,442	13,494,658	14,235,012
Iron pyrites	9,496	985	—	10,481	10,535
Lead ore	—	17,084	23	17,107	20,744
Lignite	—	500	—	500	1,783
Limestone (other than chalk) ..	2,477	235,983	10,303,113	10,541,573	11,115,909
Manganese ore	—	5,140	—	5,140	4,640
Natural gas	—	—	c. ft. 85,000	c. ft. 85,000	c. ft. 87,000
Ochre, umber, etc.	44	4,790	5,325	10,159	8,089
Oil shale	2,994,386	—	14,846	3,009,232	2,998,052
Rock salt	—	129,030	—	129,030	131,348
Salt from brine.. .. .	—	—	1,831,418	1,831,418	1,874,257
Sandstone	160,513	32,174	1,806,621	1,999,308	2,520,856
Slate	—	46,184	130,643	176,827	226,037
Soapstone	—	391	—	391	850
Sulphate of strontia	—	—	2,513	2,513	640
Tin ore (dressed)	—	6,161	1,731	7,892	8,144
Tungsten ores	—	388	6	394	331
Uranium ore	—	51	—	51	82
Zinc ore	—	8,476	—	8,476	12,057
Total	267,062,950	2,658,795	34,413,753 c. ft. 85,000‡	304,135,498 c. ft. 85,000‡	307,394,321½ c. ft. 87,000‡

* Exclusive of the produce of most of the Quarries less than 20 feet deep, but including the produce of all open workings for iron ore, bog ore, ochre, sulphate of strontia, and tin ore, etc.

† Including china clay, china stone and mica clay.

‡ Natural gas.

Journal of the Society of Chemical Industry.

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Official Notices.

CHEMICAL TRADES COMMITTEE APPOINTED.

The Minister of Reconstruction announces that he has appointed a Committee to advise him as to the procedure which should be adopted for dealing with the position of the Chemical Trades after the War. The Committee will be composed as follows: Sir Keith W. Price (Chairman), Ministry of Munitions; Mr. John Anderson, Secretary, National Health Insurance Commission (Eng.), attached Ministry of Shipping; Mr. J. F. Brunner, M.P., Mr. Charles Carpenter, D.Sc., M.I.C.E.; Professor J. G. Lawn, Explosives Department, Ministry of Munitions; Sir William Pearce, M.P.; Mr. K. B. Quinan, C.I.L., Explosives Supply Department, Ministry of Munitions; and the Rt. Hon. J. W. Wilson, M.P. Mr. G. C. Smallwood, of the Ministry of Munitions, will act as Secretary to the Committee. The Officers of Government Departments are appointed with the concurrence of their respective Ministers, and the other members of the Committee have been appointed at the suggestion of a representative meeting of Chemical Manufacturers. Dr. Addison has requested the Committee to conduct their deliberations with a view to the creation of some organisation which should be adequately representative of the trade as a whole and by means of which the trade may be enabled hereafter to continue to develop its own resources and to enlist the closest co-operation of all those engaged in the chemical industry.

RESTRICTIONS ON DEALING IN CALCIUM CARBIDE.

The following Order, dated 24th September, has been made:—

1. The Minister of Munitions hereby takes possession, as from the date hereof until further notice, of all calcium carbide, now or hereafter situated in the United Kingdom, except the stocks of persons who do not own more than half a cwt.

2. If any person having control of any calcium carbide to which Clause 1 hereof applies without the consent of the Minister of Munitions, sells, removes, or secretes it, or deals with it in any way contrary to any conditions imposed in any permit that may have been granted in respect thereof, he will be guilty of an offence against the Defence of the Realm Regulations.

3. No person shall, as from the date hereof, until further notice, buy, sell, or supply, except for the purpose of carrying out a contract in writing existing at the date hereof, enter into any transaction or negotiation in relation to the sale or purchase of, calcium carbide situated outside the United Kingdom, except under and in accordance with the terms of a permit issued under the authority of the Minister of Munitions.

4. No person shall, as from the date hereof until further notice, offer to sell, sell, supply or deliver any calcium carbide situated in the United Kingdom except under and in accordance with the terms of a permit issued under the authority of the Minister of Munitions.

5. All persons shall within seven days from the first day of each month commencing in the month of October, 1917, send in to the Controller of Non-Ferrous Materials Supply, AM2/H, Hotel

Victoria, Northumberland Avenue, London, W.C.2, monthly returns of: (a) All calcium carbide held by them on the last day of the preceding month; (b) All calcium carbide purchased or sold by them for future delivery and not yet delivered on such last day; (c) All calcium carbide delivered to them during the preceding month.

Notwithstanding the above, no return is required from any person where the total stock of calcium carbide in hand and on order for future delivery to him has not at any time during the preceding month exceeded half a cwt.

6. All applications in reference to this Order shall be made to the Controller of Non-Ferrous Materials Supply, as above, and marked "Calcium Carbide."

RESTRICTIONS ON THE MANUFACTURE AND SUPPLY OF CERTAIN GLASS AND GLASSWARE.

The Minister of Munitions has issued an Order, dated 19th September, imposing restrictions on the manufacture and supply of certain glass and glassware. The following is the text of the Order:—

(1) Every person shall as from the date hereof in the manufacture of glass and glassware comply with all directions and regulations applicable to such manufacture whether of general application or otherwise which may from time to time be given or made by the Director of Glassware Supply on behalf of the Minister of Munitions.

(2) As from the date hereof no person shall manufacture and no manufacturer shall supply or deliver any chemical and medical glass (excluding bottles) or any electric lamp glass or any glass tubing and rod, except:—

(a) In fulfilment of an order in writing given by an Ordering Firm (which expression shall include every person, firm or company giving an order) who shall have furnished to the manufacturer a declaration in writing stating that they are the holders of a direct contract from the Admiralty, War Office or Minister of Munitions, and specifying the reference and number of such direct contract, and stating that the glass specified in the order is required for the purpose of fulfilling such direct contract and for no other purpose, or

(b) In fulfilment of an order in writing which has been submitted to and approved by the said Director on behalf of the Minister of Munitions and a copy of which has been received by the manufacturer duly certified by the said Director or so approved, or

(c) Under and in accordance with the terms of a licence issued by the said Director on behalf of the Minister of Munitions.

(3) Every declaration made by an ordering firm for the purposes of this Order shall be signed by a partner, director, manager or other responsible official, and every statement contained therein shall be true and accurate.

(4) No person shall as from the date hereof buy, sell or deal in any chemical and medical glass, or any glass tubing and rod situated or to be manufactured outside the United Kingdom except under and in accordance with the terms of a licence issued by the said Director on behalf of the Minister of Munitions.

(5) No person shall as from the date hereof buy, sell or deal in any electric lamp glass, whether situated or to be manufactured in or outside the United Kingdom, except under and in accordance with the terms of a licence issued by the said Director on behalf of the Minister of Munitions;

provided that nothing contained in this clause shall be deemed to prohibit the supply or delivery of any electric lamp glass by the manufacturer thereof in accordance with the provisions of clause 2 hereof, or any purchase or sale of or other dealing in any electric lamp glass which forms part of a manufactured article the total value of which exceeds four times the value of the electric lamp glass forming part thereof and which is *bona fide* sold with such glass.

(6) All persons shall furnish to the said Director as and when required by him such returns of glass and glassware at any time manufactured, purchased, sold, supplied or delivered by them at such times and in such form as the said Director shall from time to time direct. All persons heretofore required to furnish returns relating to glass and glassware shall until further notice continue to furnish returns in accordance with such previous requirements.

(7) Nothing in this Order shall affect any obligation to obtain from the Board of Trade (Department of Import Restrictions), 22, Carlisle Place, London, S.W.1, or otherwise, import licences for the import of glass and glassware.

(8) For the purposes of this Order the expression "glass and glassware" shall include all kinds of glass or glassware made at the furnace, in the blow-pipe flame, or by any other process, or any of them; and the expression "chemical and medical glass" shall include resistance, chemical and bacteriological glassware, carboys, thermometers, miners' safety lamp glasses, X-ray tubes and valves, and glass for X-ray apparatus, artificial glass eyes, hospital glassware and glass vessels (graduated or otherwise) manufactured for the purpose of containing reagents, drugs, medicines pharmaceutical or biological substances or preparations, or any of them; and the expression "electric lamp glass" shall include all glass used or intended for use in the manufacture of electric lamps, except glass used or intended for use in lamp caps for insulating purposes, but shall not include glass shades and similar accessories; and the expression "glass tubing and rod" shall include all glass tubing and glass rod made by the process of drawing, or either of them.

(9) The Orders of the Minister of Munitions dated respectively the 2nd January, 1917, and 23rd March, 1917, relating to certain classes of glass and glassware are hereby cancelled, but such cancellation shall not affect the previous operation of those Orders or the validity of any action taken under them or either of them, or the liability to any penalty or punishment in respect of any contravention or failure to comply with the same respectively prior to their cancellation or any proceeding or remedy in respect of such penalty or punishment.

(10) All applications in reference to the above Order should be made to the Director of Glassware Supply, Ministry of Munitions of War, 117, Piccadilly, London, W.1.

(11) This Order may be cited as the Glass Control (Consolidated) Order, 1917.

Explanatory notes.

(a) Subject to any directions or regulations which may be given or made by the Director of Glassware Supply applicable to the manufacture of glass and glassware and to any priority directions a manufacturer may without licence accept any orders for glass and glassware, other than chemical and medical glass (excluding bottles) and electric lamp glass and glass tubing and rod, and manufacture the glass and glassware required to carry out such orders.

(b) As all chemical and medical glass (excluding bottles) and electric lamp glass and glass tubing

and rod are subject to the provisions of Clause 2 of the above order, no materials of this kind may be manufactured or supplied or delivered by a manufacturer unless the requirements of that clause have been complied with.

(c) In order to obtain the approval referred to under Clause 2 (b) of the above Order it will be necessary for ordering firms to submit their orders in duplicate to the said Director, accompanied by a covering letter setting out the purpose for which the glass and glassware is required. If approved one copy of the Order will be forwarded direct to the manufacturer duly certified and the other copy will be retained by the said Director. An advice will be sent to the ordering firm indicating the action taken in respect of such Order.

(d) Licences may be granted to manufacturers under Clause 2 (c) of the above Order to accept and carry out orders from dealers for reasonable quantities of the glass and glassware affected by that clause for the purpose of stock or export. Licences may also be given to manufacturers to manufacture limited quantities of such glass and glassware for their own stock or export. Licences to manufacturers to manufacture for their own stock may be given in such a form as will make it unnecessary to obtain any further licence for disposing of or dealing in the glass or glassware manufactured under such licence except in the case of electric lamp glass. A dealer who has obtained any glass or glassware in compliance with the provisions of clause 2 of the above Order will not require any further licence for disposing of or dealing in such glass or glassware, except in the case of electric lamp glass.

(e) In the case of electric lamp glass to be supplied by a dealer and not by a manufacturer, in order to obtain the licence of the said Director for the purchase or sale of or other dealing in electric lamp glass situated in the United Kingdom, the order on the dealer for which a licence is desired must be submitted in duplicate to the said Director, accompanied by a covering letter setting out the purpose for which the glass is required. If approved one copy of the order will be forwarded direct to the dealer and the other copy will be retained by the said Director. An advice will be sent to the ordering firm indicating the action taken in respect of such orders. No licences to purchase, sell or deal in electric lamp glass situated in the United Kingdom will be granted unless these conditions have been complied with.

(f) No licence is required under the above Order to be obtained for the purchase or sale of or other dealing in glass and glassware situated or to be manufactured outside the United Kingdom other than those types of glass and glassware affected by clauses 4 and 5 of the above Order.

(g) In order to obtain the licence of the said Director for the purchase or sale of or other dealing in any glass and glassware of the types affected by clauses 4 and 5 of the above Order situated or to be manufactured outside the United Kingdom, full details must be submitted in duplicate of the glass and glassware which it is proposed to buy, sell or deal in, accompanied by a covering letter stating the purpose for which the glass and glassware is required and to whom it is to be supplied. If approved one copy of such details will be certified as licensed and returned to the person submitting it, who must be the actual importer of the glass and glassware in question, and such certificate will constitute his authority for the purchase, sale or other dealing. No further licence will be required to dispose of or deal in such glass and glassware except electric lamp glass, provided nothing to the contrary is specified in the licence issued as authority for purchase, sale or delivery. A licence given to an importer to buy, sell or deal in glass

and glassware situated or to be manufactured outside the United Kingdom may be in such a form as will make it unnecessary for any further licence to be obtained, whether by the seller or the buyer for disposing of or dealing in such glass and glassware except in the case of electric lamp glass.

(h) A licence to buy, sell or deal in glass and glassware situated or to be manufactured outside the United Kingdom will only be given on condition that the importer renders to the said Director full and accurate returns of his imports, stock and deliveries of glass and glassware in accordance with the directions from time to time given by the said Director.

(i) Special attention is directed to clause 7 of the above Order relating to the necessity of obtaining import and other permits and licences which are or may be from time to time required.

ACETIC ACID AS WAR MATERIAL.

In pursuance of the powers conferred upon him by Regulation 30A of the Defence of the Realm Regulations, the Minister of Munitions has ordered that the "war material" to which that Regulation applies shall include acetic acid of all strengths.

All applications and enquiries regarding this Order should be addressed to the Director, Chemical Section, Trench Warfare Supply Department, King Charles Street, Westminster, London, S.W.1.

Manchester Section.

Meeting held at Grand Hotel on Friday, April 13th, 1917.

MR. J. H. ROSEASON IN THE CHAIR.

THE MANUFACTURE OF NITRIC ACID FROM NITRE CAKE.

BY DR. J. GROSSMANN.

In the manufacture of nitric acid it has in general been found impracticable to use equivalent quantities of nitre and sulphuric acid in such proportions as to produce the neutral sodium sulphate. A large excess of acid is used, with the result that the residue, which is termed "nitre cake," contains on an average about 28% of H_2SO_4 , the remainder being, with the exception of some impurities, sodium sulphate. There is thus a very large amount of sulphuric acid wasted, and when it became imperative to reserve practically all the available sulphuric acid for the manufacture of explosives, to the exclusion of other industries, nitre cake, on account of the free acid contained in it, appeared to be a suitable substitute for acidifying and similar purposes, particularly in the textile industries. Unfortunately, however, nitre cake is a troublesome material to handle, being produced in the shape of slabs 2 inches and more in thickness. It attracts moisture; it must be stored under cover, and special arrangements are required to keep the drainings from percolating into flues and foundations, all of which render it expensive to store. Notwithstanding its drawbacks,

nitre cake is now used, practically under compulsion by the Government, in the woollen, cotton and other textile industries, in galvanizing works, and in grease recovery, i.e., in general for acidifying purposes. Pressure has been put on manufacturers to utilise the cake in the manufacture of superphosphate and ammonium sulphate, but the products obtained are inferior in strength and quality, expensive to produce, and costly to transport. In almost every case in which nitre cake is used as a substitute for sulphuric acid, great inconvenience has been caused to the user who, moreover, has to pay from 15s. to 20s. and more per ton for an article which in normal times was valued at about 2s. 6d. per ton.

It is impossible to say how much of the total nitre cake produced has been used for these purposes; probably only a comparatively small fraction, and that only in such districts in which the users were not too far distant from the producers. By indirect calculations, it appears that the amount of sulphuric acid used for the manufacture of nitric acid cannot be less than three-quarters of a million tons per annum, possibly considerably more, and this would produce a somewhat larger amount of nitre cake containing a quantity of sulphuric acid equivalent to about one-quarter million tons per annum, and the question arises whether there might not be some means by which the manufacture of nitric acid as carried on at present could be improved in such a way as to liberate a certain amount of sulphuric acid for other purposes, and thus to some extent, if not altogether, relieve the textile and other industries from the necessity of using nitre cake. Anyone who has had to deal with nitre cake in the last year or two must have been struck with the fact that in many cases it contains undecomposed nitre far in excess of what is considered to be permissible in good work; this entails a waste of both nitrate of soda and sulphuric acid. It is also evident that there are cases in which, with a little more attention, a smaller amount of sulphuric acid might give as good results as those obtained at present. If the Government were to insist upon weekly returns from each nitric acid works, showing the amount of raw materials used, the amount of nitric acid (with tests) produced, the complete composition of the nitre cake (particularly in free acid, iron, nitrate of soda, and nitric acid), with occasional check tests made by independent parties, a saving in the use of sulphuric acid could no doubt be effected, and the compulsory use of nitre cake proportionately reduced. A saving of only 5% of sulphuric acid would amount to about 40,000 tons of H_2SO_4 per annum, which is equivalent to nearly 150,000 tons of nitre cake.

The utilisation of nitre cake for acidifying and neutralising purposes, which was adopted under the stress of necessity, represents no technical progress. Only one commercially appreciable ingredient, and that in quantity and quality the lowest, is rendered available, and the uses mentioned above can only be looked upon as temporary makeshifts to be replaced as soon as practicable by more rational methods of utilisation, i.e., by purely chemical manufacturing processes in which all the constituents of nitre cake are utilised so as to yield their utmost value.

Apart from methods which would achieve the purpose in an indirect manner, of which the one I brought to the notice of this Society last year (see this Journal, 1916, 155) is an instance, those methods which aim at the production of an acid and the simultaneous recovery of sodium sulphate appear to be the most likely to fulfil the above conditions. Amongst these the direct recovery of the sulphuric acid would be the simplest; but considerable difficulties, both in engineering and chemical details, may be anticipated and have so far been met.

with in that direction. The next important application would appear to consist in the use of nitre cake for the manufacture of hydrochloric acid, and this has been carried out for a number of years. Technically there are no difficulties in it which could not be overcome, though commercially it might in normal times not have been an unqualified success. It must, however, be borne in mind that in those times the value of hydrochloric acid was extremely low, and now that the acid itself is sold at many times the price it used to obtain formerly, the possibilities of commercial success are far more promising. It does not appear that the process has received any special attention from the Government though hydrochloric acid is far more suitable for a number of purposes than nitre cake, and could also be utilised for the manufacture of bleaching powder, of which large quantities will be required for disinfecting purposes in the near future to prevent epidemics.

The most rational of all possible processes for the utilisation of nitre cake would appear to be one by which nitric acid could be produced from it; in that case, we should either be in a position to increase our output of nitric acid by 30 or 40% with our present supply of sulphuric acid, or to produce the same amount of nitric acid as at present from a greatly reduced quantity of sulphuric acid. In the latter case, there would be the further advantage that the quantity of nitre cake as compared with that produced at present would be considerably reduced; also, that the reduced quantity of sulphuric acid required for nitric acid would mean a reduction in the shipment and importation of the raw material used for the manufacture of sulphuric acid, *i.e.*, pyrites, amounting probably to over 200,000 tons per annum.

For some time I have been attempting to solve this problem, and I have found that under certain conditions in a mixture of sodium nitrate, nitre cake, and charcoal or other suitable form of carbon, the sodium nitrate is completely decomposed, with a steady evolution of nitrous fumes and without frothing, at a comparatively low temperature, and that in the reactions which take place no reduction to nitrous oxide or nitrogen occurs, so that the yield of technically available nitrogen compounds is practically quantitative. The conditions under which this takes place are as follows:—The ingredients must be very finely ground and intimately mixed; the carbon must be present in excess, and a current of air must be passed through the system during the whole of the operation.

There is, of course, no difficulty in grinding sodium nitrate or carbon. As regards nitre cake, it is known that it has been and is ground very finely in the Oehler-Meyer process of producing hydrochloric acid. It is stated by some authorities that there is no difficulty in obtaining a product of which 90% would pass through a 50-mesh sieve. Other authorities state that the wear and tear on the disintegrators is considerable. I have found it troublesome to grind nitre cake in the laboratory, and in order to render my process free from any possible objection as to its practicability on a large scale, I have endeavoured to find a means by which nitre cake could be ground more easily. I have succeeded in this by pouring the molten nitre cake on to a thin layer of sodium carbonate and chilling the mass quickly. The carbon dioxide which is liberated leaves the mass after cooling in a spongy condition, quite friable and easy to powder in a porcelain mortar. 5% of Na_2CO_3 on the nitre cake produces excellent results; with a little modification, such as diluting the sodium carbonate with powdered sodium sulphate, even 2½% of Na_2CO_3 will give a good spongy material. The molten nitre cake coming from the stills could at once be treated in this manner, and old stock could be re-melted and thus rendered useful.

The nitre cake which I used for my experiments

contained after treatment with sodium carbonate 23% of free sulphuric acid. It was ground very finely in a porcelain mortar, and mixed with an excess of finely ground coke and such a quantity of sodium nitrate as would ultimately produce a slightly acid sodium sulphate. Although I did not sieve the ground nitre cake, it was in the state of a powder of which the greater part, if sieved, would pass through a 60 mesh. The mixture was placed in a retort which was connected with a series of bottles containing a solution of caustic soda, and the mass was heated gradually to 250° C. whilst a current of air was drawn through the system. It was found that the fumes changed colour at different temperatures, which points to the fact that different reactions take place at different stages; thus the evolution of red fumes commences below 70° C.; at 100° C. the fumes are getting yellow; at a higher temperature, they become colourless, and at 199° C. they again show a brown coloration, which decreases with a further rise in temperature. The analysis of the residue showed that at 100° C. under 50% of the nitre was decomposed; at from 120° to 130° C., about 70%; at from 140° to 160° C., 87%; at 250° C., the decomposition was complete. It was found that substantially all the nitrogen was recoverable in the caustic soda as nitrate or nitrite, which proves that in work on a manufacturing scale it will be possible to convert into and practically recover all the gases evolved as nitric acid. A typical test showed the following results:—

Recovered as sodium nitrate	54.5
Recovered as sodium nitrite (calculated as sodium nitrate) ..	42.8
Undecomposed	0.9
Loss (by difference)	1.8
	<hr/> 100.0

Even with five condensing bottles nitrous fumes were still going away unabsorbed, and it may therefore be assumed that the loss of 1.8% was due to incomplete absorption and that the reaction is quantitative so far as nitrogen compounds recoverable as nitric acid are concerned.

It is well known that the oxidation of nitrous fumes to nitric acid is a time reaction, and it is extremely difficult, if not impossible, in carrying out quantitative experiments of this kind in the laboratory to give sufficient time to the gases to interact. On a large scale, these difficulties are overcome by having large chambers in which the mixture of nitrous fumes and air is allowed to take place over a certain period. In the Birkeland and Eyde process, the difficulties of producing nitric acid from these nitrous fumes have been solved. Considering that the gases in the process which I have described are produced at a very low temperature, *viz.*, 250° C., whereas in the atmospheric process a temperature of from 1500° to 3000° C. is required, and that the gases evolved in my process are far more concentrated in proportion to the air mixed with them, it is more than probable that oxidation and condensation will be much easier to conduct and that a higher strength acid will be obtained in my process than in the Birkeland and Eyde and similar processes, which only produce acid of 50% HNO_3 . Where the strongest acid is required, it will, of course, be necessary to redistil the acid by any of the means used at present for that purpose. For many purposes, such as the manufacture of nitrate of ammonia and similar applications, an acid of 50% or even less would be quite suitable, and in these cases, no further concentration of the acid would be required. For the manufacture of sulphuric acid, the application of this process would be particularly suitable, as the gases evolved might be passed straight into the chambers or the Gay-Lussac tower. The manufacture of calcium

nitrate or nitrite (and through these of ammonium nitrate and sodium nitrite) could be combined with this process, with or without the simultaneous production of nitric acid.

The residue produced is in a friable condition. As it is practically free from chloride, which in the manufacture of nitric acid and in this process, is evolved as nitrosyl chloride, it is in a particularly suitable condition for the manufacture of the highest strength caustic soda by the Leblanc process, and the coke which has been used in this process is thus not lost, with the exception of the small quantity which has been used up in the reaction.

In a series of further experiments, I omitted the carbonaceous matter altogether, and used only a mixture of nitre cake and sodium nitrate very finely ground as stated above and intimately mixed. The experiments were carried out in exactly the same way as in the series of experiments with carbonaceous matter, air being passed through the system whilst the mixture was heated up gradually, the gases evolved being absorbed in caustic soda solution. I found that here also the decomposition was complete at 250° C. At 100° C., white fumes came from it and the mass in the retort swelled slightly on the top. The fumes up to 140° C. were colourless or slightly yellow; between 160° and 190° C., brown fumes appeared which decreased and became again yellowish at over 200° C., and towards the end, at 240° C., there appeared to be no fumes given off. In a typical experiment I recovered:—

As sodium nitrate	..	..	..	..	..	85.2
As nitrite, calculated as sodium nitrate	..	..	..	..	..	13.1
Undecomposed	..	..	..	..	..	0.3
Loss (by difference)	..	..	..	..	..	1.4

Having worked in exactly the same way as previously, the results are comparative. They show that in this second method a much greater amount of nitric acid is evolved as such, and that the oxidation and condensation of the other oxides of nitrogen will be far more complete and more rapid than is the case in the previously described method, so that by this process, with less condensing plant, a much stronger acid should be obtained. The resulting mass is not quite as friable as in the carbonaceous method, but considering the low temperature at which the reaction takes place, it is not likely that this would interfere with the continuous working of the process on a manufacturing scale. Either of the two processes could be worked in ordinary muffle furnaces by hand, or by mechanical means. The salteake obtained from either of the two processes contained from 2 to 4% of free sulphuric acid.

The grinding of the nitre cake should not interfere with the commercial success of the process. With proper supervision, it should not cost more than 5s. per ton to grind nitre cake in the state in which it is produced at present, especially if the slabs were made of lesser thickness. If it were found advisable to use my method for producing spongy nitre cake by means of sodium carbonate, the extra labour involved would be balanced by the lower cost of grinding, and as for every hundredweight of sodium carbonate used one and a third hundredweight of sodium sulphate would be obtained, in a charge with 2½% of sodium carbonate, the chemical would only add about 1s. 3d. to the cost per ton of nitre cake. All charges involved for grinding and mixing may therefore be taken at under 10s. per ton of nitre cake, and as less than 3 tons of nitre cake will be sufficient to decompose 1 ton of sodium nitrate and produce over 3 tons of salteake, whilst saving 1 ton of sulphuric acid, there is the value of 3 tons of salteake and that of 1 ton of sulphuric acid as a set-off against the expense of grinding and mixing. On the prices ruling before the war, this would show an advantage over the present mode of working of nearly £6 per ton of nitre;

on present prices, it would show an advantage of over £10 per ton of nitre. The actual working expenses should be no higher than in the ordinary method of making nitric acid, as any extra expense in labour would be fully balanced by the reduced quantity of fuel required and the lesser wear and tear on the plant, owing to the low temperature at which the reactions take place. Either of these methods would enable the nitric acid manufacturer to decompose each ton of nitrate of soda with three-fourths of the acid which is required at present, and to get rid of a troublesome by-product; and there appears to be no reason why he should not manufacture caustic soda on the spot from the salteake produced, and thus add further to his revenue.

Since writing this I have found a method by which nitre cake can be obtained as a fine powder at about 2s. per ton; this will further reduce the cost of producing nitric acid from nitre cake as given above, and as no sodium carbonate is used in this method, 2½ tons of nitre cake will be sufficient to decompose one ton of sodium nitrate.

DISCUSSION.

The CHAIRMAN said that Dr. Grossmann was to be congratulated on the success of his method, especially having regard to the application of so low a temperature. Some 20 years ago a process had been described in the Journal of this Society (Vol. XII., p. 44) for the utilisation of nitre cake by the cooling of practically saturated solutions of the substance, when owing to the conditions of temperature neutral sodium sulphate and free sulphuric acid were formed. For technical purposes, such as for souring, this would be a convenient way of obtaining a moderately strong sulphuric acid.

Mr. W. THOMSON enquired whether it was possible to dispense with the use of sodium bicarbonate and obtain a friable, spongy mass by blowing air into the molten nitre cake, after the manner of making slag wool.

In analyses of samples of nitre cake he had made, he was struck by the completeness with which the nitric acid had been removed from the nitre used.

Mr. STANLEY SMITH said that those who had not had an opportunity of observing the Birkeland-Eyde process in operation could not possibly form a conception of the difficulties experienced in the absorption of the nitrous gases. The gases obtained by Dr. Grossmann were doubtless very much more concentrated than those obtained in the nitrogen fixation process, but considerable capital expenditure would be required for their recovery. It was by no means possible to recover the whole of the gases in water. It was necessary that the last gas should be washed with an alkaline solution. Milk of lime had not been used in the Birkeland-Eyde process for a long time. In Dr. Grossmann's process it was apparent that soda ash must be used for part of the absorption, and this would mean that a certain amount of nitrous gases would be recovered not as nitric acid but only as sodium nitrate. Dr. Grossmann pointed out that his process was practically a quantitative reaction; carried out on a small scale, however, a 1.8% loss was found. The recovery of the nitric acid would entail a further loss, which would result in additional expense. If by this process most of the nitrous gases were absorbed in water, the maximum strength of the nitric acid obtained without a very elaborate absorption plant, would be about 30%. This did not appear to be of very much value under present circumstances, since the chief demand is for the strong acid.

A remark had been made that it might be possible to utilise nitre cake in the manufacture

of chlorine. The utilisation of large quantities of chlorine in an economical manner was the only drawback to the manufacture of alkali by electrolysis on a largely increased scale. Should it be possible to find a remunerative outlet for large quantities of chlorine, there was no doubt that the quantity of alkali manufactured by the ammonia-soda process would be very much reduced.

Dr. GROSSMANN, in reply to the Chairman, said that it was quite correct that a solution of nitre cake stronger in sulphuric acid than the ordinary solution could be obtained by crystallising out some of the sodium sulphate; but at the same time the impurities in the nitre cake would also be in a more concentrated form in the solution.

The process Mr. Thomson suggested, of exposing molten nitre cake to an air blast, might produce a substance similar to slag wool, but would not have the effect of rendering the mass friable. As regards the nitric acid and nitrate left in nitre cake, his experience had been quite different from Mr. Thomson's.

Referring to Mr. Stanley Smith's remarks, Dr. Grossmann said that the difficulty of absorbing the unoxidised nitrous fumes would be considerably less than in the Birkeland-Edyde process and even if the last traces had to be absorbed in soda, the amount of the latter required should only be a negligible quantity. The assumption that the condensed nitric acid would only contain 30% HNO_3 was contrary to the best authorities, such as Dammer, who state that the strength of acid recovered by the atmospheric process is 35° B., i.e., 50% HNO_3 . Such an acid would have to be concentrated to render it applicable for certain, though not for all, purposes. This was successfully done now, and improvements were constantly being made in that direction, and were to be found in the patent literature.

The reaction was practically quantitative, and the figure 97.3% represented the actual quantities of nitric and nitrous acids recovered and obtained by distillation of a mixture of nitre cake, nitre, and charcoal.

Mr. Smith's remarks on the chlorine industry of the future were purely controversial; the fact remained that at present hydrochloric acid was scarce and absurdly high in price, and that under these circumstances the use of nitre cake for its production would be advantageous.

Correspondence.

UTILISATION OF NITRE CAKE.

SIR,

Of the two methods which I have worked out for the utilisation of nitre cake, and which are published in this issue of the Journal, only the first method, dealing with the reactions which take place when nitre cake, sodium nitrate, and coke are heated, was brought before the Manchester Section; the second method, owing to a prohibition from the Army Council (since withdrawn), was not published at the time. The first method was submitted in November, 1916, to the Explosives Department of the Ministry of Munitions which, of its own volition, tried it in the Research Laboratory and reported that only 33% decomposition was found. A full account of the mode in which I had carried out my experiment was then forwarded, and elicited a further statement that "working substantially on my lines" the Department only obtained 33% decomposition of the nitre, against 97% which I claimed and 99% which has since been found by an independent analytical chemist of the highest repute. On my offering to demonstrate in my laboratory the correctness of my statements, I received a communication which without direct admission implied that the experiments carried on by the Ministry of Munitions might not have been on exactly the same lines as mine; but without giving any reasons based on facts the Department declined to go further into the matter.

The adherence to a result which shows a discrepancy of 66% can only be accounted for by assuming that the matter was *a priori* not considered of sufficient importance to receive serious attention. It is entirely within the discretion of the Explosives Department of the Ministry of Munitions to subject a process to examination or not, but it is of national importance that if a process is submitted to investigation the experiments should be carried out in accordance with the inventor's instructions and in the most careful and efficient manner. Unless this is done, no sound conclusions as to the value of a process can be arrived at.

I am, etc.,

J. GROSSMANN.

Manchester,

22nd September, 1917.

Journal and Patent Literature.

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Patents from 1908 to date, *L'imprimerie Nationale*, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

Filtration: Principles of—, D. R. SPERRY. Met. and Chem. Eng., 1916, 15, 198-202; 1917, 17, 161-166.

IN the filtration of a liquid containing a solid in suspension, there are two concurrent processes: (1) Flow of liquid through the porous filtering medium, and (2) building up of the filter cake. The author shows experimentally that the rate of flow is directly proportional to the pressure above the liquid, which is in accord with the Poiseuille formula for the eddyless flow through tubes. Filtration is a capillary phenomenon. A mathematical expression is deduced connecting the two processes, 1 and 2, and this has been

tested experimentally by studying the time-discharge curves of a filter through which a suspension of kieselguhr in water was forced under pressure. The requirements of the equation deduced were nearly but not exactly fulfilled. This was traced to sedimentation of the suspension which thickened the filter cake at a rate faster than that due to passage of the liquid through it. By eliminating sedimentation the validity of the mathematical treatment was confirmed.—H. J. H.

Pervaporation, perdistillation, and percrystallisation. P. A. KOBER. J. Amer. Chem. Soc., 1917, 39, 914-948.

WATER held in a collodion or parchment membrane container evaporates through the walls as though

no membrane were present. This phenomenon is called pervaporation. The speed of pervaporation is so great that it is impossible to heat water to the boil by means of a Bunsen flame when the water is in a closed collodion container. The method may prove useful for concentrating sterile preparations, such as foodstuffs, toxins, and anti-toxins, under sterile conditions. For example a globular collodion container fitted with a glass tube at the top and closed with a cotton plug and tin-foil, was sterilised and filled with 300 c.c. of a sterile meat infusion broth medium. By pervaporation in a large incubator, the infusion was converted into a product resembling Liebig's beef extract in colour, taste, and consistency. Perdistillation, or distillation by pervaporation, can be effected at low temperatures under ordinary pressure as well as *in vacuo*. When a dialysable constituent of a liquid in a collodion or parchment membrane container reaches saturation, crystallisation usually takes place on the outside of the container; this is termed percrystallisation. The crystals are dry and practically free from mother-liquor. They dissolve when a little water is added inside the container.

Thermostat: A high temperature — J. L. Houghton and D. Hanson. Inst. of Metals, Sept. 19, 1917. [Advance copy.] 12 pages.

THE instrument consists of a double-walled vessel made into a furnace by winding it with nichrome wire. This vessel acts as a gas thermometer, and the variations in the pressure of the air contained in it operate a contact-breaker which regulates the current supplied to the furnace. The contact-breaker is a U-tube, containing mercury and fitted with two platinum contacts, which breaks the relatively small current of a solenoid relay; this in turn pulls a fork into or out of two mercury cups, thus cutting off or putting in an external resistance to the furnace. One side of the relay is connected to the furnace bulb, and the other to the closed bulb of a simpler thermostat, similar in principle to the main thermostat. This device is necessary to protect the instruments from the variations otherwise caused by changes in atmospheric temperature and pressure. Using a modified bulb, slow rates of cooling, of the order of 1° or 2° C. per day, can be obtained.—J. H. P.

Decolorising-carbon. See IIb.

PATENTS.

High vacua; Means and apparatus for obtaining — The British Thomson-Houston Co., Ltd., London. From General Electric Co., Schenectady, N.Y., U.S.A. Eng. Pat. 108,596, Oct. 18, 1916. (Appl. No. 14,821 of 1916.)

IN apparatus of the type described in Eng. Pat. 105,357 (this J., 1917, 584), the blast of mercury vapour is made to enter the condensing chamber in a downward direction, and this chamber is connected with the vessel to be exhausted through a trap, so that mercury vapour cannot enter the vessel.—W. H. C.

[*Mercury*] boiler. W. L. R. Emmet, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pat. 1,236,155, Aug. 7, 1917. Date of appl., Nov. 26, 1913.

IN a mercury boiler consisting of vapour and liquid chests connected by bent header pipes, the joints between the pipes and headers are enclosed and connected with a means of producing a vacuum to draw off any mercury vapour, and with a drain to draw off any liquid mercury which may leak through the joints.—W. H. C.

Boiler-feeding means. W. L. R. Emmet, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pat. 1,236,154, Aug. 7, 1917. Date of appl., Nov. 26, 1913.

A NUMBER of generators for liquid of high boiling point are connected together at about the liquid level by pipes which dip down so as to form practically U-bends between the individual generators; the bends contain sufficient liquid to prevent vapour passing from generator to generator, but allow the passage of liquid. The vapour space of each generator is connected with a common vapour main by a pipe having a non-return valve. Each generator is connected with a gravity feed main by a pipe provided with a float valve.

—W. H. C.

Catalytic material; Method of making — C. B. Morey and C. R. Craine, Assignors to Larkin Co., Buffalo, N.Y. U.S. Pat. 1,232,830, July 10, 1917. Date of appl., Feb. 2, 1916.

AN insoluble compound of a catalytic metal, for example, an insoluble salt of nickel, is suspended in water and mixed with an absorbent non-catalytic material, such as fullers' earth, from which the moisture and gases have been driven off by heat, so that the solid compound enters into the interstices of the absorbent material. The mixture is then dried, ground, and reduced.—W. H. C.

Mixing machine. T. J. Sturtevant, Wellesley, Mass., Assignor to Sturtevant Mill Co. U.S. Pat. 1,234,230, July 24, 1917. Date of appl., Oct. 7, 1916.

A HORIZONTAL cylinder, open at one end, is mounted within a casing so that it can be rotated in either direction. Materials to be mixed are charged through a shoot which passes through the casing into the open end of the cylinder, and are mixed by rotating the latter. When the mixing is complete, the direction of rotation is reversed and the contents are discharged into a shoot placed in the lower part of the casing.—W. H. C.

Solutions, emulsions, and the like; Method of thickening (condensing) or drying — P. Askenasy, Karlsruhe, Germany, Assignor to Akt.-Ges. für Chemische Produkte vorm. H. Scheidemandel, Berlin. U.S. Pat. 1,234,714, July 31, 1917. Date of appl., Dec. 12, 1916.

SMALL globules or beads of glue or gelatin are added to the solution or emulsion to be thickened and kept in contact therewith for a sufficient time to absorb a portion of the liquid present; the beads containing the absorbed liquid are removed and a thickened residue thereby obtained; the separated beads are dried and used again for a similar purpose.—J. F. B.

Furnace-charging system. L. D. Anderson, Midvale, Utah, Assignor to United States Smelting, Refining and Mining Co. U.S. Pat. 1,234,998, July 31, 1917. Date of appl., Dec. 27, 1915.

AN elongated furnace has a charging, measuring, and mixing hopper, of approximately the same length as the furnace, which is charged with the different ingredients from various bins. The materials are mixed, formed into a layer of approximately the same length as the furnace, and then charged into the latter.—W. H. C.

Cooling tower. C. W. E. Clarke, Brookline, Mass. U.S. Pat. 1,235,291, July 31, 1917. Date of appl., Oct. 28, 1916.

A COOLING tower contains a series of rows of baffle-plates, each consisting of a sheet of metal, straight at one end and curved at the other to form a channel for collecting and conveying the deposited spray. The baffle-plates are arranged

in alternate rows, those in one row being oppositely disposed and not in alignment with respect to those in the next row.—B. V. S.

Straining liquids: Apparatus for —, J. E. Fitch and F. C. Stephens, Assignors to R. A. Wittmann, Buffalo, N.Y., U.S. Pat. 1,235,672, Aug. 7, 1917. Date of appl., Apr. 1, 1914.

The straining surface is maintained in a clean condition by an adjustable scraper which is supported on rollers and passes over the surface. The scraper is formed of a band of resilient material the lower edge of which is divided by transverse slots into a number of resilient fingers which pass over and conform with the irregularities of the straining surface.—W. H. C.

Rotary-mill construction. M. F. Williams, Assignor to Williams Patent Crusher and Pulverizer Co., St. Louis, Mo., U.S. Pat. 1,235,868, Aug. 7, 1917. Date of appl., Oct. 28, 1915.

A MILL of the disintegrator type is fed from a hopper which opens into the upper part of the grinding chamber and is provided with a slide regulator. A conduit which extends in a centrifugal direction from the point of the casing just below that at which the feed hopper is attached, serves as a receptacle for any foreign material that may get in to the mill and be thrown out by the beaters, and also as a conduit through which air enters the grinding chamber.—W. H. C.

Crushing machinery. R. W. Pringle, Gatooma, S. Rhodesia, S. Africa, U.S. Pat. 1,237,383, Aug. 21, 1917. Date of appl., Feb. 2, 1917.

SEE Eng. Pat. 102,767 of 1916; this J., 1917, 123.

Compressing machines or apparatus, also adapted for expressing oil or other liquid from seeds and other materials. Eng. Pat. 108,329. See XII.

Machines for expressing oils or liquids from seeds, nuts and other solids. Eng. Pat. 108,515. See XII.

HA.—FUEL; GAS; MINERAL OILS AND WAXES.

Peat: Economic utilisation of — from Châteauneuf-sur-Rhône (Hle-et-Vilaine). C. Galaine, C. Lenormand, and C. Houlbert. Comptes rend., 1917, 165, 337–340.

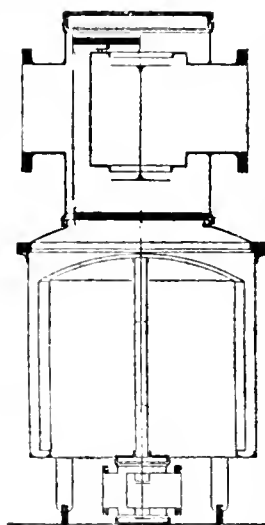
EKENBERG (Fr. Pat. 331,720 of 1903; this J., 1903, 1122) has shown that peat heated under pressure to a temperature above 150° C., loses its gelatinous consistency and can then be easily dried by compression. The process has not yet been applied industrially, but the product possesses very striking properties, being no longer peat, and for convenience the authors have given it the name "tourbon." The calorific value of "tourbon" is 10% higher than that of dried peat and is about 6500 kilo.-cal. The hydro-cellulose being destroyed in passing through the autoclave, "tourbon" does not absorb moisture after drying. "Tourbon" is particularly rich in volatile matter, one sample of anhydrous "tourbon" showing 61.3%. The authors first reduce the water content of the peat in a continuous press (Mabille, Aurep system, etc.) at a pressure of 50 to 100 kilos. per sq. cm. (700 to 1100 lb. per sq. in.), bringing the water content of the briquettes produced down to 60%. The briquettes are placed in layers in carriages and

heated for 25 minutes in horizontal autoclaves by means of steam at 160° C. Freed from gelatinous matter the product dries rapidly in air, but still better in chambers heated by the furnace gases. A great part of the heat is recovered by a recuperative system, an efficiency of 91% being attained with a consumption of one kilo. of coal for the production of 11 kilos. of "tourbon." "Tourbon" can easily be made to contain only 20 to 25% of water and may be used in place of wood for household purposes, in gas producers, or in distillation processes for production of combustible gas and by-products (sulphate of ammonia, methyl alcohol, coke, etc.).—J. E. C.

Gas-firing: New system of —, A. C. Ionides, Inst. of Metals, Sept. 19, 1917. [Advance copy.] 9 pages.

For efficiency in gas heating, an unvarying, correctly proportioned mixture of gas and air is necessary. Constancy of composition may be attained by passing the gas and air through the author's

"mixing balance," by which a variation in the pressure of either brings about a corresponding variation in the other. The balance consists of a sensitive floating bell, the under side of which is subjected to the static pressure of the gas supplied, and the upper side to that of the air supplied. It will be seen from the diagram that if the gas pressure increases the bell will rise, thereby tending to close the gas valve below and open the air valve above. If the air pressure increases the bell will fall, tending to close the air valve and open the gas valve. The effect is to maintain a constant ratio of gas to air after passing through the bal-



ance, though either be varied. As an indicator of the quality of the gas mixture made, an incandescent gas mantle is used, the brightness of which is a maximum for theoretical mixtures. The author proposes to use a crucible furnace, in which the gas and air burn in a cylindrical inner chamber, the waste gases passing from the top and downwards through a surrounding annular space, and out of the furnace into a flue connected to the centre of the base. Furnaces on the same principle have been constructed for heating machine gun barrels. Where a suitable atmosphere, oxidising or reducing, must be maintained, the use of the mixing balance permits this, and an improvement in the quality of the products.—H. J. H.

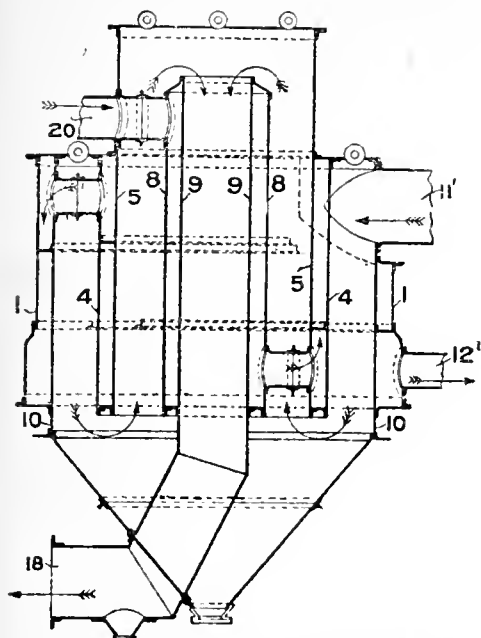
Dehydration of tar. Sharples. See III.

PATENTS.

Regenerators or heat interchangers for gas producer plants. A. H. Lynn, London, L. A. Riley, New York, and N. E. Ramburh, London. Eng. Pat. 108,710, Aug. 11, 1916. (Appl. No. 11,471 of 1916.)

A HEAT interchanger for use in connection with a gas generator consists of a series of concentric chambers in which the heating medium (producer gas) and the medium to be heated (steam and air)

alternate. The producer gas enters tangentially at 11', and passes successively through the chambers 10, 5, and 9, escaping at 18, whilst the steam and air to be heated enter at 20, pass



successively through the chambers 8, 1, and 1, and escape at 12'. The heating spaces for the air and steam may take the form of a series of vertical tubes arranged within a cylindrical inner and an annular outer heating chamber.—J. E. C.

Inflammable liquid, and process of producing same. J. Greer, East Orange, N.J. U.S. Pat. 1,236,557, Aug. 14, 1917. Date of appl. May 24, 1915.

A VOLATILE inflammable liquid is produced from the liquor condensed in the manufacture of illuminating gas, when oil is used in the process of manufacture. The liquor is deposited before the gas leaves the low-pressure gasholder. It is collected without exposure to the atmosphere, held in a closed vessel at the pressure of the gasholder, and distilled at such pressure at temperatures rising to 150° C., the distillate being collected.—J. E. C.

Hydrocarbons; Treatment of — for the production of other hydrocarbons of different specific gravity and boiling point. L. B. Cherry, Kansas City, Mo., U.S.A. Eng. Pat. 101,330, Dec. 1, 1916. (Appl. No. 17,250 of 1916.) Under Int. Conv., Feb. 21, 1916.

SEE U.S. Pat. 1,229,886 of 1917; this J., 1917, 863.

Composition of matter for adapting carbon residues from the distillation of petroleum for use in smelting furnaces. U.S. Pat. 1,236,147. See X.

Chlorination of oil gas. U.S. Pat. 1,235,283. See XX.

Lubricant testing machine. Eng. Pat. 101,975. See XXIII.

IIb.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

Decolorising-carbon. Chem. Trade J., Sept. 15, 1917, 218.

EXPERIMENTS have been carried out by the

sectional chemical committee of the Royal Society on the production of decolorising-carbons similar to the German and Dutch products known as "eponite" and "norite." From microscopic examination of various charcoals it was concluded that eponite is made from a mixture of coniferous wood, such as pine or cedar, and angiospermous wood, such as poplar or willow. A preliminary treatment of the wood on the lines of Ostrejko's Eng. Pat. 18,040 of 1900 (this J., 1902, 58) gave improved results. In the experiments wood as sawdust or shavings was boiled with a solution of calcium or magnesium acetate, then dried, and carbonised at a red heat with addition of lime or magnesia, and the charcoal washed with hydrochloric acid, then with water, dried, and again heated to redness. The addition of starch mullage to the treated wood increased the decolorising power. Charcoals made at higher temperatures (approaching white heat) from a mixture of pine and willow treated with calcium acetate and starch and from cedar wood treated with calcium acetate, were superior to eponite. Experiments were carried out on willow and cedar as two distinct types of wood under the following conditions:—(1) Natural wood, without treatment; (2) Wood treated with milk of lime; (3) Wood treated with calcium acetate. These were carbonised at white heat, and the charcoal washed with hydrochloric acid, then with water, and finally heated. Process (1) gave a charcoal useless for decolorising; (2) and (3) gave very active charcoals, all equal to eponite. The calcium-acetate charcoals were slightly more active than the milk-of-lime material and the type of wood had little or no influence on the result. The process used was:—Sawdust from pine, willow, or cedar was mixed with milk of lime to form a dough, and the mixture heated to drive off some of the water. The mass was placed in a crucible, covered with a layer of lime, and raised to a temperature approaching white heat. The charcoal was boiled with excess of hydrochloric acid, filtered, washed, drained, and heated in an iron retort to a red heat. The charcoal was then powdered and sifted through a No. 60 sieve. For carbonising a No. 6 salamander crucible heated in a Fletcher radial injection furnace was used.—J. E. C.

PATENTS.

Destructive distillation; Art of —. Apparatus for destructive distillation. S. E. Seaman, Brooklyn, N.Y., Assignor to The Seaman Waste Wood Chemical Co., Inc., New York. U.S. Pat. 1,236,884 and 1,236,885, Aug. 14, 1917. Date of appl., May 27, 1916.

WOOD or other similar material in a finely divided state is forced into an inlet passage-way leading to a retort, compressed therein to expel the air, and forced into the retort during the distilling operation. Escape of gases is thus prevented during the feeding operation, and a similar sealing device is used at the discharge end of the retort.—J. E. C.

Electrodes for electric arcs for medical and other purposes. J. C. Round, London. Eng. Pat. 108,437, Mar. 29, 1917. (Appl. No. 4588 of 1917.)

THE electrode is formed of powdered wolfram, or other ore of tungsten, or oxide of tungsten, or tungsten powder, enclosed in a metallic sheath or cover.—B. N.

Filaments; Drawn — for electric incandescence lamps. P. F. Guardiola, Barcelona, Spain. Eng. Pat. 108,817, Mar. 1, 1917. (Appl. No. 3046 of 1917.)

DRAWN filaments are made from an alloy con-

taining a preponderating proportion of chromium the following being given as suitable proportions: Cr, 40%; Cu, 15%; Ni, 25%; Pt, 20%.—B. N.

Incandescence lamp; Electric — with gas filling and a holder for the incandescent wire. E. Podszus, Neukölln, Germany. U.S. Pat. 1,234,691. July 24, 1917. Date of appl. Nov. 13, 1914.

A HOLDER, for highly-heated metal filaments in a gas-filled electric incandescence lamp, is made of a refractory insulating nitride, such as boron nitride, and is used in an atmosphere containing nitrogen.—B. N.

Vapour electric apparatus. F. G. Keyes, East Orange, N.J., Assignor to Cooper Hewitt Electric Co., Hoboken, N.J. U.S. Pat. 1,235,699, Aug. 7, 1917. Date of appl. Nov. 21, 1913.

A QUARTZ lamp comprises a luminous tube, a liquid cathode exposed at one end, and a solid anode at the opposite end consisting of a flat spiral of tungsten. A barrier, consisting of an internal ring within the end of the luminous tube, is interposed between the spiral and the main body of the tube.—B. N.

Electrode; Arc-lamp —. W. R. Mott, Lakewood, Ohio, Assignor to National Carbon Co., Inc. U.S. Pat. 1,235,396, Aug. 7, 1917. Date of appl. Sept. 25, 1914.

THE electrode contains calcium fluoride, an oxide of uranium, and a conducting body of carbon.—B. N.

III.—TAR AND TAR PRODUCTS.

Tar; Dehydration of —. G. H. Sharples, N. Brit. Assoc. Gas Managers, Sept. 7, 1917. Gas J., 1917, 139, 469—471.

A COMPARISON of tars from horizontal and vertical retorts shows an increased yield of crude naphtha, light oils, and creosote from vertical retorts, with a lower specific gravity and a decreased yield of pitch. A more detailed comparison gives the following results for vertical retort tar and horizontal retort tar respectively in lb. per ton of coal carbonised:—Total naphthas (90's benzol and toluol and solvent naphtha), 3.549 and 3.021; 60's carbolic acid, 1.557 and 0.124; cresylic acid, 8.574 and 3.234; creosote, 55.304 and 26.902; pitch, 62.901 and 87.7. The rectified naphthas (90's benzol, 90's toluol, and solvent naphtha) from the vertical retort tar contained 19, 12, and 6% paraffins, as against a maximum of 1% from horizontal retort tar. In dehydration considerable quantities of creosote are carried over but conversely considerable quantities of naphtha are left in the tar. A large part of the tar acids is recovered in the crude oil taken off in dehydration, but 50% is left in the dehydrated tar. A comparison of light oils from dehydration plants with light oils as obtained by the ordinary method of distillation is given, along with an epitome and diagram of the general arrangements of a dehydration plant. The following results of a test are given:—Total tar used, 349 galls.; quantity per hour, 87.25 galls.; time exposed to heat, 34.5 mins.; temperature of leaving coil, 236 C.; light oil recovered, 192 galls.; water, 19 galls.; dehydrated tar, 125 galls.; specific gravities: crude tar, 1.08; light oil, 1.002; dehydrated tar, 1.16; viscosity of prepared tar, 66 seconds. The free carbon in the prepared tar was 6.01%, as against 5.001% in the crude, indicating that the tar does not suffer decomposition in passing through the coil. One serious drawback is the quantity of valuable products left in the dehydrated tar.—J. E. C.

Sulphonation kettles. F. Pope, Met. and Chem. Eng., 1917, 17, 177—180.

THE methods of regulating the temperature and effecting agitation in sulphonating vessels are discussed. Temperature is usually regulated by using a jacket through which low-pressure steam or water is passed. For temperatures above 110 C. high-pressure steam or superheated water can be used. Vessels for use with high-pressure steam have been made by casting them with wrought iron coils in the wall of the vessel. Another method is to make a jacket of boiler plate and line it with cast iron. There are limitations to the use of superheated steam at low pressure as its thermal capacity diminishes at higher temperatures, so that it becomes an unsatisfactory medium for carrying heat. Heat may be applied by circulating hot mineral oil through the jacket and a coil placed in a furnace. The oil must be carefully dehydrated and if heated to above 150° C., a reflux condenser must be employed to prevent loss of lighter fractions. Temperatures of 300° C. may then be maintained. The vessels may also be fire-heated. Various types of agitator are described. U-shaped stirrers may be placed eccentrically to give better agitation. Propeller agitation is largely used. The speed and size of the propeller must be adjusted to the type of vessel and contents, to give good results. This is a disadvantage where the nature of the liquid changes during a reaction. Two propellers on one shaft may be used with varying pitches and throwing in opposite directions. The shaft is preferably placed slightly off centre.—H. J. H.

Amines; Catalytic decomposition of —. *Formation of aniline from substituted anilines.* P. Sabatier and G. Gaudion. Comptes rend., 1917, 165, 309—313.

FINELY divided nickel, produced by the reduction of the oxide at a temperature below 700° C., is capable of decomposing various amines. At 356° C., nickel converts cyclohexylamine into aniline, whilst the reverse reaction takes place below 180° C.; under similar conditions, piperidine yields pyridine, primary amines are converted into nitriles, and methyl-*o*-toluidine into indole. In many cases, ammonia is split off; ethylamine yields ammonia and ethylene, which in turn is decomposed with the formation of carbon, hydrogen, methane, and ethane. Benzylamine yields toluene and ammonia. Methylaniline and dimethylaniline in contact with nickel at 350° C. yield benzene, aniline, ammonia, etc.; ethylaniline and diethylaniline react in a similar way.—W. P. S.

Preparation of nitro-derivatives of toluene. Kidokoro. See XXII.

PATENTS.

"Resins" from benzol-plant residues; Method of recovering —. M. Darrin, Wilkesburg, Pa., Assignor to H. Koppers Co., Pittsburgh, Pa. U.S. Pat. 1,236,917, Aug. 14, 1917. Date of appl. Dec. 30, 1916.

BENZOL-PLANT residues are dissolved in solvent naphtha, the insoluble solid matter is removed, and the solution is distilled until the desired vapour temperature is attained, when a gas is blown through the solution.—F. W. A.

Catalytic hydrogenisations; Effecting —. [Reduction of aromatic amines.] O. Schmidt, Ludwigshafen, and H. Blankenhorn, Mannheim, Assignors to Badische Anilin und Soda Fabrik, Ludwigshafen, Germany. U.S. Pat. 1,237,828, Aug. 21, 1917. Date of appl. May 8, 1915.

SEE Eng. Pat. 6109 of 1915; this J., 1916, 920.

IV.—COLOURING MATTERS AND DYES.

Palatine Chrome Black 6B; Preparation of—
I. Tomioka. Kogyo-Kwagaku-Zasshi (J. Chem. Ind., Tokyo), 1917, 29, 577—587.

1-AMINO-2-NAPHTHOL-1-SULPHONIC acid was prepared by the following methods: (A) α -nitro-naphthalene was heated with sodium bisulphite solution (over 20% SO_2), and the 1-aminonaphthalene-2,4-disulphonic acid produced was submitted to alkaline fusion; (B) 1-nitroso-2-naphthol was heated with 35% sodium bisulphite solution; (C) Orange II. was reduced by stannous chloride or zinc dust and hydrochloric acid, the 1-amino-2-naphthol produced was treated with bleaching powder, and the resulting β -naphthoquinone- α -chlorimide treated with sodium bisulphite solution. By using one of these methods a yield of 94% of the theoretical quantity was obtained. 24 parts of 1-amino-2-naphthol-4-sulphonic acid was dissolved in 11.3 parts of 15% ammonia solution diluted with 60 parts of water, and 58.2 parts of zinc chloride solution (40 B.; sp. gr. 1.381) added; the zinc salt was cooled in ice, and 16 parts of 90% sodium nitrite in 50 parts of water added gradually at 2—5.5°C., the temperature being subsequently raised to 13° in 2 hrs., kept at 25—30°C. for 1 hr., and at 40—45°C. for 1 hr. The diazo solution was cooled to 30°C., and 39 parts of 25% acetic acid added; after stirring for 1 hr., 40 parts of soda ash was added gradually, the solution was warmed to 40°C., and 16 parts of β -naphthol dissolved in 6 parts of caustic soda and 30 parts of water at 80°C. added with vigorous stirring; after stirring for 5 hrs. at 50°C., the zinc salt of the dyestuff was salted out, and converted into the free acid by concentrated hydrochloric acid; the yield was 53.6 parts, corresponding to 95.8% of theory.—F. W. A.

PATENTS.

[*Trisazo*] *colouring matters; Manufacture of*—
E. F. and H. W. Ehrhardt, Birmingham. Eng. Pat. 108,613, Nov. 22, 1916, and Jan. 6, 1917. (Appl. Nos. 16,752 of 1916 and 301 of 1917.)

DIAZOTISED *p*-phenylenediamine-azo-salicylic acid is combined with picramic acid-azo-*m*-toluylenediamine, *m*-phenylenediamine, or -chloro-*m*-phenylenediamine. The products dye chrome-mordanted wool a yellowish shade of brown than picramic acid-azo-*m*-toluylenediamine, faster to light than the monoazo dyestuff, and of equal fastness to scouring and milling.—F. W. A.

[*Trisazo*] *dyestuffs*. J. H. Stebbins, jun., New York. U.S. Pat. 1,235,253, July 31, 1917. Date of appl., Jan. 9, 1917.

1,8-DIHYDROXYNAPHTHALENE-3,6-DISULPHONIC acid is first combined with tetrazotised benzidine and then with a diazotised amine, and the products combined with a naphtholsulphonic acid. The dyestuffs produced give bluish or purplish shades on cotton from a sodium sulphate bath, and blue to black to brown shades on wool from an acid sodium sulphate bath. The product using picramic acid and 1,4-naphtholsulphonic acid is specially laimed.—F. W. A.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Straw. Utilisation of surplus—.

IN anticipation of a surplus production of straw in Scotland next year, amounting to over 420,000 tons, a Memorandum has been prepared by the Consulting Chemist to the Highland and Agricultural Society of Scotland. The Memorandum

states that the use of straw in this country as a constituent in the manufacture of paper has been largely curtailed owing to irregularities of supplies and fluctuations in prices. Prior to the war the supply of esparto was quite regular and ample, and was obtainable at more or less regular and moderate prices. Esparto and wood pulp have been the raw materials most largely used hitherto in the manufacture of cheap writing papers and the better class of printing papers. Paper manufacturers see no reason why straw should not be much more largely used in the manufacture of various grades of paper in the United Kingdom, provided constant supplies can be obtained, and provided also that farmers will take the trouble to keep straw reasonably free from stalks of thistles, etc. Straw pulp may be looked upon as a substitute for esparto, although it does not seem probable that it can ever entirely supersede that product. The best quality of straw pulp could be freely used in the hardening of ordinary writing paper, which is largely composed of wood and esparto pulps, but which could be made entirely from wood and straw pulps. Experiments have recently been carried out in two Scottish mills for the purpose of determining the yield, and of testing the utility, of straw pulp. Both wheat and oat straw were tested, and fairly satisfactory results were obtained. A yield of pulp was obtained from oat straw equal to 35 per cent. of the weight of bone-dry straw. Among possible consumers of straw must be included the manufacturers of straw boards. Up to the present time the United Kingdom has taken supplies of these boards entirely from abroad. The utilisation of straw for straw boards could be effected by paper manufacturers if they cared to augment their present machinery by the special machinery which would be necessary. The cheapest straw boards are made from straw and waste material, and it is these that are imported from abroad. Boards for expensive books are of British manufacture. It may be possible, says the writer of the Memorandum, for United Kingdom manufacturers to turn out suitable straw boards, such as are found on the covers of ordinary books. The Memorandum also discusses the utilisation of straw for increasing the yield of nitrogen in the soil, and also its utilisation for feeding.

Pulp and paper industry of Canada. O. F. Bryant. Pulp and Paper Mag. J. Roy. Soc. Arts, 1917, 65, 619—626, 631—639.

At the present time there are about 80 pulp and paper mills in Canada. The percentage proportions of the different types of pulp manufactured in Canada in 1915 were: Mechanical, 52.9; sulphite, 33.5; sulphate, 13.1; soda, 0.5. Spruce was used to the extent of 50% of the total pulp manufactured, balsam fir 33%, while the remainder was made up of hemlock, jack pine, and poplar. In most cases no logs under 1 in. diam. are accepted; the amount of bark on a log is about 10% by weight and the loss of weight in removing it by a disc barker is about 20%. With barking drums a considerable saving is effected, the yield of air-dry pulp per cord being 1700 lb. with disc barkers and 1980 lb. with drum barkers. In the manufacture of mechanical pulp, cold-ground pulp is ground with plenty of water and is suitable for finer products, while hot-ground pulp, in the production of which the quantity of water is restricted and the temperature rises to 66°C., is suitable for fast, coarse work, such as news paper manufacture. In the manufacture of sulphite pulp, rotary sulphur kilns give more efficient results than the old type of horizontal burner. Another modern type consists of a vertical cylindrical shell at the top of which is a melting pot; the molten

sulphur drips down the tower over shelves which cause it to travel from side to side exposed to the action of the ascending air. In Canada both the limestone process and the milk of lime process are employed for the production of the liquor. The pulp digesters are lined with acid-resisting flint brick jointed with a mixture of litharge, glycerin, and quartz. These bricks are set over a course of ordinary bricks cemented with Portland cement and quartz. Pulp is digested by the rapid method at a maximum pressure of 75 lb. per sq. in. and a temperature of 165° C. and by the slow "Mitscherlich" process at a maximum pressure of 55—60 lb. In the manufacture of soda pulp the wood is chopped more finely than for sulphite pulp; digestion with caustic soda is carried out in upright digesters under a pressure of 100—125 lb. per sq. in. for about 8 hours. The sulphate process has been established in Canada for about 10 years and is used chiefly for the manufacture of "kraft" pulps; various inferior qualities of wood can be worked by this process which are unsuitable for the manufacture of sulphite pulp. Digestion is carried out sometimes in stationary digesters and sometimes in "tumblers" revolving on their short axis, having a maximum capacity of 2½ tons. The pulp is preferably washed in closed "diffusers" by means of weak liquors from previous charges. Evaporation of the black lye is performed in a combination of a multiple effect evaporator and a disc evaporator heated by the gases from the calcination furnaces; the latter consist of a rotary furnace placed in front of a smelting furnace in which a very high temperature is maintained in order to burn the carbon and reduce the sodium sulphate. For bleaching wood pulp many of the mills are equipped with electrolytic plant for preparing chlorine and caustic soda, the chlorine gas being absorbed in milk of lime. In 1908, 64% of the pulp-wood cut was exported in the raw state, whereas in 1915 the raw wood exported was only 11.1%. During that period the export of pulp-wood has increased by only 6.7%, whereas the export of wood-pulp has increased by 190%. At the average rate of 10 cords of wood per acre, a mill producing 200 tons of news paper per day would require the product of 9000 acres per year and allowing 40 years for a crop, such a mill would be served by a tract of 400,000 acres with systematic cutting and re-planting. Canada is producing about 1800 tons of news paper alone per day, and the total cut of pulp wood in 1915 was 2,355,550 cords. The total production of pulp in 1915 was 1,074,805 tons, of which 743,776 tons was mechanical pulp. The industry is concentrated in the provinces of Quebec and Ontario. The estimated amount of paper produced is 6,752,000 lb. per 24 hours. Developments are at present under way which will increase the daily output of pulp by 880 tons.—J. F. B.

PATENTS.

Coated fabric. E. W. Adams and S. G. W. Farthing, London. Eng. Pat. 108,376, Aug. 28, 1916. (Appl. No. 12,138 of 1916.)

THICK twill canvas is coated on both sides with a composition consisting of hard paraffin, 2 parts; soft paraffin, 4 parts; wood charcoal, 0.5; and powdered talc, 0.5 part. The ingredients are melted together, stirred until cold, and rubbed in cold.—J. F. B.

Wool, hair, or like substances contaminated with lime; Method of deliming —. J. Lucas, Passaic, N.J. U.S. Pat. 1,235,214, July 31, 1917. Date of appl., June 1, 1916.

MATERIAL such as wool, hair, or bristles, contaminated with lime, is steeped in a bath containing a pure culture of butyric acid Schizomycetes, such as *B. bonoprius* or *B. subtilis*; the bacilli in the bath are nourished during the deliming process

by a regulated supply of food so as to maintain the natural functions of the bacilli until the lime has been dissolved.—J. F. B.

Rice straw: Process for producing fibrous material from —. J. K. Toles, San Francisco, Cal., Assignor to Union Fibre Co., Winona, Mich. U.S. Pat. 1,235,258, July 31, 1917. Date of appl., Mar. 1, 1915. Renewed June 15, 1917.

RICE straw is boiled in an alkaline solution in order to break down the substances surrounding the fibres; the material is then washed in water and treated with an acid solution.—J. F. B.

Retting. B. S. Summers, Port Huron, Mich. U.S. Pat. 1,235,738, Aug. 7, 1917. Date of appl., Aug. 24, 1914.

A RETTING solution is prepared by dissolving albuminous material in a solution of sodium sulphide; the fibre is steeped in this solution and simultaneously subjected to heat and pressure, and the albuminous matter is subsequently precipitated in the fibre by treating the latter with an oxidising solution, such as bleaching powder.—J. F. B.

Cellulose compound and method of making the same. E. L. Bloch-Pimentel, Paris. U.S. Pat. 1,234,720, July 31, 1917. Date of appl., June 24, 1915.

CELLULOSE is treated with formaldehyde and ferric chloride, dried *in vacuo*, and heated in an oven sufficiently to form trioxymethylene and to cause this to react with the cellulose in the presence of the ferric chloride.—J. F. B.

Pyroxylin composition. W. E. Masland, Philadelphia, Pa., Assignor to E. I. du Pont de Nemours Powder Co., Wilmington, Del. U.S. Pat. 1,234,921, July 31, 1917. Date of appl., June 19, 1914. Renewed Feb. 19, 1917.

PYROXYLIN is combined with 2—10% of aldol and 10—60% of a vegetable oil, e.g., castor oil, the amount of aldol and oil being between 40 and 75% of the constituents.—J. F. B.

Insulating material [from fibre]: Process of producing an —. W. Schewelin, Moscow, Russia. U.S. Pat. 1,235,061, July 31, 1917. Date of appl., July 9, 1911.

FIBRE for use as an insulating filling material, is washed, dried, and lixiviated in a solution of caustic and calcined soda; it is then again washed in hot water together with disinfecting and "non-odour developing substances," and dried in the presence of formalin vapour.—B. N.

Obturator material and method of making same. M. W. Marsden, Philadelphia, Pa. U.S. Pat. 1,235,220, July 31, 1917. Date of appl., July 8, 1913.

CORN (maize) stalks are cut in pieces and digested with steam under pressure to free them from saccharine and fermentative matter; this is separated from the digested mass and the latter is treated with alkali to remove the incrusting matter. The comminuted mass of fibres and pith is compressed to a block having a cork-like texture characterised by the property of suddenly swelling when wet.—J. F. B.

Wood and other cellulose-containing materials; Art of transforming —. G. W. Herbein, San Francisco, Cal. U.S. Pat. 1,235,895, Aug. 7, 1917. Date of appl., Aug. 5, 1916.

WOOD or other cellulose-containing material is boiled in paraffin or paraffin and resin for about 40 minutes at 340°—400° F. (171°—205°C).—J. F. B.

Cellulose; Method for the manufacture of —.
Apparatus for boiling fibre for the manufacture of cellulose. H. B. Ellis, Assignor to J. W. Wilhelm, Pahnetto, Fla. U.S. Pats. 1,236,072 and 1,236,370, Aug. 7, 1917. Dates of appl. Jan. 24 and Jan. 12, 1917.

FIBROUS material is shredded and the fibre separated from the dust. The fibre is heated in a pre-heating arrangement and a solution of caustic soda, previously heated, is introduced; the mixture is agitated during the operation of pre-heating and is subsequently brought to the boiling point. The apparatus comprises a series of tubular chambers, superposed and in parallel, having connections whereby an undulated passage is formed for the cellulose material. A steam pipe extends longitudinally through each tubular chamber to heat the cellulose material, and means are provided for conveying the material from a container through the heated passage. The container is surrounded by a jacket for preheating the material, the jacket being connected with the steam heating arrangement, and means are provided for disintegrating or breaking up the material as it leaves the heated passage.—J. F. B.

Paper [ornamental]; Manufacture of —. J. W. Mackenzie, London. From The Strathmore Paper Co., Mittineaque, Mass., U.S.A. Eng. Pat. 108,340, July 27, 1916. (Appl. No. 10,660 of 1916.)

A COLOURING or decolorising medium is applied to the uneven surface of the sheet or web of paper by means of a pressure roller to which the medium is supplied, e.g. by a brush spraying apparatus: the medium is thus transferred to the paper under rolling pressure and displaced from the elevated portions of the paper into the depressions. The uneven surface may be obtained by putting out of action the suction box in front of the dandy roll, so that the pulp is banked up and crushed under the dandy, and the coloured medium may be sprayed on to the upper couch roll.
 —J. F. B.

Fibrous materials; Separating impurities from waste —. Naamlooze Vennootschap Neo-Cellulose Maatschappij, Rotterdam, Holland. Eng. Pat. 108,434, May 2, 1916. (Appl. No. 3560 of 1917.) Addition to Eng. Pats. 24,057 of 1912 and 105,055 of 1916 (this J., 1913, 1104, and 1917, 868).

For removing printers' ink from waste papers a mixture of a foam producer and foam stabiliser is employed, the latter of which may amount to 20% of the mixture. A soap such as sodium stearate may serve as the foam producer and a vegetable or animal fat or solid or semi-solid hydrocarbon such as margarine or vaseline as the stabiliser. The mixture is produced in the form of a homogeneous, permanent, marketable mass. (Reference is directed under Sect. 7, Sub-section 4, of the Patents and Designs Act, 1907, to Eng. Pats. 12,385 of 1884; 11,981 of 1886; 5981, 7830, and 9857 of 1888; 21,431 of 1891; 19,732 of 1893; 24,240 of 1903; 29,113 of 1909; 17,714 of 1911; 24,795 and 29,122 of 1913; this J., 1885, 550; 1887, 727; 1889, 290, 714; 1892, 446; 1894, 962; 1904, 195; 1910, 1214; 1912, 812; 1914, 1215; 1915, 144.)—J. F. B.

Paper; Manufacture of glazed or loaded —, and coating and loading materials therefor. N. Statham, Hastings-on-Hudson, N.Y., U.S.A. Eng. Pat. 108,783, Nov. 8, 1916. (Appl. No. 16,028 of 1916.)

SEE U.S. Pats. 1,209,221 and 1,209,222 of 1916; this J., 1917, 212.

Paper pulp; Machine for staining —. W. W. Beaumont, London. U.S. Pat. 1,237,280, Aug. 21, 1917. Date of appl. Jan. 4, 1916.

SEE Eng. Pat. 17,552 of 1913; this J., 1914, 916.

Process of dyeing. U.S. Pat. 1,236,868. See VI

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

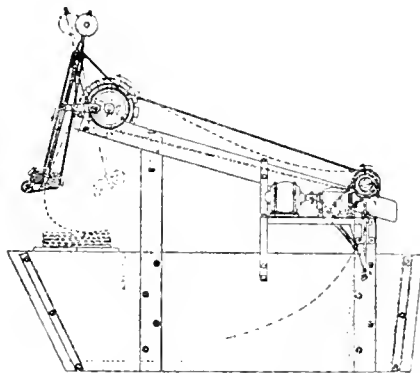
PATENTS.

Dyeing, scouring, and washing wool and other fibrous materials; Machines for —. J. and R. Whitaker, Dewsbury. Eng. Pat. 108,809, Jan. 23, 1917. (Appl. No. 1106 of 1917.) Addition to Eng. Pat. 101,060 (this J., 1916, 961).

IN dyeing and like machines of the type specified in the main patent, the side tipping discharge mechanism for the hinged inner chamber is operated by power-controlled overhead lifting gear which is arranged so that the lift is applied in an approximately circumferential direction to secure a wider tipping movement, and is combined with spring buffer and stop devices.—F. W. A.

Dye-beck. C. Buhl, Assignor to The Johnson Van Vlaandaren Machine Co., Paterson, N.J. U.S. Pat. 1,232,653, July 10, 1917. Date of appl. July 20, 1916.

AN apparatus for treating fabrics (see fig.) comprises a wheel or the like for advancing the fabric, journaled in a support on a horizontal axis, a



swinging fabric-guiding structure pivoted in the support on a horizontal axis above the wheel, and a link connecting this structure with an eccentric part of the wheel. The fabric-guiding portion of the structure is below the wheel and consists of a pair of co-acting fabric-guiding rollers, and means are provided to transmit rotary motion from the wheel to the rollers.—F. W. A.

Dyeing hanks and fabrics; Machine for —. L. S. Thompson, Brooklyn, N.Y., Assignor to Simultaneous Dyeing and Drying Co. U.S. Pat. 1,236,788, Aug. 14, 1917. Date of appl. Mar. 9, 1917.

A DYEING and drying machine consists of a vat containing a pair of wheels adjustable on a rotary axis, with curved ribbons mounted at the inner side of the wheels to support the material on and between the wheels.—F. W. A.

Detergent, bleaching, and disinfecting composition. F. F. Carmona, Assignor to Compania Exploradora Navezten, Mexico. U.S. Pat. 1,237,267, Aug. 14, 1917. Date of appl. Aug. 29, 1914.

A CLEANING and bleaching composition having disinfectant properties consists of the reaction

products of sodium carbonate, caustic soda sodium chloride, chloride of lime, sodium bisulphite, and the "saponifying-bark" derivative "shixhi."—F. W. A.

Dyeing; Process of—J. Puring, Assignor to Robeson Process Co., New York, U.S. Pat. 1,236,868, Aug. 14, 1917. Date of appl. Sep. 16, 1916.

TEXTILE materials are treated first with a solution obtained by the interaction of commercial concentrated sulphite waste liquor and iron sulphate, and afterwards with a colour-developing substance, e.g., a solution containing pyrazolol.—F.W.A.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Potassium chloride from mother liquor in manufacture of sea-salt. T. Nishimura, Kogyo-Kwakaku-Zasshi (J. Chem. Ind., Tokyo), 1917, 20, 587—621.

THE annual production of bittern in Japan is 240,000 tons, and its composition when freshly obtained is: 12.27—20.63% $MgCl_2$, 2.30—3.48% KCl , 0.26—0.47% $MgBr$, 6.04—7.62% $MgSO_4$, 2.90—7.96% $NaCl$, and 67.53—69.30% water; it may be one of the most important sources of potash in Japan. The isolation of the potassium chloride is described; 80% of the potassium can be recovered as chloride of 80% purity.—F.W.A.

Catalysis. III. Some induced reactions. [Reduction of mercuric chloride, etc.] N. Dhar, Chem. Soc. Trans., 1917, 111, 690—706.

IN aqueous solution at 100° C. mercuric chloride is not reduced by oxalic acid but, under the influence of sunlight, formation of mercurous chloride occurs even at the ordinary temperature. A similar result is obtained in the dark on the addition of a drop of N/10 potassium permanganate to the aqueous mixture. This phenomenon appears to be of general occurrence; the reduction of mercuric chloride or bromide by oxalic acid, tartaric acid, citric acid, malonic acid, malic acid, glycollic acid, lactic acid, hydroxylamine hydrochloride, and hydrazine hydrochloride, of gold chloride by various reducing agents, and of silver nitrate, cupric chloride, and selenious acid by various organic acids, is promoted by the addition of such oxidising agents as potassium permanganate, persulphate, and nitrite, manganese dioxide, and hydrogen peroxide. Chromic acid and nitric acid induce the reduction of mercuric chloride by oxalic acid only in the additional presence of manganese sulphate, which exerts a marked catalytic effect on reactions of this type involving mercuric chloride, oxalic acid, and an oxidising agent; sulphuric acid on the other hand behaves as a negative catalyst. The possibility that the reducing effect in the above examples is due to the intermediate formation of hydrogen peroxide or of formic acid is discountenanced by the fact that these substances are not sufficiently active in this direction. Favour is given to the view that whether under the influence of light, of a catalyst, or of an inductor as described above, the effect is due to the intermediate transformation of the reacting molecules into an active condition.

—D. F. T.

Zinc sulphide; Phosphorescent—E. MacDougall, A. W. Stewart, and R. Wright, Chem. Soc. Trans., 1917, 111, 663—683.

PURE zinc sulphide prepared in various ways can

be obtained in a phosphorescent condition, but heat is necessary in order to produce this state; ordinary precipitated zinc sulphide shows no trace of phosphorescence. The addition of certain impurities has a marked effect in most cases, either inhibiting the phosphorescence, as in the case of iron, or altering the tint as in the case of manganese. The presence of a chloride, either of zinc or other element, increases the phosphorescence. The factor which has the greatest influence, however, is the temperature to which the zinc sulphide is heated, and this may be varied within limits. A sample heated for a very short time to a high temperature has been found to give effects similar to those observed in another sample heated for a longer time at a lower temperature, provided that the latter is not lower than about 750° C. Washing, rubbing, or disturbance of the final product in any way, tends to diminish its phosphorescent power. The amorphous sulphide does not phosphoresce, nor does the purely crystalline sulphide show such good phosphorescence phenomena as samples which contain semi-crystalline material. Specimens made from zinc salts free from chlorides, do not show such brilliant phosphorescence as those produced in the presence of chlorides. It is suggested that when the impure sulphide is heated, a surface film of zinc chloride is produced; and this film, on cooling, may contract and produce a strained condition of the material within the film. When manganese is present, however, it is difficult to avoid the conclusion that some chemical phenomenon must be concerned.—B.N.

Ozone; Determination of—and of oxides of nitrogen in the atmosphere. F. L. Usher and B. S. Rao, Chem. Soc. Trans., 1917, 111, 799—809.

THE ozone was estimated by making use of the reaction with sodium nitrite in dilute aqueous solution, this reaction taking place according to the equation: $O_3 + NaNO_2 = O_2 + NaNO$. Two samples of air were collected by displacement of purified water in 7-litre stoppered bottles. One sample was admitted through two tubes containing respectively chromic acid and powdered manganese dioxide, both compounds being specially purified, and the other sample was passed through a tube containing chromic acid only. The samples thus collected were shaken with 25 c.c. of N/40,000 sodium nitrite (made up with N/1000 sodium hydroxide in place of water), mixed with 100 c.c. of water. All the reagents used were specially prepared and purified. The nitrite content of the bottles was subsequently determined colorimetrically by the Griess-Hosvay method with α -naphthylamine and sulphanilic acid, the solutions being afterwards compared in a Duboseq colorimeter. The first sample of air contains only nitrogen peroxide, the ozone and hydrogen peroxide having been absorbed, and the increase of nitrite in the bottle is equivalent to the nitrogen peroxide absorbed. The second sample contains ozone and nitrogen peroxide, and the difference between the quantities of nitrite in the two bottles after shaking is equivalent to the ozone present. It is stated that the method will detect 1 part of nitrogen peroxide in 56 millions of air. In fourteen complete determinations made by the method on samples of air taken from the atmosphere in Bangalore, S. India, covering the period, July, 1916, to January, 1917, on no occasion was any ozone found. On two occasions, after thundery weather, with very little rain, nitrogen peroxide was present to the extent of 1 part in 5 millions and 1 in 4 millions respectively, but never exceeded 1 part in 20 millions on other occasions. There appears to be ground for the opinion that ozone and nitrogen peroxide never occur together in the atmosphere.—B. N.

PATENTS.

Nitric acid; Manufacture of concentrated—. K. Birkeland, Assignor to Norsk Hydro-Elektrisk Kvaelfstofaktieselskab, Christiania, Norway. U.S. Pat. 1,236,662, Aug. 14, 1917. Date of appl., Jan. 13, 1913.

A METAL capable of forming a nitrate is treated with dilute nitric acid and the solution of the nitrate evaporated. The salt is decomposed with steam to metal oxide and a gas containing oxides of nitrogen, the peroxide being converted into nitric oxide, which is converted into nitric acid by steam and oxygen.—J. H. P.

Radioactive mineral waters containing radium-precipitating acids; Preparation of—. H. C. Aggersborg, Frediksberg, Denmark. Eng. Pat. 101,295, Aug. 24, 1916. (Appl. No. 12,020 of 1916.) Under Int. Conv., Aug. 24, 1915.

THE radium salt and the other constituents of the mineral water—including those like sulphates and phosphates which precipitate radium—are dissolved separately in distilled water containing carbon dioxide under a pressure of 4 atmospheres. The two solutions are then mixed, the pressure being maintained, and the precipitation of radium thus prevented.—H. J. H.

Perborates; Manufacture of—. Deutsche Gold- und Silber-Scheideanstalt, Frankfurt, Germany. Eng. Pat. 106,460, Aug. 8, 1916. (Appl. No. 11,186 of 1916.) Under Int. Conv., May 17, 1916. Addition to Eng. Pat. 100,153 (this J., 1917, 83).

IN the process as described in the previous patent, the disintegration of electrodes of base metal, e.g., zinc, tin, or aluminium, can be diminished or avoided by the addition of small quantities of chromic acid or chromates to the electrolyte; 5 grms. of chromic acid to 10 litres of electrolyte has given good results in regard to colour of product and current efficiency. The parts of the electrodes not immersed in the electrolyte can be protected by a coating of varnish or vulcanised rubber. (Reference is directed in pursuance of Sect. 8, Sub-sect. 2, of the Patents and Designs Act, 1907, to Eng. Pat. 101,620; this J., 1917, 137.) —H. J. H.

Borax; Extraction of—*from mixtures containing boric acid or borax and sodium sulphate*. Deutsche Gold- und Silber-Scheideanstalt vorm. Roessler, Frankfurt, Germany. Eng. Pat. 107,019, June 7, 1917. (Appl. No. 8160 of 1917.) Under Int. Conv., May 17, 1916.

A SOLUTION of sodium sulphate saturated or almost saturated with borax is heated to boiling, thus precipitating most of the sodium sulphate. This is separated and borax crystallised from the solution at 34° C. whilst the residual Glauber salt remains in solution. If boric acid is present soda is added.—J. H. P.

Sodium ferrocyanide; Method of making—. T. Boberg, and Techno-Chemical Laboratories, Ltd., London. Eng. Pat. 108,692, May 15, 1916. (Appl. No. 6935 of 1916.)

A MIXTURE of one part of coke and four parts of sodium carbonate is finely ground and heated to a bright red heat in presence of nitrogen, with the formation of cyanide and cyanamide of barium which are recovered by lixiviating with water. The barium is precipitated from the solution with sodium carbonate. The solution is treated at 0° C. with iron dust, and when no free cyanide remains the caustic soda is carbonated by blowing a carbon dioxide. The solution of sodium ferrocyanide and sodium carbonate is evaporated at 80° C. to crystallising point and slowly cooled, when sodium ferrocyanide crystallises out. At

35° C. the mother liquor is drawn off before soda crystals separate. The mother liquor is then cooled to a low temperature and the mixture of sodium carbonate and ferrocyanide deposited is used to precipitate barium from the melt.—J. H. P.

Base-exchanging bodies; Process of making—. G. Rudolf, London. Eng. Pat. 108,773, Oct. 17, 1916. (Appl. No. 14,763 of 1916.)

A 5% SOLUTION of sodium aluminate is added to a solution of sodium silicate. A gelatinous precipitate is formed which is collected in a filter-press or on a suction filter, and the press-cake dried, without washing, at 70°–100° C. The cake is exposed to the air for a day and plunged into water. This breaks it up into angular fragments, 1–2 mm. in diameter, and the water washes the cake. The material may be freed from water in a centrifugal machine or used directly.—J. H. P.

Prussic [hydrocyanic] acid; Process and apparatus for manufacturing—. Process of producing prussic acid. O. Liebknecht, Frankfurt, Germany, Assignor to Roessler and Hasslacher Chemical Co., New York. U.S. Pats. (A) 1,235,342 and (B) 1,235,343, July 31, 1917. Date of appl., Jan. 27, 1917.

(A) HYDROCYANIC acid is produced by the action of a high voltage arc upon a mixture of a hydrocarbon, hydrogen, and nitrogen. The mixture is passed through a chamber into which the electrodes project from small side chambers. Into the latter are led inert gases so as to sweep the space round the electrodes free from gases capable of depositing carbon and thus breaking down the insulation. (B) The process is worked under a pressure of about 1.6 atmospheres.—H. J. H.

Cyanogen compounds; Process of manufacturing—. H. Foersterling, H. Philipp, and R. N. Sargent, Perth Amboy, N.J., Assignors to The Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,235,887, Aug. 7, 1917. Date of appl., Oct. 29, 1913.

FINELY divided carbon, nitrogen, and the vapour of a metal are brought together in theoretical proportions at the boiling point of the metal, so that combination occurs. The reaction is exothermic, and once started, external heat is withdrawn, the temperature being maintained and regulated by feeding fresh supplies of the reagents at suitable rates and in suitable proportions.—H. J. H.

Ammonium fluorides; Process of producing—. H. F. Chappell, Assignor to Mineral Products Corporation, New York. U.S. Pat. 1,235,552, Aug. 7, 1917. Date of appl., July 17, 1913.

GASES and vapours containing silicon fluoride produced in the preparation of phosphoric acid and phosphate from phosphatic material containing fluorine, are brought into contact with a solution of ammonia. Ammonium fluoride and bifuluoride are produced and silica is precipitated. After separating the latter, the solution may be used for washing the gas again so as to obtain a more concentrated solution.—H. J. H.

Oxide of titanium; Process for obtaining—*from materials incorporating other substances*. L. E. Barton, Niagara Falls, N.Y., Assignor to Titanium Alloy Manufacturing Co., New York. U.S. Pat. 1,235,638, Aug. 7, 1917. Date of appl., Mar. 30, 1917.

MATERIAL containing titanium oxide is dissolved in a suitable acid and the solution electrolysed in the cathode chamber of a cell the electrodes of which are separated by a diaphragm. The anode chamber contains an acid solution. The cathode

solution is withdrawn and on heating deposits hydrated titanium oxide which is removed and calcined.—H. J. H.

Nitrogen: Fixation of—R. H. McKee, Ridgefield Park, N.Y., U.S. Pat. 1,236,853, Aug. 11, 1917. Date of appl. Oct. 26, 1916.

The reaction is effected in a container having exposed interior walls of an alloy of nickel, chromium, and iron. The composition of the alloy is approximately Ni 60, Cr 12, Fe 25%, with small quantities of manganese and carbon.

—J. H. P.

Potash: Recovery of—F. G. Breyer, Palmerton, Pa., U.S. Pat. 1,236,903, Aug. 11, 1917. Date of appl. Aug. 26, 1915.

CARBONACEOUS matter and refuse of low carbon content and high ash is burnt with limestone in a blast-furnace. The limestone forms a slag with the ash, and a sufficiently high temperature is used to volatilise the potash.—J. H. P.

Potash of felspar and similar materials: Process for rendering available the—W. Glaeser, Brooklyn, N.Y., Assignor to G. T. Bishop, Macedonia, Ohio, U.S. Pat. 1,237,197, Aug. 11, 1917. Date of appl. Sept. 16, 1911.

The material is burned at a low red heat, suddenly cooled, mixed with less than 20% of burned lime, and then fused at 1600° C. The product may be used in agriculture, or ground and treated with sulphuric acid to form potash alum.—A. B. S.

Chlorine gas: Process for producing—L. C. Jones and G. N. Terziev, Syracuse, N.Y., Assignors to The Solvay Process Co., Solvay, N.Y., U.S. Pat. 1,236,570, Aug. 11, 1917. Date of appl. Aug. 3, 1915.

AN alkali chloride is heated with ferric sulphate in the presence of oxygen. The ferric sulphate is formed by treating ferric oxide mixed with sodium chloride with sulphur trioxide at a temperature below that at which chlorine compounds are evolved.—J. H. P.

Magnesium chloride: Manufacture of anhydrous—E. A. Ashcroft, London, Eng. Pat. 108,755, Sept. 12, 1916. (Appl. No. 12,873 of 1916.)

SEE U.S. Pat. 1,231,711 of 1917; this J., 1917, 925. Carbon, or a sulphur compound, such as salena or zinc blende, may be added to the charge for the purpose of producing an exothermic reaction.

Magnesium chloride: Manufacture of anhydrous—alone or conjointly with other metal chlorides. E. A. Ashcroft, London, Eng. Pat. 108,920. (Appl. Nos. 13,259, Sept. 19, and 13,614, Sept. 26, 1916.)

SEE U.S. Pat. 1,232,169 of 1917; this J., 1917, 926. A sulphide or other substance may be added to promote the exothermic nature of the reaction.

Chalk: Manufacture of light precipitated—N. Statham, Boonton, N.J., U.S.A., Eng. Pat. 102,928, Aug. 11, 1916. (Appl. No. 11,171 of 1916.) Under Int. Conv., Dec. 23, 1915.

SEE U.S. Pat. 1,178,962 of 1916; this J., 1916, 631.

Titanic acid products: Manufacture of—H. Wade, London, From Titanium Alloy Manufacturing Co., New York, Eng. Pat. 108,693, June 15, 1916. (Appl. No. 8165 of 1916.)

SEE U.S. Pat. 1,189,229 of 1916; this J., 1916, 890.

Process of making window glass and hydrochloric acid. U.S. Pat. 1,231,457. See VIII.

VIII.—GLASS; CERAMICS.

Refractory brick: Testing of—C. E. Nesbitt and M. L. Bell, Amer. Soc. for Testing Materials, June 17, 1917. Met. and Chem. Eng., 1917, 17, 181-186.

Slag penetration. Tests involving the total immersion of a brick in a bath of molten slag did not give uniform results, besides requiring large and elaborate apparatus. The best results were obtained by studying the absorption of liquid slag in a pocket drilled into one face of the brick. The drill was pointed at an angle of 150°, and cut a hole 2½ in. in diameter, the depth at the side being ½ in. The hole was cleaned out, and the brick then heated to 1350° C. A known quantity of powdered slag was placed in the pocket, and after maintaining a temperature of 1350° C. for 2 hours, the brick was allowed to cool. When cold it was sawn in two, so as to bisect the original cavity at the centre, thus exposing an area of penetration of the slag. This area was measured by means of a planimeter. Increasing the duration of the test above 2 hours had no great effect, neither had the fineness of the slag, although it was usually ground to pass a 40-mesh sieve. Increasing the quantity of slag taken did not markedly affect the area of penetration if corrected for the differing area of contact.

Crushing test. The brick to be tested is ground so that opposite faces are parallel, measured, and heated in a furnace to 1350° C. The time taken to heat up should be at least 6 hours, and the temperature of 1350° C. should be maintained for 2 hours. The brick is then quickly placed in position in a testing machine of standard type, with asbestos board above and below the specimen. The crushing weight is determined.—H. J. H.

Refractory materials under load at high temperatures: Testing of—Amer. Soc. Testing Materials, June, 1917. Met. and Chem. Eng., 1917, 17, 186-187.

The following procedure is recommended in tentative tests submitted by the Committee on Refractories of the Amer. Soc. for Testing Materials. A full-sized brick on end is heated under load under specified conditions and the resulting deformation measured. A furnace is described. It is heated by two tangentially disposed burners—gas or oil—the flames from which are separated from the brick by a cylinder of alundum. The brick should be uniformly heated and its temperature measured by a thermo-couple, the junction of which is 1 in. from a face of the brick. Alternatively an optical pyrometer may be used. The brick rests on a highly refractory block, e.g., of carborundum, placed at the centre of the furnace, and carries another block of the same material which projects through the top of the furnace. The load is applied to this block by means of a cross beam, supported on guide pillars and carrying weights attached at each end so as to apply a pressure on the brick of 25 lb. per sq. in. The specimen is heated to the test temperature in 1½ hours and maintained there for 1½ hours. Silica material is tested at 1500° C., high-grade clay goods at 1350° C., medium at 1300° C., and low-grade at 1100° C. The cooling is slow and lasts 5 hours at least. The length of the brick is measured to 0.02 inch before and after test and the percentage decrease calculated.—H. J. H.

PATENTS.

Glass: Apparatus for the manufacture of—J. A. Chambers, Pittsburgh, Pa., U.S. Pat. 1,232,494, July 10, 1917. Date of appl. May 1, 1916.

A TANK of molten glass is provided with a ladle or

pot having a removable cover and a glass receiving port in the bottom. An air exhaust channel passes through the side wall of the ladle, near the top, and tongs are provided to grip the pot, the tongs having an exhaust channel which can be brought into communication with the air exhaust channel of the pot.—W. C. H.

Glass; Apparatus for the manufacture of —. J. A. Chambers, Pittsburgh, Pa. U.S. Pat. 1,232,495, July 10, 1917. Date of appl., May 9, 1916.

SUPPORTS are arranged in a tank furnace for supporting refractory vessels, and mechanism for grasping these vessels is provided, comprising a reciprocating arm with pivoted clamping jaws at one end, means for operating the jaws, and means for reciprocating the arm.—W. C. H.

Window glass and hydrochloric acid; Process of making —. W. Glaeser, Brooklyn, N.Y. Assignor to G. T. Bishop, Cleveland, Ohio. U.S. Pat. 1,234,457, July 24, 1917. Date of appl., May 1, 1916.

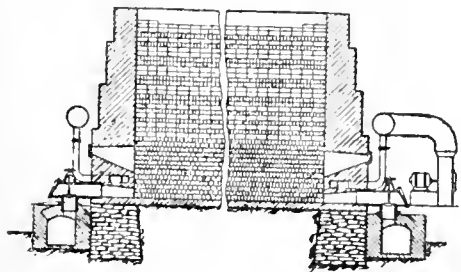
As a step in the manufacture of window glass, a mixture of sand, lime, sodium chloride, and carbon is heated to about 800° C. in the presence of steam in an open kiln.—W. C. H.

Refractory material; Manufacture of a porous mineral product for use in chemical and electrical operations, as a —, *and for other purposes.* M. Barrett, Leeds, Eng. Pat. 108,619, Dec. 2, 1916. (Appl. No. 17,304 of 1916.)

A POROUS mineral product composed essentially of crystalline silica or a vitrified silica-containing substance (e.g., porcelain or stoneware) combined chemically and mechanically by heat with a relatively small proportion of feldspar or feldspathic material. In the process of manufacture, tar, sodium or potassium silicate, and an organic adhesive may be incorporated with the other materials. (Reference is directed, in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pats. 4216 of 1873; 2470 of 1874; 22,784 of 1892; 684 of 1898; and 4355 of 1900; this J., 1894, 154; 1898, 764.)—W. C. H.

Brick kiln. G. C. Heilman, Philadelphia, Pa. U.S. Pat. 1,237,036, Aug. 14, 1917. Date of appl., Oct. 10, 1916.

In a gas-fired kiln of the Scotch type (see fig.), arched combustion chambers, built through the two side walls, are supplied with gas through



lower apertures and air through upper ones in such a manner that both gas and air are heated before they are mixed and burned in the combustion chamber.—A. B. S.

Clay; Treatment of —. W. Feldenheimer, London, Eng. Pat. 108,808, Aug. 11, 1916. (Appl. No. 1099 of 1917.) Addition to Eng. Pat. 106,890, July 10, 1916 (this J., 1917, 879).

SODIUM sesquicarbonate, ammonium carbonate, or potassium carbonate is used in place of the

sodium carbonate specified in the previous patent. It is stated that for suspending 500 parts by weight of china clay from Fraddon, Cornwall, in 10,000 parts by weight of water, the limits for sodium sesquicarbonate are 8.8 and 126.6; for ammonium carbonate 23.5—78.5, and for potassium carbonate 9.0—69 parts by weight. The two latter give results inferior to the sodium compound.—A. B. S.

Abrasive wheel. C. R. King, Assignor to Norton Co., Worcester, Mass. U.S. Pat. 1,235,325, July 31, 1917. Date of appl., May 28, 1914.

THE wheel consists of particles of abrasive material united by a silicate binder into a body with a porous structure, the voids of which are filled with a supplementary bond consisting of a synthetic resin which is applied to the wheel in a liquid form and is changed by the action of heat alone into a permanently solid substance, insoluble in water, and having a melting point higher than the temperatures attained in ordinary grinding operations.—W. C. H.

IX.—BUILDING MATERIALS.

Silica brick; Manufacture of —. C. E. Nesbitt and M. L. Bell, Amer. Soc. for Testing Materials, June, 1917. Met. and Chem. Eng., 1917, 17, 181—184.

IN America the raw material used for the manufacture of silica brick is ganister with 98% of silica and 1% each of iron and alumina, freed from contaminating foreign material. The selected ganister is ground to pass a 4-mesh sieve and ground with water and 2% of lime. For hand-made bricks, 10% of water gives a suitable mixture which is then moulded. Great care is necessary here if the bricks are to be free from defects. The bricks are then dried slowly and carefully in tunnels or on warm floors until bone dry, otherwise cracks may appear on firing. The bricks are burnt in down-draught kilns taking 50,000 to 150,000 bricks. They are taken up to cone 16 at which the temperature is maintained for 1 to 3 days. Ten to fifteen days are taken for the heating up and five days for cooling down. Experiments are recorded on the influence of pressure and fineness of grinding on the product. The pressure in making the bricks was varied from 187 lb. to 2500 lb. per sq. in. Tests on slag penetration, spalling loss, strength against impact, and linear expansion showed that little is gained by raising the pressure, although the product is denser. Tests were made on bricks made of material ground to pass 12-mesh, 8-mesh, and 4-mesh sieves. Fine ground material gave the stronger bricks but the coarser material was more resistant to spalling. The 4-mesh material pressed at 1500 lb. per sq. in. gave bricks which showed the same spalling loss as hand-made bricks, i.e., 30%. Besides being better shaped and finished. Power pressing is advocated instead of hand making.—H. J. H.

Portland cement concrete road construction; Influence of grading on the value of fine aggregate used in —. F. H. Jackson, jun. J. Agr. Res., 1917, 10, 263—271.

RESISTANCE of concrete roads to wear, i.e. to abrasion and impact, mainly depends on hardness and toughness of the material, and the author has studied the effect on these produced by grading the aggregate. For the tests, standard mortar briquettes and cylinders, 2 by 2 inches, were made from a mixture of 1 part of cement and 2½ parts of specially graded sand. Potomac River concrete sand was first divided into 3 sizes.

namely, coarse, composed of equal parts of material which passed a $\frac{1}{4}$ -inch screen, but was retained by a 10-mesh sieve, and of material which passed a 10-mesh but was retained by a 20-mesh sieve; medium, composed of equal parts of 20- to 30-mesh, 30- to 40-mesh, and 40- to 50-mesh material, and fine, composed of all that passed the 50-mesh. These grades were re-combined into 60 different combinations. Specimens for the hardness tests were prepared by drilling 1-inch cores through the centre of the 2-inch cylinders. The ends of the specimens were held against a revolving steel disc on to which quartz sand was fed as an abrasive. The loss of weight after 1000 revolutions was taken as an index of the hardness. When more than 10% of the coarse sand was present, the loss was very slightly more than that which a specimen of solid quartz would suffer. With the medium and fine sand, but no coarse, the loss increased about 40 times. When the ratio of cement to sand was as 1 : $1\frac{1}{2}$, the loss of specimens containing coarse sand was practically the same, but was reduced to about $\frac{1}{4}$ in the case of fine sand. When unscreened sand was used, the hardness of the mortar specimens was greater than that of neat cement, and was practically the same for all ratios of cement to sand up to 1 to 3. Toughness tests were made on 2 x 2 inch cylinders with the Page impact machine, a $\frac{1}{2}$ kilogram hammer being allowed to fall on the test-piece through 1 cm. for the first blow, 2 cm. for the second, and so on till the piece was fractured, when the height of fall in cm. was taken as the index of the relative toughness. Roughly, the toughness increases with the percentage of coarse sand and when any medium and fine sand present are in about equal amounts. Toughness increases as the ratio of cement to sand is increased up to the ratio of 1 : 1, but neat cement is no tougher. Tensile and compressive strengths were determined on standard briquettes and 2 x 2 inch cylinders. In tension and compression the maximum strength was obtained with an aggregate containing 70% of the coarse sand, 10% medium, and 20% fine; and the strength generally decreases with increase in fine material. For road construction it seems probable that greater resistance to wear would be obtained by increasing the coarse sand (the $\frac{1}{4}$ -inch to 20-mesh material) over what is usually considered good practice.

—W. C. H.

Testing of refractory brick. Nesbitt and Bell. See VIII.

Testing of refractory materials under load at high temperatures. See VIII.

PATENTS.

Road making. J. S. Robeson. Au Sable Forks, N.Y., Assignor to Robeson Process Co., Camden, N.J. U.S. Pat. 1,236,875, Aug. 14, 1917. Date of appl., Feb. 27, 1911.

The road is faced with a mixture of calcareous material, a clay-yielding silicate rock, and a preparation of sulphite waste-liquor containing a sesquioxide, such as alumina, and oil is subsequently applied to make the surface waterproof.—A. B. S.

Paving material. E. J. Lovegrove and N. G. Crompton, London. U.S. Pat. 1,237,920, Aug. 21, 1917. Date of appl., Mar. 2, 1915.

SEE Eng. Pats. 5989 and 7539 of 1914; this J., 1911, 1053.

Bituminous grouting. E. J. Lovegrove and N. G. Crompton, London. U.S. Pat. 1,237,921, Aug. 21, 1917. Date of appl., Mar. 2, 1915.

SEE Eng. Pat. 12,973 of 1914; this J., 1915, 231.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Grey cast iron; Note on the heat treatment of —. Part I. J. E. Hurst. Iron and Steel Inst., Sept., 1917. [Advance proof.] 8 pages.

In connection with the rapid deterioration of the cast iron cylinder components of internal combustion engines, it is pointed out that in the Diesel engine the flame is driven directly against the centre of the piston head, the inner surface of which thus attains a temperature of at least 900–950° C. The characteristic "star cracks" produced in such piston heads after short periods of use are frequently traceable to mechanical defects; but, on the other hand, the strength of grey cast iron is known to decrease rapidly with increasing temperature. The analytical results of samples taken from various parts of cracked Diesel engine pistons showed the greater part of the combined carbon to have been converted into the graphitic form in every case, but no oxidation of carbon or silicon was indicated. Similar results as regards carbon were obtained when a series of grey cast iron bars containing 0.016–0.85% P, were heated to 750° and 900° C. for 2–4 hours and quenched in water, the temperature and varying phosphorus content being apparently without influence. When further samples of similar grey cast iron, containing 1.19% P, were heated for 5–15 mins. at 900°–950° C., it was found that a portion of the free carbon had been re-absorbed. Micrographic investigation showed that, in all the heat-treated samples, the worm-like graphite forms of the original grey cast iron had swollen and become somewhat thicker—a circumstance which is regarded as exerting a large influence on the weakening of the metal after subjection to heat. In the author's experience, the cracking of mechanically perfect Diesel engine piston tops is generally traceable to a high phosphorus content of the cast iron (normally about 1%) and can be practically eliminated by reducing the amount of this impurity to the lowest possible limit.—W. E. F. P.

[Steel.] *The acid open-hearth process.* F. Rogers. Iron and Steel Inst., Sept., 1917. * [Advance proof.] 12 pages.

In a critical survey of the principal features affecting the production of sound, clean ingots by the acid open-hearth process, the importance of ideal "dead melting" and of the proper use of lime and deoxidisers is emphasised. The conditions necessary for the full utilisation of the high degree of deoxidation obtained, and for minimising piping, are also considered; and top casting, through a refractory head into a mould with the wider end uppermost, is advocated.

—W. E. F. P.

Acid open-hearth steel; Investigation upon a cast of —. T. D. Morgans and F. Rogers. Iron and Steel Inst., Sept., 1917. [Advance proof.] 10 pages.

To determine the general quality and uniformity of a cast of acid open-hearth steel used for the manufacture of H.E. shell, some twenty ingots were investigated. Analyses were made of pit samples taken immediately before casting each ingot, and of the top, middle, and bottom billet from each ingot. The latter samples were also subjected to tensile and hardness (Brinell) tests and to micrographic examination. The analytical and mechanical results showed great uniformity throughout the series, while the variations of structure noted were only such as ordinarily occur in good steel of this class.—W. E. F. P.

Steels; Influence of heat treatment on the electrical and thermal resistivity and thermo-electromotive potential of some—. E. D. Campbell and W. C. Dowd. *Iron and Steel Inst.*, Sept., 1917. [Advance proof.] 12 pages.

THE specific resistance, thermal resistivity (ingot iron=1), and thermo-electromotive potential (against ingot iron) of a series of carbon, nickel, nickel-chromium, silicon, and manganese steels were determined after annealing at and quenching from appropriate temperatures. Curves are given showing the correlation of the thermal and electrical resistivities as influenced by the chemical constitution and heat treatment of the samples. In all cases, both resistivities were increased by quenching, the extent of the change corresponding closely with the carbon content of the steel. The results are discussed in the light of the hypothesis previously suggested (this J., 1916, 1018), in which the essential unity of mechanism of solid and aqueous solutions is assumed, and are regarded as conforming generally to the requirements of that conception.—W. E. F. P.

Steels; The heterogeneity of—. H. Le Chatelier and E. L. Dupuy. *Comptes rend.*, 1917, 165, 349–352.

THE composition of the metallographic reagent previously described (this J., 1915, 1050) has been modified to increase its sensitiveness, and even to bring out the heterogeneity of low phosphorus steels. The composition of the new reagent is:—Alcohol (95%) 100 c.c., water 10 c.c., cupric chloride crystals 1 grm., picric acid 0.5 grm., concentrated hydrochloric acid 1 c.c. to 2.5 c.c. The concentrations of copper chloride and picric acid may be varied somewhat without ill effect, but the concentration of alcohol must be adhered to. The proportion of hydrochloric acid must be determined by trial within the limits given to get the best results. A good plan is to prepare two solutions of limiting hydrochloric acid concentration, and to make up intermediate solutions by mixture. Time of contact in etching varies from 10 seconds to 1 minute, according to temperature. The structure is brought out normally by a brown non-metallic deposit on a bright metallic background. If a photograph is required, the effect is intensified with a stronger acid solution until the deposit has changed to metallic copper and the pattern is difficult to distinguish. The specimen is then placed as anode in a 10% solution of sodium bicarbonate and a current of density 0.1 amp. per sq. cm. passed through it. The thin portions of the patterns now pass into solution, exposing the bright metal background, while the thicker parts are oxidised to a black copper oxide deposit. This reagent discloses the heterogeneity of all steels, even those containing less than 0.015% of phosphorus. It is better for microscopic work than either sulphuric acid or iodine, although it has the disadvantage of necessitating a preliminary polish. Thermal treatment of the specimens may alter the intensity, but does not alter the form of the patterns. The cause of the heterogeneity thus displayed has not been ascertained with certainty. It is not due to the irregular distribution of carbon. It may be due to the cored structure of the original crystallites at the moment of casting.—H. J. H.

Copper refining; By-products in electrolytic—. L. Addicks. *Met. and Chem. Eng.*, 1917, 17, 169–176.

IN a previous paper (this J., 1917, 966) the various impurities associated with copper were discussed. In the present the methods of working them up to saleable products are described. Some of the by-products (the precious metals, lead, nickel,

and antimony) can be sold in any quantity produced; others, like bismuth, arsenic, cobalt, and selenium, have a very restricted market, while tellurium has practically no market; large quantities of tellurium and selenium could be produced if necessary. The working up of typical anode slimes is discussed. Up to 10% of copper may be present in the slimes, and this is reduced to 1% by hot leaching with sulphuric acid and nitre or by furnace oxidation and leaching combined. If the product is melted it separates into three layers, bullion, matte, and slag on top. The slag is skimmed and the matte blown to oxidise it, with the production of a second slag. This is skimmed and the bullion cleaned by air and nitre, with the production of a third slag. The bullion contains nearly all the gold and part of the silver, the rest being recovered from the slags. The bullion is parted either by solution with sulphuric acid or more generally by electrolysis. The possibilities of improving the above processes are surveyed. Mechanical concentration of precious metals by screening, dressing on tables, and by flotation methods, is discussed. Possible improvements in the oxidation and leaching out of the copper and in the smelting of the residue are suggested. Little improvement is to be looked for in the parting.—H. J. H.

Brass melting furnaces; Fuel economy possibilities in—. L. C. Harvey. *Inst. of Metals*, Sept., 1917. [Advance proof.] 16 pages.

THE over-all heating efficiencies obtained in present brass-melting practice are compared on the basis of the estimated output for 1916, viz., 2,000,000 tons of the 70:30 alloy melted and superheated to 10% above its melting point. The following ratios of total fuel consumed to that usefully employed are given, those for coke- and gas-fired furnaces being in terms of coal:—Coke-fired pit and tilting furnaces, 27:1 and 9:1, respectively; tilting furnaces using powdered coal, 6:1; single crucible pit or tilting furnaces using town gas, 13:1; multiple crucible pit furnaces or single crucible tilting furnaces using producer-gas, 12:1; oil-fired pit and tilting furnaces, 19:1 and 7:1, respectively. Notwithstanding the greater economy of the tilting furnace, pit furnaces employing smaller crucibles are still largely used on account of the better quality of metal produced. Suggestions are made for increasing the efficiency of coke- and oil-fired pit furnaces by improving the present designs; and drawings are given of a multiple crucible furnace for oil, gas, or powdered coal, which has proved satisfactory in use, and of a special form of grate pan for economising solid fuel in tilting furnaces.—W. E. F. P.

New system of gas firing. *Ionides.* See IIa.

PATENTS.

Metals [high-speed steel]; Means for the heat treatment [hardening] of—. P. Winn, Birmingham, and A. H. Wilkes, Four Oaks, Warwickshire. *Eng. Pat.* 108,826, Apr. 5, 1917. (Appl. No. 4912 of 1917.)

IN apparatus for hardening high-speed steel by quenching it in a blast of cold air, the cooling chamber is substantially cylindrical and is open at one end and closed at the other end through which the nozzle for the compressed air projects. The nozzle is provided with a series of openings directed radially outward or backward, and also a smaller central opening directed forward. The inner surface of the cooling chamber is grooved longitudinally, and a uniform distribution of the blast over the article to be cooled is obtained. The apparatus is combined with a gas-fired heating

furnace, the compressed air being obtained from a branch of the pipe supplying the air for combustion.—W. F. F.

Roasting or calcining furnaces: Mechanical

Akt.-Ges. für Zink-Industrie vorm. Grillo, and W. Scheffzik, Hamborn, Germany. Eng. Pat. 10,879, May 2, 1914.

SEE Ger. Pat. 287,078 of 1913; this J., 1916, 181. Regulated quantities of preheated air may be introduced into each muffle to accelerate the roasting process. An iron bar carried by arms projecting radially from a shaft mounted in the ends of the furnace structure, extends horizontally through each muffle, and is provided on its underside with two or more rows of teeth of triangular cross-section, not in alignment, and presenting oblique faces at each side. The shaft is oscillated, whereby the bar swings from side to side, and the teeth stir the ore and feed it forward.

[Ore roasting] furnace. F. J. Bowman, Assignor to The Grasselli Chemical Co., Cleveland, Ohio. U.S. Pat. 1,235,003, July 31, 1917. Date of appl., Nov. 10, 1916.

A NUMBER of superposed roasting hearths are connected together at alternate ends by sloping conduits, which make an acute angle with each of the hearths. The under wall of the conduit is formed as an arch which extends downwards into the hearth below and constitutes a wall against which the ore piles up and seals the hearth.

—W. H. C.

Furnace: Metallurgical —. U. Wedge, Ardmore, Pa. U.S. Pat. 1,237,129, Aug. 11, 1917. Date of appl., Dec. 2, 1915.

THE furnace is provided with a series of hearths arranged in the form of shelves at different levels, each of these, excepting the top one, projecting beyond the hearth above it. The escape of material over the edge of each projecting hearth is prevented by upstanding rims on the edges, and gaps, with inclined bottoms, are provided in the hearths for discharging the material on to the hearths below. Means are provided for moving the material over the hearths in a forward direction towards the gaps.—B. N.

Flux for hard soldering. H. R. Law, Glasgow. Eng. Pat. 108,778, Oct. 31, 1916. (Appl. No. 15,511 of 1916.)

TWO parts of hydrofluoric acid, one part of phosphoric acid, six parts of borax, and a small quantity of gum arabic, are intimately mixed together to form a flux.—B. N.

Metals [zinc or spelter]: Furnace for refining

G. Kermode, London, and A. R. Miller, Birmingham. Eng. Pat. 108,782, Nov. 1, 1916. (Appl. No. 15,800 of 1916.)

A FURNACE particularly adapted for refining zinc or spelter comprises a closed muffle having flues along the top and on both sides. The furnace is arranged below the muffle, at one side and at the front end, and baffle-plates are provided in the flues so that the gases pass up one side, transversely across the top, and down the other side to the next upward passage, and so on backward and forward till the further end of the muffle is reached. The gases then pass through a flat transverse passage below the muffle to an exhaust stack. The muffle floor slopes downward from front to rear, and metal containers are sunk in the floor near the rear end so that molten metal of an increasing degree of purity may drain into them in succession.—W. F. F.

[Zinc: Method and] furnace [for purifying —]. R. Ziesing, Assignor to The Grasselli Chemical Co., Cleveland, Ohio. U.S. Pat. 1,237,141, Aug. 14, 1917. Date of appl., May 4, 1916.

IN purifying zinc from heavier metals, the zinc is heated to a temperature just above the melting point, and the heavier metals which settle are drawn off separately from the relatively pure zinc above. The zinc is transferred to a distilling chamber connected with the melting chamber, the distilled zinc is collected, and the heavier portion allowed to drain back into the melting chamber.—W. F. F.

Carbon residues from the distillation of petroleum: Composition of matter for adapting — for use in smelting furnaces. E. D. Kendall, Elizabeth, N.J., Assignor to L. T. Haggin, Closter, N.J., and M. V. Haggin, A. McCulloh, and H. E. Moller, New York. U.S. Pat. 1,236,447, Aug. 14, 1917. Date of appl., July 26, 1912.

CARBON residues from petroleum distillation are crushed, and mixed with a cement composed of silica, lime, and alumina, and with freshly burnt lime, and the mixture is briquetted.—W. F. F.

Precious metals and other metals: Process of extracting — from ore. J. M. Tippet, Colorado Springs, Colo. U.S. Pat. 1,236,501, Aug. 14, 1917. Date of appl., Dec. 23, 1916.

THE ore is mixed with an equal or greater quantity of cyanide solution, and alkali added in quantity sufficient to neutralise the acidity of the ore. Oil in quantity less than 1% of the ore is then added, gas bubbles are produced in the mixture, and the values recovered by flotation.—W. F. F.

Ores: Concentration of — by flotation. G. D. Van Arsdale, New York. U.S. Pat. 1,236,504, Aug. 14, 1917. Date of appl., Feb. 7, 1916.

HYDROGEN sulphide is supplied to the ore-bearing pulp, during agitation, in excess of the amount required to combine with the non-sulphide mineral present, and the treated pulp is allowed to stand until the excess of gas has been absorbed. The mineral and gangue are then separated by flotation.—B. N.

Ore concentration. R. B. Martin, Assignor to Minerals Separation North American Corporation, New York. U.S. Pats. (A) 1,236,856 and (B) 1,236,857, Aug. 11, 1917. Date of appl., Jan. 28, 1916.

(A) ORE pulp containing oxidised copper is mixed with a soluble sulphide and agitated and aerated under such conditions that the oxidised particles are not coated with a visible layer of sulphide. A froth of concentrates is thus obtained and separated. (B) Ore pulp containing copper is agitated and aerated with a frothing agent prepared by heating an oil with sulphur to about 250° C. and allowing the distillate to return to the mixture during treatment. A froth of concentrates is obtained.—W. F. F.

Flue-dust: Apparatus for extracting values from —. T. F. McGrath, Anaconda, Mont. U.S. Pat. 1,236,581, Aug. 14, 1917. Date of appl., Feb. 2, 1915. Renewed May 16, 1917.

THE products to be treated are forced into a closed tank through delivery pipes spaced along the bottom. Liquid is passed through the tank from one end to the other in a tortuous path formed by vertical baffle-plates, and horizontal perforated screens are provided between adjacent baffle-plates.—W. F. F.

Filter-press [for hydrometallurgical processes] and method of preventing the oxidation of the filtrate in the containers thereof. L. D. Mills, San Francisco, Cal., Assignor to Merrill Metallurgical Co. U.S. Pat. 1,236,737, Aug. 14, 1917. Date of appl., Dec. 24, 1912.

THE oxidation of the precipitate and precipitant, in the containers of open top-discharge filter-presses in which hydrometallurgical precipitation and filtration is effected, is prevented by discharging the filtrate from each filter-plate at a point above the uppermost limit of the mixture within the press, whereby the admission of air into the containers is avoided.—B. N.

Welding or fusing of nickel and alloys containing a high percentage of nickel; Method of auto-genous —. R. Samesreuther, and Autogenwerk Sirius, Ges.m.b.H., Düsseldorf-Eller, Germany. Eng. Pat. 24,646, Dec. 24, 1914. Under Int. Conv., Dec. 29, 1913.

SEE U.S. Pat. 1,221,418 of 1917; this J., 1917, 655.

Roasting or calcining furnaces; Mechanical charging apparatus for —. *Hydraulic mechanism for actuating the stirring and feeding apparatus of mechanical roasting and calcining furnaces.* Akt.-Ges. für Zink-Industrie vorm. W. Grillo, and W. Scheffzik, Hamborn, Germany. Eng. Pats. 109,036 and 109,037, May 2, 1914. (Appl. Nos. 9127 and 9128 of 1917.)

SEE Fr. Pat. 473,310 of 1911; this J., 1915, 557.

[Mercury] boiler. U.S. Pat. 1,236,155. See I.

Drawn filaments for electric incandescence lamps. Eng. Pat. 198,847. See III.

XI.—ELECTRO-CHEMISTRY.

PATENTS.

Depolariser; Higher oxide of manganese —. A. A. Wells, Montclair, N.J., Assignor to National Carbon Co., Long Island City, N.Y. U.S. Pat. 1,232,873, July 10, 1917. Date of appl., Oct. 22, 1915.

A DEPOLARISER, for miniature dry batteries of the Leclanché type, comprises an oxide of manganese having more oxygen than corresponds to MnO_2 , but less than corresponds to Mn_2O_3 , associated with a form of artificial manganese dioxide.—B. N.

Depolarising agent; Manganous manganate and permanganate —. C. Ellis, Montclair, N.J., Assignor to National Carbon Co., Long Island City, N.Y. U.S. Pat. 1,232,901, July 10, 1917. Date of appl., Oct. 25, 1915.

MANGANOUS manganate, in a flaky form, is used as a depolarising agent in dry batteries.—B. N.

Electrolytic gas generator. C. F. Euler, Topeka, Kans. U.S. Pat. 1,234,319, July 21, 1917. Date of appl., May 5, 1916.

AN electrolytic tank is partly filled with liquid, and a number of negative electrodes are spaced apart horizontally across the tank, the ends of the electrodes being secured to the adjacent walls, so as to keep the electrodes out of engagement with the bottom of the tank. The positive electrodes are similarly spaced apart and secured to the walls above the negative ones, but are disposed below the surface of the liquid.—B. N.

Electrolytic cell. F. G. Wheeler, Assignor to Bleach Process Co., Appleton, Wis. U.S. Pat. 1,236,025, Aug. 7, 1917. Date of appl., Oct. 30, 1915.

AN electrolytic cell is composed of a container, with a cathode-diaphragm within it supported by the base of the vessel and forming one wall of an anode vessel. A hollow column is located in the interior of the cell, and is supported wholly on the bottom of the anode vessel, the column serving as support for a removable anode cover. The latter is thus supported independently of and at an elevation lower than the upper marginal edge of the cathode-diaphragm, thus permitting the anodes to be supported by the cover and entirely immersed in the electrolyte throughout their length below the cover. The hollow column forms an internal feed cup for the anode compartment.—B. N.

Electrode-packing for melting furnaces. M. Sperling, Assignor to F. Krupp A.-G., Essen, Germany. U.S. Pat. 1,231,946, July 31, 1917. Date of appl., Nov. 13, 1911.

AN annular member, cooled by a fluid, and rigidly secured to the roof of the furnace, is provided with a flange, projecting inwards, on which is seated a liner of insulating material. The flange and liner are provided with central openings of greater diameter than the electrode, so that the latter has considerable play, and a tight-fitting packing ring is placed around the electrode. The ring is suspended from the top of the liner and is situated loosely on the top of the annular member, so as to permit movement of the electrode in the openings in a direction transversely to the axis. The packing ring is provided with an outer metallic casing and a core of insulating material.—B. N.

Furnace; Electrical induction —. *Multiphase induction furnace.* J. R. Wyatt, Assignor to The Ajax Metal Co., Inc., Philadelphia, Pa. U.S. Pats. (A) 1,235,629 and (B) 1,235,630, Aug. 7, 1917. Date of appl., July 19, 1916.

(A) The walls of the furnace body are adapted to contain a pool, and also to form a closed channel connected at both ends with the pool well below the normal surface. The channel is provided with an acute-angled bend at a distance from the furnace proper, and is obtuse-angled at its points of connection with the pool, so that the channel is converging in direction where it enters the pool. The walls of the furnace are made of a first-class electric conductor, a transformer-inducing current being passed through the channel walls, with the contents of the channel as secondary. An outward flow of material into the pool is produced from each channel toward the other, by means of motor drive. (B) The pool of the furnace may be connected with several parallel acute-angled channels meeting the pool in a generally upward direction, and a multi-phase transformer is employed for applying a different phase of the current to the induction of current as secondary in each of the channels. Thus, three channels may be employed, with the contiguous connections of different channels located near the apices of a nearly equilateral triangle, and with a three-phase transformer embracing one leg of each channel.—B. N.

Electrically insulating liquid; Unflammable —. G. Lépine, Neu-hâtel, Switzerland. U.S. Pat. 1,235,339, July 31, 1917. Date of appl., Apr. 13, 1914.

A MIXTURE of 93% of pentachloroethane, 5% of dichloroethane, and 2% of hexachloroethane.—B. N.

Electric furnaces. British Thomson-Houston Co., Ltd., London. From General Electric Co., Schenectady, N.Y., U.S.A. Eng. Pat. 108,902, Aug. 28, 1916. (Appl. No. 12,117 of 1916.)

SEE U.S. Pat. 1,206,603 of 1916; this J., 1917, 90.

Electrodes for electric arcs for nuclear and other purposes. Eng. Pat. 108,137. See IIb.

Process of producing an insulating material [from fibre]. U.S. Pat. 1,235,061. See V.

Manufacture of perborates. Eng. Pat. 106,460. See VII.

Process and apparatus for manufacturing prussic [hydrocyanic] acid. Process of producing prussic acid. U.S. Pats. 1,235,342 and 1,235,313. See VII.

Process for obtaining oxide of titanium from materials incorporating ether substances. U.S. Pat. 1,235,638. See VII.

XII.—FATS; OILS; WAXES.

Decolorising-carbon. See IIb.

PATENTS.

Oils; Process of refining saponifiable —. C. Baskerville, New York. Eng. Pat. 101,097, Aug. 2, 1916. (Appl. No. 10,908 of 1916.) Under Int. Conv., Aug. 2, 1915. (See U.S. Pat. 1,105,741 of 1914; this J., 1914, 930.)

THE oil is agitated with alkali and with cellulose material (other than mechanical paper pulp), which, after separation of the bulk of the oil, is pressed to remove as much as possible of the remaining oil. The efficiency of the process is increased by impregnating the absorbent material with alkali sufficient or in excess of that required to neutralise the free fatty acids in the oil. After being pressed the residue in the press may be digested with an alkali to form a soap product containing the absorbent material as a filler. Cotton fibres, or "linters," preferably cut into short lengths, are a suitable absorbent material, undue absorption of oil being prevented by moistening the material with water or an aqueous solution of alkali. To prevent the soaps formed in the process producing emulsions, an addition of an anhydrous salt, such as sodium carbonate (soda ash), capable of taking up water of crystallisation, may be made to the oil during the treatment, as described in U.S. Pat. 1,130,698 of 1915 (this J., 1915, 431).—C. A. M.

Compressing machine or apparatus, also adapted for expressing oil or other liquid from seeds and other materials. B. C. Barton, North Ferriby. Eng. Pat. 108,329, May 3, 1916. (Appl. No. 6317 of 1916.)

THE apparatus comprises a fixed drum or chamber constructed of top and bottom plates, having between them piles of plates arranged radially, so as to provide radial passages from the interior to the exterior of the drum. The seed, or other material, is fed into a box or casing, which rotates within the fixed drum, and is forced downwards by means of a worm screw on a vertical shaft, and then outwards into the radial passages by the pressure of a loosely mounted rotatable wheel, the teeth of which engage with teeth upon the inner ends of the plates. Here the oil or other liquid is expressed, and the residue is extruded through the periphery of the drum in strips or lengths, which fall upon a rotating ring or table, and are cut into pieces of the required size by means of attached knives.—C. A. M.

Oils or liquids from seeds, nuts, and other solids; Machines for expressing —. G. R. Schueller, Kingston-upon-Hull. Eng. Pat. 108,515, Aug. 19, 1916. (Appl. No. 11,781 of 1916.)

THE material is expressed in an annular chamber formed by two concentric tubes built up of rings, or the like, in which are passages or grooves for the escape of the oil. The outer wall is longer or higher than the inner wall, so as to enclose the compressing worm, or a portion thereof, and this worm has two or more sets of semi-helical threads or ribs, all or each two sets of which may be separated by a plain annular space. The rings, or the like, forming the inner wall of the expression chamber may be mounted so as to rotate with the compressing worm, and as the expressed material is expelled from the chamber it may be divided into portions by means of knives at the outlet. (See also Eng. Pat. 27,991 of 1913; this J., 1915, 92).—C. A. M.

Oil; Method of recovering — from "foots." O. C. Hagemann, Yonkers, Assignor to C. A. Dieterich, Mount Vernon, N.Y. U.S. Pat. 1,232,913, July 10, 1917. Date of appl., Nov. 4, 1913.

THE material, e.g., "foots" from cotton seed oil, is suspended in several times its volume of a liquid, such as a solution of sodium sulphate, the density of which can be increased, and the mixture is heated to about 95° C. so as to cause the oil in the "foots" to separate readily and rise to the surface.—C. A. M.

Soap powder; Process and apparatus for the manufacture of —. A. Haeblerle, Göppingen, Germany. Eng. Pat. 101,863, Aug. 26, 1916. (Appl. No. 12,113 of 1916.) Under Int. Conv., Mar. 16, 1916.

THE materials (e.g., sodium carbonate, water, and soap), are stirred together, while hot, in a mixing apparatus, and cold air then blown into the mass which is still agitated until a fine powder is obtained. Apparatus claimed for this process comprises a kneading trough containing a perforated pipe for the introduction of hot air, and provided with a cover to prevent the powder being blown out of the trough.—C. A. M.

Lubricant testing machine. Eng. Pat. 101,975. See XXIII.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Phosphorescent zinc sulphide. MacDougall and others. See VII.

PATENTS.

Red lead and orange lead; Manufacture of —. C. A. Rowe, Liverpool. Eng. Pat. 108,735, Aug. 23, 1916. (Appl. No. 11,963 of 1916.)

THE rabbles, in a mechanically operated oven for the manufacture of red lead or orange lead, are disposed around the centre of the hearth, and consist of straight, curved, or tapered plates mounted on a frame or carrier, which is preferably adjustable for varying the position and height of the rabbles with respect to the hearth. One rabble, or series of rabbles moves the material under treatment from the centre to the circumference of the hearth, and another rabble, or series of rabbles moves the material in the opposite direction.—B. N.

Paints and pigments: Manufacture of.—H. Wade, London. From The Titanium Alloy Manufacturing Co., New York. Eng. Pat. 108,805. Jan. 11, 1917. (Appl. No. 596 of 1917.)

TITANIC oxide, a composite titanic oxide pigment, or a paint containing titanic oxide, is incorporated with a white mineral "extender substance," in the form of barytes, silica, gypsum, "asbestine," whiting, or china clay, the index of refraction of which is less than that of titanic oxide. (See also U.S. Pat. 1,223,357 of 1917; this J., 1917, 659).—B. N.

Pigment: Composite titanic oxide—and method of producing the same. I. E. Barton, Niagara Falls, N.Y., Assignor to The Titanium Alloy Manufacturing Co., New York. U.S. Pat. 1,236,655. Aug. 14, 1917. Date of appl., July 14, 1914.

A TITANIC compound is digested in sulphuric acid until titanic sulphate is formed, and calcium chloride is added in quantity insufficient to combine with all the sulphate in solution. The resulting precipitate is filtered off, the filtrate digested with barium chloride, and the precipitate of barium sulphate and titanic acid is separated, dried, and calcined. A soft, fine, white, amorphous powder, tinged with a cream colour, of sp. gr. 3.95 to 4.10, is obtained, containing not more than 0.5% of iron oxide, 85 to 89% of barium sulphate, and 11 to 15% of titanic oxide.—B. N.

Phenols, formaldehyde, and salts of sulpho-acids: Process for obtaining solid products of condensation from—K. Tarassoff, Moscow, and P. Shestakoff, Petrograd. U.S. Pat. 1,237,579. Aug. 21, 1917. Date of appl., Feb. 8, 1916.

SEE Eng. Pat. 102,635 of 1916; this J., 1917, 150.

Method of recovering resins from benzol-plant residues. U.S. Pat. 1,236,917. See III.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Resin, [mineral matter, and nitrogen] in raw rubber: Percentage of—Communication of the Netherlands Government Institute for advising the Rubber Trade and Industry. India-Rubber J., 1917, 54, 260—261.

THE apparatus used for the determination of the acetone extract or the "resinous matter" of rubber is a modified Berntrop extractor; in this the extraction thimble containing the finely divided rubber is suspended by two threads which are gripped between the cork and the mouth of a wide-necked flask, the thimble actually hanging in the boiling solvent for the first 2—3 hours, and then being raised so as to be thoroughly washed out for 1—2 hours longer by the acetone falling from the condenser. For the final removal of the acetone a glass tube is introduced into the flask in place of the paper cup. The results obtained by this method accord well with those yielded by the Soxhlet extractor; for 35 samples of plantation Hevea sheet the average percentage of "resin" was 2.89, an average of 2.88 being obtained with 102 samples of plantation Hevea crêpe, whilst with hard fine Para rubber the average is also near 3%. The observation of Hinrichsen and Marcusson (this J., 1910, 224) that the resins from *Hevea brasiliensis* rubbers are optically inactive whereas those from rubbers of other botanical origin possess optical activity, is confirmed; a difference between rubbers of various botanical origin also exists not only in the percentage of resinous matter but also in the extent to which these resins are saponifiable: thus

hard fine Para, Hevea sheet, Hevea crêpe, Castilloa, Congo, Jelutong, Dyera crêpe, and oxidised cut sheet rubbers yielded respectively 3.0, 1.8, 3.2, 18.9, 1.4, 38.1, 7.2, and 60.5% of resins, of which respectively 25.4, 48.3, 22.0, 73.7, 68.3, 83.2, 77.8, and 2.1% resisted saponification.

In comparative experiments on the extraction of balata with various solvents, higher yields of extractive matter were obtained with alcohol than with acetone; ether gave results generally exceeding those obtained with alcohol, and the addition of alcohol to the ethereal extract caused the formation of a white precipitate. Determinations of the proportion of constituents of balata insoluble in xylene indicated that these constituents coincide to some extent with those soluble in the above extraction solvents such as alcohol. With gutta-percha the alcoholic extract is lower than the acetone extract, and the conclusion is drawn that acetone is the most suitable solvent for the extraction of resins from balata and gutta-percha, the extraction being effected for three hours in the liquid and two above the liquid with the Berntrop apparatus.

The average ash for 35 samples of Hevea sheet was 0.38%, and that for 102 samples of Hevea crêpe 0.30%; individual figures may range from 0.15 to 0.65%; wild Para rubber yields approximately the same proportion of ash which, however, unlike the ash from plantation Hevea, always contains a fairly large amount of iron, the origin of which is uncertain. In Hevea rubbers produced by evaporation of the latex, the ash figure is higher, exceeding 1.5%, and reaches 1.2% or more even after the rubber has been washed. Bleaching with sodium bisulphite appears to be without influence on the ash content of plantation rubbers. In inferior qualities of plantation rubbers the yield of ash may exceed that stated above on account of the presence of sand, which may be detected in the ash by microscopical examination.

For the determination of nitrogen in rubber by the Kjeldahl process the acid used is a mixture of sulphuric acid (sp. gr. 1.84) and phosphorus pentoxide in the proportion of 1 litre to 200 grms.; 30 c.c. of this mixture together with one drop or 0.6 grm. of mercury are taken to 1 grm. of the rubber; the subsequent procedure is as usual, distillation of the ammonia being effected after the addition of caustic soda solution containing sodium sulphide. Applying the commonly accepted conversion factor 6.25, the average content of protein matter in Hevea sheet or crêpe was 2.82%. Rubbers produced by evaporation processes contain a higher proportion of protein, the values obtained ranging from 4.7 to 5.4%; Para rubber however generally gives results below 3% and sometimes even under 2%, so that either the Para process is not one of simple evaporation or the composition of Brazilian latex must differ from that of plantation latex. From the observation that nitrogenous matter is invariably found in the acetone extract, although to a varying extent with rubbers of different origin, it is probable that only part of the nitrogen present consists of protein. A small quantity of nitrogenous material is also removed on extracting rubber with water at 100° C.—D. F. T.

PATENTS.

Devulcanisation: Process of—D. Spence, Norwalk, Conn. U.S. Pat. 1,235,850. Aug. 7, 1917. Date of appl., June 27, 1914.

VULCANISED rubber in a finely divided condition or in solution in a suitable solvent, is treated with a substantial excess of a vulcanising accelerator together with a reagent adapted to combine with the sulphur liberated from the rubber; this reagent may be a part of the accelerator itself. D. F. T.

Vulcanised rubber; Process for removing the combined sulphur from — D. Spence, Norwalk, Conn. U.S. Pat. 1,235,852, Aug. 7, 1917. Date of appl., Dec. 20, 1916.

AFTER removal of the uncombined sulphur the vulcanised rubber is dissolved in xylene and subjected to the action of caustic alkali in a fine state of division in the absence of water. The solution is subsequently treated with acid and the rubber then precipitated from it. (See preceding abstract.) —D. F. T.

Plastic composition and process of making same, J. P. A. McCoy, Wilkesburg, Pa. Assignor to Westinghouse Electric and Manufacturing Co. U.S. Pat. 1,236,190, Aug. 7, 1917. Date of appl., Feb. 3, 1916.

PLASTIC compositions are prepared by heating a mixture of rubber or gutta-percha with a filler, and a resinous coal tar product containing cumarone, indene, para-cumarone, and para-indene, under reduced pressure until the material exhibits no substantial vapour pressure. —D. F. T.

Process for making [rubber] coated leather articles, U.S. Pat. 1,236,019. See XV.

XV.—LEATHER; BONE; HORN; GLUE.

Tannin [extraction]; Effect of hard water on — T. A. Faust, J. Amer. Leather Chem. Assoc., 1917, 12, 360—374.

RESULTS obtained by several workers indicate that only slight losses in tannin occur when hard water is used for extraction. This does not agree with the work of Nihoul and Martinez (this J., 1901, 1905). It is suggested that temporary hardness is destroyed according to the amount of acid in the tanning material or extract, also that such hardness may have a solubilising action on tannins compensating for precipitation due to sulphates and chlorides. —F. C. T.

PATENTS.

Tanning of bulls or hides and apparatus therefor, J. E. Maude, Liverpool. Eng. Pat. 198,796, Dec. 9, 1916. (App. No. 17,732 of 1916.)

Two flexible chains, or like elements, are disposed round two series of pulleys, on opposite sides of a vat, in such a manner that each of the chains forms a polygon, one pair only of the opposite wheels in the series being sprocket wheels, and these are positively coupled together by bevel gearing, so that the two chains are kept accurately in step. The chain links are provided with apertured brackets, which serve to support removable rods, or perforated tubes, and ridge pieces are arranged near the path of the chains to prevent the rods from becoming disengaged. The hides are carried in sequence through the tanning liquor, and alternately immersed therein and lifted therefrom by means of the rods. —B. N.

Leather; Production of light coloured — S. Saxe, New York. U.S. Pat. 1,235,959, July 31, 1917. Date of appl., Aug. 11, 1915.

ALUMINIUM sulphate is added to the liquors in the later stages of tanning, to the extent of 5–10% of the vegetable tanning material employed. —F. C. T.

Fish skins or the like; Process for tanning — K. Bendixen, Copenhagen. U.S. Pat. 1,235,513, Aug. 7, 1917. Date of appl., Dec. 29, 1914.

Fish skins are treated with an alkaline solution to remove part of the oils or fats. The excess of alkali is then neutralised, and the skins washed with water. —F. C. T.

Leather articles; Process for making [rubber] coated — J. H. Butler, Assignor to F. W. Austin, Gloversville, N.Y. U.S. Pat. 1,236,049, Aug. 7, 1917. Date of appl., Oct. 22, 1914.

LEATHER is degreased on the surface, and treated with a solution of raw rubber. The solvent is then evaporated and sheets of raw rubber applied to cover the coated leather surface. The article is then heated to a vulcanising temperature, when the leather and rubber form a practically homogeneous fabric. —F. C. T.

Glue-like material; Process and apparatus for drying — L. Mooney, Searon, N.J. U.S. Pat. 1,235,716, Aug. 7, 1917. Date of appl., July 28, 1916.

LIQUID glue material is cooled and congealed in sheets on a corrugated cylinder, from which it is stripped and subsequently dried on drying conveyors. —F. C. T.

Method of deliming wool, hair, or like substances contaminated with lime, U.S. Pat. 1,235,214, See V.

XVI. SOILS; FERTILISERS.

Soils; Alkali —; some biochemical factors in their reclamation, J. H. Barnes and B. Ali, Agric. J. India, 1917, 12, 388—389.

AT Narwala in the Lyallpur district of the Punjab, the soil is barren owing to excess of salinity, the soluble salts present varying from about 0.5% to 4.4%. There is no toxicity in the salts themselves, which are chiefly sodium and calcium sulphates and chlorides and sodium carbonate. The barrenness is due to the osmotic pressure of the soil solution being greater than that of the cell sap of the plant, which causes the protoplasm to shrink from the walls of the cells and the plant to become flaccid. The osmotic pressure was measured indirectly by the activity of the bacteria in the soil, which is reduced by an increase of the osmotic pressure. The chemical changes which the bacteria produced in the soil were taken as a measure of their activity, and these were studied under three heads. (1) Carbon dioxide formation. The soil sample was placed in a Woulff's bottle and 1% of Indian colza, in the form of oil-free cake, and sufficient water to give 30% of saturation were added, and the bottle was incubated at 25–30°C. Each day the air contents of the bottle were removed by aspiration through baryta water and the amount of carbon dioxide absorbed determined. 200 grms. of normal soil gave by this method 684 mgrms. of carbon dioxide in 15 days, whereas the saline soil gave only 23 mgrms. When the saline soil was washed before testing, the amount of carbon dioxide formed was 839 mgrms. This showed how the reduction in the osmotic pressure in the soil solution caused by washing, enabled the bacteria present to develop and become active, and to produce even more carbon dioxide than the bacteria in a normal soil. (2) Nitrification. 50 c.c. of Omélsansky's solution was inoculated with 1 c.c. of 100% soil emulsion, 0.5 gm. of calcium carbonate was added, and the whole incubated at 30–35°C. The nitrite and nitrate contents were determined each week. Another form of this test was to add 1% of Indian colza to the soil, with water to 30% saturation, and to incubate at 30–35°C.; the ammonia, nitrite, and nitrate in the mixture were determined. The results in Omélsansky's solution were the production in 5 weeks of 1.2 mgrms. of nitric nitrogen from the saline soil, 1.8 mgrms. from a sterile patch, and 6 mgrms. from normal soil. In the sterile patches, the

salinity was less than in the general barren soil, but the osmotic pressure was not sufficient to destroy the activity of the nitrifying bacteria; whence it is deduced that these organisms are more resistant to higher osmotic pressure than ordinary plants. In the soil itself, the nitric nitrogen remained constant in the case of the saline soil and a sterile patch, but in washed saline soil the nitric nitrogen after 5 weeks was 6 mgrms. with 16 mgrms. of nitrous nitrogen, and in washed saline soil inoculated with normal soil the nitric nitrogen increased to 11 mgrms. with 9 mgrms. of nitrous nitrogen. (3) Fixation of nitrogen. A nutrient mannitol solution was prepared, to which calcium carbonate was added. This was sterilised and then inoculated with the soil emulsion, and incubated for 11 days. The total nitrogen was determined, a blank being done with sterile soil. It was found that the saline soil fixed 1.2 mgrms. of nitrogen, a sterile patch 7.8 mgrms., and normal soil 7 mgrms. This showed that *Azotobacter chroococcum* must have a higher osmotic pressure in its protoplasm than nitrifying and oxidising bacteria. As a result of these experiments, the barren land was washed with canal water and drained; on examining the reclaimed soil on the above lines, confirmatory results were obtained. Photographs of the land before treatment, and with the first and second year's crops after treatment, are inserted, and full details of the crop yields are given.—J. H. J.

Soils; Variation in the chemical composition of — W. O. Robinson, L. A. Steinkoenig, and W. H. Fry. Bull. No. 551. U.S. Dept. Agric., June 26, 1917. 16 pages.

THE main constituents in 45 typical American soils, ranging from fine sandy loams to heavy clay loams, were determined. The results confirmed previous observations that where there is a distinct sub-soil, differing in colour and texture from the surface soil, there may be a pronounced difference in the chemical composition of the two, especially in the respective amounts of silica, iron, and alumina. Thus, in the case of the samples taken from 34 places, the silica was higher in the surface soils in all but two instances, the iron in all but five, and the alumina in all but one. The extreme variations of the constituents were as follows:—Silica, 97.01 to 44.15; iron oxide, 16.23 to 0.23; alumina, 27.58 to 1.19; potash, 4.07 to 0.02; soda, 2.06 to 0.01; lime, 1.73 to 0.01; magnesia, 1.93 to 0.01; phosphoric acid (P_2O_5), 0.22 to 0.03; and sulphuric acid, (SO_3) 0.34 to 0.02%. Some soils of the same type may differ considerably in chemical composition, and, on the other hand, soils of different types may resemble each other as closely in chemical composition as different samples of the same type. Owing to unavoidable analytical errors differences of several hundred lb. are not significant when the amounts of the constituents are stated in lb. per acre. (C. A. M.)

Soils; Methods for determining the reaction of — H. R. Christensen. Soil Sci., 1917, 4, 115—178.

IT is necessary to distinguish sharply between the absolute acidity of the soil, and its ability to absorb bases (i.e., to liberate acids). The majority of methods for making a quantitative determination of the acidity of the soil give no information as to the content of truly acid-reacting substances in the soil, i.e., substances which in solution cause a hydrogen-ion concentration greater than corresponds to the value 10^{-7} ; but only of its ability to absorb bases. All mineral soils showing an acid reaction to litmus have a large lime-requirement. In such instances a quantitative deter-

mination of the acid content of the soil, which expresses the amount of lime necessary for neutralising the acid present, will also give reliable though insufficient information as to the degree of the lime requirement of the soil. Many soils which show a neutral reaction to litmus, however, have a decided lime-requirement, and in such cases it is impossible to use the acidity determination in determining the degree of the lime-requirement of the soil. It is probable that this question of the lime-requirement of the soil is predominantly a question of the presence or absence of certain easily decomposed acid-saturating calcium (or magnesium) compounds, and that the efforts to find a quantitative expression for the lime-requirement should be in the direction of methods which can express the amount of lime-fertiliser necessary for supplying the soil with a sufficient quantity of such compounds. J. B. C. K.

Soils; Adsorption by — J. E. Harris. J. Phys. Chem., 1917, 21, 151—473.

EXPERIMENTS are described which were undertaken to determine whether the acidity of those soils which reddened litmus paper, but which give a neutral solution, is due to colloidal adsorption. Soil was placed in contact with dilute solutions of barium chloride for 24 hrs., with occasional shaking, and the amount of barium in solution before and after the treatment determined. When the results were calculated according to the equation $x/m = a \cdot c^b$, representing the adsorption isotherm, the values obtained for $1/m$ were constant, showing that the action was one of adsorption and not of double decomposition. No chlorine was adsorbed from the barium chloride. Solutions containing other metallic ions were also used, and it was found that the number of equivalents adsorbed was the same for ions of the same valency and increased with the valency, except in the case of potassium, which was adsorbed in very high quantity. The potassium adsorbed by a soil could be recovered by treatment with salt solutions, again in the order of the valency of the metal. When a soil was treated with a solution of two salts, the number of equivalents of each metallic ion adsorbed was less than with each salt separately, but the total number was greater. J. H. J.

Cyanuric acid from soil; Isolation of — L. E. Wise and E. H. Walters. J. Agric. Res., 1917, 10, 85—91.

CYANURIC acid was separated from soils obtained from various parts of the United States (Maine, Texas, Florida, and Indiana), the largest amount found being 0.150 gm. from 23 kilos. of the Indiana soil. W. P. S.

Ammonia formation in soil; Effect of different salts on — G. P. Koch. J. Biol. Chem., 1917, 31, 111—113.

DRIED blood was added to soil together with varying combinations of the three salts, magnesium sulphate, potassium sulphate, and calcium dihydrogen phosphate, the soil solution being made up to an osmotic pressure of two atmospheres. The mixture was incubated for 8 days and the ammonia determined. When the calcium phosphate was present as $\frac{1}{10}$ of the molecular proportion of the total salts, there was a considerable increase in the ammonia formed over the same soil without the salts. When it formed $\frac{1}{10}$ of the combination or was used alone, there was an increase of 26% of ammonia over the normal; when it was absent, the magnesium and potassium sulphates caused the ammonia formation to fall below the normal.—J. H. J.

Calcium cyanamide: Addition of tar to — to facilitate spreading. Schmoeger and Lucks. Mitteil. deutschen Landwirts.-Ges., 1917, No. 10, 156—157. Bull. Agric. Intell., 1917, 8, 842—844.

EXPERIMENTS have been carried out in Germany with a mixture of calcium cyanamide with 15% coal tar, the cyanamide being first mixed with the tar, and then passed through a mincing-machine. The material obtained in this way is similar in appearance to superphosphate, and can be easily spread over the soil without powdering. Pot-manuring experiments were carried out with oats in 1915 and 1916, and proved that the tar had no deleterious effects upon the plants. Experiments carried out in the open with wheat in 1915—1916 confirmed the results of the pot-trials with oats, the relatively small increase of the manured plots in this case being ascribed to the bad conditions which prevailed when the wheat was sown.

—J. B. C. K.

Nitrogenous manures: Comparative action of ammonium sulphate, sodium nitrate, and some organic —. I. Jakouchkine. Annals Agric. Inst. Moscow (Russian), 1916, 22, 137—141. Bull. Agric. Intell., 1917, 8, 700—701.

OATS, flax, and potatoes were grown in soil to which the following manures were added: mono-potassium phosphate and potassium chloride, together with castor oil cake, horn-scrappings, fish, peat-litter, sodium nitrate, or ammonium sulphate. The proportions used were equivalent to 25 parts of N, 2 parts of P_2O_5 , and 4 parts of K_2O . It was found that in clay soil ammonium sulphate was preferable to sodium nitrate, because it dissolved the phosphate added as well as that in the soil. Horn scrappings and castor oil cake were about equal in value to sodium nitrate, the action of the horn being possibly partly due to its sulphur content. The assimilation of the nitrogen of fish manure was about half that of sodium nitrate. Peat litter gave up its nitrogen more readily than ordinary litter.—J. H. J.

Potash salts: Substitution of finely crushed Austrian phonolites for Stassfurt —. J. Stoklasa. Oester.-ung. Zeits. Zuckerind. u. Landwirtsch., 1916, 45, 121—156. Bull. Agric. Intell., 1917, 8, 698—700.

IN Austria, phonolite powder has been used as a substitute for Stassfurt salts, chiefly as a fertiliser for beet. The phonolite is found in central Bohemia, and in most cases the nepheline usually present is replaced by sodalite. A table of the different varieties is given, showing the respective amounts of total potash which vary from 5.74 to 8.54%. The percentage of this potash which is soluble in concentrated hydrochloric acid is very variable, the extremes being 21.44% and 54.7%. Only a small amount of the potash is soluble in a saturated solution of carbon dioxide. Experiments were made upon the influence of phonolite upon the growth of soil bacteria; the increases in growth and activity were found to be small compared with those effected by kainit.—J. H. J.

Plants: Action of bacteria and fungi in the tissues of —. E. Berthold. Jahrb. wissensch. Botanik, 1917, 57, 387—458. Bull. Agric. Intell., 1917, 8, 704—705.

EXPERIMENTS were made on the depth to which bacteria and fungi could penetrate the tissues and their longevity in them. It was found that the tissues of herbaceous plants and the sap and heart-wood of woody plants are normally free from bacteria. Where wood is attacked by fungi, their presence can be demonstrated in the wood, but bacteria are never present at the same time.

The vessels of a section of a woody plant placed in water become infected with bacteria and the spores of fungi from the water are absorbed, the penetration depending upon the length of the vessel. Bacteria injected into the tissues of living herbaceous plants and into living wood, remain alive for as long as ten months, but no sign of any development can be observed. Dead tissue only can be utilised for bacterial growth.—J. H. J.

Toxic values and killing efficiency of arsenales. Lovett and Robinson. See XIXb.

PATENTS.

Fertilisers: Process of making —. J. E. Zilk. Sharpsburg, Pa. U.S. Pat. 1,236,812, Aug. 14, 1917. Date of appl., Nov. 11, 1916.

AN intimate mixture of phosphate rock 2000, coke 200—300, limestone 200—300, and a flux (such as marl) 300—400 parts—with or without water to form a paste—is heated and rolled at 1300°—1400° F. (about 700°—760° C.) to incipient clinkering under conditions capable of burning only the coke.—A. B. S.

Process for rendering available the polish of felspar and similar materials. U.S. Pat. 1,237,197. See VII.

XVII.—SUGARS ; STARCHES ; GUMS.

[American] invert sugar syrups: Sources and composition of some commercial —, with notes on sorghum syrup. S. Jordan and A. L. Chesley. J. Ind. Eng. Chem., 1917, 9, 750—758.

IT is estimated that in 1916 more than two million gallons of invert sugar syrups was used in the United States. American "light syrup," made from refined sugar, usually consists of a large proportion of invert sugar (70 to 78%) with a small proportion of unchanged sucrose (0.5 to 4.0%) and from 0.05 to 0.2% of acidity calculated as tartaric acid. In some samples hydrochloric acid (up to 0.15%), partly free and partly combined, has been found. The mineral matter present is small, varying from traces to about 0.5%. Some brands of light syrup contain, however, much more sucrose (up to 33.0%). "Dark syrup" is invert made from raw sugars or mixtures of (i.), invert from raw sugar and molasses; (ii.), "light syrup and molasses; or (iii.), invert with soured honeys, along with wastes from sugar houses. It rarely contains more than 72.5% of total sugars, a varying amount of which is invert sugar, viz., 18.0—73.0%. The ash varies from 0.5 to 3.5%.

Glycerin (95%) will take up about 15% of moisture, whilst invert syrups will retain about 14%, but the latter require the application of a high temperature to obviate their stickiness and cause them to penetrate in the same way as glycerin. They may replace glycerin, however, in cases where the latter has been used to counteract the effects of crystallisable sugar. For these purposes the authors suggest the following standards:—(1) *Light syrup special* to contain at least 75% of total sugars (invert and sucrose), the proportion of the sucrose not to exceed about 2.5%. The ash should not exceed 0.02% and the acidity, which should be entirely due to organic acids, not to exceed 0.1%, calculated as tartaric acid. (2) *Light syrup* should be similar to (1), except that the sucrose should not exceed 20%. The syrup should be bought on its total sugar units. (3) *Dark syrup special* should be made from raw sugar and a suitable organic acid which should not exceed 0.3% by weight of the

syrup. It should contain at least 75% of total sugars (sucrose and invert sugar only) and the sucrose should not exceed 5%. The ash should not exceed 0.5%. (4) *Dark syrup* should be made from any suitable blend of invert syrups and molasses. It should not contain less than 72.5% of total sugars, of which at least two-thirds should consist of invert sugar. The ash should not exceed 2.5% and the acidity should not exceed 0.3%.

Sorghum syrup.—It is estimated that about 17 million gallons of sorghum syrup was produced in 1900 in the United States, and since that time the industry has developed in certain districts. The average cost of production is estimated at about 19 cents (9.5 pence) per gall. The syrup is capable of being used as the source of all the "dark invert syrups," and by passing the dark syrup through animal charcoal it could also be used to produce the light syrups, at a probable cost of about 75% of that of the invert syrups made from cane sugar. A representative sample had the following composition:—Total solids, 74.6; ash, 2.4; sucrose, 1.0; reducing sugars, 28.4; "gums" and extractives, 4.0; and acidity (as tartaric acid), 0.8%. The "gums" consisted largely of starch and dextrin. A sample was exposed for six weeks without crystallising, and then contained about 15% of water. The finished syrup should contain at least 70% of total sugars, not more than 5% of starch and gums, and not more than 3% of mineral matter; whilst the acidity should not be more than about 0.8%.

—C. A. M.

Decolorising-carbon. See IIb.

PATENT.

[*Sugar*] *liquors*: *Treatment of certain*—. F. A. Monroe, jun., Assignor to The Dyer Company, Cleveland, Ohio. U.S. Pat. 1,236,997, Aug. 7, 1917. Date of appl., Mar. 8, 1916.

COLD saccharate waste water is heated by mixing with steam from the evaporation of sugar solutions to cause precipitation of saccharate, which is then separated from the liquid. The heating may be effected in stages: e.g., apparatus is claimed in which the cold waste water is first warmed by injection into a heater receiving steam from the last unit of a multiple-effect evaporator and then further heated by injection into a second heater receiving steam from an earlier unit.—J. H. L.

XVIII.—FERMENTATION INDUSTRIES.

Beer: *Distribution of nitrogen in*—. J. S. Sharpe. Biochem. J., 1917, 11, 101-111. (See also H. T. Brown, this J., 1907, 881).

A QUANTITATIVE investigation was made of typical British beers, to ascertain the amounts of the different classes of nitrogenous substances present. The total nitrogen-content of the samples ranged from 0.039 to 0.112%. Of this, 13-37% was present as protein, which was determined by precipitation with tannic acid in presence of a little phosphoric acid, 25-46% was present as amino-compounds, determined by Van Slyke's method, and 25-52% was purine nitrogen present as uric acid and xanthine compounds, leaving a balance of 2-6% of the total nitrogen undetermined. Of the purine nitrogen, uric acid accounted for proportions ranging from 15-90% in the different samples. Tests for hypoxanthine, adenine, guanine, and methylpurine gave negative results. From beers rendered alkaline with sodium hydroxide, chloroform extracted small quantities (0.007-0.012%) of an oil of

alkaloidal character, which darkened in the air, was fairly volatile at 190°C., had an odour like that of juice from a tobacco pipe, and gave many of the reactions of cocaine, which Chapman found in hops (see this J., 1911, 879). This substance, together with a small quantity of a base, probably betaine, almost completely accounted for the 2-6% of the total nitrogen referred to above as undetermined.—J. H. L.

Micro-organisms and heat production in silage fermentation. Hunter. See XIXa.

PATENTS.

Beer: *Process of treating*—. C. S. Ash, Assignor to Gould and Ash, San Francisco, Cal. U.S. Pat. 1,234,255, July 21, 1917. Date of appl., Feb. 4, 1916.

BEER is stabilised by treating the wort or the fermented beer with a mixture of tannin or a tannate and sulphurous acid or a sulphite, and removing the precipitate formed; e.g., krausened beer may be treated with 35-60 mgrms. of tannin and 25-50 mgrms. of sulphurous acid per litre to prevent it acquiring a "cooked" flavour and becoming discoloured after pasteurisation.

—J. H. L.

Beer wort: *Apparatus for cooling and rousing*— and for precipitating sludge from the same. L. Nathan, Zürich, Switzerland. U.S. Pat. 1,235,231, July 31, 1917. Date of appl., July 7, 1911.

A CLOSED receptacle for the hot wort has within it a number of cooling plates over some of which the wort flows in a thin layer. Means are provided for cooling the plates and passing air over the surface of the wort. The plates are connected with one another, and are removable together to enable the sludge to be washed from them.

—J. H. L.

[*Alcoholic*] *beverages*: *Process of preparing*—. *Product for brewers' use*. G. Deffen, Newton, Mass. U.S. Pats. (A) 1,235,881 and (B) 1,235,882, Aug. 7, 1917. Date of appl., Mar. 27, 1917.

(A) Two modifications of the process described in U.S. Pat. 1,214,518 (this J., 1917, 399) are claimed, viz., carrying out the heating of the material containing starch and protein with acidulated water in presence of hops, and treating the products of the heating with a proteolytic enzyme. (B) Claim is made for unfermented liquid products, or concentrated residues obtained therefrom by evaporation, containing fermentable sugars and protein, and prepared from amylaceous and nitrogenous matters as described in U.S. Pats. 1,214,518 and 1,235,881 (see above). The products may contain active proteolytic enzymes.—J. H. L.

Method of deliming wool, hair, or like substances contaminated with lime. U.S. Pat. 1,235,214 See V.

XIXa.—FOODS.

Milk fat of the cow and sheep: *Distribution of the fatty acids in the*—. C. Crowther and A. Hynd. Biochem. J., 1917, 11, 139-163.

THE method employed for separating the fatty acids consisted in heating an ethereal solution of the fat with an excess of methyl alcohol containing a small quantity of hydrogen chloride, separating the mixed methyl esters thus formed, and subjecting them to repeated fractional distill

ation, the first fractions being distilled under ordinary pressure and the later ones under 15 mm. pressure. The weight of each ester in the various fractions was calculated from the iodine and saponification values. The following average percentages of fatty acids were found in fat from cow's milk: butyric acid, 4.27; caproic acid, 1.61; caprylic acid, 1.16; capric acid, 1.19; lauric acid, 5.01; myristic acid, 16.13; palmitic acid, 11.83; stearic acid, 3.10; dihydroxystearic acid 0.38; oleic acid, 11.12. In fat from sheep's milk: butyric acid, 6.51; caproic acid, 1.18; caprylic acid, 1.23; capric acid, 1.79; lauric acid, 4.70; myristic acid, 13.71; palmitic acid, 13.31; stearic acid, 4.39; dihydroxystearic acid, 0.27; oleic acid, 40.67. In the case of fat from cow's milk there was 9% less myristic acid, 6% more palmitic acid, and 3% more stearic acid in the fat from the "first runnings" than in that from the "last runnings."—W. P. S.

War bread: Improvement of—by neutralising the bran. Lapicque and Legendre. *Comptes rend.*, 1917, 165, 316–319.

BREAD made from flour containing a considerable quantity of bran is greatly improved in appearance and taste if lime-water is used in place of water in preparing the dough.—W. P. S.

Alfalfa (lucerne) silage: Chemical studies in making— C. O. Swanson and E. L. Tague. *J. Agric. Res.*, 1917, 10, 275–292.

EXPERIMENTS were made on a laboratory scale in bottles and also on a larger scale using a 10-ton silo. It was found that silage can be made from alfalfa alone if the containers insure absolute exclusion of air and retention of carbon dioxide, but such conditions cannot be obtained on a practical scale. The addition of supplementary substances (e.g., molasses, rye, maize, etc.), increases and accelerates the production of acids, and the presence of these is unfavourable for the development of putrefactive organisms. Wilted alfalfa is more suitable for making silage than is unwilted; the addition of water to wilted alfalfa has no effect, but is injurious to unwilted alfalfa. Molasses is the most effective supplementary substance to use; germinated maize is very similar to molasses in its action and is more effective than sound maize. Rye has a strong odour when made into silage. Alfalfa itself contains only a small quantity of amino-nitrogen; in good alfalfa silage the amino-nitrogen is about one-third of the total nitrogen (6.6%) whilst in bad silage it is about one-half of the total nitrogen. The acidity of silage varies from 2 to 3% (as lactic acid) and the greater part of the acidity is produced during the first 10 days. Sugar, when added to silage, disappears very quickly, and is never present in completely matured silage.—W. P. S.

Silage fermentation: Micro-organisms and heat production in— O. W. Hunter. *J. Agric. Res.*, 1917, 10, 75–83.

SINCE heat production in fermenting forage (silage) is prevented when the material has been heated previously or treated with chloroform, it is concluded that the heat production is due to bacterial activity and not to intramolecular respiration of the tissue cells.—W. P. S.

Feeding-stuffs: New—used in Germany during the war. M. Kling. *Landwirtsch. Jahrb. f. Bayern*, 1916, 6, 183–513. *Bull. Agric. Intell.*, 1917, 8, 892–899.

(1) *Rhubarb leaves.* The green leaves contain 90% of moisture, 2.78% of protein, and 0.1% of fat.

The dried leaves are said to be better than hay of the first quality. (2) *Seaweed.* As a rule seaweed contains little protein and fat, but a large quantity of nitrogen-free extract and crude fibre. When used as a feeding stuff, no trace of its smell could be found in the meat or in the eggs. It is advisable to give the seaweed in the ground, dry state, as a supplementary food. (3) *Straw meal.* The ground straw of cereals is unsatisfactory for pigs, cattle, and horses. (4) *Spelt chaff meal* is not superior to whole chaff. (5) *Concentrated straw fodder.* By boiling straw in an alkaline solution under pressure, a concentrated, easily digested food is obtained. It is mixed with about 30% of molasses and the whole dried. The product contains 3.55% of protein (amides), 29% of nitrogen-free extract, and 53% of fibre. To supply the deficiency in albumin, the fodder was enriched by the addition of dried yeast, now replaced by ground lupin seeds freed from their bitter elements. Thus enriched, it contains 6–10% of protein, 14–15% of nitrogen-free extract, and 28–34% of fibre. Feeding experiments showed this product to be suitable for all animals, and capable of replacing oats for horses. (6) *Crushed and ground maize ears.* The feeding value does not exceed that of wheat chaff, and it is not recommended. (7) *Heather stalks.* An excellent food may be prepared from the leaves, flowers, seeds, and fine stalks of heather. It contains about 4% of protein, 3% of fat, 45% of nitrogen-free extract, and 35% of fibre. (8) *Kohl-rabi by-products.* The decomposing roots, made into slices and then dried, gave a fairly good food. Another food prepared from the peelings contained so much sand that it could not be used with safety. (9) *Ground sugar-beet seeds.* Seeds which have lost their germinating power are ground. They contain about 11% of protein, 1% of fat, and 9% of mineral matter. Their nutritive value is two-thirds that of wheat bran. (10) *Parsley seed.* Seed which had remained unsold was crushed. It contains about 23% of crude fat, and can be given in moderate amount to animals receiving rations poor in stimulants. (11) *Wild radish husks.* Nutritive value 40% that of good barley. Not suitable for pigs. (12) *Mixture of brewers' grains and yeast.* By a special process the dry grains are mixed with the moist yeast, and the whole dried. The mixture contains about 75% of grain and 25% of yeast, and is most suited for horses and cattle. (13) *Wine yeast.* The fresh yeast is washed to free it from tartar and made into a cake. (14) *Ground grape pips.* The pips are obtained from grape residues after distillation to remove alcohol. They are ground, and form a food very rich in crude fibre, with a nutritive value corresponding to that of medium quality meadow hay. (15) *Beechnut cake.* The ground nuts contain about 18% of protein, 4% of fat, 28% of nitrogen-free extract, 19% of fibre, and 11% of mineral matter including 6.5% of sodium chloride. The last was added to disguise the taste of tannin, in which the nuts are very rich. (16) *Walnut cake.* The nuts are pressed with the shells and give a cake very similar to beechnut cake. The cake is also prepared from nuts pressed without their shells, and then forms a food readily eaten by cattle. (17) *Food for fattening pigs.* Six varieties are described, only two of which are considered satisfactory: one, made from crushed maize, ground maize ears, and acorn meal, contained about 9% of protein and 3% of fat; the other was composed of corn bran, crushed corn, barley, oats, acorn meal, ground seeds of weeds, seaweed meal, and fish meal, and contained 15% of protein. (18) *Poultry food.* Many by-products of little value are being sold. (19) *Horse food.* One is made from corn chaff, dried beetroot, and pea meal. (20) *Feeding meal.* One contained ground spelt chaff, ground grape residue, straw meal, and 2.5% of sodium chloride.—J. H. J.

Cottonseed meal; Nutrition investigations upon —. III. Cottonseed flour. The nature of its growth-promoting substances, and a study in protein minimum. A. E. Richardson and H. S. Green. *J. Biol. Chem.*, 1917, **31**, 379—388. (See this J., 1916, 860; 1917, 937.)

SUFFICIENT of an ether extract of cottonseed flour was added to a balanced diet to represent 50% of flour in the diet, which was then fed to white rats, with the result that the growth of the animals was retarded, showing a deficiency of the fat-soluble food accessory in the flour. When the extract was increased to represent 138% of flour, growth became normal again. When an aqueous extract of the flour corresponding to 50% of flour was added to the diet, growth was normal, showing the flour to contain sufficient water-soluble accessory. To determine the minimum of protein as cottonseed flour which could be used in a diet, varying amounts of the flour were added to balanced diets to give a content of 4—18% of protein. The 18% diet gave practically normal growth in the rats, although the second generation were slightly undersized. With a 12% diet the growth was slightly below normal, with a 6% diet there was very little growth, and with a 4% diet the rats lost weight rapidly at first, but continued alive and active.—J. H. J.

Perraporation, perdistillation, and percrystallisation. Koher. See I.

PATENTS.

Food substances; Preserving —. L. Fulda, Bow. Middlesex. Eng. Pat. 108,616, Nov. 25, 1916. (Appl. No. 16,937 of 1916.)

AN intimate mixture of about 92% of sodium bisulphite and 8% of sodium bisulphate, both powdered finely to pass through a sieve with 60 meshes to the inch, is stored in air-tight vessels for use as a food-preserving material. In use, a very small proportion of the mixture is incorporated with the food, solid or liquid, to be preserved, the substance being heated if necessary to 150° F. (65.5° C.); the contained moisture in the food is sufficient to render the composition active.—J. H. J.

Preserving vegetables, fruits, and the like; Process for —. J. von Epler, New York. U.S. Pat. 1,236,382, Aug. 7, 1917. Date of appl., Jan. 3, 1917.

THE substance to be treated is pulped and the juice separated from the fibrous material by pressure. The juice is concentrated below 212° F. (100° C.) to the consistency of a syrup, the fibrous material is impregnated with fat above 212° F., and the two are recombined, with the addition of 5% of salt if required.—J. H. J.

Milk; Process of drying —. J. Roch, Assignor to Crystallized Milk Co., Spokane, Wash. U.S. Pat. 1,235,161, July 31, 1917. Date of appl., Mar. 14, 1910.

A SMALL quantity of milk is instantaneously warmed under pressure, then heated at about 140° F. (60° C.) until dry, when the temperature is raised to 170° F. (about 77° C.).—J. H. J.

Maize; Manufacture of — into fine flour. J. and F. W. Parker, Limerick, Ireland. Eng. Pat. 108,803, Jan. 8, 1917. (Appl. No. 342 of 1917.)

Method and apparatus for indicating the volumetric flow of gases [for flour bleaching]. Eng. Pat. 108,711. See XXIII.

XIXB.—WATER PURIFICATION; SANITATION.

Iodide of starch; Use of — in treatment of infected wounds. A. Lamière. *Comptes rend.*, 1917, **165**, 376—377.

IN the disinfection of wounds it is desirable to use a reagent which is not destroyed quickly by the tissues, and which will continue active for several days. Experiments proved that 10 grms. of muscle tissue, showing incipient decomposition, decolorised 100 c.c. of iodine solution, containing 25 mgrms. of iodine, in half-an-hour, and putrefaction proceeded in the ordinary course; whereas under the same conditions iodide of starch containing the same weight of iodine retained its blue colour for a month. It was found that iodide of starch, containing one part of iodine in 50,000 parts, was effective in killing *Streptococci*, *B. coli*, and *B. pyocyaneus* in 24 hrs. at 37° C.; and a much weaker solution was effective against *Staphylococci*. Iodide of starch containing 1% of iodine was found a convenient strength in practice to use in dressing battle wounds, and caused them to remain sterile for three dressings. A solution of iodide of starch containing 0.5 gm. of iodine per litre can be used in the irrigation method of treating wounds, and is as effective as Dakin's solution (this J., 1915, 919) and not irritant to the tissues.—J. H. J.

Arsenates; Toxic values of —. A. L. Lovett and R. H. Robinson. *J. Agric. Res.*, 1917, **10**, 199—207.

COMPARATIVE tests of the toxic action of solutions of different arsenates upon the common tent caterpillar (*Malacosoma phucialis*), have shown that lead hydrogen arsenate (Robinson and Tartar, this J., 1914, 1008) is more effective than solutions of calcium or basic lead arsenates of the same strength. The amount of arsenic retained by insects feeding upon foliage sprayed with arsenates varies with the arsenate used. Thus, in the case of lead hydrogen arsenate most of the arsenate is retained in the tissue, whilst a large proportion of basic lead acetate is rapidly eliminated. It requires about 0.1595 mgm. of arsenic pentoxide to kill 1000 small tent caterpillars, and about 1.84 mgrms. to kill 1000 nearly mature caterpillars, irrespective of the particular arsenate used for the spray. Preliminary field tests with sprays of calcium arsenate and calcium ammonium arsenate showed that they cause too severe injury to the foliage of trees to be safe spraying materials.—C. A. M.

Determination of ozone and oxides of nitrogen in the atmosphere. Usher and Rao. See VII.

PATENTS.

Filtration; Art of —. Filtering apparatus. W. M. Jewell, Assignor to Jewell Engineering Co., Chicago, Ill. U.S. Pats. (A) 1,232,805 and (B) 1,233,061, July 10, 1917. Dates of appl., Oct. 23 and Nov. 16, 1915.

(A) IN washing a filter acting under gravity, use can be made of the filtered water for this purpose, by shutting off the inflow of water to the filter, applying suction above the level of the filter material and drawing the filtered water in a reverse direction through the material. (B) The apparatus consists of a chamber containing one or more filter beds, separately enclosed above and connected together at the bottom. Each bed has a separate water inlet situated above the level of the filter material, and a common outlet pipe at the bottom, emptying into a receiver. For washing the beds, suction means are provided

connected with the inlets, whereby water is drawn from the receiver upwards through the material.

—J. H. J.

Boiler-water; Process of treating —. H. Kriegsbom. Assignor to The Permutit Co., U.S.A., New York. U.S. Pat. 1,235,815, Aug. 7, 1917. Date of appl., Apr. 22, 1915.

A HIGH concentration of a corrosion-preventing dissolved salt is established in the water in the boiler, and some of the boiler water is run back into the heated feed-water before the latter is run into the boiler.—J. H. J.

Sterilising apparatus [using ultra-violet radiations]. F. G. Keyes, Boston, Mass., Assignor to Cooper Hewitt Electric Co., Holoken, N.J. U.S. Pat. 1,235,698, Aug. 7, 1917. Date of appl., July 1, 1915.

A GAUZE screen of fibrous material is supported so as to hang in a vertical plane, and the liquid to be sterilised is distributed along the top of the gauze. A source of ultra-violet radiations is provided in proximity to the gauze, and the sterilised liquid is cooled by passing it into a trough at the bottom.

—B. N.

Insecticide or fungicide [Paris green] and method of making the same. R. V. Brown, Chicago. Assignor to The Sherwin-Williams Co., Cleveland, Ohio. U.S. Pat. 1,235,285, July 31, 1917. Date of appl., July 13, 1914.

IN the manufacture of Paris green the solution containing sodium arsenite or sodium and copper arsenites is precipitated by the addition of lime, the precipitate treated with lead arsenate, and copper sulphate and lime added to the mixture. By this method loss of arsenic and copper is prevented, and an insecticide may be obtained containing approximately 58% of calcium and copper arsenites, 8% of lead arsenate, 14% of copper hydroxide, and not more than 20% of inert substances.—B. V. S.

Hydrocyanic acid gas; Process of generating —. C. J. Marvin, Los Angeles, Cal., U.S.A. Eng. Pat. 108,807, Aug. 23, 1916. (Appl. No. 1029 of 1917.)

SEE U.S. Pat. 1,214,206 of 1917; this J., 1917, 339.

Detergent, bleaching, and disinfecting composition. U.S. Pat. 1,237,267. See VI.

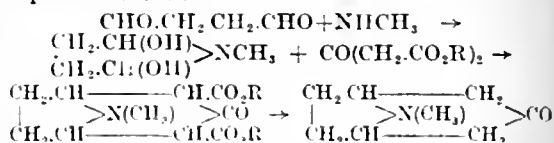
Process of making base-exchanging bodies. Eng. Pat. 108,773. See VII.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Tropinone; Synthesis of —. R. Robinson. Chem. Soc. Trans., 1917, 111, 762–768. (Compare Willstätter, this J., 1903, 227.)

SUCCINDIALDEHYDE, acetone, and methylamine in aqueous solution at the ordinary temperature react with formation of a poor yield of tropinone. A better result is obtained by using a mixture of succindialdehyde, ethyl acetonedicarboxylate, and methylamine in alcoholic solution at the ordinary temperature, the primary reaction product, viz., ethyl tropinonedicarboxylate, being subsequently converted into tropinone by boiling with dilute sulphuric acid; a modification of this method applying succindialdehyde, methylamine, and calcium acetonedicarboxylate in aqueous solution at the ordinary temperature, likewise gives rise to

tropinone. The course of the synthesis may be represented thus—



For the identification of the tropinone obtained it was found convenient to convert this into its dipiperonylidene derivative, $\text{C}_{24}\text{H}_{21}\text{O}_5\text{N}$, bright yellow needles, m. pt. 214°C ., which forms a yellow hydrochloride crystallising in microscopic needles.

—D. F. T.

Ginger; Pungent principles of —. A new ketone, zingerone (4-hydroxy-3-methoxyphenylethyl methyl ketone) occurring in ginger. H. Nomura. Chem. Soc. Trans., 1917, 111, 769–776.

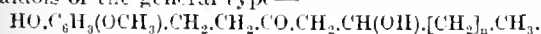
ON extracting powdered ginger with ether, a crude solution of a ketonic-phenolic substance is obtained; this can be isolated by removal with dilute sodium hydroxide solution, liberation by carbon dioxide, separation of the accompanying acidic impurities by treatment with sodium carbonate solution, and subsequent distillation under reduced pressure. The resulting zingerone, $\text{C}_{11}\text{H}_{14}\text{O}_3$, forms colourless crystals, m. pt. $40^\circ\text{--}41^\circ\text{C}$., and gives a sodium bisulphite compound, a benzoyl derivative, colourless crystals, m. pt. $126^\circ\text{--}127^\circ\text{C}$., an acetyl derivative, m. pt. $40^\circ\text{--}42^\circ\text{C}$., b. pt. $204^\circ\text{--}205^\circ\text{C}$. at 14 mm., a methyl ether, $\text{C}_{12}\text{H}_{16}\text{O}_3$, m. pt. $55^\circ\text{--}56^\circ\text{C}$.; b. pt. $186^\circ/16\text{ mm}$. (compare Kaufmann and Radosevic, Ber., 1916, 49, 675), and an ethyl ether, $\text{C}_{13}\text{H}_{18}\text{O}_3$, m. pt. 66°C .; the methylzingerone forms an oxime crystallising in colourless needles, m. pt. $93^\circ\text{--}93.5^\circ\text{C}$. From the behaviour of the zingerone in producing these derivatives the presence of one hydroxyl group must be assumed, whilst its reaction with bisulphite and its relative resistance to oxidation by ammoniacal silver nitrate indicate the presence of a ketonic group. On oxidation with sodium hypochlorite, ethylzingerone yields ethylvanillic acid, whilst methylzingerone with potassium permanganate gives veratric acid; with sodium hypobromite the methyl-compound produces bromoform and β -3,4-dimethoxyphenylpropionic acid. These results are in good accordance with the identity of zingerone as 4-hydroxy-3-methoxyphenylethyl methyl ketone, $\text{CH}_3 \cdot \text{CO} \cdot \text{CH}_2 \cdot \text{C}_6\text{H}_3(\text{OCH}_3)_2\text{OH}$, this structure being demonstrated also by a synthesis based on the reduction of 4-hydroxy-3-methoxystyryl methyl ketone, which is obtainable by the condensation of vanillin with acetone.—D. F. T.

Ginger; Pungent principles of —. I. Chemical characters and decomposition products of Thresh's "gingerol." A. Lapworth, L. K. Pearson, and F. A. Royle. Chem. Soc. Trans., 1917, 111, 777–790.

FROM the alcoholic extract of African ginger there was separated a refined "gingerol," constituting a viscous faintly yellow phenolic oil (compare Garnett and Grier, Pharm. J., 1907 [iv.], 25, 118), the further purification of which proved difficult. It was therefore converted by methyl sulphate and alkali into crystalline "methylgingerol," $\text{C}_{11}\text{H}_{14}\text{O}_4$ or $\text{C}_{11}\text{H}_{16}\text{O}_4$, needles, m. pt. 61°C .; $[\alpha]_D^{20} = +27.3$, in chloroform. This substance on treatment with hydroxylamine gave a hydrated oxime, and also appeared to contain a hydroxyl group. Gingerol, when oxidised with chromic acid, formed *n*-heptic acid and probably *n*-hexoic acid, whilst on treatment with baryta water it yielded *n*-heptaldehyde and zingerone, $\text{C}_{11}\text{H}_{14}\text{O}_3$, a ketonic phenolic substance crystallising in needles, plates, or rhombohedra, m. pt. $31^\circ\text{--}34^\circ\text{C}$., which was further converted into its phenyl-

hydrazone, m. pt. 143° C.; semicarbazone, m. pt. near 133° C.; ethylcarbonato derivative, $C_{11}H_{13}O_5 \cdot O \cdot CO_2C_2H_5$, prisms, m. pt. 45°—47° C., and methyl derivative, colourless needles, m. pt. 55.5°—56.2° C.; the last possessed no phenolic properties but yielded an oxime, $C_{12}H_{17}O_3N$, needles, m. pt. 91°—92° C., and reacted with sodium hypobromite giving bromoform and 3-3-4-dimethoxyphenylpropionic acid, whence it is probable that methylzingerone is to be represented as CH_3O

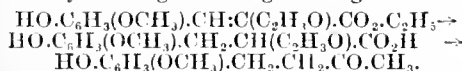
$CH_3O \text{---} \text{C}_6\text{H}_3 \text{---} CH_2 \cdot CH_2 \cdot CO \cdot CH_3$ (see preceding abstract). Gingerol itself must be essentially a mixture of optically active saturated phenolic compounds derived from zingerone in association with a molecular proportion of the residue of an aliphatic aldehyde, the chief being *n*-heptaldehyde: the constituents of the mixture are probably aldols of the general type—



—D. F. T.

Ginger; Pungent principles of—. *II. Synthetic preparation of zingerone, methylzingerone, and some related acids.* A. Lapworth and F. H. Wykes. Chem. Soc. Trans., 1917, 111, 790—798.

METHYLZINGERONE, needles, m. pt. 55°—56° C., was synthesised by the condensation of veratraldehyde and acetone to 3,4-dimethoxystyryl methyl ketone, $HO \cdot C_6H_3(OCH_3)_2 \cdot CH : CH \cdot CO \cdot CH_3$, with subsequent reduction of this product in alcoholic solution by means of sodium amalgam. Zingerone (4-hydroxy-3-methoxyphenylethyl methyl ketone), was obtained in poor yield by the condensation of vanillin with acetone, and reducing the resulting 4-hydroxy-3-methoxystyryl methyl ketone; much better results were obtained by reducing ethyl vanillylideneacetoacetate, and after hydrolysis of the product, causing the elimination of carbon dioxide by heating, the stages being—



3,4-Dimethoxystyryl methyl ketone on oxidation with aqueous sodium hypobromite gave rise to dimethylcaffeic acid, $C_6H_3(OCH_3)_2 \cdot CH : CH \cdot CO_2H$; ethyl vanillylideneacyanoacetate— $HO \cdot C_6H_3(OCH_3)_2 \cdot CH : C(CN) \cdot CO_2 \cdot C_2H_5$, yellow needles, m. pt. 107° C., prepared by the interaction of vanillin and ethyl cyanoacetate, on successive reduction, hydrolysis, and elimination of carbon dioxide was converted into hydroferulic acid, $C_{10}H_{12}O_4$, needles, m. pt. 89°—90° C. In a similar manner ethyl α -cyanoacrylate, $C_6H_3(OH)_2 \cdot CH : C(CN) \cdot CO_2 \cdot C_2H_5$, a yellow microcrystalline solid, m. pt. 162°—166° C., was obtained by the condensation of protocatechuic aldehyde with ethyl cyanoacetate, and by successive reduction, hydrolysis, and elimination of carbon dioxide, was made to yield hydrocaffeic acid.

—D. F. T.

Gingerol and paradol. E. K. Nelson. J. Amer. Chem. Soc., 1917, 39, 1466—1469.

THE main constituents of gingerol and paradol, the pungent essences of ginger and grains of paradise (*Amomum melegueta*) are monomethyl ethers of a dihydric phenol, the difference between them probably being due to the position of the methyl group. Gingerol is a pungent, yellow oil of which the sp. gr. at 20°/20° C. is 1.0713, $[a]_D = +12.9^\circ$, and $n_D^{20} = 1.5212$. It contains 9.26% of methoxyl. Methylation with dimethyl sulphate gives 43% of a non-pungent methyl ether, m. pt. 65°—65.5° C., $[a]_D = +9.3^\circ$, and 50% of a liquid product. On distillation, gingerol gives a main

reaction boiling at 227°—229° C. at 6 mm. pressure. This fraction is optically inactive, gives a green colour with ferric chloride, and does not give a crystalline ether on methylation. Its sp. gr. at 20°/20° C. is 1.0503, and $n_D^{20} = 1.5212$. Paradol is a pungent yellow oil of which the sp. gr. at 20°/20° C. is 1.0690, $[a]_D = +9.2^\circ$, and $n_D^{20} = 1.5232$. It contains 10.95% of methoxyl. On methylation it gives a crystalline product, identical with the methyl ether of gingerol, and an oil. The main fraction obtained by distilling paradol boils at 230°—234° C. at 8 mm. pressure, its sp. gr. at 20° C. being 1.0415 and $n_D^{20} = 1.5198$. It is optically inactive, and does not give a crystalline methyl ether. Gingerol and paradol differ in their stability on boiling with alcoholic caustic potash, the pungency of gingerol being practically destroyed, while that of paradol is only slightly affected. The work was discontinued when Lapworth's study of gingerol (see preceding abstracts) came to the notice of the author.—F. SP.

α -Hydroxypyridine and adenine; Alleged anti-neuritic properties of—. A. Harden and S. S. Zilva. Biochem. J., 1917, 11, 172—179. (See this J., 1916, 942, 1130.)

BOTH varieties (needles and granules) of crystallised α -hydroxypyridine were injected into polyneuritic pigeons, but no cure or amelioration in the condition of the birds was observed; re-crystallised α -hydroxypyridine also proved to be ineffective. Pure adenine, as well as adenine which had been treated with sodium ethoxide in a sealed tube for 5 hours at 100° C., had no curative action.—W. P. S.

Alkali butyrates; Oxidation of—by hydrogen peroxide with the production of succinic acid. E. Cahen and W. H. Hurteley. Biochem. J., 1917, 11, 164—171.

EXPERIMENTS were made on the oxidation of sodium butyrate (1 grm.-mol.) in aqueous solution by hydrogen peroxide (3, 6, or 12 grm.-mols.) at 37° and 65° C.; the total volume was in most cases 190 c.c. Besides aldehydes, acetone, and carbon dioxide, and small quantities of volatile acids, succinic acid was formed in quantity corresponding under the most favourable conditions to a yield of over 50% of the theoretical amount, referred to the weight of butyric acid oxidised. The results indicate that when oxidised by hydrogen peroxide, the butyric acid molecule may be broken down by attack at the α -carbon atom, with formation of propionic aldehyde and acid, etc.; at the β -carbon atom, with formation primarily of acetoacetic acid and then of acetone and carbon dioxide; and at the terminal carbon atom of the methyl group, with formation of succinic acid. It is considered that the last-mentioned mode of attack is by far the most important.

Percaporation, perdistillation, and percrystallisation. Kober. See I.

Catalytic decomposition of amines. Formation of aniline from substituted anilines. Sabatier and Gaudion. See III.

Preparation of nitro-derivatives of toluene. Kido-koro. See XXII.

PATENTS.

Gaseous hydrocarbon and chlorine or other gaseous halogen; Manufacture of products from reaction between—, and apparatus for use in such manufacture. B. S. Lacy, Sewaren, N.J., U.S.A. Eng. Pat. 101,708, Sept. 27, 1916. (Appl. No. 13,755 of 1916.) Under Int. Conv., Oct. 6, 1915.

In the chlorination of methane, the chlorine is diluted with a part of the methane and this mixture

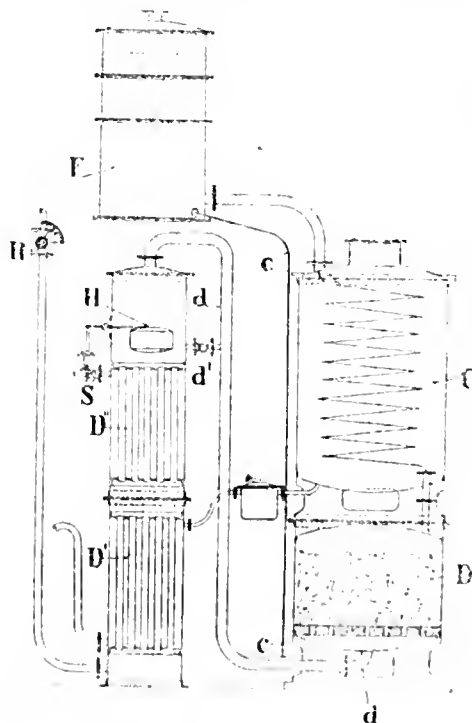
then treated with the rest of the methane heated to a suitable temperature. In the apparatus described, the stream of methane is divided into two parts in any desired proportion, one part passing into the chlorine supply tube and the other part passing through a heating chamber and then joining the chlorine-methane stream just before its entry into the reaction chamber. The leading-in pipes for the chlorine and the heated mixed gases are made of silica, or similar substance unaffected by chlorine, and the reaction chamber, made of metal, is lined with similar resisting material, assisted by packing such as ground flint between the lining and the metal outer case and on the floor of the chamber. The heat supplied to the one portion of methane is arranged to supplement the heat of reaction so as to give a temperature of 300° — 500° C. and the reaction chamber is supplied with external heating appliances sufficient to keep the outer shell at the temperature of the interior. For instance, in the manufacture of monochloromethane, about 5 parts of methane is mixed with the chlorine and a further 10 parts heated to about 300° — 500° C. and then mixed with the first mixture. The method is applicable to other hydrocarbons and to other halogens.—B. V. S.

Oil gas; Chlorination of — B. T. Brooks and D. F. Smith, Assignors to Gulf Refining Co., Pittsburgh, Pa. U.S. Pat. 1,235,283, July 31, 1917. Date of appl., Mar. 16, 1916.

OIL-GAS is chlorinated by the progressive action of sulphuryl chloride at a temperature of 10° — 40° C.—B. V. S.

Ether; Apparatus for the continuous manufacture of — E. Barbet et Fils et Cie., Paris. Eng. Pat. 101,721, Oct. 6, 1916. (Appl. No. 14,236 of 1916.) Under Int. Conv., Oct. 7, 1915. Addition to Eng. Pat. 100,406, May 5, 1915 (this J., 1917, 569).

ALCOHOL passes through the valve, R, into the heater, D'. D' is heated by the condensed



water from the steam-heated vessel, C, and D' may be heated by steam, the supply of which is controlled by the float, H, and the valve, S. From D' the alcohol passes, either as vapour by d, d, or as hot liquid by d', d, according as D' is heated or not, to the mixing chamber, D, containing regenerated sulphuric acid from a previous operation. The ethylsulphuric acid then passes into a lead coil in the heated vessel, C, where it is decomposed and the mixture forced upwards by its own vapour pressure into the separator, F. The acid separated in F passes back by the pipe, c, into the pipe, d. Greater strength and durability of the coil and chamber, C, as well as cheapness are obtained by having the steam outside the coil, since only the coil is made of lead, the chamber and the coil supports being of iron or steel.—B. V. S.

Aldol; Process of making — N. Grünstein, Frankfurt, Germany. U.S. Pat. 1,231,156, July 24, 1917. Date of appl., Dec. 13, 1916.

ACETALDEHYDE, mixed with a little water, is treated with the oxide of an alkaline-earth metal, such as strontium oxide. The resulting solution is neutralised with acid and distilled *in vacuo*. —B. V. S.

Products of condensation [aldol]; Manufacture of — from acetaldehyde. N. Grünstein, Frankfurt, Germany. Eng. Pat. 101,636, Sept. 27, 1916. (Appl. No. 13,751 of 1916.) Under Int. Conv., Sept. 25, 1915.

SEE U.S. Pat. 1,234,156 of 1917; preceding. Alkaline-earth carbides may be added to serve as catalysts, and the reaction may be started with only part of the acetaldehyde, the remainder being added as the reaction proceeds.

Vitamine preparation; Highly active — thoroughly freed from inactive ingredients. A. Gams and B. Schreiber, Assignors to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,235,198, July 31, 1917. Date of appl., Feb. 2, 1917.

ORGANIC food products are extracted with dilute alcohol and the alcohol removed from the extract by distillation *in vacuo*. The aqueous solution of the extract is treated successively in acid condition with lead acetate and in neutral condition with basic lead acetate for the removal of impurities. After freeing the solution from lead it may be evaporated to dryness, or may be first further purified by treatment with an alkaloid precipitant, decomposition of the precipitate, and re-solution of the alkaloid. The resulting vitamine products are yellowish-brown hygroscopic substances, soluble in water forming solutions feebly acid to litmus, and giving with alkalis yellow solutions with a strong smell of methylamine. The aqueous solutions give precipitates with tannin, silver nitrate, phosphomolybdic and phosphotungstic acids, the last of which gives characteristic colour reactions with sodium carbonate and diazobenzene-sulphonic acid.—B. V. S.

Medicament [antipyretic] and process of producing the same. A. D. Barr, McHuo, Ark. U.S. Pat. 1,235,278, July 31, 1917. Date of appl., Oct. 1, 1913.

A STIMULATING antipyretic is obtained by heating a solution of an aniline derivative containing the acetyl group, such as acetanilide (24.68%), with an organic acid, such as citric acid (36.56%), adding a vegetable alkaloid, such as caffeine (38.74%), heating and evaporating the solution, and crystallising the compound formed.—B. V. S.

Coca extracts: Process of preparing—F. R. Eldred, F. E. Bibbins, and R. N. Reed, Assignors to The Eli Lilly and Co., Indianapolis, Ind. U.S. Pat. 1,235,450, July 31, 1917. Date of appl. Feb. 5, 1917.

Coca leaves are steam distilled and then extracted with boiling water. The concentrated extract is treated with alcohol to remove ecgonine, benzoyl-ecgonine, and most of the cocaine, and the aqueous solution of the residue is treated with fuller's earth and filtered. The clear solution is concentrated and the extract mixed with the original distillate.—B. V. S.

Alcohols; Method of manufacturing polyvalent—O. Matter, Cologne, Germany. U.S. Pat. 1,237,076, Aug. 14, 1917. Date of appl. July 11, 1915.

POLYVALENT alcohols are produced by heating a chlorinated hydrocarbon in a closed vessel with a solution of an alkali carbonate and/or bicarbonate in presence of copper, the amount of water greatly exceeding that of the unaltered chlorinated hydrocarbon present.—F. W. A.

Tobacco; Method of dehydrating and curing—G. H. Benjamin, New York. Eng. Pat. 169,618, Apr. 4, 1917. (Appl. No. 1877 of 1917.)

SEE U.S. Pat. 1,224,703 of 1917; this J., 1917, 608. The temperatures stated should be read as degrees Fahrenheit instead of degrees centigrade.

Preparation of radioactive mineral waters containing radium-precipitating acids. Eng. Pat. 101,295. See VII.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

PATENT.

Photographic film. P. W. Lovejoy, Assignor to Eastman Kodak Co., Rochester, N.Y. U.S. Pat. 1,232,702, July 10, 1917. Date of appl. Jan. 19, 1914.

THE base of the film consists of separate layers of two substances which develop respectively positive and negative electric charges when excited frictionally. For instance, a film of cellulose nitrate is coated on one side with a layer of mixed cellulose acetate and cellulose nitrate and on the other side with a light-sensitive film.—B. V. S.

XXII.—EXPLOSIVES; MATCHES.

Nitro-derivatives of toluene; Preparation of—T. Kidokoro, Kogyo-Kwagaku-Zasshi (J. Chem. Ind., Tokyo), 1917, 20, 460—480.

o-NITROTOLUENE is best prepared by addition of a mixture of 1 part nitric acid (sp. gr. 1.40) and 2 parts of sulphuric acid (sp. gr. 1.84) to 1 part of toluene, with stirring, at 30° C. for 6 hrs., the product being washed with water and dilute alkali, and distilled *in vacuo*; yield, 55.1% of theory. p-Nitrotoluene is obtained by nitration of 1 part of toluene with 2 parts of fuming nitric acid (sp. gr. 1.47) at the ordinary temperature for 15 hrs., purifying as described for the *ortho*-compound; yield 60% of theory. 2,4-Dinitrotoluene is prepared by addition of 110 c.c. of toluene to 230 c.c. of fuming nitric acid at the ordinary temperature, with stirring; the mixture is cooled, and 230 c.c. of sulphuric acid (sp. gr. 1.84) added; the mixture is warmed on a water-bath for 30 mins., poured on to ice, and the crystals of dinitrotoluene recrystallised from alcohol; yield, 98% of theory (m.pt. 71° C.). 2,4,6-Trinitrotoluene is obtained by

dissolving 40 grms. of dinitrotoluene in 88 c.c. of sulphuric acid (sp. gr. 1.84), adding 10 c.c. of nitric acid (sp. gr. 1.52), and heating the mixture for 1—5 hours on a water-bath until evolution of bubbles has ceased; yield, 96% of theory. Trinitro-*tert*.-butyltoluene (artificial musk) is prepared in the following stages: 50 grms. of strongly cooled butyl alcohol is saturated with dry hydrogen chloride and heated in a sealed glass tube for 24 hrs. at 100° C. giving 49 grms. of iso-butyl chloride; 50 grms. of toluene, 10 grms. of iso-butyl chloride, and 2 grms. of powdered aluminium chloride are heated for 1 hr. at the b.pt. of toluene, giving 16.61 grms. of *m-tert*.-butyltoluene; nitration of *m-tert*.-butyltoluene with a mixture of 1 part of 18% oleum and 2 parts of fuming nitric acid (sp. gr. 1.52) in 20 hrs. at 100° C. gives trinitro-*tert*.-butyltoluene (recryst. m.pt. 96°—97° C.). Certain reduction products of the above nitro-compounds are also dealt with.—F. W. A.

PATENTS.

Explosives; Process of drying—W. A. Phillips, Philadelphia, Pa., Assignor to E. I. du Pont de Nemours Powder Co., Wilmington, Del. U.S. Pat. 1,237,551, Aug. 21, 1917. Date of appl. Aug. 13, 1913.

SEE Fr. Pat. 477,343 of 1915; this J., 1916, 618.

Pyroxylin composition. U.S. Pat. 1,231,924. See V.

XXIII.—ANALYSIS.

Determination of ozone and oxides of nitrogen in the atmosphere. Usher and Rao. See VII.

Testing of refractory brick. Nesbitt and Bell. See VIII.

Testing of refractory materials under load at high temperatures. See VIII.

Percentage of resin, [mineral matter, and nitrogen] in raw rubber. See XIV.

Methods for determining the reaction of soils. Christensen. See XVI.

PATENTS.

Lubricant testing machine. J. W. Lowry, Chicago, U.S.A. Eng. Pat. 101,975, Oct. 25, 1916. (Appl. No. 15,202 of 1916.) Ender Int. Conv., Oct. 25, 1915.

THE lubricant to be tested is supplied to grooves in a bearing, in which a shaft is rotated at a known speed. The bearing may be divided horizontally and a predetermined load applied to the upper half, and an opening is provided for a thermometer. The shaft is rotated from driving pulleys through a clutch comprising two rings, carrying co-operating cam flanges. A spindle is held between the cam edges, and is forced axially against a resistance to a position depending on the pressure between the clutch members, due to the resistance opposed to the rotation of the shaft by the viscosity of the lubricant. The axial resistance to the movement of the spindle is provided by a pivoted stem, acting on a spring, and the movement is measured by the rotation of a pointer.—W. F. F.

[*Viscosity of fluids; Apparatus for ascertaining the properties*—W. M. Groszner, Ridge-wood, N.J., Assignor to Perkins Ghe Co. U.S. Pat. 1,236,706, Aug. 14, 1917. Date of appl. July 11, 1914.

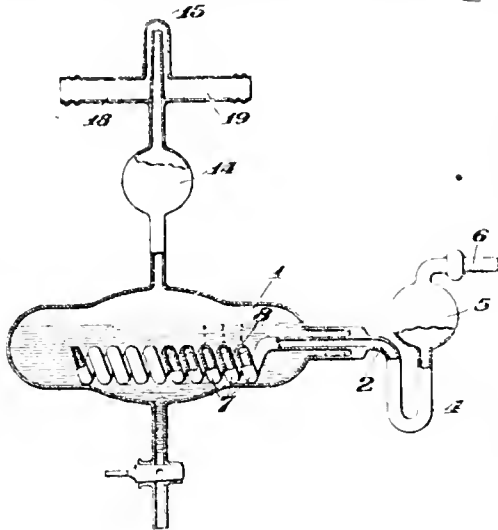
THE liquid to be tested is placed in a removable cylindrical container supported on a constantly rotating turntable. A solid cylindrical body is suspended concentrically in the liquid by means

which measure the torsion exerted on the body by the rotation of the liquid. The bottom of the suspended body is recessed so as to enclose a volume of air to prevent contact of the liquid with the body except on the cylindrical surface.

—W. F. F.

Gases: Method of and apparatus for indicating the volumetric flow of—. E. E. Werner, St. Louis, Mo., U.S.A. Eng. Pat. 108,714, Aug. 14, 1916. (Appl. No. 11,473 of 1916.)

Gas to be measured is supplied through the pipe, 6, bulb, 5, and trap, 4, to the helically coiled tube, 2, sealed into the vessel, 1, containing liquid.



At the top of each coil, 7, a small orifice, 8, is provided through which bubbles of gas escape. The rate of flow of gas is measured by the number of orifices, 8, from which bubbles of gas are rising. The gas passes upward through a bulb, 11, for the collection of moisture, to the outlet, 15, where it may be mixed with air supplied by the pipe, 18.

the mixture passing out by the pipe, 19. The apparatus is particularly applicable for regulating the flow of gas used in bleaching flour. In a modification, the tube, 2, may be vertical and provided with successive enlargements along its length, each enlargement having an aperture in its upper surface. In another modification the tube, 2, may be straight but inclined, and provided with orifices along its upper wall.—W. F. F.

Trade Report.

MINERAL PRODUCTION OF CANADA IN 1916.

The accompanying statistics (subject to revision) of the mineral production of Canada during the year 1916 are taken from a preliminary report on the subject issued by the Canadian Department of Mines, Ottawa; the definitive figures for 1915 are added for purposes of comparison.

The value of the metal and mineral output of Canada last year was the highest yet recorded, the previous record being 145,634,812 dols. in 1913. As regards copper, it is notable that while the output increased by 18.8% in quantity as compared with 1915, the value increased by 87.1%. With the exception of a small production in experimental work, there was no recovery of zinc spelter or refined zinc in Canada prior to 1916. In 1915 the shipments of zinc ores to American smelters for reduction amounted to 14,895 tons, valued at 551,938 dols., and containing 12,231,439 lb. of zinc. Assuming a probable recovery of 80% of the metal, the production of zinc in 1915 from Canadian ores may be put at 9,785,151 lb., valued at 1,294,575 dols. Adding to the result of a similar estimate for 1916 the actual output of zinc at Trail, it would appear that the production of zinc from Canadian ores in that year was 23,515,030 lb., valued at 3,010,864 dols. According to the Report for 1916 of the British Columbian Minister of Mines, the output of zinc from the smelter at Trail in that year was approximately 15,000,000 lb. At the beginning of 1917 the output of the smelter was from 25 to 30 tons per day.

		1915.		1916.	
		Quantity.	Value.	Quantity.	Value.
Metallic—			Dols.		Dols.
Nickel	lb.	68,308,657	20,492,597	82,958,564	29,035,497
Copper	lb.	100,785,150	17,410,635	119,770,814	32,580,057
Gold	oz.	918,056	18,977,001	926,983	19,162,025
Silver	oz.	26,625,960	13,228,842	25,669,172	16,854,635
Lead	lb.	16,316,450	2,593,721	41,593,680	3,540,870
Iron, pig, from Canadian ore	tons of 2000 lb.	158,595	1,715,874	115,691	1,328,595
Other metallic products			1,395,271	—	4,538,366
Total metallic		—	75,814,841	—	107,040,935
Non-metallic—					
Coal	tons of 2000 lb.	13,267,023	32,111,182	14,461,678	38,857,557
Asbestos	tons of 2000 lb.	111,142	3,553,166	136,016	5,139,332
Natural gas	1000 cu. ft.	20,124,162	3,706,035	25,238,568	3,924,632
Pyrrites	tons of 2000 lb.	286,038	985,190	309,411	1,084,019
Gypsum	tons of 2000 lb.	474,815	854,929	341,618	730,831
Salt	tons of 2000 lb.	119,900	600,226	124,033	668,627
Petroleum	barrels	215,464	300,572	198,123	392,284
Cement, Portland	barrels	5,681,032	6,977,024	5,359,050	6,529,861
Clay products		—	3,914,488	—	4,196,033
Stone		—	4,244,997	—	3,868,069
Lime	bus-hels	5,947,244	1,015,702	5,182,876	1,089,505
Other non-metallic products		—	3,030,819	—	3,901,809
Total non-metallic		—	61,294,330	—	70,377,539
Grand total		—	137,109,171	—	177,417,574

Journal of the Society of Chemical Industry.

No. 20, Vol. XXXVI.

OCTOBER 31, 1917.

No. 20, Vol. XXXVI.

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Hon. Local Secretary and Treasurer:

T. Fairley, 17, East Parade, Leeds.

Official Notices.

NEW MEMBERS OF COUNCIL.

At a Meeting of Council held on the 23rd October, the following gentlemen were elected Members of the Council to fill two vacancies which have occurred since the last Annual General Meeting:—

Mr. W. J. A. Butterfield, of London, in place of Professor H. E. Armstrong, F.R.S., resigned; and Mr. E. F. Hooper, of Stroud, Glos., in place of Mr. R. D. Pullar, deceased.

CROSS AND BEVAN ESSAY PRIZE OF £20 AND LATHAM RESEARCH GRANT OF £300.

The Council desires to remind intending competitors for the Cross and Bevan prize that Essays must be received at the offices of the Society before the close of the present year.

The Essay prize is open to all members of the Society who are British subjects. The Research Grant is limited to competitors under 25 years of age at the time of sending in the essay.

Full particulars were published in the issues of the Journal for 15th January and 15th and 28th February, 1917.

CENTRAL COMMITTEE ON SUPPLIES OF MATERIALS.

Dr. Addison, the Minister of Reconstruction, after consultation with other Government Departments concerned, has appointed a Committee to consider and report upon questions connected with the supplies of raw materials which will be required by British industries for the purpose of restoring and developing trade after the termination of the war, and the best means of securing and distributing supplies, due regard being had to the interests of the Allies. The Committee is requested, in regard to any commodities which might not be available in sufficient quantities and at reasonable prices through the ordinary commercial channels, to consult members of the trades concerned with regard to any steps that may be necessary to safeguard the needs of industry and to secure convenient and equitable distribution. The Committee, which will be known as the Central Committee on Supplies of Materials, consists of the following:—Sir Clarendon Hyde (Chairman), Sir Henry Birchenough, K.C.M.G.; Mr. Cecil Budd, Sir Charles W. Fielding, K.B.E., Sir H. Babington Smith, K.C.B., Mr. Wallace Thorneycroft, and Mr. Andrew Weir. The Secretary to the Committee is Mr. J. F. Ronca (Board of Trade), communications to whom should be addressed at the Ministry of Reconstruction, 2, Queen Anne's Gate Buildings, Westminster, London, S.W.1.

POTASSIUM COMPOUNDS.

MINISTRY OF MUNITIONS ORDER, OCT. 17TH, 1917.

The Minister of Munitions, in exercise of the powers conferred upon him by the Defence of the Realm Regulations and all other powers enabling him, hereby gives notice and orders as follows:—

1. No person shall as from the date hereof until further notice offer to purchase, purchase, or take delivery of any potassium compounds as defined in Clause 3 hereof except under and in accordance with the terms of a licence issued on behalf of the Minister of Munitions by the Controller of Potash Production, or offer to sell, sell, supply or deliver any such potassium compounds to any person other than the holder of such a licence and in accordance with the terms thereof

provided that no such licence shall be required (a) By the Admiralty or War Office. (b) By any person for the purchase and delivery of potassium compounds in quantities not exceeding in weight an aggregate of 3 lb. avoirdupois during any one calendar month.

2. All persons shall furnish returns to the Controller of Potash Production at the times and in the manner prescribed by him of all potassium compounds held in stock by them or otherwise under their control or manufactured, produced, bought, sold or otherwise dealt in by them.

3. The potassium compounds to which this order relates are caustic potash (KOH), chloride or muriate of potash (KCl), carbonate of potash (K_2CO_3), and sulphate of potash (K_2SO_4), whether in a pure or in a commercial form, and any material (other than blast furnace dust referred to in the Order of the Minister of Munitions of 7th August, 1917) of which more than 10% consists of any one or more of the above.

4. All applications in reference to the above Order to be addressed to The Controller of Potash Production, Ministry of Munitions, 117, Piccadilly, W.1.

MAXIMUM PRICES FIXED FOR COMPOUND FERTILISERS.

The Minister of Munitions has made an Order, dated 13th October, fixing maximum prices for sales of compound fertilisers. The Order took effect as from 17th October. The prices fixed are for sales during December, and reductions or increases in prices are to be made according as the month for delivery precedes or is subsequent to December. Schedules appended to the Order prescribe (1) the maximum unit rates authorised to be charged for specified constituents, and (2) the limits of error allowed in the invoice statement of the percentage of constituents which must be made in respect of each sale. These provisions do not apply to any sale of compound fertiliser for export from the United Kingdom.

The Order also requires persons producing and dealing in compound fertilisers to make such returns with regard to their businesses as may be required by the Minister of Munitions.

All applications in reference to this Order should be addressed to the Director of Acid Supplies, Ministry of Munitions, Department of Explosives Supply, Storey's Gate, Westminster, London, S.W.1., and marked "Fertilisers."

TAR OILS ORDER (see page 1110).

Edinburgh Section.

Meeting held at Edinburgh, on Tuesday, October 16th, 1917.

MR. D. B. DOTT IN THE CHAIR.

The CHAIRMAN gave a short address dealing with the teaching of science in schools, with special reference to recent reports and speeches on the subject.

THE UTILISATION OF FATTY ACIDS FOR FEEDING PURPOSES.

BY ALEX. LAUDER, D.S.C., F.I.C., AND T. W. FAGAN, M.A.

The great increase in the manufacture of glycerin during the last three years for the making of explosives has caused a corresponding increase in the production of fatty acids. As the amount produced is much in excess of what can ordinarily be utilised, the most suitable means of making

use of the increased production has frequently been under consideration.

During the early months of the present year, when there appeared to be every prospect of a serious food shortage, the possibility of utilising the free fatty acids to replace fat in feeding stuffs for cattle was considered.

The difficult question as to how fats are absorbed in the intestine has been the subject of much investigation and discussion. It is now held that the neutral fats are split in the intestine and the free fatty acids are in part absorbed in solution in the bile, and, in part, combined with alkalis to form soaps. After absorption, the neutral fats are regenerated again from the fatty acids. The soaps are also absorbed and decomposed, the alkali set free being secreted again into the intestine and used for the re-formation of soaps (Moore and Richmond, Hammersten's *Physiol. Chem.*, 1914, 536).

There does not appear to be, therefore, any reason from the physiological standpoint why free fatty acids should not be assimilated. The formation of fats from carbohydrates is now well established, and it appeared reasonable to conclude that an animal if supplied with a fatty acid should be able to convert it into a fat.

Munk (*Bied. Centr.*, 1881, 106) found that a dog fed with flesh and fatty acids from mutton suet deposited fat 96% of which had the same composition as ordinary suet. He consequently concluded that the fat had been formed from the fatty acids and not from the proteins, since the latter would have yielded dog fat. Experiments to test if the free fatty acids could be used to replace a certain amount of carbohydrates and fat in a ration were therefore undertaken with pigs.

Samples of various mixtures of fatty acids were obtained: these differed considerably in their average molecular weight and in the amount of unsaturated fatty acids which they contained.

The fatty acids from coconut oil were finally selected, not because the mixture was the most palatable or had the most agreeable smell, but because it could be obtained in sufficient amount without delay. The average molecular weight was 212 and the iodine value was 8.2.

The pig-feeding experiments were carried out by the kind permission of the Edinburgh District Board of Control, at the Bangour village farm, Dechmont, Linlithgowshire, where pigs from the well-known herd of "Large Whites" were placed at our disposal.

A preliminary experiment with 10 pigs was commenced on April 18th, 1917. These were divided into two lots of five each, but as the pigs varied considerably in age and weight it was not possible to get the lots sufficiently equal to enable very definite conclusions to be drawn.

The most suitable ration to feed along with the fatty acids was a question of some difficulty. It was desirable that it should have a low fat content, and owing to the restricted number of feeding stuffs available and to the fact that it was impossible to get potatoes, the choice was somewhat limited. Finally a mixture of equal parts of maize meal and sharps was selected for the ration for the control lot of pigs.

The average composition of maize meal and sharps is as under:—

	Maize meal.	Sharps.
	o/o	o/o
Proteins	10.5	15
Oil	5.0	4.5
Soluble carbohydrates	70.0	57.0
Crude fibre.....	2.0	8.0

For the other lot, about 5% of the weight fed was replaced by fatty acids, it being assumed

that the fatty acids were equivalent to 2.4 times their weight of carbohydrates. The "starch equivalent" of the mixture of maize meal and sharps was taken as 70. A weighed amount of green food was also used in addition.

This experiment was continued for four weeks, until a supply of young pigs, from which a better selection of animals could be obtained, was available. The fatty acids were melted in hot water and mixed with the meals; the pigs ate the mixture readily and made, as far as could be judged, quite as satisfactory live weight increases as the pigs in the control lot.

A more accurate experiment was commenced on May 7th, 1917, when 10 newly weaned young pigs, about seven weeks old, were carefully selected from a large number which were then available.

The weights of the two lots at the beginning of the experiment were as under:—

No.	Lot 1.	Lot 2.
	lb.	lb.
1	32.5	31.0
2	28.5	31.0
3	29.0	27.0
4	23.5	24.0
5	24.0	24.5
Total	137.5	137.5
Average	27.5	27.5

The following table shows the daily ration supplied for each lot of five pigs:—

Date.	Lot 1.	Lot 2.
	lb. meals.	5.25 lb. meals plus 5.0 oz. fatty acids.
1917.		
May 7	6.25	6.5
" 17	8.0	6.5
" 24	9.0	7.5
" 31	10.0	8.25
June 7	10.0	8.25
" 14	10.0	8.25
" 21	10.0	8.25
" 28	10.0	8.25
July 5	11.0	9.25
" 12	11.0	9.25
" 19	12.0	10.0

During the latter period of the experiment the pigs were given about 3 lb. cabbage per lot per day, in addition to the above rations as the diet was rather monotonous. The health of both lots of pigs was excellent and no difference could be detected between the lots in this respect.

The pigs were weighed in the morning and always, with one exception, in a fasting condition.

Pig No. 3 in Lot 2 never did well and was ill from time to time with some chest disease. It recovered to a certain extent as the experiment went on, but it will be noticed that it did not put on weight with the same regularity as the other pigs.

The pigs were weighed weekly; the table on p. 1071 shows the live weight increases obtained.

The results show that the increase in weight of the two lots is practically identical, and, as the amount of the ration was intentionally kept low, there can be no doubt that the fatty acids were assimilated and that they replaced about 2½ times their weight of carbohydrates. It had originally been intended to continue the feeding until the pigs were fat and to obtain specimens of their fat from the butcher after they had been killed in the ordinary way. By the end of July, however, neither lot was making the normal increase

Weight in pounds.

Lot 1 (Meals only).						Lot 2 (Meals and fatty acids).				
Date.	1.	2.	3.	4.	5.	1.	2.	3.	4.	5.
1917.										
May 7	32.5	28.5	29.0	23.5	24.0	31.0	31.0	27.0	24.0	24.5
" 17*	34.0	30.5	28.5	25.0	25.5	33.5	31.0	27.0	26.5	25.0
" 24†	41.0	35.0	32.0	29.5	30.5	40.5	36.0	32.0	31.0	29.0
" 31	38.0	33.5	32.5	29.5	32.0	41.0	36.0	31.0	32.5	30.0
June 7	43.5	37.0	37.5	33.5	35.5	47.0	42.0	35.5	38.0	35.0
" 14	47.5	39.0	39.5	35.5	33.5	49.5	43.5	39.5	39.5	37.5
" 21	51.0	42.0	42.5	39.0	38.5	54.0	46.5	35.0†	42.0	40.5
" 28	54.0	45.5	44.0	41.0	41.0	58.0	50.0	37.5	44.0	42.0
July 5	59.0	49.5	46.5	44.0	43.0	60.5	52.0	39.0	45.0	44.0
" 12	61.5	52.0	48.0	46.0	46.5	64.5	55.5	42.0	47.5	48.0
" 19	68.0	58.5	53.5	50.0	53.0	69.5	60.0	47.5	51.0	52.5
Total increase	35.5	30.0	24.5	26.5	29.0	38.5	29.0	20.5	27.0	28.0

Total increase: Lot 1=145.5 lb.

Lot 2=113.0 lb.

Notes.—(*) Interval of 10 days. (†) The pigs were fed before being weighed; this explains the abnormal gain in weight and the apparent low increase the following week. (‡) No. 3 ill.

in weight for pigs of their age, due probably to the great heat experienced about that time and to the monotony of the diet. It was therefore judged better to discontinue the experiment and put the pigs back to their ordinary diet.

We have to express our indebtedness to Professor James Walker, F.R.S., who suggested the experiment and who procured the necessary supplies of fatty acids for us.

We have also to express our thanks to Lt.-Colonel Keay, M.D., R.A.M.C., in command of Bangour Military Hospital, and to Mr. William Smith, Chairman of the Edinburgh District Board of Control, for the facilities afforded us in carrying out the experiment.

College of Agriculture,
Edinburgh.

Communications.

A NOTE ON THE CORROSION OF STEEL WATER PIPES.

BY A. B. BRADLEY.

During the last few months the writer has experienced considerable trouble arising from the corrosion of hydraulic steel pipes used in a deep well water service at Bermondsey. The water itself is of interest, being particularly hard when compared with other well waters from the immediate neighbourhood. The following is the average composition of the water, taken from 12 monthly analyses.

	Parts per 100,000.
Total solids	131.8
Calcium carbonate	32.6
Magnesium carbonate	8.0
Magnesium sulphate	19.7
Sodium sulphate	33.3
Sodium chloride	31.1
Sodium nitrate	0.82
Silica, iron oxide, etc.	1.72

Temporary hardness, 33; permanent hardness, 29.

The water when freshly pumped is perfectly clear, with a very slight smell of hydrogen sulphide, but, on standing for an hour or more, it becomes slightly turbid, with the evolution of gas. The water was found to be suitable for domestic purposes from a bacteriological point of view, and was in use in the factory for nearly all purposes (boilers excepted). The service had been working for about four years without com-

plaint, when suddenly considerable trouble arose through the raising main, which conveyed the water from the pump house to the main supply tank at the top of a block of buildings becoming perforated. The pipes in question were hydraulic steel tubes 6 in. and 4 in. bore, having a wall thickness of $\frac{3}{8}$ in. to $\frac{1}{2}$ in. In every case where a perforation was found the pipe was in a horizontal position, and the perforation always formed at the top. On cutting sections through a defective pipe the steel was found to have been eaten away the whole length, a channel having been formed about $\frac{1}{2}$ in. to $\frac{3}{4}$ in. wide; leaving the steel wall of the tube about $\frac{1}{8}$ in. thick at the top. Several perforations have formed on a single length of pipe at different times. This defect was thought to be so serious that efforts were made to ascertain the cause. Glass cylinders of 2000 c.c. capacity were filled with freshly pumped well water and left in a horizontal position, continuous observation being made. After a short time, minute bubbles of gas were seen to have formed on the surface of the cylinder and gradually rose to the top, so that after about an hour a continuous string of bubbles had formed the whole length of the cylinder. After standing for 12 hours, 6.2 c.c. of gas had been evolved from 2000 c.c. of well water. The gas was found to consist chiefly of carbon dioxide, with a small amount of hydrogen sulphide. Carbon dioxide, as is well known, readily attacks most metals in the presence of moisture, so that this suggested itself as the cause of the trouble. Two perfectly bright weighed steel rods were placed in a 2000 c.c. cylinder filled with freshly pumped well water, in such a position that one was at the bottom covered with water, the other being fixed at the top so as to be in contact with any gas evolved. After a few hours both rods were seen to have been attacked, the top much more vigorously than the bottom one. After 100 hours' contact both rods were taken out, carefully wiped dry, and weighed. The top rod was found to have lost 0.6% of its weight, and the bottom one 0.16%. Microscopically the bottom rod was observed to be perfectly even on the surface and of a dull grey colour, as if a film of sulphide had formed, whereas the top rod was seen to have been eaten quite badly, almost the whole surface being etched quite deeply. Cast iron elbows used in the service, when in a horizontal position, were found to be in almost perfect condition, except where the thread had been cut into them, the water thus coming into contact with the soft under metal, the hard surface metal being unaffected.

The conclusion arrived at was therefore as follows:—The action of pumping water highly charged with carbonates and carbon dioxide liberates some of the gas which, so long as it is being driven through the pipes, is carried upwards with the water, but as soon as pumping ceases the gas rises to the top of the horizontal sections, where it has free play on the metal until driven off by the next pumping. It should be mentioned that pumping is not continuous, the supply tank being fed to overflow when pumping ceases. No trouble has been experienced with pipes which lead from the supply tank, most of the free gas having escaped. A perfect coating of pitch or similar material should protect the pipes, and this experiment is being carried out; pipes thus treated are to be examined at yearly intervals. If the pipes were laid out of the horizontal in such a manner that the gas rose to a common angle joint as soon as formed, a greater part of the trouble could doubtless be overcome, the gas being removed from the angles through a small tap.

VULCANISATION CATALYSTS.

BY D. F. TWISS.

Under the above heading (this Journal, 1917, 950) Mr. S. J. Peachey has recently made reference to my paper on the "Chemistry of Vulcanisation" (this J., 1917, 782) and suggests that this "is likely to give rise to an erroneous impression that basicity is an invariable concomitant of accelerating power."

Such an impression was far from intended, as indeed is indicated by my statement "*almost* the whole of the known effective organic accelerators are basic" (p. 780). My investigations in this direction have not been restricted to a working theory that basicity is essential in an accelerator, but the fact that strongly basic substances generally appear capable of exerting an accelerating effect on vulcanisation is suggestive of a common mode of action for this class of vulcanisation catalyst; the consideration of the mechanism of acceleration given on p. 787 was therefore definitely restricted to the case of basic accelerators.

Experiments which I have made with nitroso-compounds as vulcanisation catalysts have not been limited to those containing also an amino-group, but *p*-nitrosodimethylaniline, being the first discovered and also, as Mr. Peachey agrees, probably the most effective, may be regarded as the best example of the nitroso-class. In my paper, results were given showing that *p*-nitrosodimethylaniline is much inferior to some of the strongest of the basic accelerators (organic or inorganic) and my statement (p. 787) that "the nitroso-compound is much more effective in mixings containing a high percentage of sulphur . . . and that mixings . . . with a low percentage of free sulphur have been found to behave less satisfactorily with the nitroso-compound" serves to emphasise this point. It is certainly most desirable that investigations of the acceleration of vulcanisation should be made in as many different directions as possible especially because, in our present state of knowledge, there appears to be no satisfactory explanation as to the manner in which the effect is produced.

Mr. Peachey's fear lest my paper should impart the idea that only basic vulcanisation catalysts exist will, I hope, prove to be without justification. It is, however, my decided opinion, the grounds for which are not restricted to published experimental results, that no known accelerator of the nitroso-type nearly approaches in activity the best basic accelerators.

Institute of Metals.

The Autumn Meeting of the Institute of Metals, held under the presidency of Sir George Beilby in the rooms of the Chemical Society on September 19th, proved to be of great interest. Dr. Haigh's paper on the fatigue of brasses described experiments with an alternating stress machine, in which the stress, produced by electro-magnetic means, varies in a perfectly regular manner according to a sine curve, so that the experimental conditions may be reproduced exactly with different metals, and an exact comparison with the resistance to static stresses may be made. Among the observations which attracted attention in the discussion was the influence of corroding agents, such as ammonia, in reducing the resistance to alternating stresses. The effect of comparatively small surface scratches in starting failure by fatigue was also well shown, indicating the desirability of polishing machine parts subject to alternating stress. Prof. Turner raised the general question of the nature of hardness and of the mechanism of hardening by cold work, and in the course of a review of the subject, expressed the opinion that the increased rigidity of a work-hardened metal is due to the existence of tension in the films of amorphous material which, as shown by the President, are formed at the internal surfaces on which slipping has taken place during deformation. The discussion turned largely on the terms employed, it being well known that different methods of determining hardness do not really measure the same property. The numerous experiments on the softening of cold-rolled aluminium sheet by heat, described by Prof. Carpenter and Mr. Taverner, showed that whilst softening was very rapid at temperatures above 300° C., the tenacity of the annealed metal being independent of the temperature of annealing, it took place much more slowly as the temperature was reduced, and it was not yet quite clear whether the same final value would be obtained, say, at 100° C., if the heating were continued for a sufficiently long time. The fact of an actual rise in tenacity at one stage of the annealing process was observed, and its meaning discussed. The President pointed out that the absolute dimensions of the metal were of importance in such low-temperature annealing experiments, thin wires behaving quite differently from larger masses. Other speakers discussed the influence of the impurities in commercial aluminium, silicon especially having an important effect in modifying the softening. A note by Prof. Jeffries, which was taken as read, disposed of a statement by Hanriot, which has been accepted in many quarters, to the effect that permanent hardening may be produced by uniform hydrostatic pressure. The source of the error was shown, and new experiments described to prove that hardening only occurs where there is deformation, this view being in accordance with Beilby's hypothesis.

The evening session was devoted to a further discussion of some of the problems of metal melting, which had aroused such a lively interest at the Spring Meeting. Mr. Ionides had arranged a demonstration of his new system of gas-firing, and the lecture table was occupied by an elaborate installation of burners, measuring instruments, and furnace equipment. A hot and steady flame was produced, using air under pressure and the ordinary gas supply. It was not easy to understand from the paper the exact nature of the new method, but Dr. Harker, in opening the discussion, showed that the principle was that of burning an explosive mixture of gas and air in such a way as to prevent firing back, the ratio of gas to air being maintained constant, in spite of accidental

variations in the supply, by an ingenious and delicate pressure balance. Figures were given showing the efficiency of the system as applied to melting and billet heating furnaces, but the figures of gas consumption by other systems given for comparison aroused much discussion, several of the speakers claiming that equally good results were obtained from gas furnaces of different types. This point led to a lively controversy, and it will be interesting to compare the experimental data furnished by the speakers concerning the systems of which they had personal experience, when the printed record of the discussion appears. The second paper, by Mr. Harvey, dealt with fuel economy in brass melting, and gave many figures, the author's preference being for firing by means of powdered coal, but this opinion was not shared by subsequent speakers. Among other objections, the use of powdered raw coal does not overcome the difficulty of the loss of by-products, which is inevitable in any system which does not provide for a partial or complete gasification of the raw coal. However, the paper also contained useful suggestions as to the improvement of efficiency in gas-heated brass furnaces. Taken together with the discussion at the Spring Meeting, the series of papers on metal melting contributed to the Institute form an invaluable source of information on this important subject.

It was announced that Prof. Carpenter, of the Imperial College of Science and Technology, had been chosen as the next President of the Institute.

Abstracts of the papers read at this meeting will be found in this Journal, 1917, pp. 1051 and 1097-1099.

Industrial Notes.

DEVELOPMENT OF IMPORTANT CHEMICAL INDUSTRIES IN RELATION TO THE WAR.

The following is a summary of a paper by Prof. E. Molineri, in *Annali di Chimica Applicata*, 1917, 8, 13-41.

Sulphuric acid.—Prior to the war Italy produced about 318,000 tons of sulphuric acid, about 80% of which was used in the manufacture of superphosphate, and only about 18,000 tons for explosives. In France about 70,000 tons, and in Germany and Austria about 300,000 tons were used in the manufacture of explosives. In 1916 Italy consumed over 160,000 tons for explosives; France not less than 1 million tons; England about 800,000 tons; Russia and other allied countries about 500,000 tons; whilst Germany and Austria must have used at least 2 million tons. In Germany the pyrites used in the manufacture is utilised efficiently, the cinder containing not more than 0.8 to 1% sulphur, and the leaden chambers produce up to 10 kilos. of sulphuric acid per cb. m. of space in 24 hours, whereas in Italian works the pyrites cinder contains 3 to 4% of sulphur, and the output of acid does not reach more than 4 to 5 kilos. per cb. m. A new process has recently been introduced in Germany, in which calcium sulphate is heated to a high temperature in a suitable furnace in the presence of silica and bisulphate (nitro cake). In Italy and France the difficulty of increasing the output is due to want of plant and not, as in Germany, to insufficient material.

Nitric acid.—In peace time Germany annually imported about 800,000 tons of sodium nitrate, about 80% of which was intended for artificial manures, and only about 20% used in chemical industries, chiefly for the manufacture of nitric

acid. The amount of nitrate used by the other nations in chemical industry varied from 10 to 15% of their imports of nitrate. The estimated consumption of nitric acid by Germany in 1915 is 500,000 tons. It has been established that to fix 1 kilo. of atmospheric nitrogen in the form of nitrate or nitric acid Pauling's process, established at Innsbrück, requires 70 kilowatts per hour, the Birkeland-Eyde process 60 kilowatts, and Schönherr's process, applied by the Badische Anilin und Soda Fabrik, 58 kilowatts. Pauling's process has been adopted in works in Rome and elsewhere in Italy. The nitric acid thus obtained requires concentration before it can be used in the manufacture of explosives. Prior to the war, Germany produced about 150,000 tons of ammonia from the distillation of about 40 million tons of coal, and this output has probably been doubled by now. Formerly, only about 1800 tons of calcium cyanamide was produced in Germany, whereas in 1916 the output reached 450,000 tons. To this may be added the ammonia recovered by the Mond process from coal dust, lignite, and peat, and that obtained by direct synthesis from atmospheric nitrogen and hydrogen by the process of Haber and Rossignol. In England, ammonia is now oxidised on a large scale by the Kuhlmann-Ostwald process; and a large plant has been put up at Angoulême (France), which produces 10,000 kilos. of concentrated nitric acid per day.

Distillation of coal.—The amounts of coal distilled for gas or metallurgical coke in 1910 were as follows:—United States, 60 million; Germany, 40 millions; England, 46 million; Russia, 5 million; Belgium, 4 million; France, 8 million; Austria, 4½ million; and Italy, 1.4 million tons. By distillation of all the coal tar then obtained throughout the world there would be at most an output of 100,000 tons of crude benzene and toluene, whilst by recovering the benzene and toluene from the illuminating gas it would have been possible to produce 1,700,000 tons. Coke ovens with plant for recovering benzene accounted for only 5% of the possible yield in 1900, and 16% in 1909 in the United States. In England, the corresponding figures were 10% in 1900, and 28% in 1909; whilst in Germany the output increased from 10% in 1900 to 82% in 1909. Phenol and picric acid are now prepared synthetically from benzene, by processes which had not been found suitable in times of peace. Benzene is treated with chlorine in presence of iron as catalyst, and the monochlorobenzene is nitrated and the product saponified; or, benzene is sulphonated, the sodium salt of the resulting benzenesulphonic acid fused with caustic soda to produce phenol, which is then nitrated to obtain picric acid. Picric acid thus manufactured in England, France, and Italy, furnishes the greater proportion of the explosives used in the war. In Italy alone, one plant produces 16,000 kilos. of synthetic phenol per day from pure benzene obtained from Italian coal and from light tar oils imported from England. From 50,000 to 60,000 kilos. of picric acid is produced daily by various factories in England by means of these processes, whilst, in France, the Soc. Usines du Rhône now produces daily up to 150,000 kilos. of phenol for the manufacture of picric acid. Other factories in France produce from 30,000 to 50,000 kilos. per day; whilst others, again, produce immense quantities of dinitrophenol. It is estimated that during 1916 approximately 1,805,000 tons of explosives was produced throughout the world, the chief consuming countries being as follows:—England, 200,000; Germany, 540,000; France, 300,000; Italy, 45,000; United States, 160,000; Russia, 100,000; Japan, 90,000; and Austria, 150,000 tons.

Dyestuffs.—In 1911 Italy imported 6823 tons of coal tar dyestuffs and derivatives, and in 1913.

7663 tons. Owing to the war, the conditions are now changed, and the existing plant in Italy is capable of producing 12,000 tons of pure benzene, and 2000 tons of toluene per annum, in addition to 560 tons of phenol, about 3000 tons of naphthalene, and 560 tons of anthracene. These quantities should be sufficient to meet any future demand for dyestuffs in Italy.—C. A. M.

REPORT OF THE FUEL RESEARCH BOARD.

The Fuel Research Board has presented to the Committee of the Privy Council for Scientific and Industrial Research a report on their scheme of research and on the establishment of a fuel research station.

In their First Report (which was not published) the Board stated that they had in view two main lines of research: First, a survey and classification of the coal seams in the various mining districts by means of chemical and physical tests in the laboratory, and, second, an investigation of the practical problems which must be solved if any large proportion of the raw coal at present burned in its natural state is to be replaced by the various forms of fuel obtainable from coal by carbonisation and gasification processes.

In preparation for the organisation of the first line of enquiry, an experimental study of standard methods for the examination of samples of coal in the laboratory has been made. Hitherto in the systematic examination of coals in the laboratory there has been no generally accepted low-temperature carbonisation test. Certain existing tests are designed to ascertain the suitability of coal for gas or coke making, but as both these methods of carbonisation are carried out at temperatures above 900° C. they give little or no direct information as to the behaviour of the coal when carbonised at 500° to 600° C.

A test has been elaborated which by direct weighing and measurement gives the yields of gas, oil, water, and carbonaceous residue which result from carbonisation at any definite temperature. The apparatus is simple and is so arranged that the progress of the distillation can be watched from start to finish. The products can be weighed or measured with reasonable accuracy, and any or all of them can, if desired, be submitted to further examination. The method has been tested on certain typical coals and at a variety of temperatures, but before publishing the results it is proposed to make further tests with a wider range of samples.

It is not proposed to start any extensive organisation for the collection and registration of samples till the preparations for the second line of enquiry are further advanced.

The gas retort and the coke oven have become highly developed appliances for the carbonisation of coal at temperatures ranging from 900° to 1200° C. In the former the primary object of the carbonisation is to obtain the maximum yield of gas suitable for domestic and industrial lighting and heating, while in the latter coke is regarded as the principal product. In considering the broad question of the replacement of any considerable proportion of the coal which is at present being burned in its raw or natural state by manufactured forms of fuel, the part which may be played by high temperature methods of carbonisation will need to be taken into account. For this purpose a great amount of experience is available, and trustworthy data on which to base the calculation of the economic possibilities are in existence.

The distillation of oil shales at low temperatures for the production of mineral oils, paraffin wax, and ammonia is a highly developed industry, but

the oil shales are totally unlike coal in their nature and in the products which they yield so that the experience gained in this industry, though undoubtedly valuable, is only indirectly useful so far as coal is concerned.

As regards the carbonisation of coal at low temperatures there is no corresponding body of experience in existence and there are very few properly accredited data available. Some work has been done by individual inventors and syndicates and a certain amount of experience has been gained. While only portions of this experience have been disclosed enough is known to justify the conclusion that much still remains to be done in devising the special forms of apparatus required for the economical carrying out of this type of carbonisation.

The way is clearly open for a serious attempt to determine whether an economical and efficient apparatus can be devised for the carbonisation of coal at low temperatures and whether, by the use of such an apparatus for the carbonisation of properly selected coals, products will be obtained of a collective value greater than that of the original coal plus the cost of carbonisation and handling. Obviously the evolution of an economical and efficient apparatus is at the root of the whole matter, for only after a thoroughly practical apparatus is available can trustworthy tests of the various classes of coal be made and the economic possibilities of the method be fully weighed and considered.

The solution of these fundamental problems will supply a new base from which to attack questions like the following:—

(1) Can the 35 to 40 million tons of raw coal which is used every year for domestic heating be wholly or partially replaced by smokeless fuel, solid and gaseous, prepared by the carbonisation of this coal?

(2) Can adequate supplies of fuel oil for the Navy be obtained by carbonisation of the coal which is at present used in its raw form for industrial and domestic purposes?

(3) Can supplies of town gas be obtained more economically and conveniently by methods of carbonisation and gasification other than those at present in use in gas-works?

(4) Can electric power be obtained more cheaply if the coal used for steam raising is first subjected to processes of carbonisation and gasification?

(5) Will the more scientific development of the preparation and use of fuel, which would be implied in the successful working out of the foregoing questions, enable the peat deposits of the United Kingdom to take a serious place as economic sources of fuel for industrial purposes?

(6) Can the use of gaseous fuel in industrial operations be forwarded by the development of more scientific methods of combustion in furnaces, muffles, and ovens used in metallurgical, ceramic, and chemical operations?

The answers to these questions will only be obtained by co-ordinated research carried out on the lines of a broad and well-considered scheme. The subjects to be dealt with are already attracting the attention of serious workers in the industries, and it is to be expected that solutions of some of the problems will be supplied by these workers. The Board sincerely hope that this will be the case. They would regard it as a great misfortune if the establishment of a Government organisation for Fuel Research were to result in the discouragement or limitation in any way of the activities of outside workers or organisations. They venture to hope rather that many of these workers will be disposed to welcome a national scheme of research, the aims of which are broad and yet definite and in which the more specialised contributions from all sides will naturally take their place.

In considering new and extensive schemes of carbonisation it is necessary to bear in mind that outlets for all the products of carbonisation must be found. The gas, coke and shale oil industries are all of old standing and each has had to develop outlets for its products by patient and continuous effort. No new carbonisation scheme can be justified economically if it can only live by poaching on the preserves of the existing industries. Even if an efficient method of low temperature carbonisation is evolved it will be valueless in the wider sense unless profitable outlets for all the important products can be developed. It is obvious that the Fuel Research Board, which is in official touch with the Admiralty, the Ministry of Munitions, the Board of Trade, and other public Departments, is exceptionally placed for the furtherance of schemes which involve the finding of large outlets for products new and old. It is known for instance that the Admiralty attach great importance to the development of supplies of fuel oil from home sources, so that it may be taken for granted that this requirement alone would absorb all the oil which could be produced by the carbonisation of tens of millions of tons of coal per annum. This fact alone gives an entirely new aspect to the extension of carbonisation in hitherto untried directions, but while it will undoubtedly help on the economic side of the problem it in no way relieves the pressure on the technical side. In a way, moreover, it accentuates the problem now to be referred to, the profitable disposal of the coke or carbonaceous residue left when the volatile products are distilled from the coal. The percentage of coke obtained varies with the quality of the coal and the temperature at which it is carbonised, but it may be taken on the average that each ton of coal carbonised will give about 15 cwt. of coke. Thus to obtain one million tons of fuel oil for the Navy it would be necessary to carbonise twenty million tons of coal, and the coke produced would amount to 15 million tons.

The disposal of this very large quantity of coke or char at a profitable price must be regarded as the vital question if low temperature carbonisation is to be established on a sound economic basis. The research scheme must therefore include a very complete enquiry on three main lines:—

(1) The use and value of this coke for the direct firing of steam boilers.

(2) Its gasification in producers for the manufacture of low-grade fuel gas and the recovery of its nitrogen as ammonia.

(3) Its use for industrial and domestic heating either directly, as it comes from the retorts, or after its conversion into briquettes.

The second of these enquiries will involve the development of a special form of gas producer and auxiliary plant if the best results are to be obtained from the coke. It will also involve the development of a system of boiler firing in which fuel gas of 130 B.T.U. can be burned at least as efficiently as coal both as regards thermal efficiency and the effective evaporation per square foot of heating surface.

In all that concerns the preparation and use of special forms of fuel there are two distinct stages of development to be successfully passed. In the first stage apparatus and methods have to be evolved and tested till a practical standard of efficiency is reached. In the second stage the consumers of fuel must be induced to study the new apparatus and methods till they thoroughly understand and in the end adopt them. This second stage will be most readily passed, if an expert staff trained at a fuel research station is available to undertake the education of those who desire to adopt the new methods and appliances.

The use of town gas as a fuel for industrial purposes has made great strides during the past

few years and a number of experts are to-day engaged on the design and adaptation of furnaces and apparatus for these purposes. The actual practice of gas-heating still lags a long way behind the ideals of economy and efficiency and there is room for much useful experimental enquiry into principles and methods.

The use of the lower grades of fuel gas, though successfully carried out in certain directions, is very imperfectly understood in the majority of industries in which gas might be used for heating and power purposes. In this direction there is scope for much useful work both in research and in the education of experts and consumers.

A single illustration may be given of the complicated enquiries which will have to be conducted before an answer can be given to what seems to be a simple question.

There is a very general belief among electrical experts that the future of British industry will be greatly affected by the cost at which power in bulk can be supplied in the form of electricity. It has been proposed, for instance, that large electro-chemical works should be established in this country for the manufacture of products which in the past have been manufactured in parts of the world where cheap water power is available. In this connection it has been suggested that the cost of producing power from coal in this country would be substantially reduced if instead of burning the coal directly under the steam boilers it were first subjected to carbonisation and gasification processes which in addition to fuel gas would yield valuable by-products. Plausible statements have been issued showing the enormous savings or profits which would accrue if schemes of this sort were adopted. Unfortunately these estimates have generally been made on a very slender foundation of knowledge and experience. On the other hand those who by experience and practice are best qualified to judge, hesitate to prophesy as to what the economic result of a combined carbonisation and power generating scheme would be, but they agree that the interests at stake are so great that the question ought to be authoritatively answered once for all. But no answer can be accepted which is not founded on the complete working out of the scheme, no important step in the series of operations being omitted or slurred over. This series of operations will start from the mechanical preparation of the coal and its conversion into solid, liquid and gaseous products by carbonisation. It will end with the delivery of a known weight of high-pressure steam under the conditions most favourable for power production by turbo-generators. In the proposed scheme of research it will be seen that the investigation of each of the steps involved in the above enquiry is provided for. Three, at least, of these steps involve pioneering work on an industrial scale and the work may occupy a considerable time. The Board realise that it is possible that the net result of this particular enquiry may be to show that purely as a means of cheapening the cost of electric power the use of carbonisation methods has not much to commend it, but that certain incidental advantages will justify its use in particular cases.

Fuel research station.

The scheme of research which has been outlined in this Report can only be efficiently carried out in a Fuel Research Station designed and equipped for the purpose in which operations on an industrial scale can be carried out under proper working conditions. A description is given of the equipment which will be required for the research work at present in view.

It was realised that the Research Station should be situated in the neighbourhood of a large gas works, and Dr. Charles Carpenter, on behalf of

the Board of the South Metropolitan Gas Company, has made the following very generous offer to this Board: (1) To lease to the Government at a peppercorn rent sufficient land at the East Greenwich Gas-Works for the erection of a Research Station, (2) to prepare drawings and specifications for this station on lines to be laid down by this Board, and to make contracts for its erection, (3) to give every facility for the transport of coal and other supplies to the Station and to take over at market prices the surplus products, gas, tar, liquor, and coke resulting from the operations at the Station. The proposed site is a strip of level ground about 250 feet wide by 700 to 800 feet long situated on the main siding which connects the gas-works with the South-Eastern Railway and with access to an existing road.

The foregoing scheme of research is obviously not intended to cover the whole of the territory which is open for exploration to-day. Still less ought it to be regarded as setting any limits to the exploration of new territories in the future. The root idea of the scheme is that certain fundamental changes in the preparation and use of fuel which have been proposed are of such far-reaching importance that the solution of the technical and economic problems involved ought to take precedence of all other matters. This does not mean that other lines of research will be ignored, but only that the larger issues must be kept well to the front till definite solutions of those technical and economic problems can be given. Though no direct reference has been made to the preparation and use of fuels from oil shales, brown coals, and peat, it is obvious that experimental enquiries on these matters will naturally find a place in the developments of the present scheme.

The Research Station, as planned, will be capable of any extensions which will be required for future researches. Out of the four acres which it is proposed to lease for the Station, only one acre will be occupied by buildings under the present scheme. Further, a large part of the equipment of these buildings will be of a permanent character and will serve all the general purposes of a Research Station. Future extensions will, therefore, not repeat this permanent equipment but will be based upon it.

COMMONWEALTH ADVISORY COUNCIL OF SCIENCE AND INDUSTRY.

The Executive Committee of the Australian Advisory Council of Science and Industry has issued a report of its work covering the period from the date of appointment (Apr. 14, 1916 to June 30, 1917).

In the introductory part the constitution of the Committee and the policy and nature of its work are outlined, and a list of the Special Committees appointed is given.

Agricultural and pastoral industries.

Attention has been given to numerous questions concerning the control and eradication of pests and diseases of stock and crops and to the cultivation of new or improved crops. In connection with flax cultivation, mention is made of a new process of chemical retting in which an extract of linseed is used. The subject of cotton cultivation is considered at some length. Mention is also made of the desirability of a systematic soil survey of the Commonwealth.

Forest and vegetable products.

Wood-pulp. As far as the Committee have been able to ascertain, the only plant erected in Australia for the manufacture of wood-pulp is

that belonging to the Queensland Pine Co., Ltd., at Yarraman Creek. At this mill hoop pine (*Arucaria cunninghami*) and bunya bunya (*A. bidwilli*) were treated by the sulphate process, and a good type of wood-pulp prepared, which obtained a ready sale. The mill had to close down in 1916 owing to lack of water, and has not been reopened. The company state that some form of assistance to the enterprise by the Federal Government would be necessary to induce them to re-start operations. Some years ago the Australian Paper Mills Co. prepared some excellent wood-pulp, utilising the filamentary waste of the mountain-ash (*Eucalyptus regnans*). The Queensland Pine Co. experimented with ironbark, spotted-gum, crowfoot, and yellow-wood, and found them unsuitable.

Destructive distillation. Messrs. Cuming, Smith, and Co.'s works at Yarra Junction, Victoria, and Mr. J. V. Vale's works at Wyee, New South Wales, are at present the only works in Australia distilling timber, as far as the Committee can ascertain. The former firm's works have been in operation for a number of years, during which they have distilled all available eucalyptus timbers, and they report that the yield from all the species is very similar. There are, however, certain difficulties in treating eucalypts which are not present in the case of European and American hardwoods, and a serious obstacle to the development of the industry is the lack of markets in Australia for many of the chemical products of distillation and the comparatively small demand for charcoal. Mr. Vale's works have only recently commenced operations, and have at present dealt with swamp oak (*Casuarina glauca*), the yield from which is satisfactory. The New South Wales Forestry Commission has arranged with Mr. Vale to have tests made on 1-ton samples of about 30 other timbers. In the so-called myrtle (*Fagus cunninghami*) of Tasmania and Victoria, Australia possesses a true beech closely akin to the beeches of Europe and America, whose timber is one of the main raw materials used in those countries in the distillation industry.

Sources of tannin. The supply of tan-bark for use in Australian tanneries has for many years past been obtained mainly from two species of wattle—the golden wattle (*Acacia pycnantha*) of South Australia, and the black or green wattle (*A. decurrens*) and its varieties. As a result of the gradual destruction of wattle-trees the Australian supply has become inadequate, and has been largely supplemented by wattle-bark imported from Natal, where plantations have been formed by the utilisation of Australian seed. Owing to the cheap labour available in South Africa, and the fact that the wood from the wattles is in demand for firewood in that country, where timber is scarce, there seems little chance of Australia being able to compete with Natal in the production of wattle-bark. In addition to the wattles, a valuable tan-bark is yielded by the mallet (*Eucalyptus occidentalis*) of Western Australia, but though the useful properties of this bark were only discovered in 1903, its exploitation was so rapid that only comparatively small quantities now remain. Four possible means have been suggested to insure a local supply of tannin for the future, viz.: (1) Regulation of bark collecting to prevent the destruction of young trees, and thus secure the maximum amount of bark. (2) Plantation of wattles for the production of bark. Many such plantations were formed some 30 years ago, but owing to the slow growth of the trees and the great danger from bush-fires, wattle-plantations are not successful in Australia. (3) Discovery of new sources of tannin. Barks of about 150 species of Australian trees have been analysed as to their tannin content, and fifteen have been found to average over 20% of tannin.

Of these, nine are wattles, but, except for the two species already mentioned, they are not very abundant trees, though some of them are utilised locally to some extent. Two are cypress-pines, and one of these (*Callitris calcarata*) is a plentiful tree in Eastern Australia, and is utilised to some extent. Three are mangroves, but the bark from these trees has hitherto not been utilised to any extent in Australia, owing to the fact that mangrove-bark contains a dye which gives a red colour to the leather. The Executive has appointed a Special Committee to consider the best means of utilising the bark and possible methods for decolorising the tan-liquors obtained from it. The remaining species is the mallet, already referred to. In addition, the kino (gum) produced by the redgum of Western Australia (*Eucalyptus calophylla*) contains a high percentage of tannin, which is also present in the kino-saturated portions of the bark. As in the case of the mangrove, a dye is also present which stains the leather a red colour, and largely prevents the use of this bark for tanning purposes. The redgum is a very abundant tree in Western Australia, and the Executive has appointed a Special Committee to investigate the whole question. (1) Manufacture of tannin extracts. This is perhaps the most promising solution of the shortage of tanning materials, as it allows of the utilisation of leaves, twigs, etc., as well as of barks containing too little tannin to be used directly. It would be a means of avoiding the great amount of waste involved in the present methods of collecting wattle-bark, in which the tree is cut down and the bark stripped from the trunk whilst the smaller branches and twigs are not utilised. Extracts have been prepared from wattle-twigs, etc., by several Australian firms, but one of the difficulties is that gums and dyes are also extracted in the process, and the extracts have to be decolorised, whilst the presence of the gums is detrimental. Before the war large quantities of Australian barks, including those of wattle, mallet, and mangrove, were utilised in Germany for the production of extracts, and these German extracts were imported into Australia. Chemical research in Germany had solved the problems of decolorisation and of the removal of undesirable gummy matter, and these problems should be investigated in Australia.

Other vegetable extracts.—The Executive Committee has received numerous suggestions as to possible methods of utilising several native Australian vegetable substances. A number of correspondents have prepared dyes of brown and khaki shades from mangrove bark, and similar dyes have been prepared from the resin of the grass-tree and from eucalyptus barks, and the investigation of native plants, with a view to their utilisation as sources of dyes, is being carried on at the Technological Museum, Sydney. The camphor-laurel (*Cinnamomum camphora*) is commonly cultivated in Queensland, and it was suggested that it might be utilised for the production of camphor. A native Queensland tree known as the sassafras (*Cinnamomum oliveri*) has also been shown to contain camphor. A special committee in Queensland is making an investigation of this question. A committee has also been appointed to investigate the chemical composition of grass-tree (*Xanthorrhoea*) resins.

Mining and metallurgy.

There is wide scope in Australia for investigational work, with a view to developing new or improved processes, especially for the treatment of low-grade ores, and determining the properties of various alloys. One of the matters originally suggested to the Committee as requiring immediate consideration was the question of the best means of extraction of zinc from its ores, with special

reference to the electrolytic process. Since the Committee was formed, however, the Amalgamated Zinc Co. have taken up the problem of the electrolytic extraction of zinc, and as a result, the Electrolytic Zinc Co. has been formed and has made arrangements for carrying it out on a large scale.

Another matter suggested for early consideration was the production of ferro-alloys for high-speed steel. Research on this problem had already been begun by Messrs. A. J. Higgins and E. B. Brown at Melbourne University, under the auspices of the Federal Munitions Committee, and a request was received from that body that further financial assistance for this work might be given by the Advisory Council. This was granted, and the work has since proceeded as a research by a Special Committee of the Advisory Council. Up to the present the work has been confined to investigations of the manufacture of ferro-chrome and ferro-tungsten. The experiments on the manufacture of ferro-chrome prove that there is no difficulty in manufacturing this alloy at a reasonable cost, providing a sufficiently cheap source of electric supply is available. Ferro-tungsten has presented more difficulties, and the Committee is not yet able to give final conclusions as to the best method to adopt in its manufacture. A very pure alloy has been made by the reduction of wolfram ore with carbon in the electric furnace, but the yield was very low, owing to the fact that the ore contains manganese and that a prolonged treatment was necessary in order to volatilise that impurity. A number of experiments have been made with charges of wolfram ore and carbon, with a view to ascertaining whether it would be possible to produce a pure alloy direct from the ore without an excessive loss of tungsten. The Committee has succeeded in reducing the loss of tungsten to 1%, but the alloy produced was very impure, containing too much manganese, silicon, and carbon. Some of this alloy was refined by smelting in the electric furnace with hematite iron ore, lime, and fluorspar, but the refined metal was still too impure for use. As the ores of tungsten are liable to contain impurities which become reduced together with the iron and tungsten in the electric furnace, thus rendering the alloy impure, it was thought that more satisfactory results would be obtained by the use of pure tungstic oxide instead of wolfram ore. A number of experiments have been made with pure tungstic oxide, and so far the results obtained confirm this opinion. The pure tungstic oxide was made by fusing the wolfram ore with sodium carbonate, extracting the sodium tungstate with water, filtering, and decomposing the sodium tungstate with hydrochloric acid. The tungstic oxide thus produced was washed till free from salt, and dried. A small charge of the tungstic oxide was then mixed with carbon and iron, and the mixture reduced in the electric furnace. The alloy produced was very pure, much purer than that made by the direct reduction of wolfram ore, but it is more expensive to produce, owing to the cost of preparing the pure tungstic oxide.

The Committee has made some inquiries on the production of aluminium in Australia, but has been unable to obtain any information as to the amounts of aluminium or aluminium ware imported into Australia. The best methods of utilising alunite for the extraction of potash and alumina have formed the subject of the investigations of a Special Committee (see p. 078).

The Committee has made inquiries as to the probability of finding rock phosphates and mineral oils in Australia, and also in connection with the utilisation of materials of which large deposits are known to occur in Australia, but which have not hitherto been fully utilised. Under this heading information has been collected in connection with brown

coal, iron and aluminium phosphates, alunite, and clays. The scientific problems connected with the utilisation of these minerals are mainly chemical, and the work on alunite and phosphates is dealt with later. Clays are dealt with in connection with the pottery industry. The Victorian New Industries Committee and the State Government are taking active steps to promote the utilisation of brown coal.

Chemical industry.

A Special Committee has been appointed to investigate and report on the possibilities of local manufacture of chemicals now imported.

The Committee confined its enquiries in the first instance to the possibility of producing locally the so-called heavy chemicals. In order to produce alkalis at a price comparable to pre-war European prices, works would have to be established on a very large scale, and the output of such works would be equal to the amount consumed in Australia. It is obvious that if more than one company undertakes the manufacture of alkali here the chances of making the enterprise a success are considerably reduced, owing to the very limited market in Australia. This applies not only to the alkali industry but to many other chemical industries. The Committee has been informed that a large chemical company is seriously considering the establishment of an alkali works in Australia.

Fertilisers.—Australia is largely dependent on outside sources for the raw material of artificial fertilisers, and the Executive Committee have devoted much attention to the consideration of possible local sources of phosphates, potash, and nitrogenous fertilisers with a view to reducing this dependence of our agriculture on foreign countries. Of most pressing importance is the need for developing local sources of potash. The sources of potash which have been suggested are—(a) alunite; (b) kelp; (c) suint; (d) molasses; (e) wood-ashes; (f) ground igneous rocks; (g) saline deposits.

There is a very large deposit of alunite at Bullahdelah, in New South Wales, and smaller though purer deposits in South Australia. A Special Committee was appointed to consider the best means of utilising alunite, of which the Australian deposits are the most extensive in the world, specially with a view to ascertaining the best treatment for the extraction of the potash. It was found that a comparatively simple process, *i.e.*, that of heating alunite to bright redness for a short period, is the most satisfactory method of treating the mineral. A furnace of the reverberatory type is required. The calcined material contains nearly 30% of potassium sulphate and about 60% of alumina, and may be employed as a potash fertiliser without further treatment. In this case, however, no use would be made of the alumina. By treatment of the calcined material with hot water, the potassium sulphate is separated from the alumina. No serious technical difficulties stand in the way of producing potassium sulphate and alumina from Australian alunite, and the Committee is of opinion that the manufacture of potassium sulphate could be carried on with profit if done on a sufficiently large scale by means of modern appliances, always provided that a local market for the output of the plant could be obtained.

A small plant for treating kelp has been established in Tasmania, and is producing potassium chloride. If the whole Australian wool clip were scoured in Australia and the potash extracted, this would probably suffice for local needs. The recovery of potash in wool-scouring is considered in connection with the production of lanoline (see below). The recovery of potash from molasses

has been considered by a sub-committee of the Queensland State Committee. They had before them details of a method for absorbing the molasses in megass, producing charcoal and gas therefrom, and then burning the charcoal to an ash from which the potash could be recovered. They reported that all methods hitherto tried for recovery of potash from molasses have led to only small proportions being finally recovered, and that the prospect of burning to ash with megass did not appear at all promising, even in war-time. The extraction of potash from the wood ashes of saw-mills and of eucalyptus distillation plant has been suggested, but the amount of potash is probably too small to render this a commercially profitable source. Experiments are being conducted as to the feasibility of extracting the potash from the ash left when prickly pear is burnt. The utilisation of ground igneous rocks as potash fertilisers has often been discussed. The Committee considers that leucite-bearing rocks are unlikely to be able to compete with alunite as a source of potash.

The most satisfactory solution of the potash difficulty would be the discovery of a saline deposit in Australia rich in potash salts. It seems not improbable that such a deposit might exist in some of the lake-basins of Central Australia.

The possibility of increasing the local supply of phosphate fertilisers depends on either (a) the discovery locally of rock phosphates suitable for the manufacture of superphosphates, or (b) the discovery of means whereby the phosphates of iron and aluminium, of which there are considerable deposits in Australia, can be made available as sources of phosphorus to crops. The known deposits of calcium phosphate on the mainland are small. Experiments as to the fertiliser value of iron and aluminium phosphates under different conditions are in progress in Victoria and Western Australia.

The question of the production of nitrates from atmospheric nitrogen has also been considered, and it seems possible that ultimately the Tasmanian hydro-electric scheme may be utilised for this purpose. The Committee have come to the conclusion that, as there is no immediate prospect of Australia being cut off from the supply of Chili saltpetre, the matter should be left until the conclusion of the war.

Other chemicals.—The production of a number of other chemicals in Australia has been considered by the Executive and the Chemical Committee. Amongst these may be mentioned lanoline, cream of tartar, copper sulphate, casein, pepsin, rennet, and other by-products of the meat industry, starch, glucose, and industrial alcohol. The latter is dealt with in connection with alcohol engines in the section on Engineering (see page 1080).

In Australia there is as yet no recovery of lanoline and the other valuable by-products of wool scouring. Hitherto only a very small proportion of the wool exported from Australia has been scoured before shipment, but it is thought that in the future a much greater proportion will be treated here. The Committee has, therefore, taken steps to bring together possible users and producers of lanoline.

During the year 1914-15 the value of the cream of tartar and tartaric acid imported into Australia was over a quarter million sterling. Only a very small proportion of the crude cream of tartar is recovered in the wine-producing States of Australia. The estimated production of cream of tartar in Australia, if recovered, would not equal the amount imported, but co-ordinating committees have been appointed in each of the wine-producing States for the purpose of investigating the matter.

Copper sulphate is now being produced on a considerable scale in Australia, and extensive

establishments for the manufacture of electrolytic zinc and calcium carbide respectively are under construction in Tasmania. The production of white lead in Australia is not equal to the demand, but a factory capable of producing 5000 tons of white lead per annum will be in operation before the end of this year.

The question of the production of casein was investigated, and the evidence obtained showed that the small local demand was already met. In normal conditions the largest gross return is obtained from milk by using it for the manufacture of cheese, the smallest by producing butter and casein. Under these circumstances the manufacture of casein, beyond that required to satisfy local demands, is not likely to be undertaken permanently in Australia, though under present war conditions it would probably be more profitable than cheese-making.

At least one firm has undertaken the manufacture of rennet on a commercial scale, and a factory for the production of starch and glucose from maize has recently been established in Victoria.

Other secondary industries.

Leather and tanning.—The leather industry is one of the most important secondary industries in Australia, yet it seems probable that it will become even more important when tanning is placed on a more scientific basis. The Executive has appointed a Special Committee to investigate processes of extraction of tannin from wattle-bark with a view to the determination of a standard and scientific method of procedure under practical conditions (see also p. 1076).

Food supply.—A Special Committee appointed to examine problems connected with the sterilisation of milk, found that certain thermophilic spore-bearing organisms not only survived, but multiplied at a temperature of 50°–55° C. The changes they produced in the milk were slight and progressed slowly, but the presence of a number of organisms was revealed on culture. In another experiment an alternating current was passed through agar jelly seeded with coliform organisms; no evidence of sterilisation due to electrolysis was apparent, the growth of the organisms being apparently as abundant in the immediate proximity of the electrodes as at a distance from them.

Another Special Committee has studied the growth in a malt wort of yeast leading to rapid ripening of dough. The doughs have been prepared with 270 lb. flour, including the weight of flour used on the table, and 160 lb. water. The average yield of bread has been 175 loaves, weighing, approximately, 355 lb. The doughs have usually stood six hours in the trough, at a temperature of 83° F. For some time doughs standing five hours in the trough were used. The quantity of yeast has been determined by counting the number of yeast cells in a given amount of wort. The weight of yeast obtained from a wort containing a given number of yeast cells has been ascertained. The weight of yeast used in the doughs has varied from 2½ to 5 oz. The acidity of the worts has been usually less than 10 c.c. N/10 acid in 100 c.c. wort, when estimated by titration with methyl orange as indicator. In the preparation of yeast it has been found that the temperature of the wort during the growth of the yeast should be less than the temperature at which the dough stands. Abundant oxygenation favours the development of yeast fermenting rapidly. The presence of flour in the wort prevents any check to fermentation when the yeast is mixed in the dough. The worts have contained about 15% solid matter, of which one half consists of reducing sugars. In the bake-house, the wort is made with a decoction of hops, to which flour and

ground malt are added. This mixture stands at 155° F., until the whole of the starch disappears. The mash is strained from the liquor. The wort is boiled and cooled rapidly. It is placed in a large flat enamel pan, which has been sterilised by boiling water in it for some time. The wort is beaten with a whisk to aerate the liquid, and is inoculated by the addition of a considerable amount of stock from the previous brew. The yeast grows for 16 hours. The multiplication of yeast cells in this time is about ten times, but varies greatly.

Pottery.—Australia possesses an abundance of clay and kaolin suitable for the manufacture of bricks, tiles, stoneware, and various grades of porcelain ware, but deposits of "ball" clay—the white burning, highly plastic clay—are rare. A certain proportion of "ball" clay is required in porcelain work, and it has been found necessary to import this from England. In the manufacture of certain grades of stoneware Australian potteries are not behind other countries, and stoneware pipes have been exported in large quantities to eastern countries, notably the Philippines. In regard to the better grades of clay products the industries are in a very backward state, due chiefly to the need of trained technologists. The Committee is strongly of opinion that active measures should be taken to collect and co-ordinate the data on clays published by the various State Geological Departments, to encourage the establishment of schools of pottery, to assist competent research chemists and physicists in carrying on ceramic investigations, and to induce manufacturers to produce the higher grades of porcelain ware, including domestic porcelain.

The Executive are also endeavouring to arrange for investigations on enamels, glazes, and pottery colours.

Paper-making.—Australia is at present almost entirely dependent on the outside world for its supplies of paper-making materials. The question of the local production of wood-pulp has been discussed above, but, in addition, the Committee have considered the possibility of utilising wheat-straw, marram-grass, and lalang or blady-grass. Preliminary tests of a number of materials have given promising results, but the main difficulty would probably be to obtain a sufficient supply of any except wheat-straw, to enable them to be successfully utilised on a commercial scale. Weeds such as prickly-pear, St. John's-wort, bracken-fern, and lantana, of which large quantities are available, do not appear very promising as sources of paper-pulp. Blady-grass and various weeds are being utilised for paper-making by a company which has recently started operations at Cairns, Queensland.

Textiles. Steps have been taken by the Executive to assist the growing of cotton and flax. A fibrous material of which a large supply is available locally, but for which the best treatment and usages do not appear to have been yet discovered, is the marine-fibre derived from *Posidonia australis*. The fibre has almost no elasticity, so that material made from it will not stretch, and it is unique amongst vegetable fibres in the readiness with which it can be dyed. Owing to its non-conducting and dyeing properties, it is suitable for mixing with wools for the production of low-grade materials. It is also extremely resistant to rot, and not affected by damp or heat. This property may lead to its utilisation in place of jute for bags. As a source of cellulose in the manufacture of cordite, *posidonia* fibre is unlikely ever to compete with cotton, at any rate for military purposes. As a material for paper-making, *posidonia* is fairly promising, but it seems unlikely that it will be able to compete with other materials for this purpose, as it could not be raised, washed, and delivered at a cheap enough rate. Boiling the fibre with caustic soda produces little effect upon it, but it responds readily to

treatment with chlorine, and this might be effected while it is still damp with sea-water, by submitting it to electrolysis.

Engineering. The question of manufacturing compressed gas cylinders in Australia is under consideration, and a Committee has been appointed to examine the design and manufacture of internal combustion engines using alcohol as fuel.

The Committee is of the opinion that the supply of alcohol is likely to prove a much more difficult problem than the question of the design of the engines for its use. The most economical source at the present time for the production of alcohol is sugar molasses; but even if the whole available supply of molasses in Australia were used for the purpose in view, it would be sufficient for the production of only about four million gallons of alcohol per annum, whereas the annual importations of petrol are in the neighbourhood of 17 million gallons. The total average annual quantity of molasses available in Australia for distillation is about 50,000 tons, of which about 12,500 tons is now used for that purpose. The remaining 37,500 tons is largely wasted. The present price of alcohol produced from molasses is about 1s. 9d. per gallon ex-store in Melbourne.

It appears unlikely that any considerable quantity of alcohol can be manufactured in Australia from either raw or waste materials not at present utilised. The most important of these materials are waste timber, grass-tree, prickly pear, waste fruit, and straw. The production of alcohol from cellulose, such as waste timber or straw, is costly, and the prospects of producing alcohol from these sources on a profitable basis do not appear encouraging. The whole question is, however, receiving consideration.

If the required supply of alcohol cannot be produced from raw or waste materials not at present utilised, it will be necessary to grow special materials for the purpose. The most promising sources in this respect appear to be maize, wheat, barley, potatoes, and beet. The Committee has obtained information on these matters from various distillers and other persons, and is making further enquiries.

The following figures have been collected from various sources, and represent the approximate yield of alcohol under practical conditions from various substances:—

Material.	Imperial gallons of alcohol (95%) per ton (2240 lb.).
Maize	80—83
Barley	65—70
Wheat	80—85
Potatoes	16—24
Beet	12—16
Apples and pears	9—14
Apricots and peaches	9—13
Grass-tree	12
Sawdust (soft woods)	20
Grapes	18
Molasses	65—70

It has been proposed that alcohol should be used as a fuel in admixture with other materials, such as benzene, ether, or acetylene. The Committee consider, however, that it is desirable to aim primarily at the adoption of stationary engines using alcohol alone, in view of the higher thermodynamic efficiency of that substance as a fuel. Concurrently with the development of such an engine, the Committee propose to take steps with a view to bringing alcohol, either as an admixture or alone, into general use for motor-

car work. The Committee are, accordingly, making enquiries with a view to the production in Australia of suitable materials to be used as an admixture with alcohol, and as to the efficiency of the various admixtures.

The denaturants at present necessary for industrial methylated spirits, under the Excise Act and Regulations, are as follows, viz.:—2% of wood naphtha, $\frac{1}{2}$ % each of pyridine and mineral benzene. The cost of these denaturants is 1.74 pence per gallon of alcohol. In order that power alcohol may be available at as low a price as practicable, it is desirable that an alteration should be made in the existing regulations as to denaturation. The Committee are in communication with the Comptroller-General of the Department of Trade and Customs on the matter, and have asked if the addition of 1% of pyridine only would be satisfactory. This would reduce the cost of denaturants to 0.9 penny per gallon of alcohol. The suggestion was not acceptable to the Customs authorities, who have, however, granted permission for the Committee to obtain a supply of a quarter-cask (32½ gallons) of spirit for experimental purposes denatured in the manner suggested.

The Committee are making enquiries, and are collecting data with a view of determining upon a cheap and efficient denaturant which can be produced in Australia. In this matter, particularly it is proposed to co-operate with the Imperial Motor Transport Council, London, with a view to obtaining a denaturant which will be generally acceptable throughout the Empire.

Standardisation.

General.—The Committee consider that it is of importance that arrangements be made for the following standardising work to be carried out, viz.:—(a) The standardisation of scientific apparatus and instruments. (b) The testing of electric lamps, apparatus, and machinery. (c) The testing of instruments of precision used in industry. (d) The physical testing and standardisation of materials used in industry and by the Commonwealth Government.

A beginning in this direction has been made in respect of standardisation of analytical methods in the chemical industries, and the appraisalment of alcohol in spirituous liquors. During the past two years the Society of Chemical Industry of Victoria has, in co-operation with various scientific, industrial, and commercial interests, formulated the details of a scheme for a series of investigations with a view to determining standardised methods of analysis for use in the chemical industries. The scope of the work planned may be summarised as follows, viz.:—(a) To review the best methods of analysis of materials. (b) To compare the standard methods of other countries. (c) To study the results of investigations made with those methods by various workers. (d) To conduct comparative tests on proposed methods. (e) To recommend methods for general adoption. (f) To keep in touch with all current work on analytical methods, and to report on new methods, and on old methods in the light of new research. The work is to be carried out gratuitously by members of the society.

The appraisalment of alcohol in spirituous liquors.—Under the existing system alcoholic liquors are valued in terms of "Proof spirit" (spirit of specific gravity 0.9198 at 60° F.). Proposals have been made that such liquors should be valued in terms of percentage of alcohol, and a memorandum has been forwarded to the Reconstruction Committee with a suggestion that it should be referred to Lord Balfour of Burleigh's Committee on Trade Policy after the War.

NITROGEN FIXATION.

In connection with the efforts that are being made in the United States to secure an adequate supply of nitric acid and nitrates, Dr. C. L. Parsons, as a result of enquiries and visits to plants in Italy, France, England, Norway, and Sweden, has prepared a report on the different processes in use. His conclusions are based on an estimate of the U.S. Government's maximum requirements of nitric acid for munitions purposes, viz., 20,000 tons in peace time and 180,000 tons in time of war. Dr. Parsons says: With these quantities as a maximum, and a sufficient supply of sodium nitrate in storage to meet the requirements of the Government for a period of six months to one year, no serious emergency problem confronts the Government. The increase in the output of ammonia from by-product co-ing since 1915, if oxidised to nitric acid, is alone more than sufficient to meet this requirement. The oxidation of ammonia, including that produced from the destructive distillation of coal, presents no serious difficulties, and the necessary plants using the emergency procedure adopted in Germany could in case of need be quickly installed to meet the Government requirements. Such installation would involve much cruder procedure, such as lower efficiency of oxidation and absorption of the nitrous oxides in soda lye, than would be adopted after careful experimentation and experience in the operation of the most efficient plants, but it would nevertheless furnish the country with the nitric acid required.

In my opinion, the following methods include the only ones which need to be considered in the final choice of the procedure to be employed by the Government in providing a source of nitrate supply.

Arc process.

The arc process is now installed in Southern Norway, employing 250,000 kilowatts of electricity developed from the cheapest large installation of hydro-electric power in the world. This is the only large installation of the arc process, but small installations of an experimental nature have been made in other countries. The method is one of the most inefficient known as regards production in relation to power consumed. Nevertheless, on account of the very cheap horse-power available in Norway, nitric acid can there be produced by the arc process at a cost less than by any other commercial process. Incidental to the production of nitric acid, a large excess of heat is developed, which can be, and is in part, converted into steam, which may be, and is, used for concentrating the weak nitric acid obtained in the absorption towers to the strong acid required for munitions works. The excess of steam is so large that many other methods for its application have also been devised. As the labour costs also are low, when once under way the operation goes on almost automatically. As the formation of nitric acid is direct and involves only the nitrogen and oxygen of the air and water as raw materials, no complicated processes involving intermediate products are necessary, as is more or less the case with all other processes.

In spite of these manifest advantages, however, it appears to be the general opinion of the European engineers with whom I came in contact that even with the cheap horse-power enjoyed by the Norwegian plants, they might have had to discontinue their operations except for the stimulus given by the present European war. Even as it is, the Norsk Hydro Company, operating the arc plants at Notodden and Rjukan, have been obliged to install large ammonia-producing plants in order that they might convert their nitric acid

to ammonium nitrate and thus render it transportable to markets where it was needed.

The cost of horse-power used for the production of nitric acid in Norway is less than \$5 per horse-power year. With horse-power at \$10 per horse-power year, the cost of finished strong nitric acid at the plant should be as cheap as by any other process now in operation. However, the low cost of producing nitric acid by the arc process is outweighed by so many other disadvantages that, in my opinion, the process is entirely inapplicable to the use of the United States Government, and this opinion appears to be shared by all who have given careful thought to the subject. The cost of installing the arc process is high, and it involves the use of an amount of horse-power that seemingly is not available on the American continent within reach of the points where the nitric acid would have to be used.

The great difficulty that has faced the Norwegian plants from the beginning, namely, a market for their products, would in peace times be a serious obstacle to the operation of a large arc plant in the United States. An arc plant at its best involves the use of 2-33 horse-power years per ton of weak nitric acid. This means that a water-power development of at least 50,000 horse-power would be necessary for the peace requirements of the Government, and a development of 440,000 horse-power would be required for war purposes. These figures are minimum figures on the basis of the relatively high efficiency reached in Norway. No installation should be considered by the Government of less than 75,000 horse-power for peace requirements or 550,000 horse-power for war requirements. If the arc process is to be used it would also be advisable to arrange for the production of explosives at the point where the arc plant was located. This would, of course, involve the transportation of all other raw materials needed to the plant and transportation of the finished explosives therefrom to the place of consumption. As these materials are highly combustible and for the most part carry high freight rates, it has been found necessary the world over to locate the plants intended for the production of munitions near to the point where the munitions are likely to be consumed.

An arc plant of sufficient size to meet the requirements of the Government in time of war would probably have to remain idle for the main part during times of peace, owing to the difficulty of disposing of the nitric acid that the plant would produce if in operation. On account of the large amount of horse-power required and the consequent extent of the necessary plant and tower absorption capacity, the cost of installing an arc plant to meet the war time requirements of the Government would be several times the total appropriation made for the purpose by Congress.

Haber process.

The Haber process has grown very rapidly in the last three years. It was first commercially installed in Germany in 1913 with a plant capacity of 30,000 tons of ammonium sulphate. Seemingly, it actually produced in that year some 20,000 tons of ammonium sulphate. This grew to 60,000 tons in 1914; 150,000 tons in 1915; and 300,000 tons in 1916; and it is authoritatively stated that with new works now under construction by the Badische Company, the 1917 output of ammonia by the Haber process would be equivalent to over 500,000 tons of ammonium sulphate.

The production and purification of hydrogen made either by the reducing action of coal or iron upon steam involve one of the chief items of cost in the Haber process. The fact that the

combination of nitrogen and hydrogen takes place at temperatures above 500° C., and at pressures of 125 to 150 atmospheres, involves some danger and many other technical difficulties which have, however, seemingly been overcome in Germany. The technical control of the Haber process is of such great importance and requires so high a degree of training and skill that it is reported if the Badische people were to lose their present technical staff of experts, familiar with the process, many months would be required to train another staff capable of applying the process in practice.

The Haber process is not at present in use outside of Germany on account of the lack of detailed information regarding plant construction and operation, and also owing to the very large royalty demanded by the Badische Company for its use by other concerns. It is, however, more than probable that the Badische Company will itself install and develop the process outside Germany when the war is ended.

Trustworthy information regarding the costs of production of ammonia by the Haber process indicates that pure anhydrous ammonia can be produced in liquid condition at a cost slightly less than 4 cents per pound. It is improbable that any arrangement could be made for the United States Government to use the Haber process pending the conclusion of the European war. It is probable that when the war is ended, the Haber process will be installed or will be available for installation in the United States. It is the cheapest process for the production of synthetic ammonia. It is independent of cheap power—the power being a small fraction of its cost. If desirable, it could be readily installed in moderate-sized units in connection with ammonia oxidising plants at any munitions plant.

Cyanamide process.

The cyanamide process has been developed in many parts of Europe, but in the Western Hemisphere only at Niagara Falls, Ontario, Canada. It requires cheap power for its successful operation and has obtained its greatest development owing to the fact that it requires only about one-fifth the horse-power per ton of fixed nitrogen per year that is required by the Haber process.

Ammonia from cyanamide, with power at 88 per horse-power year in a plant to be constructed by the Government, would cost 1 to 2 cents per pound more than by the Haber process. On the other hand, royalties for using the cyanamide process would undoubtedly be less. The technical problems involved are understood by many engineers both in this country and abroad, the manufacture of calcium carbide and cyanamide being established in many plants, and the basic patents having only some four years more to run. Peculiarly favourable conditions exist for its installation in certain sections of the South. If a hydro-electric plant is to be installed by the United States Government, and the electrical power so developed be used for the fixation of nitrogen, the cyanamide process has advantages over all other processes now developed, and should be adopted as the best means of utilising hydro-electric power for the fixation of nitrogen.

In Germany in 1913 there were produced 30,000 tons of cyanamide. The growth has not been so rapid as in the case of the Haber process, although the process has been subsidised by the German Government to assist in its development. However, the 1917 German production will be not far from 400,000 tons. The cyanamide interests in Germany have also endeavoured to induce the German Government to establish a nitrogen monopoly which will ensure the continu-

ation of the cyanamide industry in Germany in competition with the Haber process and ammonium sulphate from coke ovens after the war. Cyanamide has not found favour with American fertiliser manufacturers, and is not well suited as an addition to the mixed fertiliser demanded by American farmers. It is, however, successfully used in Europe where labour is much cheaper. To meet the Government's requirements of 20,000 tons and 180,000 tons of nitric acid through the medium of cyanamide would require the continuous use of 11,000 horse-power and 99,000 horse-power respectively.

If cyanamide is to be converted into the most popular form of fertiliser material, namely, ammonium sulphate, it would cost approximately 1 cent per pound to convert the nitrogen present into the form of ammonia before it could be absorbed to form sulphate. It is the necessity of converting the combined nitrogen into ammonia, if the cyanamide process is used as a source of nitric acid, that makes up a considerable portion of the difference in cost between cyanamide ammonia and Haber ammonia.

By-product ammonia.

In the United States less than one-tenth of the bituminous coal burned is coked in by-product ovens. Of the coke produced in America, over one half is still produced in beehive ovens in which the gas, ammonia, and all other by-products are ruthlessly destroyed. There has been nevertheless a rapid increase in the installation and operation of by-product ovens, and an increase in ammonia production that would not have been thought possible two years ago. By the end of the present year we will be producing at least 115,000 tons of ammonia per annum—an equivalent of 450,000 tons of ammonium sulphate. Six thousand tons of this ammonia in time of peace, or 55,000 tons in time of war, would meet the nation's requirements of nitric acid for military purposes, as estimated by the War Department. The growth of our ammonia production from by-product coking has been extremely rapid, and is still on the increase. More than fifty million dollars' worth of by-product coke ovens have been contracted for within the past twelve or thirteen months, and are now completed or in process of erection.

The general use of coke instead of coal throughout the United States would produce, besides other by-products, approximately 1,000,000 tons of ammonia. The day is far off before this highly desirable result will be reached, but it should none the less be striven for. Already legislation abroad requires the use of coke instead of bituminous coal for certain industrial purposes. By-product coke ovens, however, cannot be installed by the United States Government for the purpose of producing ammonia. The ammonia should be simply a by-product incidental to the production of coke for industrial purposes. Under war conditions, however, the output of ammonia from by-product coke ovens could, by Government regulation, be greatly increased. This has been accomplished in Germany, the by-product coke ovens furnishing Germany to-day with over one-third of the nitrogen consumed in that country. Germany has had an increase from 100,000 tons to 154,000 tons of nitrogen from this source since the war began. The possibilities for an increase in America are much greater than in Germany.

Ammonia from by-product ovens has to be purified before it can be oxidised to nitric acid. The cost of purification is, however, very small, and where purification apparatus is installed at the original ammonia absorption plant, adds but a small fraction of a cent a pound to the cost of crude ammonia liquer.

The use of by-product ammonia for the production of nitric acid for munitions purposes has the great advantage that it is already available, and that the plants, being situated in numerous parts of the country, could furnish ammonia to several small oxidising plants. Accordingly, the country's source of munitions supply would not be at any one place, and subject to capture and destruction.

The use of by-product ammonia has the great disadvantage that the present selling price of ammonia from by-product coke is high, and unless considerable price concessions could be obtained by the Government, it could not afford to utilise this source of raw material for nitric acid. The actual cost of pure ammonia, considered as a by-product from the coking of bituminous coal, is much less than by any other method now producing this substance.

Cyanide process.

The cyanide process is not yet a commercial success, but it has great possibilities. There is no difficulty whatever in the chemical reactions. No power factor of any consequence is involved, and it appears certain that if the mechanical difficulties are solved, nitrogen will be fixed in this form cheaper than by any other known synthetic process. There are also large quantities of waste nitrogen available in connection with the sodium carbonate plants of the country, where the sodium carbonate required would also be available, and there are large amounts of nitrogen that could be obtained without cost in a sufficiently pure condition at the wood-pulp plants using the sulphite process.

When the sodium cyanide is once formed it can be readily converted into ammonia, as is the case with cyanamide, but the process has the advantage that in the conversion the sodium carbonate can be recovered to be used over again. The iron can also be repeatedly used in the process. Small installations are now working successfully in the country, but the mechanical difficulties of production on a large scale are yet to be solved. Four large American corporations are engaged on the problem with ample funds for its solution.

The process has the further advantage that it would also make cheaply available cyanide which is so greatly needed by our mining industries.

Nitric acid from ammonia.

All processes for the synthetic production of nitric acid, except the arc process, involve the oxidation of ammonia. The processes commercially in use involve the direct oxidation of ammonia gas in the presence of air in contact with metallic platinum. In Germany, according to the latest published figures, approximately 100,000 tons of nitric acid are annually produced through the Frank-Caro process, which involves passing mixtures of ammonia and air through electrically heated platinum nets of 80 to 100 mesh. The platinum is heated to a dull red heat, and serves as a catalytic agent under whose influence the ammonia, instead of burning to nitrogen and water, as normally would be the case, is oxidised to nitric oxide.

In the Kaiser process, also used in Germany, the air is heated before its mixture with the ammonia, and under these conditions it is claimed that no electric heating of the platinum net is necessary. The Kaiser process does not appear to have reached any large commercial development.

In the Landis process, installed in a small experimental plant at Warners, N.J., the gas is passed downwards through the net instead of upwards, as is customary in the Frank-Caro process, and, according to the Landis patents, the gases are cooled before they are allowed to come in contact with

the net instead of being heated as in the Kaiser process. The platinum-net process is also understood to be installed in a small plant in Long Island City, and is being installed in Syracuse, N.Y., by the Semet-Solvay Company in co-operation with the Bureau of Mines.

The Ostwald-Barton process, first developed at Villevalde, Belgium, and brought there to a commercial success at the time of the opening of the war, is now installed in two large plants—one at Angoulême, France, and the other at Dagenham, England. The principle of the process is essentially that originally patented by Ostwald, but the catalyser is distinctly different from that used by him, although it consists of metallic platinum. The details of the preparation of this catalyser are kept secret, but it is known to have a very small cross-section, and is placed at the end of a 60-mm. tube, so that the products of combustion passing through the tube heat the mixed ammonia and air by radiation as they approach the catalyser. By this means no external heat is necessary. The reaction when once started continues without interruption for weeks. It is simply necessary, by means of blowers, to force the mixture of ammonia and air through the catalyser. The present commercial efficiency and output by the Ostwald-Barton process is higher than by any other concerning which exact figures have been obtained. It is higher than the published figures for the Frank-Caro process, but as figures for that process have been published only on a minimum basis, it is impossible to state whether as high an efficiency of conversion and capacity of catalyser has been reached by that process as by the Ostwald-Barton.

The processes for the oxidation of ammonia are seemingly free from any complicated patent situation. The Europeans engaged in ammonia oxidation admit freely that they have no important patent rights to sell, but they claim that they have plans, specifications, and details of processes, the purchase of which would be cheaper than the necessary experimentation to work out the details.

By the oxidation of ammonia, nitric oxide gases are obtained of much higher concentration than those produced by the arc process. Accordingly, much less tower space is necessary for their absorption, and much stronger acid can be directly obtained by concentration. Although in the arc process the concentration of 30 to 35% nitric acid to strong acid is required, in the oxidation process an acid of 50 to 55% strength is easily obtained directly from the towers, and the concentration thereof is accordingly a simpler matter.

A method has been developed in Sweden, details of which are unknown, for the oxidation of ammonia or cyanamide direct to ammonium nitrate in solution. Plants have been erected near Gothenburg, Sweden, and near Berlin, Germany. It is claimed that this process will produce ammonium nitrate much cheaper than any other.

The nitrogen situation.

In view of the fact that Germany has invested millions of dollars in synthetic nitrogen plants which will continue to produce nitrogen compounds after the war; that Germany is producing more than twice the amount of combined nitrogen that she formerly imported in the form of Chilean saltpetre; that accordingly the German market for Chilean saltpetre will be essentially non-existent after the war; that the present large American and allied consumption for munitions will cease; and that during the war the American production of ammonia from by-product coke ovens has increased to a point in excess of our apparent normal consumption, it seems certain that the

price of combined nitrogen for industrial and agricultural purposes must greatly decrease when the war is over.

It is evident at once that the peace-time requirements of the Government for nitric acid could be supplied from coal-tar ammonia with little effect on the market for the material and practically no effect on the country's nitrogen resources. It seems equally certain that in the case of war by-product ammonia could furnish 180,000 tons of nitric acid per year for at least one or two years without seriously affecting the nation's agriculture. This is particularly important when it is remembered that over 60% of the nitrogenous material used in fertiliser, consisting of organic nitrogen from cottonseed meal, tankage, dried blood, etc., would not be decreased at all, but would rather be increased through the cutting off of exports of cottonseed meal.

Furthermore, it is well known that several of our largest corporations are engaged in active plans for installing synthetic nitrogen plants of various kinds to meet their own industrial requirements, and that in all probability the Haber process will enter into active industrial competition for our ammonia markets in American plants as soon as the war is over. Plants for the oxidation of ammonia can be quickly erected in crude form, as they were erected and utilised in Germany, should the need arise.

I accordingly feel that no serious emergency problem confronts the United States that could not be met with reasonable celerity in time of war, and that our first problem, after securing a reasonable reserve of Chilean saltpetre, is to familiarise ourselves with the most efficient method for the oxidation of ammonia and to train the necessary men to construct and operate ammonia oxidation plants.

Cost of nitric acid.

The cost of nitric acid, *per se*, whether as weak nitric acid or as concentrated nitric acid, is lowest by the arc process with hydro-electric power delivered to the furnace at a cost of \$10 per horse-power year, or less. The difficulties of its transportation, the large amount of power required, and other economic reasons, as already explained, make the arc process inapplicable to American conditions.

The cost of nitric acid obtained by the oxidation of pure ammonia is independent of the source of the ammonia, and must therefore depend upon the cost of ammonia gas in the gasholders ready to be passed to the oxidising apparatus.

Cost of ammonia.

The cost of ammonia has at the present time no relation to its selling price. The actual cost of collecting, absorbing, and purifying ammonia from the gases developed by the destructive distillation of bituminous coal, in other words, the cost of ammonia considered as a by-product, is less than by any other process. The selling price of by-product ammonia is entirely a question of competition with other nitrogenous products, and has been fixed in the past almost wholly by the market price of sodium nitrate, with which it enters into competition. Even should ammonia be placed on the market by the Haber process at a price as low as 4 cents per pound, by-product ammonia will still be sold in competition therewith at a profit to the producer. The Haber process can produce, and is producing, ammonia synthetically cheaper than any other synthetic process now industrially applied. The cyanamide process stands next in order.

If mechanical difficulties now confronting the cyanide process are solved, it will produce ammonia cheaper than either the Haber or the cyanamide

process, and in close competition with the actual costs of saving by-product ammonia. The details of costs by all of the above methods will be considered in the final report.

Summary of conclusions.

(1.) The Government should obtain its nitric acid by the oxidation of ammonia. It should begin the erection of an ammonia-oxidation plant of moderate capacity at an early date in order to train men and obtain experience in the most efficient method of procedure.

(11.) The Government should proceed slowly in the matter of the erection of plants for the production of ammonia, as developments in the cyanide process and the availability of the Haber process may render valueless within a short time any large expenditure for the production of cyanamide. This is doubly true in view of the fact that present appropriations are not nearly sufficient to install water power and erect the nitrogen fixation plants necessary to meet the Government requirements as estimated by the Ordnance Department.

The adoption of the above procedure involves:—

1. Purchase by the Government of a reserve supply of sodium nitrate of at least 200,000 tons.

2. The purchase of ammonia on the open market.

3. The reservation of a supply of platinum.

4. The construction of a hydro-electric plant only if the arc or cyanamide process is to be used. The oxidation of ammonia requires very little power, and the Haber, cyanide, and by-product ammonia processes are all independent of cheap power cost. The development of water power, however, cannot but be of benefit to the country even if it is not used for the fixation of nitrogen.

I seriously doubt whether hydro-electric power will be necessary or desirable three years from now for the most efficient process of fixing nitrogen, and accordingly I deem it unwise to install such hydro-electric power, at great cost, with the sole purpose of fixing nitrogen. If, however, such water power can be utilised by the Government in the production of certain ferro alloys absolutely essential for ordnance and other munitions; can be sold to commercial companies who will take upon themselves the financial risk involved in the erection of plants for nitrogen fixation, under guarantee of cheap ammonia to the Government; or can be sold during peace times to companies requiring power for purposes which would allow instant requisition of the power by the Government in time of war without handicapping the supplies of other needed war material, the development of such hydro-electric power would be highly desirable.

The first and third recommendations have already been adopted, and are progressing towards fulfilment.

In a supplementary report, dated April 30th last, Dr. Parsons states that a small plant for the oxidation of ammonia erected at Syracuse, N.Y., is progressing successfully; another experimental oxidation plant at Laurel Hill, Pa., has developed other new features. At Syracuse two new forms of apparatus for the oxidation of ammonia are now being tried—one of which, if successful, will do away entirely with the use of platinum in the production of nitric acid.

Development has been rapid during the last two months. A synthetic ammonia process and a cyanide process have now reached a state of development where I am prepared to recommend definite action by the Government.

General Chemical Company process.

During the past four years the General Chemical Company, working on the basis that it should be

possible to develop conditions under which the synthetic production of ammonia by the direct combination of nitrogen and hydrogen should take place at lower pressures than those deemed necessary by the Haber patents, has achieved success. This process has been in successful operation on a large experimental scale with several small units for ammonia production, and one unit larger than those supposed to be used in Germany. The General Chemical Company has also developed and brought to a commercial basis the production of a mixture of nitrogen and hydrogen from coke, air, and water which will yield hydrogen at a cost lower than heretofore obtained in this country, and probably lower than that obtained in Germany. Complete engineering plans have been prepared and bids obtained on the main items of construction, so that the erection of a plant for the synthetic production of ammonia can be proceeded with without delay. The company itself would have already had a plant in operation save for the present high construction costs and other difficulties incident to operations at the present time.

The General Chemical Company has offered the free use of their process to the Government, and the full help of the Company in installing and operating the process.

It is estimated—I believe conservatively—that even under present conditions a 30-ton-per-day plant can be built for an expenditure of \$3,000,000, and can be operated at a cost of not to exceed 4 cents per pound of ammonia produced, allowing \$5.00 per ton of product for repairs and 12½% of the cost of the plant for interest and depreciation. It is believed that the charges for repairs, interest, and depreciation are excessive, as, together, they comprise more than 50% of the total cost of the ammonia production. In the estimates \$3.00 per ton of product is allowed for general expenses and overhead charges.

It is estimated that a smaller plant of at least 7½ tons per day capacity can be built at the present time for approximately \$1,100,000, including land and building. Such a plant would yield 2700 tons of ammonia per year—equivalent to 8700 tons of 96% nitric acid, assuming 85% recovery. Such a plant would require about 500 horse-power.

I recommend that an initial plant to produce 60,000 lb. of ammonia per day be immediately constructed, and to this end I recommend that the War Department set aside the sum of \$3,500,000, and that the initial plant be constructed at some point to be selected by the War Department in South-West Virginia, or adjoining territory in West Virginia, reasonably near to the sulphur, sulphuric acid, and coal supplies of that region, and so situated near to plenty of good water that an ammonia oxidation plant and a powder plant may later be erected near by.

Cyanide process.

The cyanide process, too, has greatly developed in the last few months.

The president of the Nitrogen Products Com-

pany considers the process a certain commercial success, and a probable competitor with any other process for the production of fixed nitrogen. The Company is operating two experimental plants by the cyanide process—one at Saltville, Va., in a coal-fired furnace, and one at Niagara Falls in an electric furnace.

After careful examination of this process, I am not convinced that it has yet reached a point where plant installation should begin, as I believe a few months' experimentation will add greatly to the efficiency of the furnace proposed. It is my belief, however, that the process will become an important factor in the world's nitrogen market; that it may become a strong competitor even of other processes on account of the simplicity of its operations and the low cost of plant construction; and that a furnace which I believe I see in embryo can be developed which will be much more efficient than either of those now used.

The process is so promising that I recommend that active experimentation on a large scale be conducted, that a sum not to exceed \$200,000 be set aside for this purpose. With this amount available I feel confident that this process can be put upon a commercial basis; that it will become a real competitor in the production of ammonia for nitric acid and of nitrogenous material for fertiliser.

Estimates of construction and operating costs.

In order that the recommendations made above may be considered in comparison with the older processes now operating on a large scale, I submit herewith a table summarising confidential data obtained from books of many companies bearing upon the cost of nitrogen production.

Data per ton of nitrogen—by the Arc, Cyanamide, Haber and General Chemical Company Processes.

	Arc.	Cyanamide.	Haber.	Gen. Chem.*
Product	35% HNO_2	NH_3	NH_3	NH_3
Power required	10.5	2.2	0.2	0.2
Investment	\$1410(a)	\$440(a)	\$340	\$300
Operating costs†	170	150(b)	119	97
Product	96% HNO_3	96% HNO_3	96% HNO_3	96% HNO_3
Power	10.8	2.3	0.3	0.3
Investment‡	\$1550	\$670	\$570	\$530
Operating costs§	220	270	230	217

* Estimates on General Chemical Co. process are based on present war time construction costs. All others on normal prices.

† Amortisation for cyanamide as charged by operating companies. Amortisation for Haber 20% of plant cost for repairs, interest, depreciation. Amortisation for Arc and Modified Haber 12½% interest and depreciation. \$5.00 per ton of product for repairs.

‡ Except for Arc process, includes ammonia plant as given power additional \$10, oxidation and absorption, \$140; concentration \$40; steam plant \$40.

§ Except for Arc process, includes ammonia costs as given; oxidation \$50; concentration \$70. No allowance made for unoxidised ammonia.

(a) Power plant investment reckoned at \$100 per horse power.

(b) Cyanamide production \$122, ammonia from cyanamide \$28, total \$150.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each, to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.

United States.—1s. each, to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—

Patent number, date, name of patentee, and title of invention.

French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56, Rue Feron 8, Paris (3e.)
Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

PATENTS.

Furnace; Gaseous fuel.—A. C. Ionides, jun., London. Eng. Pat. 108,701, Aug. 11, 1916. (Appl. No. 11,371 of 1916.)

A MIXTURE of gas and air in nearly theoretical proportions is delivered, by one or more jets, into a combustion chamber, and the hot products of combustion pass upwards into the heating chamber through narrow annular or longitudinal passages. The waste products pass out of the top of the heating chamber and thence down through narrow passages between the wall of the heating chamber and the outer wall of the furnace, to the waste gas flue below.—W. H. C.

Heating water or other liquids; Apparatus for.—Ajax Heaters, Ltd., and R. C. Bussell, London. Eng. Pat. 108,737. (Appl. Nos. 11,969, Aug. 23, 1916, and 811, Jan. 16, 1917.)

A TRUNCATED conical chamber which may be formed of superposed sections, is surrounded by an outer casing. The heating medium is supplied to the interior of the chamber, and is directed towards the walls by baffles. Annular perforated channels are formed at intervals round the outside of the chamber, which may have annular corrugations on the outside. The liquid to be heated is fed into a perforated annular trough at the upper end of the chamber and passes through the perforations on to the wall of the chamber, down which it flows as a film. The annular channels serve to re-distribute the liquid as a film, and the heated liquid collects in the annular space between the bottom of the chamber and the outer casing, and flows away through a superheater situated within the lower part of the conical chamber.—W. H. C.

Exhaust gases from heat engines; Method of and apparatus for the utilisation of the heat of.—W. A. Mitchell, Plymouth. Eng. Pat. 108,744, Aug. 30, 1916. (Appl. No. 12,283 of 1916.)

THE exhaust gases pass first round a steam boiler which projects into the exhaust pipe. The steam produced passes into a chamber filled with iron turnings which surrounds the continuation of the exhaust pipe. The steam is decomposed by the iron, hydrogen and iron oxide being formed, and the hydrogen is conducted to the combustion chamber of the heat engine.—W. H. C.

Refrigeration; Apparatus for mechanical.—A. S. Cachemaille, London. From J. C. Bertsch, Edgewood Park, Pa., U.S.A. Eng. Pat. 108,759, Sept. 13, 1916. (Appl. No. 13,011 of 1916.)

A ROTARY pump compresses a volatile fluid and delivers it into a coil in a cooling chamber, where the liquid evaporates and produces cold, the vapour passing to a coil cooled by water and connected through a separator with the inlet of the compressor. The inlet and outlet ports, the lubricant-distributing chamber, and all pipe connections are within the cylindrical wall of the compressor.—W. H. C.

Ice or refrigerative effects; Apparatus for the production of.—W. R. Ormandy, London, and W. E. Calvert, Halifax. Eng. Pat. 108,894, Aug. 21, 1916. (Appl. No. 11,855 of 1916.)

IN a refrigerating apparatus of the type in which a gaseous refrigerant such as ammonia is absorbed by an absorbent such as ammonium nitrate mixed with kieselguhr (see Eng. Pat. 107,040 of 1916; this J., 1917, 917), means are provided for reducing the quantity of heat supplied to or taken from the surrounding pressure-resisting casing. The casing is lined internally with insulating material to avoid contact with the supports for the trays which carry the absorbent material. The material is cooled or heated by spiral pipe coils in the trays supplied from and discharging into common headers, one at the side and the other in the centre of the casing. The refrigerant is supplied by a pipe at the top of the casing.—W. F. F.

Refrigerating apparatus.—B. E. D. Kilburn, London. From Sulzer Frères Soc. Anon., Winterthur, Switzerland. Eng. Pat. 109,320, Oct. 6, 1916. (Appl. No. 14,228 of 1916.)

THE apparatus consists of a pump, jet, and cooler for compressing and liquefying the refrigerating gas, the working liquid of the jet flowing through the jet and the pump and also in a closed circuit through the cooler. The pump is surrounded by the cooler, and the jet compresses and also liquefies the refrigerating medium.—J. H. P.

Filter-presses.—W. Guerrero, Madrid. Eng. Pat. 108,869, May 1, 1916. (Appl. No. 6215 of 1916.)

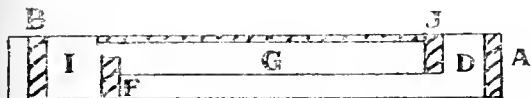
FILTER-PLATES for supporting and separating the filter cloths are constructed of intertwined helical coils of wire, forming an openwork grating with an interior free space through which the filtered liquid may be withdrawn. The frame carrying the grating may be supported between two outer frames carrying cross-bars to support the grating. The grating may be held in position in a groove in the frame or in a groove formed by the two outer frames projecting slightly beyond the inner frame. Alternatively the grating may be secured to the frame by straps or screws, or the frame may be cast on to the grating to form a solid body.—W. F. F.

Filters.—E. C. R. Marks, London. From Zahn Manufacturing Co., Buffalo, N.Y., U.S.A. Eng. Pat. 108,897, Aug. 25, 1916. (Appl. No. 12,068 of 1916.)

LIQUID to be filtered enters an inlet chamber of circular cross-section containing porous filtering tubes projecting inwards from one of its flat sides. Each filtering tube is provided with a tubular neck passing through the side of the chamber into a similar outlet chamber placed face to face with the inlet chamber. The adjacent sides of the inlet and outlet chambers are slightly separated and one of them is provided with a projecting circumferential flange seating upon the other, with an intermediate packing ring, thus forming an intermediate chamber for leakage from the inlet chamber. The intermediate chamber contains a network of stiffening ribs and a number of spacing bosses.—W. F. F.

Drying apparatus for use in drying fruit, vegetables, herbs, chemicals, powders, seeds, minerals, fibre, and the like. F. Hewett, London, Eng. Pat. 108,915, Sept. 8, 1916. (Appl. No. 12,742 of 1916.)

In apparatus for drying fruit, vegetables, and other products, of the type described in Eng. Pat. 106,549 (this J., 1917, 858), tiers of trays are used having front and back rails, A, B, and inner rails, J, F.



supporting gauze, G, for carrying the material to be dried. Hot air enters at D, and passes upwards through the material to the outlet flue, I. In a modification, the rail, J, may be inclined downwards towards the rail, A. In another modification, the rail, B, may be omitted and replaced by the wall of the casing and the trays may be supported on runners. The trays may be reversed so that the air current passes downwards through the material to be dried. The width of the flues, D, I, may be varied, or the trays may be arranged at an angle to the horizontal so as to overlap one another.—W. F. F.

Elevating liquids; Apparatus for automatically — W. A. Coxon, London, Eng. Pat. 108,921, Feb. 14, 1917. (Appl. No. 13,310 of 1916.)

AN upper chamber in the receptacle for the liquid to be elevated contains an oscillating valve for controlling the supply of compressed air and the air exhaust. This valve is operated by means of a slotted hollow float which is actuated by the rise and fall of the liquid in the receptacle. When the liquid in the receptacle reaches a certain level, the oscillating valve closes the air exhaust and admits compressed air, which expels the liquid through a rising delivery main fitted with a non-return valve. The rising main is connected with the liquid-supply pipe, and the back pressure set up by displacement of the liquid lifts and closes a valve on the liquid-supply pipe. When the liquid in the receptacle falls to a certain level, the oscillating valve shuts off the supply of compressed air and opens the air exhaust, whereupon the valve on the liquid-supply pipe drops by the action of gravity and admits a further supply of liquid to the receptacle.—J. H. P.

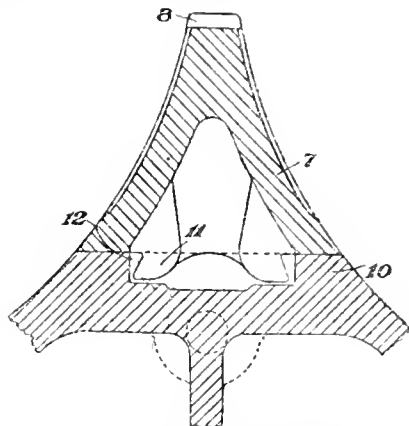
Moistening, humidifying, and otherwise treating air and the like with liquids; Apparatus for — G. F. Jackson, Blackburn, Eng. Pat. 109,913, Mar. 21, 1917. (Appl. No. 4099 of 1917.)

Air is forced through a spraying device mounted inside a main conduit and is discharged through lateral ducts. Any condensed moisture is caught by sleeves which extend slightly beyond the outer orifices of the ducts. The moisture is carried back by a main channel to the space within which the spraying device is situated.—J. H. P.

Mixing machines or the like. J. Miller, and G. Fletcher and Co., Ltd., Derby, Eng. Pat. 109,038, June 28, 1917. (Appl. No. 9278 of 1917.) Addition to Eng. Pat. 102,034, Aug. 5, 1916.

In a mixing machine in which a pair of archimedean spiral mixing blades rotate in adjacent troughs, the troughs meet at an edge, 8, which forms part of a detachable blade, 7. To lock the

blade without any projecting bolts, interlocking lugs, 11, 12, are provided at intervals along the parts, 7, 10, so as to engage when the blade, 7, is inserted and then moved longitudinally. Further



longitudinal movement is prevented by a spacing block between the end of the blade, 7, and the casing, the block being locked by a set screw. The edge, 8, of the blade may be grooved transversely.—W. F. F.

Mixing of powdered substances [explosives, etc.]. W. Dalton, Washington, D.C., U.S.A. Eng. Pat. 108,450, Sept. 7, 1916. (Appl. No. 12,692 of 1916.) Under Int. Conv., July 18, 1916.

Dry powdered ingredients are separately sifted on to a moving supporting surface in such a manner that they are deposited in successive thin layers of each ingredient, and the deposit is broken up and repeatedly re-layed. When highly sensitive explosives are to be mixed, the materials are wetted and the angle of the supporting surface so arranged as to prevent slipping of the ingredients. The material is sifted into a rotary hopper which discharges it on to the mixing surfaces, which are preferably conical. The hopper is sealed with a liquid to prevent any escape of powder.—J. H. P.

Roller mills. F. C. Bettison, and Greenwood and Batley, Ltd., Leeds, Eng. Pat. 109,116, Apr. 30, 1917. (Appl. No. 6087 of 1917.)

The pressure of the rolls in a roller mill is regulated and maintained by means of levers, the long arms of which carry weights, or alternatively by springs, in which case provision is made for adjusting the tension or compression.—J. H. P.

Catalyser and method of preparing the same. E. C. Kayser, St. Brelade's Bay, Jersey, Assignor to The Hydrogenation Co., Cincinnati, Ohio, U.S. Pat. 1,236,446, Aug. 14, 1917. Date of appl., June 12, 1914.

A NON-CATALYTIC compound of nickel is reduced by hydrogen in the presence of a relatively small proportion of copper.—W. H. C.

Recovering solvents; Apparatus for — F. Kniffen, Assignor to E. I. du Pont de Nemours Powder Co., Wilmington, Del. U.S. Pat. 1,236,719, Aug. 11, 1917. Date of appl., Oct. 16, 1912.

A CURRENT of gas is circulated by convection through an evaporating chamber and a condensing chamber situated below. The chambers are connected by vertical conduits, a cooling coil being located in the conduit leading from the evaporating

chamber to the condensing chamber, and a heating coil in the conduit by which the gas returns to the evaporating chamber.—W. H. C.

Evaporating apparatus. A. A. Dunham, Bainbridge, N.Y., Assignor to The Dry Milk Co. U.S. Pat. 1,236,825, Aug. 14, 1917. Date of appl., Oct. 24, 1916.

A ROTATING drying cylinder is partly surrounded by a hood provided with curved deflecting wings which have their concave sides opposed to the direction of a current of air which is passed between the cylinder and the hood. The dried material is removed from the cylinder by a scraper, and part of the heated air current is deflected as it leaves the discharge end of the hood so as to act on the material being removed from the cylinder.—W. H. C.

Vacuum: Method of producing —. I. Langmuir, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pat. 1,237,210, Aug. 14, 1917. Date of appl., May 15, 1914.

THE residual gases left in an exhausted space are arranged to consist at least in part of hydrogen. Phosphorus pentoxide is then introduced into the partly exhausted space and metallic tungsten is rendered incandescent therein. The tungsten is partly vaporized and combines with the gases other than hydrogen forming solid products, whilst the hydrogen is rendered chemically active and is removed in part by combination with the tungsten and in part by oxidation by the phosphorus pentoxide.—W. H. C.

High vacua: Production and maintenance of — and the purification of noble gases. British Thomson-Houston Co., Ltd., London. From General Electric Co., Schenectady, N.Y., U.S.A. Eng. Pat. 109,358, Dec. 14, 1916. (Appl. No. 17,983 of 1916.)

A RARE metal, for example thorium, is heated in an X-ray bulb which has been filled with dry air or nitrogen and evacuated to such an extent that a pure electron discharge can pass without positive gas ionisation. The metal glows and absorbs the gases, producing a vacuum so high that no gas ionisation effects can be observed when an electric current is transmitted. Impurities in argon, neon, and similar gases can be removed by filling the bulb with the gas and burning thorium in it.—J. H. P.

Homogenising liquids: Arrangement for —. W. G. Schröder, Lübeck, Germany. U.S. Pat. 1,237,222, Aug. 14, 1917. Date of appl., Aug. 26, 1916.

A CYLINDRICAL vessel, with a base of inverted conical form, is provided with a similarly-shaped inner concentric chamber which can be rotated by means of a vertical shaft. The inner chamber can also be raised or lowered inside the slightly wider containing vessel. The liquid to be homogenised is admitted by a side tube near the top and withdrawn through a lower side tube leading from the vertical stem below the conical base of the outer vessel.—J. N. P.

Separating liquids from solids in fluid suspension; Apparatus for —. A. L. Blomfield, Colorado Springs, Colo., Assignor to The Dorr Co. U.S. Pat. 1,237,715, Aug. 21, 1917. Date of appl., Nov. 13, 1915.

A SETTLING tank contains two inverted conical settling surfaces, one above the other, and of substantially the same diameter as the tank. The liquid containing suspended solid is fed to the upper part of the tank, and the solid material which settles on the conical surface is moved by rotating sweeps towards a central outlet pipe leading to the lower compartment. Similar sweeps are provided to move the solid material on the

lower surface towards a central outlet. Liquid is discharged from the upper and lower compartments by pipes at the side, the pipe leading from the lower compartment being provided with a regulating valve.—W. F. F.

Separating solid matters from fluids or fluids from fluids; Apparatus for —. F. E. Mass, Kilhey Court, nr. Wigan, and W. H. Smith, Wigan. Eng. Pat. 109,315, Sept. 11, 1916. (Appl. No. 13,026 of 1916.)

THE liquid or gas to be treated flows through a conduit which is provided with pockets which project inwards and act as baffles. The currents set up by these baffles cause the heavier or more viscous bodies to be deposited in the pockets.—J. H. P.

Condenser. A. K. Whitelaw, Woodriver, Ill. U.S. Pat. 1,237,818, Aug. 21, 1917. Date of appl., Apr. 24, 1917.

A CONDENSER consists of a pair of concentric cylinders, with a column of superposed horizontal baffle-plates inside the inner cylinder. The cooling liquid flows upwards through the annular space between the cylinders, overflows at the top into the inner chamber, and then flows downwards, falling from one baffle-plate to the next alternately at the centre and at the periphery. The vapour flows upwards through the inner chamber.

—H. J. H.

Concentrating liquids; Method of —. M. K. Serailian, Berkeley, Cal. U.S. Pat. 1,237,962, Aug. 21, 1917. Date of appl., Oct. 2, 1913.

LIQUIDS containing essential or aromatic ingredients are evaporated while flowing in a closed circuit, and the distillate is fractionally condensed. The first portion of distillate is returned to the concentrated liquid.—W. F. F.

Conveying materials [e.g., to metallurgical furnaces] by means of a current of air or other gas; Process of and apparatus for —. J. Westly, Christiana. Eng. Pat. 104,512, Mar. 1, 1917. (Appl. No. 31,059 of 1917.) Under Int. Conv., Feb. 21, 1916.

A CLOSED vessel maintained under constant pressure by means of compressed air is used as a reservoir for the material. The material drops from the reservoir into a conduit where it is carried along by a rapidly varying pressure of air. The variations of pressure are secured by a revolving valve in the conduit.—J. H. P.

Fumes; Apparatus for withdrawing — from confined spaces. J. A. Campbell, Annan, N.B. Eng. Pat. 109,338, Nov. 7, 1916. (Appl. No. 15,921 of 1916.)

AN ejector has two vertical inner nozzles, the lower orifice of the larger one being connected with a high pressure fan; the lower end of the smaller nozzle is bent at right angles to project some distance through the larger one, and is connected with the space from which the fumes are to be withdrawn. The high-velocity air current draws the fumes through the small nozzle.—J. H. P.

Filler bodies; Method of testing —. F. C. R. Marks, London. From Zahn Manufacturing Co., Buffalo, N.Y., U.S.A. Eng. Pat. 109,074, Aug. 25, 1916. (Appl. No. 12,067 of 1916.)

SEE U.S. Pat. 1,218,154 of 1917; this J., 1917, 494.

Furnaces and like structures. U. Wedge, Ardmore, Pa., U.S.A. Eng. Pat. 109,381, Jan. 24, 1917. (Appl. No. 1225 of 1917.)

SEE U.S. Pat. 1,208,217 of 1916; this J., 1917, 142.

Centrifugal apparatus for cleansing liquids. R. A. Sloan and J. E. L. Barnes, Liverpool. U.S. Pat. 1,239,731, Sept. 11, 1917. Date of appl. Nov. 7, 1913.

SEE Eng. Pat. 25,817 of 1912; this J., 1913, 1118.

IIa.—FUEL; GAS; MINERAL OILS AND WAXES.

Hydrogen sulphide; Liberation of — from gob fires in coal mines. T. J. Drakeley. Chem. Soc. Trans., 1917, 111, 853—863.

EXPERIMENTS were conducted showing that hydrogen sulphide is produced: (1) By passing sulphur dioxide over heated coal; (2) by heating mixtures of coal and sulphur; (3) by heating mixtures of coal and iron pyrites; (4) by passing water vapour over heated iron pyrites; (5) by passing hydrogen over heated iron pyrites. In each experiment the coal or iron pyrites was heated in a glass tube in an electric furnace to 500° C. The gases evolved were freed from tarry matter, dried by bubbling through concentrated sulphuric acid, and the hydrogen sulphide absorbed by copper sulphate acidified with hydrochloric acid. The presence of moisture in the stream of gases was found to increase the formation of hydrogen sulphide. It is concluded from these results that it is possible for iron pyrites to assist in the ignition of a gob fire, forming sulphur dioxide, and then for a series of reactions to take place during the initial stages of the fire whereby the sulphur dioxide is reduced and hydrogen sulphide is liberated.—L. A. C.

Flame; Uniform movement of — in mixtures of acetylene and air. W. A. Haward and S. G. Sastry. Chem. Soc. Trans., 1917, 111, 841—843.

MIXTURES of acetylene and air of known compositions were ignited in a tube 12 mm. in diameter and the speed of the flame was measured electrically between two points 40 cm. apart. The maximum speed was observed in mixtures containing 8—10% of acetylene, a rather higher percentage than the mixture for complete combustion (7.75% acetylene). In a 9 mm. tube the speeds were somewhat slower, but gave a curve (% acetylene—speed) of the same shape. The curves differed in shape somewhat from that described by Le Chatelier (see this Journal, 1896, 188) obtained by similar experiments. With a 25 mm. tube the duration of uniform speed was too short to admit of accurate measurement by the means employed.—L. A. C.

Utilisation of Italian products [petroleum and lar oils] in the preparation of benzol. Rodano. See III.

Action of coal gas on plants. II. Action on green plants. Wehmer. See XVI.

PATENTS.

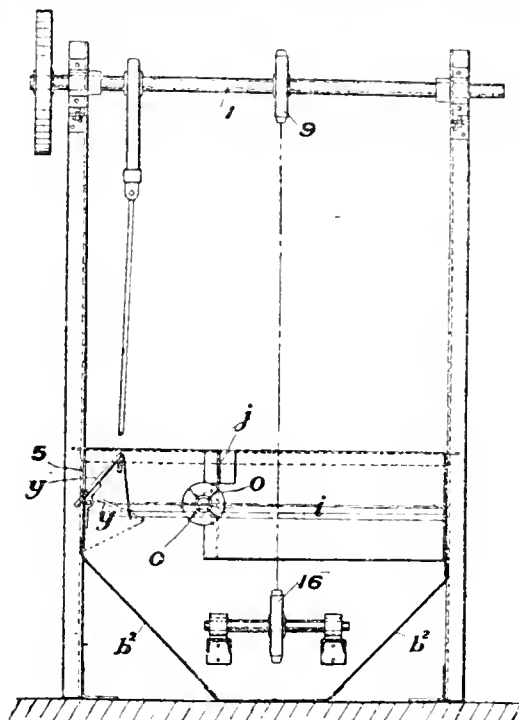
Gas; Process of purifying —. W. O. Felt, Brooklyn, N.Y. U.S. Pat. 1,237,767, Aug. 21, 1917. Date of appl. Sept. 6, 1912. Renewed Nov. 1, 1916.

A HYDROCARBON gas is mixed with glycerin under a pressure of approximately 300 lb. per sq. in. and the temperature is then reduced to about 60° F. while under compression, whereby glycerin and impurities separate, and the gas is liberated in a relatively pure condition.—J. E. C.

Washing coke, breeze, and the like; Apparatus for —. A. L. Jennings, Cleckheaton. Eng. Pat. 108,955, Oct. 27, 1916. (Appl. No. 15,324 of 1916.)

COKE, breeze, or the like is delivered into the section, *i*, of a washer. The water is agitated by

a vaned roller, *o*, which also forces the floating material beneath the surface of the water. The refuse sinks to the bottom, being directed by the inclined plates, *b*², to a bucket elevator carried by the sprocket wheels, 16, and 9. The water passes



under the partition, *j*, and the floating, washed breeze is discharged through the opening, 5, by the alternate rise and fall of an ejector plate, *y*. The vaned roller, *o*, the bucket elevator, and the ejector plate, *y*, are operated simultaneously from the shaft, 1.—J. E. C.

Volatile organic bodies [cracked spiril, etc.]; Deodorising and clarifying —. W. A. Hall, London. Eng. Pat. 109,077, Aug. 26, 1916. (Appl. No. 12,100 of 1916.)

A TANK containing oil is arranged over a furnace, or as an alternative may be filled with superheated steam. Inside the tank is a series of columns so connected that they may be joined up in any order, and any one may be cut out as desired. The first of these is filled with Raschig rings of wrought iron, and is surrounded by a coil entering the column at the bottom; the others are packed with fullers' earth (flourine). The material to be heated (crude-cracked spirit, naphthalene, or fatty acids), is fed under pressure through the coil into the first column, which acts as a dephlegmator and pre-heater, and then into one or more of the other columns as desired. In order to heat the fullers' earth throughout, the vapours are passed through a triform series of pipes within the column to the lower end, and pass upwards through the earth to the outlet at the top. The temperature of the bath is maintained above the boiling point of the distillate required and any portions of higher boiling point collect at the bottom of the first column, whence they can be withdrawn. The vapours after treatment are passed through suitable condensing apparatus. By this process, the oil is not subjected to fractionation, and thus portions of different boiling points are condensed together, avoiding loss of valuable low boiling-point constituents.—L. A. C.

Paraffin wax: Treatment of — for the production of oxygenated and other compounds [fatty acids]. A. Schmidt, Troisdorf, Germany. Eng. Pat. 109,386, Feb. 13, 1917. (Appl. No. 2163 of 1917.)

PARAFFIN wax in a molten condition, at a temperature of 100°—120° C., is treated with a blast of air or oxygen for a prolonged period. The colour changes to light red, light yellow, reddish-yellow, and finally to a deep yellow. At this stage about 70% of the wax has been converted into a mixture of fatty acids, and small quantities of formaldehyde, alcohols, and the like. The different products are separated, e.g., by distillation, and the unchanged wax treated again. Mercuric oxide, or paraffin wax which has already been subjected to the treatment, may be used as a catalyst.—L. A. C.

Lubricating compounds: Process of making plastic —. E. F. Burch, Laurel Springs, N.J., Assignor to Crew Levick Co. U.S. Pat. 1,238,101, Aug. 28, 1917. Date of appl., June 16, 1916.

A PARAFFIN oil having approximately the physical properties of dodecane is mixed with an asphaltic oil, heated to 400°—450° F. (205°—230° C.), and air is blown through the mixture till it becomes plastic. The product is suitable for use in contact with water.—W. F. P.

[Petroleum] oils: Apparatus for dehydrating —. P. W. Prutzman, Berkeley, Cal. U.S. Pat. 1,238,331, Aug. 28, 1917. Date of appl., May 6, 1913.

A RETORT contains at the bottom a steam coil definitely spaced from it; preheated oil is fed on to this coil by means of a second coil having small apertures on the under side. The pressure in the retort is approximately atmospheric.—L. A. C.

Hydrocarbon vapours: Producing and treating — during the distillation of the same. J. H. Robertson, New York, Assignor to Robertson Motor Fuel Process Corporation. U.S. Pat. 1,238,339, Aug. 28, 1917. Date of appl., Apr. 25, 1916.

THE vapours produced during the distillation of crude oils are heated and subjected, under pressure, to a current of electricity, thereby increasing the yield of gasoline.—L. A. C.

Gasoline: Process for making —. S. Davidson, Buffalo, N.Y. U.S. Pat. 1,238,644, Aug. 28, 1917. Date of appl., Apr. 19, 1916.

NATURAL gas is compressed and mixed with a volatile liquid of low specific gravity; the mixture is then subjected to high compression and condensed. The condensed liquid is passed into a suitable storage tank and the hydrocarbon vapours are led off to be mixed with further natural gas before compression.—L. A. C.

Gas-producers: Working of by-product-recovery —. T. Rigby and G. W. Andrew, Dunfries, Scotland, Assignors to Wetcarbonizing, Ltd., London. U.S. Pat. 1,239,969, Sept. 11, 1917. Date of appl., May 7, 1914.

SEE Eng. Pat. 10,981 of 1913; this J. 1914, 852. The water used for the first stage of the cooling operation may be utilised for supplying steam to the air for the gas producer.

Gaseous fuel furnaces. Eng. Pat. 108,701. See I.

Method and apparatus for utilisation of the heat of exhaust gases from heat engines. Eng. Pat. 108,744. See I.

Furnace for treatment of spent iron oxide. Eng. Pat. 108,986. See VII.

Process of producing synthetic asphalt limestone. U.S. Pat. 1,237,852. See IX.

II B.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

Flaming arc: Chemistry of the — in relation to luminescence. W. R. Mott, Amer. Electrochem. Soc., May, 1917. [Advance copy.] 16 pages.

THE subject is considered under the heads: (1) Comparison of carbon arc and flaming arc. (2) Magnified arc image (describing apparatus and method of investigation). (3) Colour of arc parts for nearly all elements. (4) Divided and diffused negative craters. (5) Volatility and crater distance. (6) Materials less volatile than carbon: pitting residues. (7) Typical characteristics for analytical purposes. (8) Light sources due to reactions with calcium fluoride in arc. (9) Effect of alkali salts on cyanogen bands. The following are among the more important conclusions drawn. From an electrochemical standpoint, the arc has considerable analogy to an electrolytic cell: the anode material moves to the cathode; the anode heat is probably due to a high resistance layer; the most electropositive elements, especially those with two or more high-temperature valencies (e.g., CaF, CaF₂) tend to give a bright arc shell due to chemiluminescence; and the electronegative (non-metallic) elements do not give light in a carbon arc as elements, but may do so as compounds. As regards the colour of different parts of the arc, in every case except with barium and vanadium, the core is blue or violet and the shell green, yellow, or red; no case of a blue arc shell is known. The easily reduced metals, excepting the iron (magnetic) group, give no arc shell, the lack of light being explained by the low energy of reaction at high temperatures. With a carbon arc, the flow of material is from positive to negative in nearly every case; but with salts of potassium, rubidium, and cesium in admixture with calcium fluoride, there is also a strong blast which comes from the negative crater, causing a marked dimness near the negative part of the arc. Dim negative craters, such as those produced by barium salts volatilised from the positive, are probably connected with nitrogen reactions at fairly high temperatures. The oxides of yttrium, zirconium, thorium, and other rare earth elements allow cratering, whilst beryllium oxide is the least volatile of the oxides which are so insulating as to inhibit cratering. Tungsten is easily the least volatile of all known elements, tantalum being second. The light sources of a yellow flame arc are due to reactions involving calcium fluoride, oxide, and carbide and elemental calcium, in addition to the usual carbon arc light sources.

—W. E. F. P.

PATENT.

Lamps: Cleaning and renewing electric (incandescence) —. F. G. Koyes, East Orange, N.J., Assignor to Cooper Hewitt Electric Co., Hoboken, N.J. U.S. Pat. 1,237,653, Aug. 21, 1917. Date of appl., Jan. 28, 1914.

FILAMENT lamps, which have been darkened or blackened by the spattering of material on the walls of the transparent portion, are cleaned by forming on the walls a volatile compound of tungsten, then removing the compound, and rinsing the lamp with air. A "restringent gas" is finally introduced.—B. N.

III.—TAR AND TAR PRODUCTS.

Benzol; Utilisation of Italian products [petroleum and tar oils] in the preparation of —. A. G. Rodano. *Annali Chim. Appl.*, 1917, 8, 7—11.

APART from illuminating gas, which is now used in Italy, to a limited extent, in the production of benzene, it would be possible to utilise, by a cracking process, crude petroleum from Ripi, and coal tar oils from which all benzene has been extracted, for the same purpose. In experiments to determine the yields from these products, the liquids were made to fall, drop by drop, into a retort, whence the vapour passed through a long tube which was packed with copper foil. This tube was heated to redness in a furnace, and was connected with a condenser. Coal tar oil freed from benzene and light oils distilling up to $170^{\circ}\text{C}.$ yielded, when cracked in this apparatus, a tar which, on distillation, gave 3.5% of light oils (b. pt. up to $170^{\circ}\text{C}.$), of which less than 2% boiling at $122^{\circ}\text{C}.$ was a mixture of benzene and toluene. Under the same conditions crude Ripi petroleum yielded about 10% of tar, rich in light oil. This had sp. gr. 0.810, and consisted of hydrocarbons rich in hydrogen. A mixture of equal parts of the original substances (coal tar oil and Ripi petroleum) gave about 7% (calculated on the original mixture) distilling up to $170^{\circ}\text{C}.$ Of this product 4.5% distilled up to $122^{\circ}\text{C}.$; 1.25% between 122° and $142^{\circ}\text{C}.$; and 1.25% between 142° and $170^{\circ}\text{C}.$ The fraction distilling up to $122^{\circ}\text{C}.$ consisted of a mixture of benzene and toluene, and yielded, on nitration, about equal parts of nitrobenzene and *o*-nitrotoluene. The yield thus obtained was about six times as great as that obtainable from an equal weight of coal.

—C. A. M.

Phenol and the cresols; Compounds of — with pyridine. W. H. Hatcher and F. W. Skirrow. *J. Amer. Chem. Soc.*, 1917, 39, 1939—1977.

THE authors draw attention to the fact that crude phenols must be extracted from coal-tar oils by means of sodium hydroxide before pyridine can be completely extracted by sulphuric acid, and they describe experiments conducted with a view to studying the extraction of mixtures of pyridine and phenol in benzene solution using pure materials. It was found that phenol can be extracted almost completely from benzene in presence of an equimolecular amount of pyridine by just sufficient sodium hydroxide to extract the same amount of phenol in the absence of pyridine, and if the pyridine be increased to four mols., the extraction of phenol is reduced by less than 5%; on the other hand, although if equimolecular amounts are treated with dilute sulphuric acid, the percentage extraction of pyridine is almost as great as though the phenol were absent, if four molecules of phenol are present, the extraction is reduced by about 75%. Freezing point curves for mixtures of pyridine with phenol, and *o*- and *p*-cresol indicated the formation of definite compounds by molecular association. The dissociation of these compounds in benzene and naphthalene solution was studied by the cryoscopic method, the compounds being present in equimolecular amounts, and it was shown that there is considerable dissociation, increasing rapidly with increased dilution.—L. A. C.

PATENTS.

Phenol; Manufacture of — [from cresols]. H. Terrisse, Geneva, Switzerland. Eng. Pat. 108,938, Oct. 4, 1916. (Appl. No. 14,118 of 1916.)

A MIXTURE of cresols is fused with a large excess of caustic soda (or potash) and treated with an oxidising agent, such as copper oxide, or peroxide of lead, manganese, barium, iron, or the like,

in order to convert the cresols into the corresponding hydroxybenzoic acids. The product may then be treated by one of two methods. (1) The fused mass is cooled on iron plates, pulverised, and heated to about $300^{\circ}\text{C}.$ in iron tubes through which a stream of carbon dioxide is passed. The phenol is condensed in suitable receivers. (2) The free hydroxybenzoic acids are isolated, dried, and heated in a still with crude anthracene oil to about $250^{\circ}\text{C}.$ when carbon dioxide is liberated and phenol distils over. This method is not so satisfactory as the first, owing to the large amount of acid required to neutralise the caustic alkali; also, in the first method, the residual alkali carbonate can be causticised and used again.—L. A. C.

Anthraquinone compounds. P. Nawiasky, Assignor to Badische Anilin und Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,238,932, Sept. 4, 1917. Date of appl., May 8, 1915.

SEE Ger. Pat. 288,464 of 1914; this J., 1916, 355.

Deodorising and clarifying volatile organic bodies [e.g., naphthalene]. Eng. Pat. 109,977. See II.A.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Paper pulp; Waste products for —. G. E. Walsh. *Paper Making*, 1917, 36, 283—285.

THE by-product of the Indian corn (maize) crop in the United States offers an attractive raw material for paper manufacture, as, at the rate of one ton of corn stalks to the acre, the annual supply would be 100,000,000 tons, not more than one-third of which is put to practical use at the present time. The valuable part of the corn-stalk for paper making is the tough outer fibre, this portion being also of least value for cattle fodder. Thus by stripping the outer fibre a double purpose would be served, and the residue would be compressed into a concentrated form of fodder. Corn stalks have been used for rough paper and cardboard, but so far not for fine printing paper. Corrugated cardboard boxes made from corn stalk pulp are capable of replacing wooden boxes for the despatch of goods and would liberate a large amount of lumber for more important uses. Broom corn offers a more valuable raw material than ordinary Indian corn, the yield of fibre is much higher (42%), and the quality is suitable for the manufacture of white book papers. The quantity of broom corn stalks available, however, is only about 500,000 tons annually, and it is not certain what would be the effect on the broom industry if the crop were greatly enlarged. In the United States about 720,000 acres are devoted to rice cultivation, the yield of rice straw being about two tons to the acre, most of which is wasted. At present, only four paper mills are using the rice straw as a raw material, but the fibre, though short, is of excellent quality and produces paper of fine texture. The fibre lint which remains after the ginning of cotton is a valuable material which, although not suitable alone for the manufacture of paper, can be digested with corn stalks or broom corn and gives softness and improved texture to the paper. Cotton stalks are not a very promising material, but flax straw should become an important source of paper supply. There are about 2,500,000 acres devoted to flax seed cultivation in the United States, yielding over 3,000,000 tons of straw; as yet this material has not been utilised.—J. F. B.

PATENTS.

Woolen fabrics; Treatment of woven— to extract vegetable matter therefrom. F. H. Heppleston, Assignee of J. Nelson, Napier, New Zealand. Eng. Pat. 160,685, June 7, 1916. (Appl. No. 8069 of 1916.) Under Int. Conv., June 11, 1915.

WOOLLEN fabric, direct from the loom and while still in its greasy state, is heated in a "tenting" or drying machine to about 170° F. (77° C.) or higher, so as to render seed and other vegetable impurities brittle. The fabric is then fed immediately into an ordinary milling machine, the rollers of which are rotated at a suitable speed; the impurities are thus subjected to a crushing and rubbing action, causing them to be loosened and to fall out of the fabric.—J. F. B.

Yarn or the like; Apparatus for drying—. H. F. Anderton and G. Bailey, Bradford, Yorks. Eng. Pat. 108,681, Sept. 13, 1916. (Appl. No. 2322 of 1916.)

AN apparatus for drying hanks of yarn consists of a series of perforated cylinders or hollow rollers mounted within a closed chamber, the rollers being formed with comparatively large axial openings so that heated air may be circulated through them and out through the openings in their peripheries, from heating apparatus adjoining the chamber. The hanks are carried over the rollers by two series of tapes and are pressed in contact with the rollers while passing through the chamber, being subsequently delivered outside.—J. F. B.

Waterproof material and process of making same. Fibre product. J. McIntosh, Norristown, Pa., Assignor to Diamond State Fibre Co., Bridgeport, Pa. U.S. Pats. (A) 1,236,460 and (B) 1,236,461, Aug. 14, 1917. Dates of appl., (A) Apr. 25, 1916. Renewed July 5, 1917. (B) June 23, 1916.

(A) VULCANISED fibre is impregnated with a solvent of bakelite, e.g., alcohol, and the solvent is displaced by a condensation product of phenol and formaldehyde; the material is then heated to convert the condensation product into its solid form. The solvent employed may be used to displace the parchmientising agent in the freshly made vulcanised fibre and be then itself displaced by the condensation product. (B) Parchmientised fabric or fibre is impregnated with a modified oil, e.g., a sulphonated oil.—J. F. B.

Fibre product; Process of making a—. J. McIntosh, Norristown, Pa., Assignor to Diamond State Fibre Co., Elsmere, Del. U.S. Pat., 1,236,959, Aug. 14, 1917. Date of appl., Mar. 10, 1917. Renewed July 5, 1917.

PARCHMENTISED fibre is treated with a water-soluble material and then with a waterproofing substance which is soluble in the first material. The first treatment may be adapted to remove the water by displacement, and the waterproofing substance may be capable of rendering the impregnated fibre flexible.—J. F. B.

Acetylcellulose and process of making the same. W. G. Lindsay, New York, Assignor to The Celluloid Co. U.S. Pat. 1,236,578, Aug. 11, 1917. Date of appl., Apr. 8, 1911.

CELLULOSE is treated with a preliminary bath, e.g., hydrous acetic acid, which without altering the cellulose, acts so as to induce acetylation when the treated cellulose is subjected to an acetylating bath miscible with the preliminary bath; the treated cellulose is then subjected to the action of a non-solvent acetylating bath at 50°–80° F. (10.5°–26.5° C.).—J. F. B.

Acetylcellulose process and product. W. G. Lindsay, Newark, N.J., Assignor to The Celluloid Co. U.S. Pat. 1,236,579, Aug. 11, 1917. Date of appl., July 11, 1911.

CELLULOSE (100 parts) is impregnated with a mixture of 200 parts of 90% acetic acid and 50 parts of zinc chloride, and then acetylated with a mixture of 450 parts of acetic anhydride and 1650 parts of benzene. The cellulose is not hydrolysed by this treatment, and the acetylcellulose, which is soluble with difficulty in chloroform, retains the fibrous structure of the original cellulose.

Paper-stock from cereal straw; Process of making—. J. E. Lappen, Assignor to Winona Pulp and Paper Co., Winona, Minn. U.S. Pat. 1,236,723, Aug. 14, 1917. Date of appl., Apr. 21, 1916.

STRAW is boiled with water under pressure, and warm water is forced through the mass, whilst it is under pressure, to remove the gummy matter which has been liberated during the digestion; cold water is then forced through the mass while it is still warm and under pressure, to displace the gummy liquor without allowing it to become mixed with the cold water.—J. F. B.

Paper-making. [Sizing.] A. Brannon, Assignor to H. F. Marston, Dayton, Ohio. U.S. Pat. 1,237,864, Aug. 21, 1917. Date of appl., Oct. 22, 1912. Renewed Feb. 10, 1917.

A WEB of paper direct from the driers of the paper machine is immersed in size, the surface portions of the size are removed by squeezing, and the sized paper is subjected to cold until the size has become absorbed by and set in the paper, which is then dried.—J. F. B.

Sulphile liquor; Process of precipitating organic substances in—. H. B. Landmark, Drammen, Norway. U.S. Pat. 1,236,948, Aug. 14, 1917. Date of appl., Dec. 7, 1916.

THE organic sulphonic acid combinations contained in spent sulphile liquor are decomposed and precipitated by treatment with a stronger acid, e.g., sulphuric acid produced by the oxidation of the sulphurous acid contained in the liquor, by the discharge of electric sparks in presence of oxygen or air, or ozonised oxygen or air, within the vessel in which the liquor is under pressure and in which the precipitation takes place.—J. F. B.

Animal hair; Process of cleaning—and producing fertiliser. H. Y. McBride, Artesia, New Mexico, U.S.A. Eng. Pat. 109,149, Nov. 7, 1916. (Appl. No. 15,943 of 1916.)

SEE U.S. Pat. 1,218,573 of 1917; this J., 1917, 450.

Drying machines [for fabrics]. T. Allsop and W. W. Sibson, Mt. Airy, Pa., U.S.A. Eng. Pat. 109,322, Sept. 20, 1916. (Appl. No. 13,367 of 1916.)

SEE U.S. Pat. 1,198,377 of 1916; this J., 1916, 1105.

Paper; Process of manufacturing water-proof—especially for metallic styli. Kimpitsu-Seishi Kabushiki Kaisha, Ltd., and S. Kuroki, Tokyo, Japan. Eng. Pat. 109,200, Jan. 25, 1917. (Appl. No. 1288 of 1917.)

SEE U.S. Pat. 1,231,615 of 1917; this J., 1917, 1001.

Drying apparatus for use in drying fruit, vegetables, herbs, chemicals, powders, seeds, minerals, fibre, and the like. Eng. Pat. 108,915. See I.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Electrical endomose and adsorption. [Theory of dyeing.] T. R. Briggs, H. L. Pierson, and H. S. Bennett. Amer. Electrochem. Soc., May, 1917. [Advance copy.] 11 pages.

THE relation between electrical endomose and the adsorption theory of contact electrification is discussed and it is shown that this theory provides a rational explanation of the phenomena. Experiments made with a modified form of Perrin's endosmometer confirmed the data accumulated by this author, and a careful study was made of the effect and temperature on the rate of electrical endomose. The results of some experiments with acid and basic dyestuffs, using an alundum diaphragm, are given, and it is shown that the phenomena encountered in dyeing are in accord with the ionic adsorption theory.—D. F. T.

PATENT.

Indigo fermentation-vat; Stable concentrated preparations for the —. A. Schmidt, Assignor to Farb- u. v. m. Meister, Lucius, und Brüning, Höchst, Germany. U.S. Pat. 1,239,526, Sept. 11, 1917. Date of appl., Nov. 13, 1914.

SEE Eng. Pat. 22,148 of 1914; this J., 1915, 1245.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Calcium carbonate; Solubility of — in boiling water. A. Cavazzi. Gazz. Chim. Ital., 1917, 47, II., 49—63.

EXPERIMENTS are described which show that calcium carbonate is slowly dissociated in boiling water, with the loss of carbon dioxide. Owing to this dissociation it is not possible to obtain a solution of calcium carbonate, by itself, in boiling water. The dissociation is inhibited in presence of about 15 c.c. of a cold saturated solution of lime per litre of boiling water in which the calcium carbonate is suspended. The substance which dissolves when calcium carbonate is boiled for a long time with water is practically entirely free lime, the quantity dissolved depending mainly on the volume of the liquid, the duration of the boiling, and the concentration of the solution. The addition of a small quantity of sodium carbonate (0.05 gm. per litre) is sufficient to prevent the dissociation by boiling water, and hence the solution of the calcium carbonate, so that the filtrate from the boiling liquid gives no turbidity with ammonium oxalate. When calcium carbonate is precipitated from aqueous solutions, it forms, even in the presence of free lime, supersaturated solutions, the stability of which depends mainly on the temperature and the concentration. —C. A. M.

Di-lead arsenate; Decomposition of — by water. C. C. McDonnell and J. J. T. Graham. J. Amer. Chem. Soc., 1917, 39, 1912—1918.

DI-LEAD arsenate, although only very slightly soluble in water, has been found to have a burning effect on tender foliage when used as an insecticide. Investigations were therefore made as to the action of large quantities of water on this compound. Quantities of the di-lead arsenate were treated under different conditions with freshly distilled water, the solid filtered off, and the filtrates tested. The proportion of arsenic to lead in these was found to be higher than in the original compound, indicating that arsenic acid was liberated and that minute traces of lead were

going into solution. A much smaller amount of lead was dissolved by hot water than by cold. Under certain conditions, e.g., when the compound was washed with cold running water, minute colourless transparent crystals were formed in the filtrate, and these, on examination, proved to be identical with crystals formed in the residues from the filters. This crystalline compound was found to be a basic lead arsenate (hydroxy-mimetite) having the formula, $Pb_4(PbOH)(AsO_4)_2 \cdot H_2O$.

—L. A. C.

Carbon dioxide and ammonia; Adsorption of — by charcoal. L. B. Richardson. J. Amer. Chem. Soc., 1917, 39, 1828—1848.

THE author has investigated the adsorption of carbon dioxide and ammonia by charcoal at pressures up to four atmospheres. In the case of carbon dioxide, equilibrium pressures were measured at twenty-one temperature points between -64° and 200° C.; in the case of ammonia, at seventeen points between -26° and 200° C. The results obtained show that, although below a pressure of 60 cm., the degree of adsorption is in fair agreement with the logarithmic isotherm equation suggested by Freundlich, $a = ap^{1/n}$ (a = vol. of gas adsorbed by one gram of charcoal at a given temperature; p = the equilibrium pressure, a = vol. of gas adsorbed at that temperature under a pressure of 1 cm., and $1/n = [d \log a] / [d \log p]$, a constant), above that pressure the adsorption rapidly decreases, indicating a maximum value for each temperature point. In the case of carbon dioxide, no evidence was obtained of the formation of a chemical compound such as that obtained by Rhead and Wheeler (this J., 1913, 276) in the adsorption of oxygen by charcoal, but in the adsorption of carbon dioxide at low temperatures, certain phenomena suggest that a small quantity of the gas may be absorbed in the charcoal structure.—L. A. C.

Liberation of hydrogen sulphide from gob fires in coal mines. Drakeley. See 11A.

Acid-resisting properties of some iron-silicon alloys. Kowalke. See X.

PATENTS.

Ammonium sulphite; Process for oxidising — to ammonium sulphate. Elektrizitätswerk Lonza, Gampel, Switzerland. Eng. Pat. 105,906, Mar. 21, 1917. (Appl. No. 4113 of 1917.) Under Int. Conv., Apr. 25, 1916.

CALCIUM sulphate is employed as an oxygen carrier to accelerate the oxidation of ammonium sulphite by air and prevent loss of ammonia. The process depends on the formation, by double decomposition, of calcium sulphite which is more rapidly oxidised than the corresponding ammonium compound.—W. E. F. P.

Sulphate of ammonia; Production of neutral —. F. Capron, Barcelona, Spain. Eng. Pat. 108,990, Dec. 8, 1916. (Appl. No. 17,648 of 1916.)

IMPURE, acid crystals of ammonium sulphate obtained by the usual processes are washed with a saturated, neutral or slightly alkaline solution of ammonium sulphate until free from acid, and then centrifuged.—W. E. F. P.

Cyanides and ammonia; Process of manufacture of —. L. P. Devauelle, Courbevois, France, and F. Bensa, Genoa, Italy. U.S. Pat. 1,237,185, Aug. 21, 1917. Date of appl., Sept. 9, 1915.

A SUITABLE reaction mass is heated in a retort through which nitrogen is passed to form cyanides. A current of steam is then substituted for the nitrogen; ammonia is thus formed, the temperature of the charge being reduced sufficiently to

prevent the production of cyanates and dissociation of the ammonia, without lowering appreciably the temperature of the furnace and retort.

—J. B. C. K.

Ammonia-oxidation process. C. Ellis, Montclair, N.J. U.S. Pat. 1,237,884, Aug. 21, 1917. Date of appl., Jan. 2, 1917.

AMMONIA and a gas containing oxygen, e.g., air, are brought into contact with an oxidising catalyst containing a compound of silver with an oxygen compound of another element, e.g., silver molybdate. Oxides of nitrogen are produced.

—J. B. C. K.

Spent iron oxide; Furnace for the treatment of —. J. Kershaw, London. Eng. Pat. 108,980, Dec. 1, 1916. (Appl. No. 17,280 of 1916.)

THE apparatus consists of one or more inclined flues, each provided with a feeding device at the upper and discharging means at the lower end. The flues may be arranged one above the other, in spiral form, around a central column, the inclination being such that the spent oxide remains in repose upon the floor of each until the sulphur is expelled, when the residue travels downwards by gravity to the place of discharge. A common collecting flue for the sulphurous gases is provided at the top of the furnace.—W. E. F. P.

Aluminium fluoride; Process for obtaining —. C. A. Doremus, New York, Assignor to J. S. Hoyt, Darien, Conn. U.S. Pat. 1,237,488, Aug. 21, 1917. Date of appl., Feb. 21, 1913.

FELSPAR is treated with 20% hydrofluoric acid to produce soluble aluminium fluoride and hydrofluosilicic acid and insoluble alkali fluosilicate. The mixture is filtered, and the hot solution treated with aluminous material to decompose the hydrofluosilicic acid, after which the liquid is again filtered and evaporated to dryness to recover aluminium fluoride.—W. E. F. P.

Calcium arsenate; Process of making —. G. R. Riches and W. C. Piver, Hoboken, N.J. U.S. Pat. 1,237,815, Aug. 21, 1917. Date of appl., Oct. 27, 1916.

CALCIUM hydroxide is treated with arsenic acid in the presence of an independent electrolyte, such as sodium hydroxide, which prevents the occlusion of a soluble compound of calcium and arsenic by the calcium arsenate formed as a result of the reaction.—J. B. C. K.

Oxide of tin; Process for the direct production of pure —. J. Terwelp, Neuss, Germany. U.S. Pat. 1,237,810, Aug. 21, 1917. Date of appl., Sept. 3, 1914.

A TIN-BEARING material is heated in the presence of a gaseous reducing agent, but in an oxidising atmosphere, to at least the reduction temperature of tin oxide, without producing a melt. The tin vapour formed by the reaction is immediately oxidised and leaves the charge as oxide fumes.

—J. B. C. K.

Iodine; Processes for producing —. R. L. Datta, Calcutta. Eng. Pat. 108,918, Sept. 12, 1916. (Appl. No. 12,878 of 1916.)

THE process depends on the decomposition of gaseous hydrogen iodide by nitrous gases, and the re-oxidation of the resulting nitric oxide by air. Since hydrogen chloride and bromide are not similarly decomposed, the iodine obtained by this means is free from other halogens. In practice, gaseous hydrogen iodide, air, and nitrous gases, at ordinary temperature, are conducted through separate inlets into a glazed earthenware chamber, the iodine being deposited in crystals on the walls;

or a current of air and nitrous gases (3 to 1 by volume) is passed over a slowly heated mixture of dry alkali iodide and sulphuric acid (or sodium bisulphate) in molecular proportions, the liberated iodine being condensed, and the escaping gases mixed with air for further use.—W. E. F. P.

Alkali metal compounds; Process of obtaining from mineral silicates and other materials containing alkalis. A. Mond, London. From W. A. Schmidt, Los Angeles, Cal., U.S.A. Eng. Pat. 109,105, Sept. 5, 1916. (Appl. No. 12,581 of 1916.)

SEE U.S. Pat. 1,200,887 of 1916; this J., 1917, 32. The process may be used for recovering potassium and like compounds as a by-product in cement manufacture.

Production and maintenance of high vacua and the purification of noble gases. Eng. Pat. 109,358, Sec I.

VIII.—GLASS; CERAMICS.

PATENT.

Kiln-baked articles; Method and means for coating —[with glaze]. J. W. Ivory, Assignor to Clay Products Co., Brazil, Ind. U.S. Pat. 1,237,520, Aug. 21, 1917. Date of appl., Jan. 22, 1917.

THE glaze material in the form of slip is fed into a horizontal tube fixed in the side of a kiln. Inside this tube is fixed axially a pipe terminating in a nozzle and connected with a supply of compressed air. The blast of air issuing from the nozzle carries the glaze material in the form of a cloud of spray into the kiln and so coats the charge.—H. J. H.

IX.—BUILDING MATERIALS.

Bauxite for lining furnaces. N. Lecesne, La Céramique, 1917. Eng. and Min. J., 1917, 104, 417.

A MIXTURE of anthracite (1 part) and crude bauxite as quarried (3 parts) is charged into a hot furnace, lined with fused bauxite. Air at an initial pressure of 40 in. water gauge is blown through and the charge rapidly heats up. The pressure rises and may reach 400 in., though usually 160 in. water gauge is the maximum attained. The bauxite gives up its water suddenly and is thereby disintegrated. Aluminium carbide is produced and burns later, raising the temperature to 3000° C. Silica is volatilised. Iron oxide is reduced to metallic iron which is expelled by the air blast with the production of a shower of sparks. The blast is continued so as to burn out excess of carbon and cool the purified product, which can then be used in the manufacture of refractory bauxite bricks.—H. J. H.

PATENTS.

Wood impregnation. H. G. Jennison, Toledo, Ohio. U.S. Pat. 1,237,521, Aug. 21, 1917. Date of appl., May 20, 1915.

THE wood is steamed, superficially impregnated by submersion under increased hydraulic pressure, and the impregnating liquid is then distributed throughout the mass by exposure to increased gaseous pressure. On releasing this gas pressure, the excess of liquid is exuded from the pores of the wood.—H. J. H.

Asphalt limestone: Process of producing synthetic — C. L. V. Zimmer, Berlin-Wilmersdorf, Germany. U.S. Pat. 1,237,852, Aug. 21, 1917. Date of appl., Aug. 11, 1915.

POWDERED limestone or the like is added to an aqueous emulsion of bituminous material, and the stone-like product is heated to 150–200° C. —H. J. H.

Refractory material, and process of making the same. H. A. Kennedy, Clearfield, Pa. U.S. Pat. 1,238,020, Aug. 21, 1917. Date of appl., Nov. 28, 1916.

A BASIC refractory material is produced in clinker form by subjecting an intimate mixture of lime, magnesia, silica, and an oxide fluxing agent to a high temperature in a rotary kiln, in such proportions that the product contains 78–92% of calcium and magnesium oxides and 2–13% of silica in addition to the oxide fluxing agent.—H. J. H.

Impregnating artificial and natural materials [wood, stone, fabrics, etc.]: Process of — B. Schwerin, Assignor to Elektro-Osmose A.-G. (Graf Schwerin Ges.), Frankfurt, Germany. U.S. Pat. 1,238,202, Aug. 28, 1917. Date of appl., Aug. 23, 1916.

SEE Eng. Pat. 101,205 of 1916; this J., 1917, 310.

Cement; Manufacture of — A. Helbronner, Paris. U.S. Pat. 1,239,912, Sept. 11, 1917. Date of appl., Dec. 29, 1913.

SEE Fr. Pat. 468,527 of 1913; this J., 1914, 965.

Process of obtaining alkali metal compounds from mineral silicates and other materials containing alkalis. Eng. Pat. 109,105. See VII.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Iron ores: Present knowledge and practice in regard to the briquetting of — G. Barrett and T. B. Rogerson. Iron and Steel Inst., Sept., 1917. [Advance copy.] 42 pages.

THE processes may be subdivided into four classes: (A) Those in which cohesion is brought about by pressure. The most widely used is the Bonay process. (B) Those in which the ore is pressed, with or without addition of a binder (e.g., lime or clay), and subsequently heated to incipient fusion or vitrification. The Gröndal process is the most satisfactory of this class. (C) Those in which the ore is mixed with a binder, pressed into moulds, and hardened in air, steam, or gas. Magnesium chloride is used in the Schumacher process, granulated slag and lime in the Stütz process, and sulphite-cellulose waste liquor or sulphite pitch in the Trainer, Pioneer, and Pollack processes. (D) Those in which the material is agglomerated by heat alone. The most widely used process is that of nodulising in rotary kilns, which are usually fired with pulverised coal, though oil, producer gas, and blast-furnace gas are also used. The so-called sintering processes include the Dwight-Lloyd, the Huntington-Hieberlein, the Greenawalt, and the West process. As regards the suitability of the various processes for iron ores, those of class A are not likely to produce satisfactory briquettes for the blast furnace, and are expensive to work. Those of class B (e.g., the Gröndal process) can be made to yield suitable products. In class C, the Schumacher process is probably the cheapest of the true briquetting processes, and appears to have

been successful in a number of works. The disadvantage of all true briquetting processes is, that in at least one stage every briquette must be moved by hand, entailing heavy labour cost and risk of breakage. The rotary kiln has a large capacity, is not subject to royalty, and needs little labour. It is effective for reducing the amount of sulphur in the ore, but requires careful working, as rings of clinkered ore are liable to form in the hottest part of the kiln. Sintering has been widely adopted in America owing to its reputed low cost of operation, simplicity, and wide range of applicability. The sintered material is strong and stands weathering and stacking well. Experiments should be made with every new material upon a small scale before agglomerating plant is installed to treat it. Comparative costs at pre-war prices are given, and descriptions of briquetting machines and coal pulverising plant. —W. R. S.

Phosphorus; Determination of — in cast iron. A. Cavazzi. *Annali Chim. Appl.*, 1917, 8, 1–6.

ABOUT 5 grms. of the finely-divided sample is boiled with dilute nitric acid (1:1) until nitrous fumes are no longer evolved, and the solution is treated with 15 to 20 c.c. of dilute sulphuric acid (8 to 9 c.c. of strong acid), and gently boiled until white fumes appear, the heat being then regulated so that the temperature of the ferric sulphate does not exceed 210° C. (decomposition temperature 350° C.). When the evolution of white fumes has practically ceased, the residue is powdered, again heated, and then cooled, and treated with 40 c.c. of a mixture of 5 c.c. of strong nitric acid, 20 c.c. of strong hydrochloric acid, and 15 c.c. of water, and the liquid gently boiled until concentrated to about a third of its volume. It is then diluted with 50 c.c. of water, cooled, and filtered, and the residue washed six times with boiling water acidified with nitric acid. The filtrate is evaporated until viscous, and then treated with about 4 c.c. of nitric acid, to expel any trace of hydrochloric acid, the mass being constantly stirred during the moderate heating. It is next cooled and treated with 30 c.c. of dilute nitric acid (15 c.c. of acid of sp. gr. 1.153 diluted to 30 c.c. with water), and heated for a few minutes to dissolve the ferric sulphate. The solution is mixed with a solution of 15 grms. of ammonium nitrate in 25 to 30 c.c. of water, boiled, and treated with 50 c.c. of a boiling solution of 2.0 to 2.5 grms. of ammonium molybdate, the mixture being well stirred, and then kept at about 80° C. for 30 mins. The supernatant liquid is decanted, and the phosphomolybdate precipitate washed four times with a solution of 25 grms. of ammonium nitrate and 20 c.c. of nitric acid (sp. gr. 1.153) in 500 c.c. of water, then dissolved in 10 c.c. of dilute ammonia solution (1:2), and the solution treated with a solution of 5 grms. of ammonium nitrate in 20 c.c. of water, and 1 gm. of ammonium molybdate in 30 c.c. of water, heated to incipient boiling, and treated with 20 c.c. of boiling nitric acid (sp. gr. 1.153). The re-precipitated phosphomolybdate is washed with ammonium nitrate solution, and dissolved in ammonia solution (1:4), and the solution treated with dilute hydrochloric acid (1:3) until the precipitate begins to appear again, when 10 to 20 c.c. of magnesia mixture is added, and the liquid heated to boiling, and treated, drop by drop, with dilute ammonia solution, with constant stirring, until a slight turbidity appears. The liquid is then cooled, and treated with sufficient strong ammonia solution to increase the original volume by a fifth or a fourth, and the precipitate of ammonium magnesium phosphate separated and converted into magnesium pyrophosphate in the usual way.—C. A. M.

Iron; Microstructure of commercially pure—between A_1 and A_2 . W. J. Brooke and F. F. Hunting. *Iron and Steel Inst.*, Sept., 1917. [Advance copy.] 7 pages.

IN an investigation to determine the causes of the characteristic red-shortness exhibited by "Armco" iron (99.84% Fe) when subjected to mechanical treatment between 900° and 800° C., pieces of the metal were heated to well above the upper critical point and allowed to cool very slowly to temperatures ranging between 1040° and 575° C., when they were immediately quenched and examined mechanically and micrographically. The brittleness exhibited by the hot metal was entirely absent in the quenched specimens. The microstructure varied with the quenching temperature. The piece quenched from 1040° C. had the character of γ -iron with "martensitic" appearance, the crystal boundaries being well broken up and showing small, crystalline grains. This structure slowly altered with the lowering of the quenching temperature, the γ -iron effect changing into a more definite ferrite form with crystal grains gradually increasing in size. At about the A_1 point (900° C.) the ferrite grains had increased considerably in size, and at the junctions of many of the crystal boundaries a constant and characteristic structure appeared, consisting of a clearly defined, more or less pearlitic area or lake, surrounded by ferrite and then by a definite boundary with which the adjacent crystal grains were connected. As the quenching temperature was lowered, this structure became gradually less pronounced until, at just above 800° C., it ceased to exist. It would thus appear that, between the A_1 and A_2 points, iron of the relative purity stated possesses the property of throwing out of solution an eutectoid (probably composed of iron carbide, phosphide, and sulphide, with traces of manganese sulphide and ferrous oxide), and that the pronounced red-shortness of the metal between these temperatures is due to or connected with this cause.—W. E. P. P.

Corrosion of cast iron, and its bearing upon the electrolytic theory of corrosion. E. A. and L. T. Richardson. *Amer. Electrochem. Soc.*, May, 1917. [Advance copy.] 6 pages.

MEASUREMENTS were made on the corrosion of samples of grey cast iron, a low carbon steel, and a commercial pure iron, which were found by chemical analysis and by photomicrographs to possess a wide range of heterogeneity in the different cases. The test pieces were carefully annealed at 750° C., and, after removing the surface oxide coating by filing, were weighed. After exposure to the atmosphere for one month, the pure iron had undergone the least corrosion, while cast iron and steel seemed about equal, and decidedly more corroded than pure iron. The rate of rusting of the cast iron decreased later, and after four months the cast iron appeared about equal to the pure iron, while steel was much more oxidised than either. At the end of seven months the test pieces were cleaned with neutral ammonium citrate and re-weighed. The losses, computed in grms. per sq. cm., were: cast iron, 0.966; steel, 1.546; pure iron, 0.771. No difference could be detected between the cast iron and the pure iron as regards the condition of the surface, the depth of the pits, and the uniformity of rusting. The steel was, on the other hand, very deeply pitted, and the rusting on the surface was irregular. These results agree with the experiments of other observers in showing that the resistance of iron to corrosion does not necessarily depend on its purity or homogeneity, as would be expected from the electrolytic theory of corrosion, and indicate that while initial rusting may be largely electrolytic in character, factors such as the adherence

of rust and the protection thereby given to the metal come into operation and outweigh any electrolytic corrosion.—J. N. P.

Groves-Echells electric [steel] furnace. E. K. Scott. *Met. and Chem. Eng.*, 1917, 17, 243—245. (See also Eng. Pat. 106,626 of 1916; this J., 1917, 891.)

THE rectangular furnace body with a curved base is made of boiler plate with a thick conducting hearth of magnesite, and is supported on grooved steel rollers. By means of a screw and gear wheels the furnace with its electrodes can be tilted backwards and forwards. The dome-shaped roof is made of silica bricks set in a steel frame and made as low as possible so as to reduce the wasting away of the electrodes by the action of the hot furnace gases. A roof will last about 100 heats, and a duplicate one is provided with each furnace to ensure continuity of operation except during the time required for changing the roof. The electrodes pass vertically downwards through apertures in the roof so that arcs can be maintained on the slag and the surface of the molten metal. Each electrode is secured in a bronze or steel holder attached to, but insulated from, a steel jib, projecting from a wheeled carriage. The carriage travels up and down a vertical mast, which is made of two channel sections bolted to the side of the body. With a three-phase current, two of the phases are connected to electrodes above the bath, and the third phase to a copper plate below the conducting hearth. About 12% of the total energy is used in the hearth, and the heat is thus favourably distributed in the lower part of the furnace. The hearth lining is at least 20 in. thick and is constructed of dolomite and magnesite so as to give a graded resistance, this being high on the inside in proximity to the charge and decreasing rapidly towards the outside. The high-tension electric supply is transformed by means of a delta star system of connections to low tension. Short-circuiting of the electrodes is guarded against by the permanent resistance in the path of the current through the hearth and by arranging the connections so that the short-circuit current of one electrode must traverse two transformers in series and in different phase, thus automatically lowering the power factor temporarily. When pouring the metal by tilting the furnace, the spout is arranged to descend in a vertical line by means of compensating rollers which move the furnace bodily forward during the tilting. The capacity of a 260 K.V.A. furnace, which takes 2 graphite electrodes, of 1 in. diam., is $\frac{1}{2}$ ton, and a 2600 K.V.A. furnace, using 1 electrodes of 10 in. diam., has a capacity of 12 tons. When working charges of steel scrap and iron ore, after melting, fluorspar is added in order to eliminate the phosphorus. After the phosphate slag has been skimmed off, a new slag is made by addition of high-grade lime, fluorspar, and white sand, in the proportions of 30, 10, and 5, and a small quantity of powdered anthracite is spread on the slag produced. An atmosphere of carbon monoxide is thus maintained and decoxidation of the steel is brought about through constant reduction of silicon from the slag and may be hastened by the addition of small quantities of ferrosilicon.—J. N. P.

Steel; The Eggertz test for combined carbon in —. J. H. Whiteley. *Iron and Steel Inst.*, Sept., 1917. [Advance copy.] 101 pages.

INVESTIGATION of the carbon dioxide content of the gases given off in the Eggertz test showed that carbon dioxide is given off at a decreasing rate during several hours, in amounts closely proportional to the carbon content of the sample and irrespective of its previous heat treatment, except in the case of austenitic steels. Hydrocyanic acid

is also evolved during solution of the sample; its amount showed unaccountable variations, and was independent of the heat treatment and the manganese or nitrogen content of the steel. Only a minute quantity of hydrocarbon (and possibly also carbon monoxide) is evolved when the test solution of either a normal or a quenched steel is heated. Thus a steel containing 1% of combined carbon when submitted to the Eggertz test would yield in the first 10 minutes 22% of the carbon as dioxide, 5–10% as hydrocyanic acid, and 2–3% as hydrocarbons. The carbon not accounted for was not evolved as a gaseous compound, but was present in the nitric acid solution as a colourless compound or compounds. The colouring matter is formed by the subsequent solution, in the nitric acid, of the brown precipitate that remains when the metal is attacked. It was separated by dialysis into a brown colloidal solution within the dialyser, and a yellowish-green solution in the outer vessel. The colouring matter in the yellowish-green solution slowly changes to a colourless or slightly coloured compound on continued boiling of the test solution. Variations in the colorimetric results are shown to be due to at least two causes: delay in the solution of the brown precipitate, and early formation of excess of colourless products. The two actions may overlap, and their separate effects cannot often be ascertained. The particles of the brown precipitate resemble in shape those of the carbide from which they are formed: as the particles of carbide decrease in size, the precipitate becomes more gelatinous and yields greener tints. The colour of the test solution is also affected by an electrolytic action set up during solution between the iron and the carbide embedded in it; and since larger carbide particles remain in contact with the metal for a greater length of time, the effects of cold-work and quenching affect the colour; drillings, for example, give higher results than cut pieces of the same steel. No simple relation could be found between the Eggertz results and the Brinell hardness of quenched steels, or those quenched and tempered at various temperatures. By adding 15 c.c. of sulphuric acid (1:3) to the cooled test solution before matching the colour, it was found possible greatly to reduce variations in the tints, though a perfect match could not be obtained in all cases.—W. R. S.

Steel; Electrolytic pickling of—. M. de K. Thompson and O. L. Mahman. Amer. Electrochem. Soc., May, 1917. [Advance copy.] 6 pages.

A COMPARISON was made of the consumption of acid and amount of iron dissolved in the chemical and electrolytic methods of removing scale from steel plates. In the chemical treatment the plate was immersed in a boiling solution of about 5% sulphuric acid until the surface was free from scale. In the electrolytic method, the plate was used as cathode with a lead anode in a solution of sulphuric acid (1·2 sp. gr.) at 60° C.; the current density was 40–60 amps. per sq. foot. In both cases the solution was concentrated until the detached scale had all dissolved, and the iron was estimated by reducing and titrating with potassium permanganate. The ratio of the amount of iron dissolved in the electrolytic method to that in the chemical method was about 0·6:1·0, and the saving of iron and acid in the former method was found to be as great as the cost of power required for the electrolysis. The cathodic reduction of magnetic oxide of iron was investigated by conducting electrolyses with cathodes of fused magnetite, and estimating the amount of hydrogen evolved comparatively with that obtained when using a metal cathode with the same current.

The reduction was found to be most efficient at a temperature of about 50° C., and with a current density of 50 amps. per sq. foot.—J. N. P.

Molybdenum and vanadium in steel; Volumetric determination of—. Travers. Comptes rend., 1917, 165, 362–364.

THE steel is dissolved in dilute sulphuric acid, the ferrous sulphate oxidised by the addition of powdered potassium permanganate, avoiding an excess, the mixture is then rendered alkaline with potassium hydroxide, boiled, and filtered. An aliquot portion of the filtrate is diluted, faintly acidified with hydrochloric acid, and treated with an excess of standardised titanium trichloride solution; the excess is then titrated with ferric chloride solution, using potassium thiocyanate as indicator. In solutions containing less than 0·05 grm. of molybdenum per litre and having an acidity corresponding with 1 c.c. of free HCl per 100 c.c., the reduction proceeds according to the equation: $2\text{MoO}_3 = \text{Mo}_2\text{O}_3 + \text{O}$. Vanadium may be determined in a similar way, the reduction being according to the equation: $\text{V}_2\text{O}_5 = \text{V}_2\text{O}_4 + \text{O}$. If molybdenum and vanadium are both present in a steel, they are determined together as described: the vanadium is then determined colorimetrically (with hydrogen peroxide), and the molybdenum is obtained by difference.—W. P. S.

Iron-silicon alloys; Acid-resisting properties of some—. O. L. Kowalke. Amer. Electrochem. Soc., May, 1917. [Advance copy.] 6 pages.

A NUMBER of iron-silicon alloys, containing 1·2 to 19·8% Si, were immersed in 10% solutions of sulphuric, hydrochloric, nitric, acetic, and citric acids for periods ranging from 51 hrs. to 29 days at 20–35° C., and the losses determined. With few irregularities, the resistance to acid attack was a minimum at 1·2 to 3·3% Si, and a maximum at 16–18% Si. The alloys were made from electrolytic iron and ferro-silicon, melted together in graphite crucibles lined with magnesium oxide, and cast in a graphite mould. The alloys of low silicon content made good soft castings, but above 3·5% Si the alloys were brittle; the test-pieces of the brittle alloys were ground to obtain a fairly smooth surface. The alloys containing 3 to 5% Si were not excessively brittle, but were very readily attacked by sulphuric, hydrochloric, acetic, and citric acids. The alloys containing 16 to 18% Si were exceedingly resistant to mineral acids, but were so brittle that they could not be machined.—J. H. P.

Brasses; Experiments on the fatigue of—. B. P. Haigh. Inst. of Metals, Sept., 1917. [Advance copy.] 23 pages.

EXPERIMENTS were made with samples of Muntz metal, naval brass, and phosphor bronze, to ascertain the effects of annealing, using stresses alternating between equal intensities of direct pull and push; to determine the relation between the limiting range of stress required to produce fatigue, and the ratio between the maximum and minimum stresses; to study the phenomena of elongation under stresses greater than the fatigue limit, but less than the ultimate tensile strength of the material; and to study the influence of corrosive agents on the endurance of the alloys under alternating stress. Under alternating stresses varying between equal intensities of pull and push, with a frequency of 2000 per min., the behaviour of the alloys was very similar to that of mild steel under the same conditions; but the limiting fatigue stresses were rather lower, the results more consistent with different specimens of the same

sample, and the fractures somewhat more regular in profile. Under the higher ranges of stress, the metal became warm and soon failed by cracking on a plane perpendicular to the axis of stress; under the lower ranges, the heating effect was imperceptible to the touch, and the endurance increased to millions of cycles before fracture occurred in the same manner. The most regular and useful ratio of comparison appeared to be that between the limiting fatigue stress and the ultimate strength of the metal, this ratio being highest in those metals showing a considerable reduction of area at fracture in the tensile test. The elongations produced by pulsating and steady stresses were found to be of the same nature, the yield point and form of stress-strain diagram of specimens extended first under pulsating and then under steady stresses being the same as for those extended under steady stress alone, and conversely. As regards the influence of corrosive agents, the endurance of annealed Muntz metal and of unannealed naval brass was not affected by superficial etching of the specimens with ammonia before testing, but much reduced when the specimens were tested in the presence of this reagent. On the other hand, the endurance of these alloys when moistened with dilute hydrochloric acid was generally greater than that of the dry specimens under the same ranges of stress, and the fatigue of phosphor bronze was not appreciably accelerated by the presence of either of these reagents or sea water.—W. E. P. P.

Etching agent [for brass and bronze]: Chromic acid and hydrogen peroxide as an —. S. W. Miller. *Inst. of Metals*, Sept., 1917. [Advance copy.] 3 pages.

A FEW drops of a strong solution of hydrogen peroxide are added to a very dilute solution of chromic acid. The specimen is immersed and kept moving in the solution for a few seconds; it is then removed and washed immediately in running water. The reagent is equally satisfactory for all brasses and bronzes, giving much better results than chromic acid alone.—W. R. S.

Aluminium sheet: Effects of heat at various temperatures on the rate of softening of cold-rolled —. H. C. H. Carpenter and L. Taverner. *Inst. of Metals*, Sept., 1917. [Advance copy.] 41 pages.

SEVERELY cold-worked aluminium sheet was subjected to temperatures from 550° to 100° C. over periods of from 1 to 2618 hours, and the loss of work hardness determined at stated intervals by measuring the tenacity and percentage elongation. Heating at 550 to 300° C. caused a very rapid softening of the metal. Over this range, softening was complete in 96 hours, and occurred almost entirely during the first hour at temperatures from 550° to 350° C. At 250° C. the rate of softening was much less rapid, 600–800 hrs. being required for completion, and the same ultimate value for tenacity was obtained as at higher temperatures. From 200° to 100° C. the rate of softening was slow, especially as the latter temperature was approached. A comparatively rapid fall in tenacity occurred during the first hour, after which there was a tendency for the tenacity to cease falling or actually to rise, this period being completed in 100 hrs. in most cases. A relatively very slow fall of tenacity then commenced and was steadily maintained at a rate indicating that from 1 to 3 years would be required for complete softening to be effected. Throughout the series of experiments, no increase of tenacity was observed to result from heating the metal, which thus differs from cold-worked brass and copper. While at

variance with A. Le Chatelier's fourth law of annealing (*Congr. Int. Méthodes d'Essai des Mat. de Construction*, 1901, 2, 1–25; compare this J., 1896, 455), this result is in agreement with Beilby's view—that between the hard and soft states a mechanically unstable condition exists in which the loss of stability is not compensated by the development of plasticity, which only occurs when the whole mass consists of properly developed crystals. The results obtained are regarded as indicating the practicability of employing cold-rolled aluminium for industrial purposes requiring temperatures up to 200° C., especially if such temperatures are only attained intermittently.

—W. E. P. P.

Silver: Addition agents in the electro-deposition of — from uncommon silver salts. F. C. Mathers and T. G. Blue. *Amer. Electrochem. Soc.*, May, 1917. [Advance copy.] 3 pages.

SILVER perchlorate, fluosilicate, fluoride, and ethylsulphate were electrolysed in baths containing glue, peptone, gum arabic, and other addition agents; the deposits were somewhat better than from nitrate baths containing the same addition agents. Phenolsulphonic acid, cresolsulphonic acid, and their sodium or ammonium salts, sodium naphthalenesulphonate, and sodium benzenesulphonate, when added, to the extent of 3% in each case, to the silver baths, including the nitrate, restrained the formation of crystals in the same manner as, but less effectively than, tartaric acid. The use of uncommon salts of silver does not seem to offer possibilities of obtaining much better deposits than those obtained from nitrate baths.

—B. N.

Hydrogen: Evolution of — from cyanide plating solutions. O. P. Watts and A. Brann. *Amer. Electrochem. Soc.*, May, 1917. [Advance copy.] 6 pages.

EXPERIMENTS were made with silver and copper cyanide solutions, with the addition of varying amounts of free potassium cyanide, in order to determine the effect of the latter on the liberation of hydrogen at the cathode. The effect was found to be much greater with copper than with silver solutions. The liberation of hydrogen is direct, and is not due to the solvent action of the free cyanide on the metal, but to the raising of the potential necessary to deposit the metal until it reaches or exceeds the discharge potential of hydrogen.—B. N.

Nickel: Influence of superimposed alternating current on electro-deposition of —. S. A. Tucker and H. G. Loesch. *J. Ind. Eng. Chem.*, 1917, 9, 841–845.

IN the electro-deposition of nickel from a nickel-ammonium sulphate electrolyte, it is necessary to use impure anodes; anodes of pure nickel do not corrode properly but become passive. The authors made comparative tests on the effect of superimposing alternating current on direct current during the electrolysis, using anodes of roughened cast nickel and smooth cast nickel (Ni 91.87, Fe 6.10, C 1.63%), rolled nickel (containing small quantities of carbon and iron), and electrolytic nickel (Ni 99.8%). The effect of superimposing alternating current on the direct current was greatly to increase the anode corrosion with all varieties of anode, and this effect increased with the alternating current density. The increased corrosion at the anode raised the current efficiency at the cathode, especially with the rolled nickel anodes. Alternating current alone caused only slight corrosion at the anode.

Antimony plating baths; Tests of ——. F. C. Mathers and K. S. Means. Amer. Electrochem. Soc., May, 1917. [Advance copy.] 3 pages.

DEPOSITION of antimony from numerous electrolytes was tried, such as the tartrate, chloride, oxalate, and fluoride, with the addition of glue, peptone, aloin, etc., as addition agents. Antimony fluoride is the most satisfactory electrolyte, when mixed with free hydrofluoric acid and a small amount of aloin, resorcinol, α -naphthol, β -naphthol, or salicylic acid.—B. N.

Antimony; Electro-deposition of ——— from fluoride baths containing addition agents. F. C. Mathers, K. S. Means, and B. F. Richard. Amer. Electrochem. Soc., May, 1917. [Advance copy.] 9 pages.

ANTIMONY fluoride (5%) and free hydrofluoric acid (3%) give the best bath for deposition of antimony, with a suitable organic addition agent to prevent a crystalline structure. Of the numerous addition agents tried, the best results were obtained with aloin, α - and β -naphthol, and resorcinol. The addition agent should be added in quantity equal to 0.025 grm. per 100 c.c. of electrolyte every 12 hours during the electrolysis. The deposits are grey and finely crystalline, but too much of the addition agent makes the deposits darker and more glossy; a similar result is produced by adding very small amounts of clove oil (0.0012 c.c. per 100 c.c. of electrolyte). A crystalline rough structure indicates the need of more addition agent, but if dark or shiny in colour, or if it tends to crack, less addition agent must be used.—B. N.

Plating baths; Essential oils as addition agents in ——. F. C. Mathers and A. B. Leible. Amer. Electrochem. Soc., May, 1917. [Advance copy.] 12 pages.

SQUARES of sheet metal, of uniform size, were shaken with aqueous solutions of the oils, and the amount adsorbed determined by difference by titrating the residual solutions. Oil was adsorbed by the metal, and the more readily the oil was adsorbed the greater was its effect as an addition agent in electro-deposition of the metal. The metals adsorb oil in decreasing order as follows: lead, antimony, copper, cadmium, zinc, iron, tin, silver. This is the order approximately of increasing difficulty in preventing rough crystalline deposits by the use of addition agents, and therefore indicates in a general way a relation between the effect of the oils as addition agents and their adsorption by the metals.—B. N.

Cerium chloride; Electrolysis of fused ——. M. de K. Thompson. Met. and Chem. Eng., 1917. 17, 213—215.

METALLIC cerium was obtained in a compact form by electrolysis, in a cast-iron crucible 6.8 cm. inside diameter and 7.5 cm. deep, the fused chloride prepared by dissolving the oxide in hydrochloric acid and dehydrating. The crucible formed the cathode, and the anode consisted of a graphite rod 2 cm. in diameter. A current of 90 amps. at 14 volts was passed, and with 882 amp.-hours, a nugget weighing 310 grms. was obtained with a current efficiency of 21%. By adjusting the current, voltage, and distance between the electrodes so as to give a temperature high enough to melt the cerium but not so high as to cause the formation of cerium carbide, a large amount of the deposited metal was caused to fuse together. The operation was conducted on a larger scale,

with current efficiencies of 20—30%, by melting the chloride in an iron electrolysis vessel of 22 cm. diameter so as to fill it to an initial depth of 2.5 cm. The anode, consisting of a graphite rod 5 cm. in diam., or a group of four of these rods, was preheated so as to prevent the salt from solidifying around it and acting as an insulator, and then inserted in the bath to a depth of 1.7 cm. The voltage between anode and cathode was adjusted to 10, giving a current of 250 to 300 amps. As the metal was deposited, the anode was raised, and chloride, preferably fused, was added. The vessel, after cooling, was broken open and the cerium remelted under sodium chloride and cast into bars in graphite moulds. A black substance, probably an intimate mixture of metallic cerium and cerium chloride, with which the metal is always surrounded, was recovered for another electrolysis by dissolving it in hydrochloric acid and evaporating to dryness.—J. N. P.

Metals; Effect of great hydrostatic pressure on the physical properties of ——. Z. Jeffries. Inst. of Metals, Sept., 1917. [Advance copy.] 5 pages.

CONTRARY to the results of Hanriot (Comptes rend., 1912, 155, 1502; this J., 1913, 606), the author finds that hydrostatic pressure up to 12,400 kilos. per sq. cm., applied at 25—40°C., has no effect on the hardness and tensile strength of aluminium or an alloy of the latter with 12% Cu. This discrepancy is possibly explicable on the ground that kerosene was used as the pressure-transmitting medium in the present work, whereas Hanriot employed vaseline, which freezes hard under pressure and thus renders hydrostatic conditions impossible. From the results obtained it is considered highly improbable that the hardness of metals can be increased without actual, permanent deformation, unless such increase in hardness is due to an allotropic change; even in the latter case, an apparent, permanent deformation would probably occur (owing to a change in volume), and the hardness of the metal would then be as likely to decrease as to increase.—W. E. F. P.

Hardness and hardening [of metals]. T. Turner. Inst. of Metals, Sept., 1917. [Advance copy.] 13 pages.

IN a general discussion of the subject, it is suggested that the hardness conferred on metals by cold-working is of a different kind from that produced by alloying; with a solid solution various methods of testing hardness should give uniform results, whereas the value obtained for the hardness of a cold-worked metal may vary with the method of testing. Cold-working also results, ultimately, in a decrease of density, and in view of these facts it is suggested that work-hardness may be due to the existence of amorphous films, or slip bands, held in tension within the metal, such bands or planes being akin to the surface films of liquids, but only limited in direction by the necessities of crystal symmetry.—W. E. F. P.

Low-temperature electro-thermal processes. Hirschfeld. See XI.

PATENTS.

Iron ore [containing aluminium, etc.]; Method of treating ——. F. A. Eustis, Milton, Mass. U.S. Pat. 1,237,765, Aug. 21, 1917. Date of appl., Jan. 12, 1917.

IRON ore containing aluminium and one or more of the metals nickel, cobalt, manganese, and

chromium is first treated to remove the whole or part of the aluminium. The residue is then subjected to a sulphating roast and, after being leached with water for the recovery of the remaining aluminium and other non-ferrous metals, is smelted for iron as usual.—W. E. F. P.

Copper: Electrolytic deposition of— from acid solutions. F. E. Studd, London. Eng. Pat. 108,688. (Appl. Nos. 6702, May 10, and 14,467, Oct. 11, 1916.)

Ores containing copper and iron are leached with the spent electrolyte recovered from a later stage of the process and containing sulphuric acid. During subsequent electrolysis, the electrolyte is kept saturated with sulphur dioxide which combines with the oxygen formed at the anode, and thus avoids the polarisation due to the accumulation of this gas on the electrode. The sulphur dioxide is introduced during the electrolysis, together with steam, through pipes disposed in the electrolysing vessel and provided with perforations at such angles that the gas and steam impinge on the surface of the anode and continuously circulate and agitate the electrolyte. The steam is regulated to maintain a temperature of 120—130° F. (49—53° C.). The most favourable current density is 13 amps. per sq. foot of anode surface. Ferric sulphate present in the solution is largely reduced by the sulphur dioxide to the ferrous salt, and its deleterious action in dissolving the cathodic copper is thus diminished. After the separation of the copper, use is made of the sulphuric acid which accumulates by dividing the electrolyte into two parts, one of which is applied for the leaching of a further quantity of ore, and the other is used for the preparation of sulphur dioxide by concentrating, and then heating with sulphur or carbon in a closed vessel. The sulphur dioxide evolved is led by pipes to a condenser for the separation of water vapour, then through sulphuric acid drying towers, and liquefied by compression.—J. N. P.

Electrodes for welding purposes. M. M. Irvine, Glasgow. Eng. Pat. 108,789, Nov. 21, 1916. (Appl. No. 16,661 of 1916.)

A WIRE or rod to be used as an electrode in electric welding processes is wound round to a thickness of 1—2 mm. with asbestos paper or pulp which is impregnated with a mixture of 5 parts of iron oxide and an aqueous solution of 5 parts of sodium carbonate and 90 parts of sodium silicate for every 100 parts of asbestos. On applying the mixture, the liquid is absorbed by the asbestos, while the iron oxide remains on the surface. The coated metal is then heated strongly to expel the water. During the process of welding, an arc is formed primarily by the electrode itself, and the external layer of iron oxide on the asbestos is reduced to metal. A conducting ring is thus formed round the crater of the arc, and the continuity of the arc is maintained after the interruption of the primary arc by the dropping of metal from the core.—J. N. P.

Solder or the like and the process of preparing the same. A. P. Bevan, Tavistock, Devon. Eng. Pat. 108,916, Sept. 11, 1916. (Appl. No. 12,806 of 1916.)

THE solder is produced by the incorporation of two metallic components, only one of which is fusible at the working temperature. Either or both components may consist of a metal, metal mixture, or alloy; as, for example, in the product obtained by incorporating finely divided and tinned particles of copper or copper alloy with ordinary soft solder.—W. E. F. P.

Annealing and like furnaces; Gas heated—. Dowson and Mason Gas Plant Co., Ltd., T. Wright, and E. W. Mawby, Manchester. Eng. Pat. 109,230, May 4, 1917. (Appl. No. 6351 of 1917.)

IN a gas-heated annealing or like furnace, gas from a horizontal supply chamber at the top passes downwards through orifices into a horizontal passage into which air for combustion is fed at one end. The mixed gases pass downwards through another series of orifices in the roof of the furnace. To produce a uniform distribution of gas and air among the orifices, these are made progressively smaller towards the inlet for the air supply by the insertion of suitable liners or otherwise, and each burner orifice is provided with a flange projecting upwards about half the height of the air passage. An upright baffle-plate, V-shaped in cross-section, equal in height to the air passage, may be provided in front of the orifice nearest the air inlet to ensure uniform distribution of the air.—W. E. F.

Smelting furnaces. H. A. Gill, London. From Vereinigte Hüttenwerke Burbach-Eich-Düdelingen Akt.-Ges. (Acidéries Réunies de Burbach-Eich-Düdelange, Soc. Anon.), Düdelingen, Luxemburg. Eng. Pat. 109,419, May 7, 1917. (Appl. No. 6498 of 1917.)

A TILTING furnace supported on rollers, for smelting ferro-manganese, spiegeliron, ferro-silicon, and like alloys, comprises two connected chambers, one at the front of the furnace for preliminary heating, and the other at the back for final melting. The charge is introduced at the front end, on to the floor of the preliminary chamber, and is heated nearly to melting point by means of liquid fuel supplied through a burner nozzle fixed horizontally at the rear end of the melting chamber. The charge is then pushed forward into the melting chamber, in the side of which a pouring spout is provided. In a modification, the floor of the preliminary heating chamber may be slightly hollowed.—W. E. F.

Hot-blast stove. H. A. Brassert and H. H. Jones, Chicago, Ill. U.S. Pat. 1,238,097, Aug. 28, 1917. Date of appl., Nov. 13, 1915.

THE air supply is admitted to the lower end of a vertical heating chamber, and passes upwards through vertical heating flues formed by courses of bricks of narrow section and small size, supported on arches. At the entrance to the flues, larger bricks are used to restrict the passages and distribute the blast uniformly among the flues.—W. E. F.

Tinplates and sheets and other like metal coated plates or sheets; Apparatus employed in the manufacture of—. H. B. Thomas, Englefield Green, Surrey, H. S. Thomas, Llandaff, and W. R. Davies, Whitchurch, Glamorgan. Eng. Pat. 109,302, Sept. 7, 1916, and Feb. 14, 1917. (Appl. Nos. 12,666 of 1916 and 2188 of 1917.)

A CONTINUOUS tinning machine of the kind described in Eng. Pat. 28,450 of 1913 (this J., 1915, 89) comprises a series of tables mounted on spring supports, side by side, at one end of the machine for the piles of sheets to be tinned. The sheets are fed forward singly by oscillating sucker devices on to rocking tables, which transfer them into a pickling bath through which they are moved by rotating wheels carrying projecting hooks. The plates are then carried by rollers under jets of water to the tinning bath, through which they pass at an

increased velocity, and thence through a "soaking pot" and "grease pot" to a branning machine. The plates then pass through two or more sets of cleaning or dusting rolls, each of which operates on the tinned surface at right angles to the preceding set. The plates are finally removed by an endless travelling conveyor moving at such a velocity that each series of plates is removed out of the path of the next following plates which are deposited on the conveyor. Two heating furnaces are used under the tin pot and soaking pot respectively. Additional flues are provided adjacent to the inlet side of the tin pot to counteract the cooling effect of the incoming cold plates on the flue, and at the side of the grease pot to heat the latter.—W. F. F.

Waste tins: Treatment of—[for recovering solder]. E. J. Lovegrove, London. Eng. Pat. 109,406, Mar. 28, 1917. (Appl. No. 4518 of 1917.) (See also Eng. Pat. 102,693; this J., 1917, 161.)

A HEATING chamber is arranged in a by-pass from the waste gas conduit or flue of any furnace other than a dust destructor. The inlet and exit for the hot gases are controlled by dampers. The tins are fed into the chamber without sorting, any adherent matter being burnt off and the solder melted in one operation. The fused solder is collected in a trough at the bottom of the chamber, the dampers are closed, and the tins then removed for pressing or baling.—W. F. F.

Metals; Process of extracting—from their ores. W. A. Schmidt, Assignor to Western Precipitation Co., Los Angeles, Cal. U.S. Pats. (A) 1,237,220 and (B) 1,237,221, Aug. 14, 1917. Date of appl., Feb. 18, 1916.

(A) THE ore is leached with a relatively weak solution of sodium chloride and ferric chloride, the resulting solution treated with metallic iron to precipitate the metal to be recovered, e.g., copper, regenerated by passing in an excess of chlorine produced by electrolysis of sodium chloride solution, and then used for the treatment of a further quantity of ore. (B) Ore containing a base metal compound in addition to the metal to be extracted is leached with a chlorine solution prepared by the action of chlorine on a solution of a chloride capable of oxidation to a higher chloride. The chloride in the leaching solution reacts with the base metal compound in the ore to form a chloride of the base metal, and the latter serves to retain in solution the metal extracted from the ore. From the resulting solution the metal is precipitated, and the solution then regenerated by the action of free chlorine, and used again. In applying the process to ore pulp, the water is first displaced by a solution of an alkaline-earth chloride, a chloride capable of forming a lower chloride is then dissolved in the solution to extract the metal from the ore, the metal is precipitated from the solution, and of the spent solution one portion is regenerated for use again and another portion used to displace water from a fresh supply of ore pulp.—J. N. P.

Ores; Process of concentrating—A. L. Pellegrin, Tucson, Assignor to H. Greenwell, Nogales, Ariz. U.S. Pat. 1,237,691, Aug. 21, 1917. Date of appl., Oct. 10, 1913. Renewed Feb. 2, 1917.

THE ore is dry crushed and separated into various predetermined sizes which, with the exception of the finest, are combined to form two or more mixtures. Each of the latter is then subjected to dry and wet concentration in succession, whilst the finest material is treated separately.—W. F. F. P.

Ore-concentrating method. A. Schwarz, Joplin, Mo., Assignor to Metals Recovery Co., New York. U.S. Pat. 1,237,961, Aug. 21, 1917. Date of appl., Jan. 17, 1917.

A GAS other than air is delivered through the perforated false bottom of one compartment of a closed vessel containing ore pulp and "modifying agents." The rising bubbles containing metal-liferous particles flow over a partition into the adjacent compartment, which is provided with a liquid seal, where the solid material is precipitated by a liquid spray. The liberated gas above the pulp mass is withdrawn and re-delivered to the bottom of the pulp compartment. Air is excluded from the system.—W. F. F.

Fine ores and like substances; Art of compressing—into blocks or briquettes. O. Kippe, Osnabrück, Germany. U.S. Pat. 1,238,022, Aug. 21, 1917. Date of appl., Jan. 12, 1917.

FINE ore is mixed with slaked lime and blast-furnace dust and subjected to the action of steam and pressure. A suitable briquette composition is fine ore concentrate 81%, blast-furnace dust (from hematite pig iron manufacture) 12%, calcium hydroxide 4%.—H. J. H.

[Zinc and barium] ores and metals; Process for the separation of—G. T. Wright and L. C. Hodson, Ames, Iowa, Assignors to Consolidated Chemical Products Co., Des Moines, Iowa. U.S. Pat. 1,238,242, Aug. 28, 1917. Date of appl., July 27, 1916.

ZINC ore containing a substantial quantity of barium sulphate is freed from gangue and oxidised till it contains zinc oxide and barium sulphate in equivalent proportions. The barium sulphate is then reduced to sulphide without reduction of the zinc oxide, and the two are caused to react, producing zinc sulphide and barium hydroxide. The latter is removed by leaching.—W. F. F.

[Ores and metallurgical products] carrying sulphur and metals; Process of treating substances—A. S. Dwight, New York. U.S. Pat. 1,238,279, Aug. 28, 1917. Date of appl., Mar. 5, 1914.

AN oxide of a metal having a strong affinity for sulphur is pulverised, mixed with carbonaceous material, and heated to reduce the oxide, and the sulphide ore or product to be treated is then added in the absence of air, so that sulphur is liberated and combines with the reduced metal forming a matte, which is subsequently used in ore smelting operations. Alternatively, the metallic oxide and the sulphide ore may be mixed and heated to redness, so that double decomposition takes place and a matte is produced.—W. F. F.

Blast-furnaces and the like; Hoists for charging—T. G. Wrightson, J. M. Ringquist, and Head, Wrightson, and Co., Ltd., Thornaby-on-Tees. Eng. Pat. 109,088, Aug. 29, 1916. (Appl. No. 12,232 of 1916.)

Blast-furnace charging plant. H. S. Bleckley, T. Atherton, and E. Massey, Warrington. Eng. Pat. 109,093, Aug. 30, 1916. (Appl. No. 12,275 of 1916.)

Cast articles [alloys] subjected to high external temperatures. Driver-Harris Wire Co., Harrison, N.J., Assignees of J. C. Henderson, Washington, D.C., U.S.A. Eng. Pat. 103,112, Nov. 17, 1916. (Appl. No. 16,501 of 1916.) Under Int. Conv., Jan. 4, 1916.

SEE U.S. Pat. 1,190,652 of 1916; this J., 1916, 930.

Metals [aluminium]; Process of winning —. V. M. Weaver, Harrisburg, Pa., Assignor to Weaver Co. U.S. Pat. 1,238,604, Aug. 28, 1917. Date of appl., Aug. 22, 1914.

SEE Fr. Pat. 481,056 of 1916; this J., 1917, 114.

Drying apparatus for use in drying fruit, vegetables, herbs, chemicals, powders, seeds, minerals, fibre, and the like. Eng. Pat. 198,915. See 1.

Conveying materials [to metallurgical furnaces] by means of a current of air or other gas. Eng. Pat. 101,512. See 1.

XI.—ELECTRO-CHEMISTRY.

Magnetite electrodes; Production and properties of —. M. de K. Thompson and T. C. Atchison. Amer. Electrochem. Soc., May, 1917. [Advance copy.] 5 pages.

ANODES formed of magnetite may be rendered less brittle by incorporation of a small amount of copper oxide. Magnetite or a mixture of magnetite and copper oxide was fused in the interior of a graphite tube, 3.8 cm. inside, and 5.1 cm. outside diameter, the lower end of which was closed by a copper plate connected with one terminal of a 60-volt current supply, while the second terminal was connected to a carbon rod, 1.3 cm. diam. and 30 cm. long, held centrally in the tube. By raising the rod an arc of about 200 amps. was maintained in the tube. After the formation of the arc, magnetite or a mixture of magnetite and copper oxide was fed into the space between the rod and tube, and as the fusion proceeded, the rod was gradually raised and magnetite added until the fused product filled the graphite tube. Measurements of brittleness were made by supporting the two ends of an electrode, and finding the load necessary to cause fracture when applied at the centre. The breaking loads with electrodes of 3.8 cm. diam. and 25.4 cm. in length were found to range from 13 kilos. with pure magnetite to 117 kilos. with anodes containing 29% copper oxide. With anodes annealed by surrounding the graphite mould with asbestos so as to extend the interval of cooling after fusion over 8 hours, the toughness was more than doubled. The loss in weight through disintegration during use as anodes in the electrolysis of sulphuric acid solution was found to amount in the case of electrodes containing 5% copper oxide to 61.5 grms., and with anodes of pure magnetite to 103 grms. per sq. dm. per 1000 amp.-hrs. The difference in durability may be explained by the lower conductivity and consequent greater heating of the pure magnetite anodes.—J. N. P.

Low temperature electro-thermal processes [japaning, etc.] C. F. Hirschfeld. Amer. Electrochem. Soc., May, 1917. [Advance copy.] 14 pp.

THE author uses the term "low temperature" as referring to temperatures below about 200°C.; and, as being fairly typical of many baking and drying processes in commercial use, the art of japaning is discussed at some length. By reason of the exact control of temperature conditions afforded, electrical heating has been found to give better results than other methods in japaning and in the baking of cores for foundry work. Suggestions are also made as to the employment of this method of heating in other industries, such as the baking of foods, etc.

—W. E. F. P.

Photo-chemical cell; A cuprous oxide —. T. W. Case. Amer. Electrochem. Soc., May, 1917. [Advance copy.] 4 pages.

A LARGE number of electrolytes have been found which deposit upon copper a photo-sensitive coating, probably due to the formation of a copper oxide or halide salt upon the electrode. A copper formate electrolyte, containing free formic acid, using highly polished copper electrodes, was studied closely. If one plate is illuminated and the other kept dark, a current is produced, the illuminated plate acting as the anode, and an E.M.F. of up to 0.11 volt is developed. The current finally drops to zero, but if the cell is rotated, illuminating the plate previously kept dark, the E.M.F. reappears. On continued rotation, the E.M.F. reaches a maximum value, but below a critical light intensity the cell gives very little response. The action of the cell is explained on the basis of the oxidation of cuprous to cupric oxide by the action of light.—B. N.

Electrical endosmosis and adsorption. [Theory of dyeing.] Briggs and others. See VI.

PATENTS.

Bi-polar electrode electrolyzers. G. G. Hepburn, Manchester. Eng. Pat. 108,707. (Appl. Nos. 11,429, Aug. 12, and 12,903, Sept. 12, 1916.) Addition to Eng. Pat. 12,730, Sept. 0, 1915 (this J., 1916, 1120).

THE liquid between adjacent electrodes is enclosed by employing opposite electrodes as two walls and inserting between the vertical edges lengths of indiarubber tubing or cord to form the side walls of the cell and serve for insulation. The bottom of each compartment is closed by means of a horizontal tube provided with an elongated slot or a series of slots or apertures. These tubes serve for the introduction of the electrolyte, which rises through the cells and overflows from the top into suitably placed troughs. The tubes forming the base of the cells are held in position by strings or insulated wires attached to weights so as to be readily removable.—J. N. P.

Electric cells; Primary —. J. W. Nicholson, London. From G. N. Antonoff, Petrograd. Eng. Pat. 108,892, Aug. 24, 1916. (Appl. No. 12,019 of 1916.)

THE electrolyte is kept acid by the addition of benzoic or salicylic acid, or their homologues or isomers, either together or separately, and the positive carbon pole is coated with platinum black or colloidal platinum.—B. N.

Depolarising agent. C. Ellis, Montclair, N.J., Assignor to National Carbon Co. U.S. Pat. 1,236,693, Aug. 14, 1917. Date of appl., Oct. 25, 1915.

A FUSED artificial higher oxide of manganese, substantially free from natural manganese dioxide, and containing manganic acid, with or without admixed carbon.—J. N. P.

Separating constituents of or materials suspended in gaseous bodies; [Electrical] method and apparatus for —. A. Mond, London. From W. A. Schmidt, Los Angeles, Cal., U.S.A. Eng. Pat. 109,106, Sept. 5, 1916. (Appl. No. 12,582 of 1916.)

SEE U.S. Pat. 1,204,906 of 1916; this J., 1917, 38.

Electrical precipitation of suspended particles from gases. A. Mond, London. From W. A. Schmidt, Los Angeles, Cal., U.S.A. Eng. Pat. 109,297, Sept. 5, 1916. (Appl. No. 12,580 of 1916.)

SEE U.S. Pat. 1,204,907 of 1916; this J., 1917, 38.

Electrodes for welding purposes. Eng. Pat. 108,789. See X.

XII.—FATS; OILS; WAXES.

[Coconut oil:] *Combined Reichert-Polenske and modified Shrewsbury-Knapp process [for determination of —].* G. D. Elsdon. Analyst, 1917, 42, 295—298.

THE flask containing the residual fatty acids after the distillation of 110 c.c. in the Reichert-Polenske process, is disconnected from the condenser and placed in cold water. The cake of fatty acids is broken and the liquid strained through a fine wire sieve, the flask and fatty acids being washed with 50 c.c. of cold water. The fatty acids are drained on the sieve until practically free from water, then returned to the flask, and the flask and its contents are dried in a water-oven, air being blown into the flask at intervals; 100 c.c. of alcohol of sp. gr. 0.9200 (prepared from industrial methylated spirit) is then added, and the process is continued exactly as described previously (this J., 1917, 400). Mixtures of coconut oil with butter and with margarine examined by the above method yielded the following figures for the content of alcohol-soluble acids:

Percentage of coconut oil	0	10	20	30	40	50	60	70	80	90	100
With butter	12.7	14.5	16.5	20.6	24.0	30.4	—	44.4	53.3	76.5	89.8
With oleomargarine	8.9	10.6	13.7	16.9	20.8	25.4	31.8	41.8	53.4	73.2	89.8

—W. P. S.

Coconut oil and palm-kernel oil in mixtures; Differentiation of —. G. D. Elsdon. Analyst, 1917, 42, 298—299.

SINCE the Polenske values for coconut and palm-kernel oils are very different (about 17.0 and 11.0 respectively), whilst the Shrewsbury-Knapp values for the two oils are practically identical, it appears possible to distinguish between coconut oil and palm-kernel oil in mixtures of fats such as margarine by obtaining both the Polenske and Shrewsbury-Knapp values and the percentage of coconut oil from these data. Palm-kernel oil is probably present in those cases where the percentage of coconut oil calculated from the Polenske value is distinctly less than that calculated from the Shrewsbury-Knapp value. Knowing the sum of the quantities of coconut and palm-kernel oils present, it should be possible to calculate the relative amounts from the Polenske value. The results obtained, are, however, untrustworthy when coconut stearin is used in the fatty mixture, as this fat and palm-kernel oil have practically identical compositions.—W. P. S.

PATENTS.

Oils and the like; Method and apparatus for extracting —. E. O. Barstow and T. Griswold, jun., Midland, Mich. U.S. Pat. 1,238,084, Aug. 28, 1917. Date of appl., Dec. 24, 1914.

A PORTION of the material to be extracted is treated

with a fluid solvent in an apparatus wherein the solvent used is removed, and the oil extracted material is then further treated with fresh solvent. A fresh portion of material is then treated with the solvent which contains the product of the previous extraction. Extraction is repeated a number of times, the solvent separated from the previous extraction being employed for treatment of material one step backward in the series or cycle of extractions, until it is finally used for the first treatment of the material, whilst the final extraction of the material is made with fresh solvent. The bulk of the mixture is maintained constant during treatment by automatically regulating the supply of fresh solvent according to the proportion of extract in the solvent separated.—A. DE W.

Catalytic reactions [hydrogenation of oils]; Process of effecting —. O. C. Hagemann, Yonkers, N.Y., and C. Baskerville, New York. U.S. Pat. 1,238,137, Aug. 28, 1917. Date of appl., Jan. 12, 1914.

AN unsaturated substance such as an oil is treated with hydrogen in the presence of a metal of the nickel group in a form other than that of thin leaves, at least a portion of the surface of the metal being coated with oxide.—A. DE W.

Deodorising and clarifying volatile organic bodies [e.g., fatty acids]. Eng. Pat. 109,077. See IIA.

Treatment of paraffin wax for the production of oxygenated and other compounds [fatty acids]. Eng. Pat. 109,386. See IIA.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Low-temperature electro-thermal processes. Hirshfeld. See XI.

PATENTS.

Colour leaves; Process of manufacturing —. G. Iwatsubo, Kyoto, Japan. Eng. Pat. 109,205, Feb. 2, 1917. (Appl. No. 1675 of 1917.)

A COARSE-GRAINED (e.g., sand-blasted) plate is coated with a layer of a volatile solid such as camphor by immersion in a solution of the same in a volatile solvent, e.g., naphtha. The dry prepared plate is then coated with a colour mixture composed of water, gelatin, glycerin, sugar syrup, and starch, together with the necessary colour, and allowed to dry. On applying heat to the plate, the colour leaf becomes detached by volatilisation of the intermediate layer of camphor.—A. DE W.

Ultramarine; Manufacture of —. L. Bock, Bad Homburg Kirdorf, Germany. U.S. Pat. 1,239,080, Sept. 4, 1917. Date of appl., Jan. 11, 1917.

SEE Ger. Pat. 293,310 of 1915; this J., 1916, 1161.

Resilient composition for printers' rollers. C. E. Soane, Assignor to Usher-Walker, Ltd., London. U.S. Pat. 1,239,630, Sept. 11, 1917. Date of appl., July 11, 1916.

SEE Eng. Pat. 2167 of 1915; this J., 1916, 368.

XIV.—INDIA-RUBBER ; GUTTA-PERCHA.

Rubber; Influence of the age of the trees on the quality of the —. O. de Vries. Communication from the Central Rubber Station at Buitenzorg, No. 3. Archief voor Rubbercultuur in Ned. Indie, 1917, 1, No. 3.

UNDER similar conditions as regards the rubber content of the latex and the method of coagulation and preparation, the tensile strength of rubber from older trees is not appreciably greater than for that from young trees, and the type of the stress-strain curve is approximately the same, but the rate of vulcanisation decreases with age whilst the viscosity increases. The common belief that rubber from young plantations is of inferior quality is probably due in part to the poorer equipment of such plantations and the lower rubber content of the latex. In the case of the wild Brazilian rubber, the lower rate of vulcanisation due to the age of the trees is masked by the method of preparation, and plantation rubber prepared by an imitation of the Brazilian method is found to vulcanise more rapidly than crêpe prepared from the latex in the ordinary manner.—D. F. T.

[*Rubber*] *latex; Partial coagulation of —.* O. de Vries. Communication from the Central Rubber Station at Buitenzorg, No. 3. Archief voor Rubbercultuur in Ned. Indie, 1917, 1, No. 3.

ON coagulating latex with one part of acetic acid to 450–600 parts of rubber, it is possible to separate a "first clot," amounting to 15–25% of the total rubber, which forms a crêpe of strong yellow to dark brown colour, high viscosity, high rate of vulcanisation, and low tensile strength, whilst the second clot obtainable by subsequent further coagulation produces a very pale but otherwise fairly normal crêpe. If a greater proportion of acetic acid is used, a larger percentage of the total rubber is found in the first clot and the difference between the quality of the two fractions tends to disappear (compare Campbell. Bull. Ceylon, No. 27).—D. F. T.

Rubber content of latex; Influence of — on the quality of the rubber. O. de Vries. Communication from the Central Rubber Station at Buitenzorg, No. 2. Archief voor Rubbercultuur in Ned. Indie, 1917, 1, No. 1.

THE tensile strength and "type" of rubber are not affected appreciably by the concentration of the latex from which it is coagulated, but the viscosity is very slightly diminished and the rate of vulcanisation appreciably reduced by dilution of the latex. In the preparation of smoked sheet, a standard concentration is in general use, 15% being the usual value in Java, and a standard degree of dilution is also desirable for the production of crêpe. Such standardisation not only ensures a more uniform product but also permits an accurate and economical adjustment of the amount of acetic acid to be used.—D. F. T.

Rubber solutions; Viscosity of —. A. van Rossem. Communications of the Netherland Government Institute for Advising the Rubber Trade and the Rubber Industry, 1917, Part III.

FOR the determination of the viscosity of rubber solutions the Ostwald viscometer as adapted by Fol (this J., 1913, 437) is recommended. Although Gorter's claim (1915. Dep. Landb., Nijverh.

Handel Ned.-Ind.) that calculation of the relative viscosity of rubber solutions in benzene from the ratio of the times of flow of the solution and of the solvent gives a result too low by 12%, is conceded, his alternative method of arriving at the value of a "viscosity index" representing the logarithm of the relative viscosity at a concentration of 1% is shown to be incorrect. By making use of numerous earlier results a set of standard relative viscosity curves has been constructed, based on rubbers of the following relative viscosities in 1% solution: 19.5, 29.5, 39.5, 49.5, 59.5, 69.5, and 79.5, the respective corresponding "viscosity numbers" (Fol, *loc. cit.*) approximating to 40, 50, 60, 70, 80, 90, 100; these curves do not intersect and, by making one measurement of relative viscosity with a solution of known concentration, the position of the curve for a new rubber can at once be determined and its viscosity number estimated directly from the curve. The viscosity of a 1% solution of rubber is unaffected by mere shaking or repeated passage through the viscometer, but on exposure to light it undergoes a noticeable reduction; the presence of moisture in the benzene causes a slight lowering in the viscosity, whilst acids induce a very marked diminution, so that solvents such as chloroform and trichloroethylene are not suitable for viscosity work. If rubber is at first incompletely dissolved in benzene, the residue gives a more viscous solution than the first extract, this result being possibly due to the influence of the resins in the first extract and to the higher viscosity of the nitrogen-enriched rubber in the second solution; the separation of the rubber into fractions of different degrees of polymerisation, by such processes of partial solution, is considered to be unlikely. Comparative experiments with benzene, toluene, and carbon tetrachloride as solvents demonstrated that at 1% concentration the toluene solution is slightly less fluid than the benzene solution, and the carbon tetrachloride solution decidedly less fluid than either, the ratio of the relative viscosities in any two of the solvents being higher, the greater the viscosity of the rubber. Removal of the natural resins from rubber by extraction with acetone decreases the viscosity on account of the effect of heat; addition of the resin to the extracted rubber reduces the viscosity still further. The introduction of compounding ingredients, such as sulphur, litharge, and magnesium oxide, causes no other change in the viscosity of the solution after it has been allowed to settle, than is to be expected from the mere additional presence of the dissolved sulphur. The real significance of viscosity tests is indicated by the fact that a uniform sheet of unsmoked Hevea rubber after heating at 100° or 130° C. in carbon dioxide exhibits a reduction in "viscosity number," in tensile strength, and in percentage elongation at break; mastication between rolls causes a still more marked decrease in all three characteristics. A high "viscosity number" in a raw rubber is generally a concomitant of rapidity of vulcanisation. After being swollen with benzene and then allowed to dry again, unvulcanised smoked Hevea sheet is found to possess increased tensile strength and especially increased elongation at break, but the resistance to stretch is diminished. It is believed that a parallelism exists between the "degree of swelling" of raw rubber and the "viscosity number."—D. F. T.

Rubber; Percentage of moisture in raw —. A. van Rossem. Communications of the Netherland Government Institute for Advising the Rubber Trade and the Rubber Industry. Int. Assoc. for Rubber Cultivation in the Netherland Indies; 1917, Part II., 40–40.

THE method of determination is to dry 3–5 grms.

of finely cut rubber in a hot-water oven until the weight is constant; the time required is at least 2 hours, and with very moist rubbers may reach 8 hours. Many analyses of first latex rubbers show that sheets have a somewhat higher moisture content than crêpes, whilst wild Para rubber generally contains a lower proportion of moisture than such rubbers as those obtained by the Kerbosch, Schadt, Byrne, or da Costa process. Apart from the probable effect of hygroscopic constituents in the rubber, originating from the latex, it is shown that the hygrometric state and temperature of the atmosphere also influence the absorption and retention of moisture. Rubber exposed to saturated air at 30° C. takes up a greater quantity of water than rubber in saturated air at 16° C.; but when the moisture in the air is below 85% of the maximum quantity, the rate of absorption of water is greatly reduced.—D. F. T.

Rubber; The so-called insoluble part of raw —. A. van Rossem and Dekker. Communications of the Netherland Government Institute for Advising the Rubber Trade and Rubber Industry. Int. Assoc. for Rubber Cultivation in the Netherland Indies. 1917, II., 56—68.

For the determination of the non-caoutchouc insoluble constituents of rubber, 2 grms. is heated with 40 c.c. of petroleum (b. pt. 230°—260° C.) for 2—3 hours, after which time a clear solution containing a little flocculent matter is obtained, the insoluble matter then being separated by centrifuging and washing. Only 55—65% of the nitrogen of the rubber is found in the residue; the total weight of the organic residue amounts to 2—3%, containing 8½—11% of protein if the latter is assumed to have a content of 16% of nitrogen. These figures were obtained for Hevea plantation rubber and hard fine Para, and indicate that the nitrogen of raw rubber is not wholly present in the form of protein matter. The earlier view of the Institute that the caoutchouc portion of raw rubber more difficultly soluble in the ordinary rubber solvents represented a more highly polymerised form of rubber is now withdrawn. When rubber, especially Hevea plantation rubber, is heated at 110°—130° C., in carbon dioxide for 0.5—3 hours, there is a marked increase in the proportion of insoluble matter present; this effect is not observed in rubber which has been masticated. The increase in the insoluble fraction is accompanied by a slight increase in the percentage of protein in the fraction, but must be attributed mainly to the decreased solubility of the caoutchouc. In 1888 (Trans. Chem. Soc., 1888, 769), Gladstone and Hibbert observed an increase in the insoluble substances of rubber when the latex was heated during coagulation. (See also Terry, this J., 1899, 173.)—D. F. T.

Rubber; Water extract of raw —. A. van Rossem. Communications of the Netherland Government Institute for Advising the Rubber Trade and Rubber Industry. Int. Assoc. for Rubber Cultivation in the Netherland Indies. 1917, II., 66—68.

The method of extraction is to treat 3 grms. of finely cut rubber for 6 hours with 100 c.c. of distilled water on the water-bath and then, after filtering, to extract the residual rubber for a second time with 50 c.c. of water; the combined filtrate is evaporated on a water-bath and dried for an hour at 100° C. The average extract for Hevea plantation rubber was about 0.5%, the maximum being near 1%, whilst the average for wild Para was 0.4 to 0.5%. Rubbers obtained by evaporation of latex naturally gave higher figures. The extract contains about two-thirds of the mineral

matter of the rubber and also a portion of the nitrogen, this result indicating the presence of other nitrogenous substances in addition to protein in rubber; other unidentified substances were also present, probably including inositol or derivatives of this substance.—D. F. T.

Rubber; Degree of acidity of raw —. A. van Rossem. Communications of the Netherland Government Institute for Advising the Rubber Trade and Rubber Industry. Int. Assoc. for Rubber Cultivation in the Netherland Indies. 1917, II., 68.

Five grams of the finely cut rubber is left standing for 24 hours with 100 c.c. of cold, recently boiled, distilled water; an aliquot portion is then titrated with N/100 sodium hydroxide solution and phenolphthalein and the "degree of acidity" represented by the number of c.c. of N/100 alkali per gram of rubber. For first latex Hevea sheets the average result was 0.5, the highest being 1.3 and the lowest 0.1; for crêpes the average was 0.1, the highest and lowest being 0.4 and 0.1 respectively. Hard Fine Para gave figures ranging from 0.4 to 0.5, whilst rubbers obtained by evaporation of latex gave higher results.—D. F. T.

Rubber; Indirect method to determine the percentage of —. A. van Rossem. Communications of the Netherland Government Institute for Advising the Rubber Trade and Rubber Industry. Int. Assoc. for Rubber Cultivation in the Netherland Indies. 1917, II., 69—70.

It is suggested that the combined total of the moisture, water-extract, and acetone extract of the original rubber and of the ash and protein (factor 6.25) on the extracted and dried sample be corrected for the part (generally 20%) of the acetone extract which is soluble in water, and then be subtracted from 100. If rubbers obtained by evaporation of latex are excluded, it is sufficient to subtract from 100 the total percentages of moisture, resin, ash, and protein (factor 6.25); the totalling of the moisture, resin content, and petroleum-insoluble fraction (see above) is a possible alternative, but gives slightly high results owing to the fact that the petroleum-insoluble matter includes only part of the protein.—D. F. T.

PATENTS.

Rubber articles; Method of vulcanising —. T. Whittelsey, Upper Montclair, N.J., Assignor to Rubber Regenerating Co. U.S. Pat. 1,238,236. Aug. 28, 1917. Date of appl., Apr. 12, 1916.

RUBBER articles are first subjected to the action of sulphur chloride and then any acids neutralised by applying an organic base capable of swelling the rubber, e.g., a solution of aniline in benzene.—D. F. T.

Caoutchouc; Synthetic products resembling —. E. Münch, Assignor to Badische Anilin und Soda Fabrik, Ludwigshafen, Germany. U.S. Pat. 1,238,930, Sept. 4, 1917. Date of appl., Sept. 26, 1913.

SEE Eng. Pat. 975 of 1913; this J., 1914, 93.

Vulcanisation of rubber and other similar substances. G. Bernstein, Royat, France. U.S. Pat. 1,240,116, Sept. 11, 1917. Date of appl., July 18, 1913.

SEE Ger. Pat. 262,708 of 1912; this J., 1913, 919.

XV.—LEATHER; BONE; HORN; GLUE.

Tanbarks; Philippine —. V. Q. Gana. *Philippine J. Sci.*, 1916, 11, A, 261—265.

ONLY mangrove and camanchili (*Pithecolobium dulce*, Benthams) barks are used at present in the Philippine Islands for tanning purposes, and as the use of either bark is attended with disadvantages, other barks have been investigated with a view to their utilisation. Of those tested only two, the Philippine pine (*Pinus insularis*) and palo maria (*Calophyllum inophyllum*) are both satisfactory in quality and sufficiently plentiful. Neither is rich in tannin, the former containing 3.8% and the latter 11.9% tannin, calculated on the dry material. Other barks are richer in tannin and yield leather of good quality, but cannot be collected economically.—F. C. T.

PATENT.

Glue and allied substances; Machine for cooling —. K. Upton, Marblehead, Mass. U.S. Pat. 1,237,587, Aug. 21, 1917. Date of appl. Dec. 20, 1916.

THE glue is pumped from a primary container into a secondary container at a higher level in which it is maintained at any desired constant level, and is fed from this secondary container on to a rotary cooling wheel.—F. C. T.

XVI.—SOILS; FERTILISERS.

Coal gas; Action of — on plants. II. Action on green plants. C. Wehmer. *Ber. Deut. bot. Ges.*, 1917, 35, 318—332. *J. Chem. Soc.*, 1917, 112, i., 531—532. (See also this J., 1917, 1021.)

It is usually affirmed that coal gas is poisonous to green plants even when the atmosphere contains only minute quantities, but cress is remarkably resistant to its influence. The seedlings will grow unchecked in an atmosphere containing as much as 30% of gas, but they die in a short time if exposed to undiluted gas. The seeds themselves are not killed by coal gas, but only prevented from germination. The ill-effects of undiluted coal gas are not entirely due to the lack of oxygen, for cress will keep fresh and green in pure hydrogen for a much longer time than in coal gas. Experiments designed to elucidate the nature of the particularly poisonous constituent of coal gas gave only negative results. Carbon monoxide, ethylene, and acetylene are not dangerous, even in concentrations much higher than those in which they commonly occur in coal gas. Benzene vapour, carbon bisulphide, and hydrogen sulphide are very toxic, but not in the concentration met with in coal gas. The really toxic constituent is probably among the minor impurities.

PATENT.

Fertilisers; Manufacture of compound —. C. Deguide, Le Portel, France. Eng. Pat. 109,079, Aug. 28, 1916. (Appl. No. 12,135 of 1916.) SEE Fr. Pat. 480,569 of 1915; this J., 1917, 152.

XVII.—SUGARS; STARCHES; GUMS.

Sugar refining; Use of vegetable decolorising carbon as compared with animal charcoal (bone-black) in —. M. Weinrich. *Int. Sugar J.*, 1917, 19, 406—407.

As a result of experiments with various kinds of

vegetable decolorising carbons in comparison with animal charcoal, made partly in collaboration with the late B. E. R. Newlands, it is stated that vegetable carbons are inferior to bone-black for use on the large scale. Animal charcoal removes as much colour as an equal volume of vegetable carbon, and in addition removes organic and mineral impurities not affected by the vegetable carbon. The specific gravity of the best kind of vegetable carbon is only about 10% of that of animal charcoal, and after each revivification, which is troublesome and expensive, the vegetable carbon is found to have shrunk more or less and to have a diminished absorptive power. The claims put forward in favour of the vegetable carbon, "Norit," are strongly criticised, and it is asserted that the process for the manufacture of another vegetable carbon, "Carbrox," was anticipated by the author's U.S. Pat. 155,875 of July 7, 1891. As a cheap filtering agent, comminuted crude bagasse, obtained by passing the bulk of the bagasse, before it goes to the furnaces, over a sieve agitated by a crank shaft, is recommended. This is added to the defecated juice which is then passed through filter-presses. Full cakes can be obtained, which are easily washed, and the filtered juice is perfectly clear.

Utilisation of horse-chestnuts. Goris. See XIXA.

XVIII.—FERMENTATION INDUSTRIES.

Beer; Oil in adjuncts and its effect on quality of —. P. Dreesbach. *Amer. Brewers' Review*, 1917, 233—235.

THE raw cereal adjuncts commonly used in brewing contain considerable amounts of oil, e.g., maize meal 1—1.5%, grits 0.8—1%, flakes 0.6—0.7%, and rice 0.7—0.8%. This oil, even in the fresh state, has a harsh flavour and cannot improve the flavour of beers. Its slow decomposition causes the adjuncts to become musty on storage. There is evidence that during the "cooking" of the adjuncts to gelatinise the starch, some of the oil is saponified, with the result that small quantities of the higher fatty acids pass into the wort; a certain quantity of the oil also appears to become emulsified by extractive matters present and thus passes into the wort, but is again liberated when the extractive matters undergo fermentation, and then affects unfavourably the flavour and head-retaining power of the beer. The author recommends the use of oil-free adjuncts, including besides brewing sugars, certain "refined" products obtained from maize by the wet milling process. These products contain only about 0.05% of oil and are practically free from protein. They do not become musty on storage and require only a very short "cooking" (refined grits) or none at all (refined flakes). They affect the flavour of beer much less than adjuncts containing oil, and they can therefore be used in larger amounts than the latter.—J. H. L.

Enzymes [urcase]; Formation of —. III. M. Jacoby. *Biochem. Zeits.*, 1917, 81, 332—341. *J. Chem. Soc.*, 1917, 112, i., 528—529. (See also this J., 1917, 663, 901.)

IN continuation of previous work, it is shown that the addition of edestin, but not of caseinogen, to Uschinski's medium promotes the formation of the urase. The addition of glycine, alanine, tyrosine, or valine was without effect. It was also found that culture on medium from certain bouillon tablets promotes enzyme formation, and that the further addition of amino-acids accelerates

this formation still more. The bouillon tablets also promote urease formation when added to Uchinski's medium. From the above-mentioned results, the conclusion is drawn that Uchinski's medium is wanting in amino-acids and some other substance which is contained in the bouillons and in the hydrolysis products of edestin. Further experiments showed that synthetic leucine had no effect on urease formation when added to Uchinski's medium, whereas pure *l*-leucine, and *d*- and *l*-isoleucine (obtained from F. Ehrlich), promoted the formation of the enzyme. It has therefore been found possible to obtain the enzyme when bacteria are grown on media containing only simple chemical substances.

Aldehydes in wines. J. Laborde. Ann. Inst. Pasteur, 1917, 31, 215—252. J. Chem. Soc., 1917, 112, i., 532.

A COMPREHENSIVE study of the catalytic and physiological agents causing aldehyde formation in wines. These agents exercise their influence principally on the young wines during their storage in barrels, which helps more or less the contact of the wine with atmospheric oxygen. The three principal catalytic agents promoting aldehyde formation are: (1) the tannin substances, more or less combined with potassium hydroxide; (2) *oxo*xydase; (3) the oxydase of *Botrytis cinerea*. Pasteurisation of normal wines, as well as the addition of sulphurous acid, checks aldehyde formation without completely preventing it. Pasteurisation has a similar effect on "cassable" wines, but in this case sulphurous acid favours aldehyde formation, whilst preventing the "casse." There are equally important opposing influences which may lead to the complete disappearance of aldehyde from the wine if it is stored in the absence of air, and on this account but small amounts of aldehydes are to be found in red wines stored normally. In the case of "cassable" wines, the aldehyde plays no part, since it is only formed after marked oxidation of the tannin substances. Aldehyde formation opposed by aldehyde destruction has only a passing influence, although always unfavourable, on the bouquet of red wines in casks.

Of the micro-organisms which live in wine, only the facultative aerobic organisms (different yeasts) and the strictly aerobic organisms (mycoderma) produce aldehyde, although certain anaerobic ferments apparently yield acetaldehyde by attacking the glycerol of the wine. The yeasts and anaerobic microbes secrete reductases in the wine, which can contribute to the complete removal of aldehydes in wine kept out of contact with air, unless the aldehydes are combined with sulphurous acid.

XIXA.—FOODS.

Milk; Analysis of —. C. Porcher and R. Dage. Ann. Chim. Analyt., 1917, 22, 170—179.

THE author criticises the method proposed by Ackermann (this J., 1917, 1025), pointing out that the refraction of milk serum is not always a measure of the amount of lactose present, soluble proteins interfering. As a result of numerous experiments with various milks, it is concluded that the value proposed by Ackermann (non-fatty solids less lactose) is of little use in judging the quality of the milk.—W. P. S.

Horse-chestnuts; Utilisation of —. A. Goris. Comptes rend., 1917, 165, 345—348. (See also this J., Auld, 1913, 173; Rousset, 1913, 243.)

THE present economic conditions render the

possibility of the industrial utilisation of horse-chestnuts a matter of importance. The brown integument contains aesculin and a tannin and is of no industrial value; it is fairly easily detached from the kernel in the fresh state, but adheres firmly after drying. The kernel (cotyledons) contains 2—3% of fat, 6—7% of nitrogenous matter, and 20—30% of starch, besides bitter substances of the saponin group and colouring matters, but contrary to the statements of some authors it contains neither aesculin nor tannin. The oil is of no interest industrially, and as it forms an obstinate emulsion with the saponins, extraction is only practicable after these have been largely destroyed or transformed by desiccation or fermentation. Owing to the medicinal properties of the saponins, and their bitter flavour, pulp or flour obtained from the kernel cannot be used as foodstuff without a treatment to remove them. For this purpose the author recommends washing with dilute acid, e.g., a 0.1% solution of hydrochloric acid, by which treatment yields of 20—25% of white, odourless and tasteless flour have been obtained in the laboratory. The starch grains are irregular, some being small, rounded or ovoid, others bulky, pear-shaped or ellipsoidal, with a well-marked linear or stellate hilum in the largest part. The striæ are not very distinct. The starch might serve for the production of alcohol or even as food. Factories for the production of starch from horse-chestnuts were formerly installed in the neighbourhood of Paris, but they were not remunerative, owing to the cost of labour and transport.—J. H. L.

Low-temperature electro-thermal processes. Hirshfeld. See XI.

Combined Reichert-Polenske and modified Shrevebury-Knapp process [for determination of coconut oil]. Edsdon. See XII.

Differentiation of coconut oil and palm-kernel oil in mixtures. Edsdon. See XII.

PATENTS.

Beverage extracts; Manufacture of —. J. L. Kellogg, Battle Creek, Mich., U.S.A. Eng. Pat. 109,084, Aug. 28, 1916. (Appl. No. 12,166 of 1916.)

SEE U.S. Pat. 1,198,393 of 1916; this J., 1916, 1129.

Cocoanuts; Preparation or treatment of — and improved products obtained thereby. F. Baker, jun., Philadelphia, U.S.A. Eng. Pat. 109,422, June 1, 1917. (Appl. No. 7901 of 1917.)

SEE U.S. Pats. 1,203,364—1,203,366 of 1917; this J., 1917, 938.

Food product and the like; Concentrated —. T. Boberg, O. Söderlund, and F. Aslund, Assignors to Techno-Chemical Laboratories, Ltd., London. U.S. Pat. 1,240,020, Sept. 11, 1917. Date of appl. June 10, 1915.

SEE Eng. Pat. 11,671 of 1914; this J., 1915, 848.

Drying apparatus for use in drying fruit, vegetables, herbs, chemicals, powders, seeds, minerals, fibre, and the like. Eng. Pat. 108,915. See I.

XIXB.—WATER PURIFICATION; SANITATION.

Silver nucleinate, a substitute for copper sulphate in combating vine mildew. A. von Degen. Allg. Wein-Zeit., Vienna, 1917, 34, 25—28. Bull. Agric. Intell., 1917, 8, 941—942.

OWING to the scarcity of copper sulphate in Austria

tests were made with a preparation of silver nucleinate, consisting of greenish black plates with a metallic lustre, completely soluble in water forming a brownish opaque solution stable in the dark. Vines subject to a moderately severe attack by *Plasmopara viticola* were sprayed with a 0.5% solution five times between May and August, with satisfactory results, the yield of grapes being excellent and the leaves formed in spring remaining on the plants till the end of autumn, whilst in untreated plants the leaves had been destroyed by June. The solution adhered well to the leaves and left small spots of precipitated metallic silver, below which the tissue was partly destroyed, though without interfering with the general functioning of the leaves. The solid nucleinate is sold at 45 Crowns (equivalent to 37s. 6d. before the war) per kilo., and 30–50% solutions are relatively cheaper; in certain cases it would prove more economical than copper sulphate at present prices.—J. H. L.

Decomposition of di-lead arsenate by water. McDonnell and Graham. See VII.

PATENTS.

Refuse burning installations. B. E. D. Kilburn, London. From Sulzer Frères Soc. Anon., Winterthur, Switzerland. Eng. Pat. 109,179, Dec. 13, 1916. (Appl. No. 17,901 of 1916.)

THE refuse is delivered into vertical water-jacketed shaft furnaces where it is burnt by means of an air blast. The charging hoppers and furnace covers are made to move alternately over the furnace openings. The gases pass out at the top into a combustion chamber having transverse baffles projecting from the top and bottom alternately, and thence to a water-tube steam generator. The clinker in the furnace is cut by a hydraulically operated knife, and drops into a truck which conveys it along a passage below the combustion chamber to a quenching tank. Flue dust is discharged into the same passage through openings in the bottom of the compartments in the combustion chamber. To avoid escape of gas and dust during removal of the clinker, the lower passage is connected with a dust exhauster operated by an air ejector which is fed from the blast from the furnace blower.—W. F. F.

Water; Treatment of—for softening, purifying, and like purposes. H. J. Magrath, London. U.S. Pat. 1,239,202, Sept. 4, 1917. Date of appl., Nov. 22, 1916.

SEE Eng. Pat. 17,133 of 1915; this J., 1916, 1079.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Alkaloids; Sensitiveness of the usual method of extracting—from their aqueous solutions. L. Launoy. Comptes rend., 1917, 165, 360–362.

THE alkaloids used in the experiments were aconitine, atropine, brucine, cocaine, colchicine, eserine, pilocarpine, strychnine, veratrine, and conicine. Two hundred c.c. of solution was rendered distinctly alkaline with sodium carbonate and extracted three times with chloroform (10 c.c., 10 c.c., and 5 c.c.); the chloroform extract was evaporated, the residue dissolved in 1 c.c. of dilute sulphuric acid (1:10), and the solution tested for the presence of various alkaloids. In this way it was found that distinct reactions could be obtained when the original solution contained as little as 1 part of alkaloid per 2 million parts of solution.

—W. P. S.

Datura alba. H. C. Brill. Philippino J. Sci., 1916, 11, A, 257–260.

IN connection with a survey of the medicinal plants of the Philippine Islands, investigations have been made regarding the alkaloid content of the various parts, fresh and dried, of the plant *Datura alba*. It was found that the fresh parts usually contain more than the dried parts and that the various parts range in the following order of alkaloid content: Mature seeds, flowers, stems, immature fruit, and leaves, the first having the highest. Prolonged drying and heating at high temperatures cause a loss of the alkaloid. The alkaloid is more readily extracted by alcohol from an acid than from a neutral or alkaline suspension. The following method is suggested for extraction on the commercial scale:—The raw material is ground finely, treated with hot acidified water, and this extract treated with fullers' earth which removes the alkaloid. The earth is then treated with alkali and extracted with alcohol.—L. A. C.

Essential oil production in British East Africa. Perfum. and Essent. Oil Rec., Sept., 1917, 263–261.

SAMPLES of oil distilled from plants grown at Lamoru, British East Africa, gave very promising results. The district is at an altitude of about 7000 ft., has two rainy seasons, and is probably entirely suitable for the growth of many essential oil-yielding plants. Oil of spike lavender had the following characteristics:—Sp. gr., 0.894; opt. rotation, $-10^{\circ} 30'$; esters, 3.0%; alcohols, 44.1%. The oil is very fragrant and pungent and has a very high content of alcohols. Rosemary oil had the following characteristics:—Sp. gr., 0.908; opt. rotation, $+1^{\circ}$; esters, 4.2%; alcohols, 15.0%. The oil was distilled from the spikes only and shows a high ester content. A sample of geranium oil was somewhat disappointing, not having a particularly pleasing odour, but was probably distilled from the leaves and stems of very old plants. A sample of lemon thyme oil contained 18% of citral and 6% of phenols; this oil, however, is probably of little market value.—L. A. C.

Citric acid and tartaric acid [; Detection of—]. T. C. N. Broeksmijt. Pharm. Weekblad, 1917, 54, 686–687. J. Chem. Soc., 1917, 112, ii, 429.

CITRIC and malic acids are oxidised by a solution of potassium permanganate in acetic acid to acetone, which can be identified by the iodoform test. The two acids can be distinguished by the fact that barium citrate can be crystallised. The acetone reaction is applicable to the detection of citric acid in tartaric acid and in lemonade syrup. The presence of tartaric acid in citric acid and in lemonade syrup can be proved by the formation of potassium bitartrate.

PATENTS.

Organic substitution products; Catalytic synthesis of—. F. G. Keyes, East Orange, N.J., Assignor to Cooper Hewitt Electric Co., Hoboken, N.J. U.S. Pat. 1,237,652, Aug. 21, 1917. Date of appl., Jan. 13, 1914.

IN order to prevent the undue heating of a reaction mixture under the catalytic action of actinic rays, a vacuum chamber is interposed between the source of the rays and the reaction mixture.

—L. A. C.

Hydrogenating organic substances [e.g., quinine]. J. W. Blagden, Heidelberg, Assignor to C. F. Boehringer und Soehne, Mannheim-Waldhof, Germany. U.S. Pat. 1,239,867, Sept. 11, 1917. Date of appl., Oct. 8, 1914.

SEE Eng. Pat. 21,883 of 1914; this J., 1915, 1225.

Method of concentrating liquids. U.S. Pat. 1,237,962.
See I.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

A cuprous oxide photo-chemical cell. Case. See XI.

XXII.—EXPLOSIVES; MATCHES.

Mixing of powdered substances [explosives].
Eng. Pat. 108,150. See I.

XXIII.—ANALYSIS.

Potassium and sodium; Determination of — [in the ash of vegetable substances]. H. Pellet. Ann. Chim. Analyt., 1917, 22, 146—152, 179—185.

THE substance is incinerated at a low heat, the carbonised mass extracted with water, the insoluble portion ignited separately, and the ash added to the solution, which is then evaporated and the residue heated gently. To determine potassium and sodium, 5 grms. of the residue is extracted many times with boiling water, the extracts are filtered, and the solution made up to 500 c.c.; 200 c.c. of this solution is treated with an excess of saturated barium hydroxide solution, phenolphthalein is added, and carbon dioxide is passed into the mixture until the pink coloration disappears. After the addition of a few c.c. of saturated ammonium carbonate solution, the mixture is heated, filtered, the filtrate evaporated, and the residue ignited. This residue is extracted with water, the solution is filtered, the filtrate evaporated with the addition of hydrochloric acid, and the residue of chlorides thus obtained is ignited at a low temperature and weighed. The excess of barium hydroxide may be removed by the addition of ammonium carbonate solution, instead of with carbon dioxide. The potassium in the mixed chlorides is determined by precipitation with platinum chloride. The filtrate and washings (a mixture of alcohol and ether is used) are evaporated to remove alcohol and ether, so that a solution is obtained containing only sodium chloride, platinum chloride, and possibly a small quantity of reduced platinum. The solution is boiled with the addition of an excess of ammonium formate, the reduced platinum separated by filtration, the filtrate evaporated to dryness, and the residue ignited to expel ammonium salts. The ignited residue is treated with a few drops of hydrochloric acid, evaporated, and the residue of sodium chloride thus obtained is weighed after gentle ignition. The quantity of sodium found should agree with that calculated from the difference between the amount of potassium chloride and that of the total chlorides. If desired, the quantity of potassium found may be checked by reducing the potassium chloroplatinate with sodium formate and weighing the platinum black.—W. P. S.

Gallium; Qualitative separation and detection of —, P. E. Browning and L. E. Porter. Amer. J. Sci., 1917, 44, 221—224.

IN the ordinary course of analysis, gallium appears in the group containing aluminium, beryllium, chromium, and vanadium, from which group the last two elements may be removed by oxidation to the acidic condition and treatment of the solution with ammonia. Potassium ferrocyanide may be used for the separation of gallium from the remaining elements of the group, the separation from aluminium being the more important since beryllium is seldom present in products containing gallium. The test depends on the insolubility of

gallium ferrocyanide in hydrochloric acid; in a series of trials, each made in a volume of 5—10 c.c., of which from one quarter to one third was strong hydrochloric acid, 0.001 gm. Ga was precipitated at once by the addition of potassium ferrocyanide, whereas 0.1 gm. Al or Be gave no precipitate. Under similar conditions a precipitate was obtained with 0.0001 gm. Ga after standing for an hour. The test is vitiated by the presence of traces of zinc, but the latter may be removed by addition of hydrogen sulphide to the sodium hydroxide solution of the metals. The zinc sulphide is filtered off and the filtrate acidified, boiled to remove hydrogen sulphide, and then made alkaline with sodium hydroxide and treated with hydrogen peroxide to oxidise the free sulphur. The liquid is then boiled to decompose the excess of hydrogen peroxide, acidified with hydrochloric acid, and treated with potassium ferrocyanide. By this means it was found possible to detect 0.0002 gm. Ga in the presence of 0.05 gm. Zn. The most satisfactory method of decomposing gallium ferrocyanide and recovering the metal as hydroxide is to fuse the compound with ammonium nitrate and treat the residue with sodium hydroxide; a solution of gallium is thus obtained from which the hydroxide is precipitated on boiling with excess of ammonium chloride. The ether process for the separation of aluminium and iron chlorides is also applicable to the separation of aluminium from gallium, the latter being obtained as chloride in ethereal solution; in this way, 0.0005 gm. Ga was detected in the presence of 0.1 gm. Al, the ethereal solution being evaporated to dryness and the residue dissolved in hydrochloric acid before the addition of potassium ferrocyanide. Subsequent experiments showed the precipitation of gallium ferrocyanide to be partly or wholly prevented by the presence of nitrates or nitric acid, but that these could be successfully removed by evaporation with hydrochloric acid.—W. E. F. P.

Determination of phosphorus in cast iron. Cavazzi.
See X.

The Eggerltz test for combined carbon in steel.
Whiteley. See X.

Volumetric determination of molybdenum and vanadium in steel. Travers. See X.

Chromic acid and hydrogen peroxide as an etching agent [for brass and bronze]. Miller. See X.

Combined Reichert-Polenske and modified Shrevesburg-Knapp process [for determination of coconut oil]. Elsdon. See XII.

Differentiation of coconut oil and palm-kernel oil in mixtures. Elsdon. See XII.

Percentage of moisture in raw rubber. Van Rossem.
See XIV.

The so-called insoluble part of raw rubber. Van Rossem and Dekker. See XIV.

Indirect method to determine the percentage of rubber. Van Rossem. See XIV.

Water extract of raw rubber. Van Rossem. See XIV.

Degree of acidity of raw rubber. Van Rossem.
See XIV.

Analysis of milk. Porcher and Dage. See XIXA

Sensitiveness of the usual method of extracting alkaloids from their aqueous solutions. Launoy.
See XX.

[Detection of] citric and tartaric acids. Broeksmit.
See XX.

Official Notice.

MINISTRY OF MUNITIONS ORDER. OCTOBER 23RD, 1917.

Tar oils.

The Minister of Munitions, in exercise of the powers conferred upon him by the Defence of the Realm Regulations and all other powers thereunto enabling him, gives notice and orders as follows:

(1) He hereby takes possession as from the 1st November, 1917, until further notice, of all tar oils then or thereafter situate in the United Kingdom produced or derived from gas coal tar or coke oven tar of a specific gravity of 1000 or exceeding 1000, or produced or derived from water gas tar, producer tar or Mond gas tar of any specific gravity.

(2) If any person having control of any tar oil to which this Order applies without the consent of the Minister of Munitions sells, removes, or secretes it or deals with it in any way contrary to any conditions imposed in any licences that be granted in respect thereof, he will be guilty of an offence against the Defence of the Realm Regulations.

(3) No person shall on or after the 1st November, 1917, until further notice purchase or take delivery of any tar oil situate in the United Kingdom except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions, or offer to sell, sell, supply, or deliver any such tar oil to any person other than the holder of such a licence and in accordance with the terms thereof. Provided that no such licence shall be required:

(a) By any person for the purchase and delivery of tar oil in quantities not exceeding an aggregate of 5 gallons during any one calendar month.

(b) By any person, after the first application by him for and pending the granting or refusal of a licence, for the delivery to him under a contract in writing existing at the date hereof of tar oil for the purpose of benzol washing or the manufacture of disinfectants, antiseptic drugs, lamp or vegetable black, or fuel, to an amount not exceeding during any one calendar month the amount of the average monthly deliveries under such contract during the three calendar months immediately preceding the date hereof.

(4) No purchase or sale of tar oil situated in the United Kingdom, or offer to purchase or sell any such tar oil whether such purchase, sale or offer is or is not under any licence issued under the authority of the Minister of Munitions, shall, in the case of any class of tar oil specified in the Schedule hereto, be until further notice at a price exceeding the price fixed for the same in the said schedule, provided that this clause shall not apply to any deliveries under and in pursuance of a contract in writing entered into prior to the 13th July, 1917.

(5) No person, whether he is or is not the actual producer of such tar oil, shall on and after the 1st November, 1917, until further notice use any tar oil exceeding in quantity 5 gallons in any one calendar month for the purpose of or in connection with any manufacture or work except under and in accordance with the terms of a licence issued under the authority of the Minister of Munitions.

(6) All persons producing or holding stocks of tar oils shall furnish to the Controller of Explosives Supply, Storey's Gate, Westminster, S.W.1, as and when required by him such returns of tar oils at any time manufactured, purchased, sold, supplied, delivered or used by them at such times and in such form as the said Controller of Explosives Supply shall from time to time direct.

(7) All persons heretofore required by the Minister of Munitions to furnish returns relating to tar oil shall until further notice continue to furnish returns in accordance with such previous requirements.

(8) For the purpose of this Order the expression "tar oil" shall mean creosote oil, green oil, sharp oil, anthracene oil, and other oils produced from or containing an admixture of oil produced from the distillation of coal tar, coke oven tar, producer tar, water gas tar and Mond gas tar or any of them.

(9) The Order of the Minister of Munitions dated the 13th July, 1917, relating to creosote and other oils produced from the distillation of coal tar is hereby cancelled as from the 1st November, 1917, but such cancellation shall not affect the previous operation of that Order prior to such last mentioned date or the validity of any action taken under it, or the liability to any penalty or punishment in respect of any contravention or failure to comply with the same respectively prior to its cancellation, or any proceeding or remedy in respect of such penalty or punishment.

(10) All applications for licences under this Order shall be made to the Controller, Mineral Oil Production Department, Ministry of Munitions, 8, Northumberland Avenue, W.C.2.

The Schedule. Maximum prices.

(1) Oil for benzol washing complying with the following specification:—

Sp. gr. at 60° F. not less than 1020. Shall deposit no naphthalene crystals at 45° F. On distillation in retort with thermometer in liquid shall give no distillate below 200° C., not less than 5% at 230°, and not less than 90% at 300°—100s. per ton.

For each degree F. by which the crystallising point is above 45° F. 1s. per ton shall be deducted from the price, and for each 1% by which the volume of distillate at 300° falls below 90% 6d. per ton shall be deducted from the price.

(2) Oil for fuel purposes.

(a) For use in Diesel engines complying with the following specification:—

Sp. gr. not exceeding 1.100 calorific value, not less than 15,800 B.T.U.'s; fluid at 600° F., maximum content of water 2%; coke 5%; ash 0.10%—87s. 6d. per ton.

(b) For other engines and furnaces generally:—

(1) Admiralty Specification oil, 72s. per ton.

(2) 75% creosote oil and 25% pitch, 61s. 6d. per ton.

(3) 66 2/3rds % oil and 33 1/3rd %, pitch 58s. per ton.

(4) 50% creosote oil and 50% pitch, 51s. per ton.

(5) 40% and less creosote oil and 60% and upwards pitch, 47s. per ton.

A commission not exceeding 2½%, in addition to the prices mentioned above, may be charged by brokers, dealers and merchants.

The prices mentioned in this Schedule are for oil delivered free on rail or barge at the sellers' works or at the nearest station or wharf into the purchasers' tank cars and sold according to the producers' weights and measurements. In cases where the seller supplies the tank cars, an additional charge of 20s. for each 2200 gallons capacity per week for the use of such cars is permitted.

In the case of oil delivered from such ocean installations as shall be approved by the Minister of Munitions, an additional charge of 1d. per gallon is permitted, which increase shall cover all charges for insurance, pumping, and such other expenses as are usually defrayed by the purchaser.

The cost of analysis, measurement and sampling may be charged to the purchaser in addition to the maximum prices above specified.

The cost of barrels (including coopering and filling) and the barges used for transport may be charged for at current rates.

Journal of the Society of Chemical Industry.

No. 21, Vol. XXXVI.

NOVEMBER 15, 1917.

No. 21, Vol. XXXVI.

Official Notices.

CROSS AND BEVAN ESSAY PRIZE OF £20 AND LATHAM RESEARCH GRANT OF £300.

The Council desires to remind intending competitors for the Cross and Bevan prize that Essays must be received at the offices of the Society before the close of the present year.

The Essay prize is open to all members of the Society who are British subjects. The Research Grant is limited to competitors under 25 years of age at the time of sending in the essay.

Full particulars were published in the issues of the Journal for 15th January and 15th and 28th February, 1917.

PROHIBITED EXPORTS.

An Order-of-Council, dated 18th October, 1917, makes the following alterations in regard to prohibitions of export* :—

The following headings are deleted :—(A) Aluminium, alloys of aluminium and manufactures of aluminium; (C) Arsenical ore; (C) Arsenic, compounds of arsenic, and mixtures containing arsenic; (A) Cresol, compounds and preparations of cresol (except saponified cresol) and nitro-cresol; (B) Cresol (saponified); (B) Lead ore; (B) Belting, hydraulic leather, pump leather and leather manufactures suitable for textile machinery; (B) Oil, fish and seal, not otherwise prohibited, and mixtures containing such oils; (C) Oils, essential (except turpentine oil); (C) Paper, Japanese tissue; (B) Waxes, animal, mineral, vegetable, and composite waxes, not otherwise prohibited.

The following headings are added :—(A) Aluminium, alloys of aluminium and manufactures of aluminium, or of its alloys; (B) Arsenical ore; (A) Acridavine, proflavine, and other acridine derivatives having antiseptic or therapeutic properties, and mixtures or preparations containing any of these substances; (B) Arsenic, compounds of arsenic, and mixtures containing arsenic; (A) Cresol, compounds and preparations of cresol and nitro-cresol; (A) Lead ore; (B) Belting, leather manufactures suitable for textile machinery and leathers cut or shaped for hydraulic or pump purposes; (B) Oil, fish, not otherwise prohibited, and mixtures containing such oil; (B) Oil, sandalwood; (A) Oil, seal, and mixtures containing such oil; (C) Oils, essential (except sandalwood and turpentine oils); (C) Paper, Japanese tissue and similar cellulose paper, whether in the piece or roll or cut into shapes for domestic or other uses; (B) Sandalwood, for medicinal purposes; (B) Waxes, animal, mineral, and vegetable, not otherwise prohibited; (A) Waxes, composite.

APPOINTMENT OF PETROLEUM EXECUTIVE.

The Rt. Hon. Walter H. Long, M.P., has been requested by the War Cabinet to take control of all questions affecting petroleum oils and petroleum

products. Mr. Long has appointed Professor Cadman, C.M.G., Petroleum Adviser to the Colonial Office, to be his technical adviser and liaison officer between the various Government Departments. Professor Cadman will also take charge of an organisation which will be established for giving effect to Mr. Long's instructions, and will assume the title of Director of the Petroleum Executive. Mr. B. S. Shrapnell-Smith, Chairman of the Joint Committee of Mechanical Road Transport Associations, has been appointed Economy Officer to the Petroleum Executive, and he will be concerned in introducing economies both in H.M. Services and in the civil use of petroleum and petroleum products. The headquarters of the Petroleum Executive are at 8, Northumberland Avenue, London, W.C. 2, to which all communications should be addressed.

Sir Beverton Redwood, Bart., Director of Petroleum Research, has been appointed to be Director of Technical Investigations in the recently created Petroleum Executive, with a view to his dealing with technical questions of the highest importance, including the co-ordination of the work of petroleum production and that of petroleum research. Sir Beverton Redwood will cease to act as Director of Petroleum Research.

NITRATE OF SODA AS "WAR MATERIAL."

The Minister of Munitions has made an Order, dated 19th October, to the effect that the war material to which Defence of the Realm Regulation 30A applies shall include nitrate of soda. All applications and communications in connection with the Order should be addressed to the Department of Explosives Supply, Ministry of Munitions, Storey's Gate, Westminster, London, S.W. 1.

Liverpool Section.

Meeting held at the University on Friday, October 19th, 1917.

MR. A. T. SMITH IN THE CHAIR.

SOME PROBLEMS CONFRONTING THE CHEMICAL INDUSTRY.

BY A. T. SMITH.

It is difficult perhaps to detach one's mind from the turmoil of events, but in such times as the present it is desirable and even essential occasionally to ignore what is going on day by day, and to endeavour if possible to look at the end. So it occurs to me that after three years of war it may not be unprofitable to pause and consider the changing phases of the chemical industry arising out of the extraordinary demands for munitions of war, as well as the constitution of a Ministry of Munitions and a Government which has assumed autocratic powers rivaling anything which has before occurred in our history.

I propose, therefore, in these few remarks to endeavour to discuss some of the problems which face us. Let me say at the outset that my object is not to criticise the action of the Government opposite the Chemical Industry, but to consider the conditions that have arisen owing to the systems of control which have been instituted, and to suggest, if I may, possible dangers to the

* The prohibition of exports is as follows :—

Goods marked (A), to all destinations;

Goods marked (B), to all ports and destinations abroad other than ports and destinations in British Possessions and Protectorates;

Goods marked (C), to all destinations in foreign countries in Europe and on the Mediterranean and Black Seas, other than France and French Possessions, Russia, Italy and Italian Possessions, Spain and Portugal, and to all ports in any such foreign countries, and to all Russian Baltic ports.

interests involved, from the point of labour as well as capital.

I remember many years ago listening to the inaugural address of Mr. Eustace Carey when Chairman of this Section, and if I recollect rightly the title of his paper was "The Invasion of the Inventor." To-day I think we are faced with an equally important problem, which I may perhaps describe as "The Invasion of the Official." This phrase is self-explanatory, but it indicates a new condition of affairs, entirely foreign to English methods of business or lines of thought, which gives much concern to those who are engaged in the conduct of large or small business enterprises. Up to the commencement of the war these may with justice be considered to owe their success to individual effort, divorced entirely from official guidance or interference, except in questions of the most abstract and non-controversial nature, such as the work of the Alkali Inspector or Factory Act Inspector, whose visits in all well-conducted works have been cordially welcomed.

The new condition of affairs arising from the creation of the Ministry of Munitions has, as we all know, brought in its train an army of officials, and a multiplicity of orders and forms which make it well-nigh impossible for some of us to give that attention to our daily work which is really called for, for the simple reason that time is largely occupied in attempting to comply with the wishes of these various new departments. It may be that this condition of affairs is inseparable from the control of manufacturers by a central department or departments in London, but I venture to suggest that rites and ordinances have been multiplied to an unnecessary degree. In the early months of the war, when the departments were in their infancy, this was not so much the case, and a great deal of useful work was promptly carried out. But undoubtedly red tape has grown apace lately, and is at present a serious drawback to the prompt despatch of business. In some cases the difficulties brought about in this way are almost insuperable, with the result that the products required are not forthcoming when they are wanted, in spite of every effort and desire on the part of individual manufacturers to carry out instructions as promptly and as quickly as possible.

A Ministry of Reconstruction has now been inaugurated, and it may be imagined that the mantle of the Minister of Munitions is eventually intended to fall on the shoulders of the Minister of Reconstruction. A Committee consisting of members of the Association of British Chemical Manufacturers has been nominated by the Minister to confer with officials nominated by him as to the method of procedure to be followed in carrying out the work of his department of the Government.

I think that this question of multiplication of officials and forms is one which the Committee should consider and deal with almost before any other, with the object of getting back to practical and business-like methods as promptly as possible.

Centralisation is all very well in its way, but in a trade like ours I venture to suggest that too much centralisation is worse than useless. The products we have to deal with are so many in number, so interdependent, so varied in their characteristics, the various qualities of even the same articles have such different properties and are required for so many different operations, that no man, unless he is actually employed in the business, can have anything more than a superficial knowledge of anything but a very limited number of them. The control of the manufacture of such products is therefore perhaps best left in the hands of the men who understand them and have devoted their lives to the study of their characteristics.

I am afraid that the British habit of self-depreciation has grown so much upon us that we are at last beginning to believe all that we say about ourselves as well as all that our enemies say about themselves. In rendering homage to Germany's great panacea for everything, "Organisation" (which I have heard described as being the docile disposition of the German people which enables them to submit to *being organised*), we have lost sight of the one quality which has always been the sheet anchor of British character, namely, "Individuality." I think it is time we should recall this to mind.

Organisation is undoubtedly useful, but I submit that it is possible to have too much of it, and whilst it is considered to be a defect in this country that we have not had enough organisation, I think it will be admitted that in Germany there has been too much. I will not go so far as to say that this is a case of cause and effect, but I do suggest that if there had been more of British individuality in Germany there would have been less of that docile submission to authority which has resulted in the whole nation being led by its rulers over the precipice which is leading it so rapidly to destruction.

Individual freedom is, in my opinion, the one quality which has enabled England to remain in the forefront of the nations, and to overcome in this war, as in former wars, the enormous difficulties which have arisen. Certainly no organisation on earth could have possibly overcome them so fully and completely in the time, had it not been backed by this individuality and initiative, which is our most valuable asset. If as a result of this war we adopt in England systems of control and State interference which are so rampant in the land of our enemies, we shall do so at the expense of that individuality which I say again is our most valuable asset, and we shall in effect be no better off then if we had lost the war.

I feel sure that the greatest dangers are in front of us if we do not, as soon as ever possible after the war, reassume or resume that individual liberty of action and freedom of initiative which has been temporarily suspended. It is not as if this state of affairs had never existed in the world before. This usurpation of the liberty of the subject is not a new thing in the world's history. Other nations have arrived at a condition of affairs which is exactly parallel with that which exists in England at the present day, and for the self-same reason—militarism. I will give one example from the history of Rome, describing the latter days of the Augustan era, which reads as follows:—

"The Roman Empire had already lost, and had never been able to restore, its prosperous farming class. It now lost likewise the enterprising and successful business men of the middle class. Diocletian therefore endeavoured to force these classes to continue their occupation. He enacted laws forbidding any man to forsake his lands or occupation. The societies, guilds, and unions in which the men of various occupations had long been organised were now gradually made obligatory, so that no one could follow any calling or occupation without belonging to such a society. Once a member, he must always remain in the occupation it implied.

"Thus under this oriental despotism the liberty, for which men had striven so long, disappeared in Europe, and the once free Roman citizen had no independent life of his own. For the will of the Emperor had now become law, and as such his decrees were despatched throughout the length and breadth of the Roman dominions. Even the citizens' wages, and the prices of the goods he bought or sold, were as far as possible fixed for him by the State. The Emperor's innumerable

officials kept an eye upon even the humblest citizen. They watched the grain dealers, butchers, and bakers, and saw to it that they properly supplied the public and never deserted their occupation. In some cases the State even forced the son to follow the profession of his father. In a word, the Roman Government now attempted to regulate almost every interest in life, and wherever the citizen turned he felt the control and oppression of the State."

This quotation is from a recently published book, called "Ancient Times: A History of the Early World," by that eminent American historian, Professor James Henry Breasted. It is worth giving this extract at length because the description might with absolute justice have appeared in the pages of any of our daily papers. If there is any truth in the maxim that history repeats itself, we shall have to take very great care that the British Empire does not follow in the steps of the Roman Empire, which very shortly after it had arrived at the state of affairs recorded above was plunged into a revolutionary period, resulting in the destruction of civilisation for hundreds of years.

There is no need for me to expatiate on this extract. The parallel is so accurate that no criticism is called for, and it is because the cases are so similar that I do want to emphasise the danger which, in my opinion, faces us unless we, whilst acknowledging the need of some control, retrace our steps as quickly as ever possible, and resume our liberty of action and freedom. We constantly hear the British soldier extolled as compared with his Continental opponent because of this very initiative which he possesses and the other does not. It would be lamentable in the extreme if England as a nation were to degenerate into a body of drilled units, with no will of their own and no mind except to obey orders. It becomes, therefore, almost a question of the psychology of the two races and of the systems which prevail and the methods of thought which are suited to the different communities. The systems will, I think, be judged by their works, and I think also that our want of organisation, bad as it is, is proving itself infinitely better than the German super-organisation, owing to the saving grace of initiative and individuality.

I hope, therefore, that as soon as ever the pressure can be relaxed the bondage of control will be done away with, and that we shall be permitted to go about our business more or less in our own way as formerly.

There are doubtless some good points about organisation and discipline, but at the present time I am afraid we have gone very much too far in that direction. I can see some good points in a limited supervision of manufacturers, but every one of those points is simply bristling with difficulties.

The recent formation of the Association of British Chemical Manufacturers is a step in the direction of commercial organisation which may have a very important effect on the future of the chemical trade. It has been brought about by the desire on the part of chemical manufacturers in this country to endeavour to sink their differences as far as possible for the common good; to avoid over-production and duplication of plants in view of the scarcity of capital, which is the natural result of the extraordinary expenditure occasioned by the war; and by closer co-operation one with the other, and one branch with the other, to oppose a united front to the cartels and rings which have been in existence for so many years on the Continent, with the one object of furthering our adversaries' trade to the detriment of the trade of every other country in the world.

The Association has already succeeded in modifying certain new Ministerial Regulations

which would have been very detrimental to the industry if promulgated in the form originally intended, and its status has been recognised by the Government. The various sections of the trade have been assembled into group systems which are settling down to regular work, and I am sure that excellent results may be looked forward to in due course.

But the threatened danger is to be looked for in more directions than one. The present attitude of labour is a very serious menace to the industry. Large numbers of men, as we know, volunteered for active service in the early days of the war, and in the enthusiasm of the moment and in ignorance of the magnitude of the undertaking facing us, they were accepted indiscriminately by the Military Authorities, and sent to the front as quickly as possible. The result was that many works were almost denuded of their best men, and have in consequence been working under a severe handicap ever since, owing to the impossibility of replacing these men with any others but those inexperienced in their particular processes and inferior in many other respects. When the call came for an increase of output it was found difficult to respond owing to the serious handicap of the lack of experienced men who, for various reasons, it was found impossible or inexpedient to bring back from the front, and the works in consequence have been obliged to do as well as they could without them.

There was a scarcity of even these inefficient substitutes and in consequence a demand arose for higher wages. The Unions have lost no opportunity of increasing their membership, and now we are faced with a labour organisation which bids fair to rival the official organisation in its "genius" for control and regulation of expenditure.

I would not like it to be thought for a single moment that I am opposed to the labour movement. I am quite in favour of giving the labouring man every conceivable privilege consistent with the rights of others. I would go, and have gone, a very long way in the direction of improving his conditions of living. But I have an uneasy feeling that the leaders of labour in many instances, as well as most of the members of the Unions, have failed to realise that higher wages and shorter hours carry with them the moral and actual obligation of more conscientious and better work. I wish that they could be persuaded to see that the true interest of the working man lies in the direction of individual effort resulting in increased output, in other words every man doing his best to get the most work out of the machines supplied instead of the least, or in any case only a dead level of mediocrity.

If the workers would only try to look at things from this standpoint and act accordingly I should feel more hopeful for the future, and particularly if they could become imbued with the spirit of the old Guilds, the prototypes of the Trade Unions in the Middle Ages. In those days the Guilds were even closer corporations and governed by more severe rules than the Trade Unions are to-day, but there was this important difference. No man was allowed to become a member of a Guild or work at his trade until he had served a real apprenticeship and even then was not allowed to become a journeyman until the Masters of the Craft were satisfied that he knew his business and produced a proof of his ability in the shape of a specimen of his work, called because of this a "masterpiece." How many full members of Unions would pass this test to-day? How much better it would be for us all if the workman of the present day took the same pride and interest in his work as the craftsman of the olden time and how much better off we should all be both physically and morally!

Money is not everything and the true measure of a man's happiness is not always the amount of money he takes home every week end, though many will say that it is. None can deny that it is a most important consideration, but I do suggest that the happiest and most contented man is the one who knows how to spend his money intelligently, who does not waste his money however large or small. Above all things he does not waste either his own time or his employer's in unprofitable idleness, but on the contrary spends his own spare time in useful outdoor work or recreation, and in the improvement of his education. When at his work he is diligent and attentive to his duties, bearing in mind the Scriptural admonition to give "full measure, pressed down and running over." I can assure you the plan is a good one—it pays; and the only ones who do not understand and do not believe it are the ones who have never tried it.

It comes back therefore to the original idea "Individuality," and each man must work out his own salvation; there is no golden rule for any of us but to work.

On the other hand the labourer is worthy of his hire, and he has not unreasonably a desire to participate in the profits resulting from his labour. Many attempts have been made to devise schemes which would satisfy this very laudable ambition, but I am afraid that many, if not most of them, have failed largely because the working man failed to realise that "to great privilege great responsibility is attached." Although he is quite willing to accept any extra remuneration, call it profit-bonus, or dividend, or profit-sharing or what you will, he appears unable to realise the duty which in turn is incumbent upon him. He should give reasonable attention to his work and refuse to waste his employer's time, which bear in mind he is paid for, and contribute what in him lies to the power of his employer, to increase or earn that profit and so pay the same or an increased profit-bonus or profit-sharing dividend.

The question as to whether a man should work eight or six hours a day is, I am afraid, more in the region of ethics than practical politics at the present time, when men are daily giving their lives ungrudgingly in defence of that freedom which has made England what she is. It seems to me that a man's duty to-day is not to consider how few hours a day he can devote to work or how many to recreation or enjoyment, but for how many hours he can do honest work to produce the maximum output and help for his comrades at the front, and what is the least time his conscience will allow him for his own ease or refreshment.

With regard to profit-sharing, and to illustrate the difficulties which confront employers who with the best will in the world want to help their men to take an intelligent interest in their work, I will give two instances:—

One is the case of a firm which instituted a bonus scheme by virtue of which a certain percentage of the wages paid was put by every year for the men in their employ, the percentage increasing with the length of service. The money so accumulated was invested by the firm and became payable to the man or relatives after he left their employ or at death. Obviously the object of this scheme was to encourage faithful service and to give each employee an interest in his work and a desire to remain at his post. What was the actual result? It was found that when a man had accumulated a substantial sum, say £50, he suddenly discovered that he wanted to leave. The result was that he drew his bonus and the main object of the scheme was defeated.

In another case a Company carrying on a satisfactory trade was approached by the men with the suggestion that they would like to have a share

in the proceeds of the business. The Directors considered the matter and came to the conclusion that, although they already paid the full Trade Union rates of wages, the request was not unreasonable. They endeavoured to meet it by paying the men after a certain period of employment a bonus calculated on the rate of dividend paid to the shareholders. It was hoped that the men would realise that this was an endeavour to identify the interests of the employees with those of the employer, and that the men would give a conscientious return for the concession made by increased diligence and attention to their work, avoidance of waste, and careful supervision and attention to their own particular section. The bonus is paid monthly and at the present time represents an increase of over 20% on the wages paid. This monthly payment was instituted to obviate the objections which arose to the system already referred to and which defeated its own object by giving the men an inducement to leave after a certain period instead of to stay on. Instead of the hopes of the Directors of this Company being fulfilled, the only practical effect appears to be, that with the exception of a very small percentage of the men, there is no result at all, except the handing over of a sum of money at the end of each month to the rest of the men. This they take without any appreciation as to why it is given to them, and without any effort at all on their part to make any return for the consideration shown to them. Labour troubles are just as common in this works as they are in other works in the neighbourhood paying lower rates of wages, without any bonus. Individuals on being questioned have no hesitation in saying that whilst they like to get the bonus they have no idea why it is paid, and have no notion that they are placed under any obligation to do anything except perform their work in the sloppiest and most perfunctory manner. They consider the employers have a very good reason for paying the bonus, and that they would not do it unless it was worth while, and so on. This is very disheartening, and makes it very difficult for employers who honestly want to help their work-people and to institute conditions which will be satisfactory to them and remove feelings which give rise to unrest and suspicion.

Personally, I am inclined to think that the trouble lies partly at the door of the education authorities and partly at the door of the Municipal and Urban and Rural District Councils. The education authorities, because they do not inculcate rules and present ideas to the children in the schools which will have a tendency to raise them above their surroundings and make them want something better. The girls are not taught to cook, and know nothing worth the name about housekeeping, with the result that when they do get married the unfortunate man who happens to be their husband is considered by them to be nothing whatever but a provider of money, which may or may not be wasted according to the whim of the moment. Instead of a comfortable home, clean and cheerful, he too often returns to a disorderly kitchen, an untidy wife, and an unsatisfactory supper.

This is where the education authorities are at fault, and they are generously helped by the local authorities. These bodies permit houses to be built for workmen to live in which are lacking in space, crowded together to a disgraceful degree, with no light, no air, and no land which can be turned into a garden so that the man may have some intelligent occupation for his spare time which is essential if he is to be kept in a state of health and happiness.

Perhaps, however, the fault lies more at the door of the municipal authorities than at the door of the education authorities. If the building

rules were much more stringent, if the specifications for workmen's dwellings were liberally improved upon, provision of adequate cubical capacity in the rooms, adequate air, light, and water, as well as land, were insisted on, the general condition of affairs would be improved. The man would become a better workman, and the master could afford to pay him higher wages because he got a better return, and in the end both parties would benefit, because the man would have more and a higher interest in life than at present.

It may be argued that the provision of this better housing accommodation is a very big financial proposition. Perhaps it is, but this is not an insuperable objection, and in many cases individual employers would be only too glad to assist in this direction if they felt that they could rely upon any return for their money. It is difficult to apply such conditions in the neighbourhood of many of the works which exist at the present time because they are already crowded out with dwellings, and there is no remedy short of pulling down and rebuilding.

Such conditions could be applied in the case of works which are being established in new neighbourhoods, and as we know they are being applied in this neighbourhood with very beneficial results.

I am perfectly certain that the object-lesson is not being lost sight of by other liberal-minded employers who are anxious to do everything they can to make the lives of their workpeople as happy as possible.

Probably, if it had not been for the advent of the war, many schemes for the improvement of housing accommodation would have been already in operation, besides the one to which I have referred. Here again stern necessity brought about by the war has rendered it impossible to continue the erection of new buildings or to provide even sufficient housing accommodation of the ordinary sort to meet the constantly-increasing demand. It may well be that before very long it will have to become a Government charge to see to the erection of such buildings, even to the extent of providing financial assistance towards the project. This, to my mind, would be a great pity, because such things are better if left in the hands of private enterprise. But that the problem will have to be tackled soon, and on a large scale, seems to me absolutely undeniable.

I will conclude with a few words on the University training of chemists, on whose fitness for their work the success of the industry so vitally depends.

It seems to me that a works' chemist, to be a success, besides accurate theoretical knowledge of his subject, should, when he leaves the University, be armed also with a practical knowledge of the economical problems which confront the manufacturers in his particular branch of the industry.

There is a charming irresponsibility about many young men who come to a works with their University honours fresh upon them. They have been accustomed in their laboratories and in their studies to regard substances and processes almost solely from the point of view of their atomic weights and chemical characteristics and without any regard to their monetary values. This is inevitable perhaps because, from the very nature of the case, they carry on their experiments with no regard to the cost of the reagents or apparatus employed. I do not mean to suggest that problems are never expressed in terms of "£ s. d." as well as in the chemical nomenclature, but I do suggest that in the laboratories there is a tendency to consider almost exclusively the theoretical side without any serious attention to the monetary value of the problems, processes, operations, and reagents involved.

It should be borne in mind that invaluable as theoretical knowledge is for its own sake, its value

really depends in the long run on its power of being translated into terms of money. This important consideration should therefore, I think, be kept well in the foreground, so that students coming into a works from the University shall be armed with the knowledge which will enable them to view things with a due sense of proportion. The information could be easily obtained by the study of the value of chemical substances as set forth in the weekly trade circulars published by those engaged in the trade and in the technical and other papers.

Finally, I would ask forbearance for the very general nature of the few points I have brought forward. Just now it is rather difficult to deal with any of the extremely important technical problems with which we are all at the present time so deeply concerned because as law-abiding subjects we by no means desire to trespass against any of the ordinances which our rulers in their wisdom have set up as worthy objects for our respect and admiration.

DISCUSSION.

Mr. T. W. STUART entirely agreed with the author's remarks on Government interference and its detrimental effect in cases where individuality untrammelled and with a free hand could alone produce the best results; he trusted that after the war the views and hopes of Mr. Smith would be realised by a return to conditions of individual and private enterprise without excessive State control. With regard to difficulties between capital and labour, he was of the opinion that the next five years in the chemical trade would be more strenuous than ever, and hence the greatest efforts of the representatives of labour and of the masters and of the Government would be required to keep the men in hand and to cope with manufacture. The war of 1870 had been the cause of a period of great prosperity for the chemical trade, lasting about two years, during which time prices rose and wages were increased; but labour became absolutely disorganised, and it was 12 years before the increase of wages was reduced by one half. Men of the widest experience and talent would be required to manipulate the situation after the present war if this country were to recuperate after the stress and strain of her present gigantic task.

Dr. E. F. ARMSTRONG said that every word the author had spoken was true in regard to the ways of officials; the lives of technical chemists had become a burden during the past three years, for half their time was wasted in having to deal with Government and other representatives who were ill-trained and unable to understand the mental attitude of the expert chemist—whose outlook on technical matters was specialised and entirely different from that of any other type of professional man; the other half of their time was absorbed in difficulties connected with labour. Referring to the University training of the chemist, he (the speaker) disagreed with Mr. Smith on the question of teaching the student the economical side of chemical manufacture before he entered the works. Year by year the young men were being sent from the Universities better equipped, and obviously the future works-chemist should thoroughly know his science first, and then on entering the factory he might develop and eventually, if capable, he would become the required article. Those "Admirable Crichtons," who would revolutionise the monetary side of a process in three months after coming to a works were very few and far between—if not impossible to find.

Mr. JOHN GRAY said that there had never been such a time for chemical industry as the present, *i.e.*, such a time of unprecedented demands and difficulties of execution, so that the interruption

from officials was highly annoying. It was interesting to read in a report of the German Iron and Steel Institute (translated by Sir Robt. Hadfield) a condemnation of the methods of "organisation" in that industry—the writer complaining of a "superabundance of Government departments." The speaker thought that broad-minded dealing between labour representatives and employers would result in a better state of affairs in industry after the war, when wages would still be high, as also would be the cost of living, but if manufacturers combined together for increase of production then the payment of high wages would be justified.

Mr. W. MANSBRIDGE thought that the adjustment of differences between labour and capital was of vital importance to reconstruction after the war; if workmen were more conscientious and gave of their best to the employers there would be no need for Trade Unions, because masters and men would automatically assist each other. Boilermakers and others in the engineering trades were setting a very bad example by their "ca' canny" tactics. Finally, with regard to the young works-chemist, there was a reluctance to pay him an adequate salary, still to be observed in some works; this was a very uneconomical practice since it tended towards a low standard of efficiency.

Mr. EDWIN THOMPSON felt that the general tone of Mr. Smith's remarks was pessimistic, *e.g.*, it was rather depressing to an Englishman to have ancient Roman history quoted against him. He (the speaker), while realising that the lecturer's remarks were intended to arouse deep thinking among chemical manufacturers, at the same time would have liked to hear Mr. Smith suggest constructional details towards an after-war policy.

Mr. A. T. SMITH, in reply to Dr. Armstrong, submitted that the element of "cost" should not be ignored in the University training of the works-chemist. He hoped that good would arise out of the war, in the way of amelioration of the conditions of manufacture and in better house accommodation for the workpeople, as also in the direction of improved relations between masters and men being permanently established.

Communication.

FURTHER EXPERIMENTS ON THE COMBINED SULPHUR CONTENT OF SLOW AND FAST VULCANISING PLANTATION PARA RUBBER.

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In a previous paper (this J., 1917, 36, 16.) we anticipated that a general agreement would be found to exist in the combined sulphur content of vulcanised rubbers showing the same state of cure as determined by the load-stretch curves. Further we showed that in the case of "slab," unsmoked sheet and crêpe prepared from the same latex (optimum time of cure 13½ hours, 2½ hours and 3½ hours respectively), coincident load-stretch curves of the three types obtained at different times of cure as above corresponded to substantially the same combined sulphur content. It remained to ascertain whether certain small differences could be attributed to a general higher combined-sulphur content in the case of fast-curing rubbers, such as slab and sheet compared with ordinary crêpe.

The combined sulphur of some thirty samples of vulcanised rubber at the optimum state of cure as determined by our standard optimum load-stretch curve was therefore estimated. Some of these rubbers were vulcanised from samples submitted for vulcanisation tests by estates, others were the normal experimental samples of our own factory, while others again were prepared by special methods. With such variously prepared samples it can reasonably be expected that the figures are fairly representative of first-grade plantation Para rubber. The optimum times of cure (O.T.C.) varied from 1 to 3½ hours; the mixing employed was, as before, 10% sulphur and 90% rubber, and the temperature of curing was 140° C. (this temperature applies to all our work on vulcanisation).

Method of estimation of sulphur.

The method of estimation of the combined sulphur is that described in our previous paper above referred to. A small improvement in the method should first be recorded. It was found that if a strand of platinised asbestos was laid lengthways along the paper packet containing the sample, before pushing the latter into the inner combustion tube, the last stages of combustion to a white ash were considerably hastened. In addition, the presence of the strand of platinised asbestos, which was looped back over the mouth of the inner combustion tube, caused a quick initial ignition, thus avoiding the necessity for the rapid current of gas originally advised.

Combined sulphur content at optimum time of cure.

In Table I. are set out all the details regarding the samples investigated. In column 4 of this table the percentages of combined sulphur found are enumerated, while in column 5 certain of these percentages have been corrected. The corrected cases are those in which the load-stretch curve did not *exactly* coincide with the standard. The basis of correction was as follows:—Near the optimum time of cure an extra period of cure of 15 minutes increases the combined sulphur content of crêpe by about 0.3%, of sheet by about 0.5%, and of slab by about 0.7%*. Again the same amount of curing, *viz.*, 15 minutes near the optimum time of cure, causes a shift in the load-stretch curve near the breaking point of about 8 mm. for crêpe, 10 mm. for sheet, and 12 mm. for slab on the scale employed (see Diagram 1). Hence 1 mm. is equivalent to 0.4% sulphur in crêpe, 0.05% in sheet, and 0.06% in slab. So long as this simple "rule of three" method of correction is restricted to very small intervals it may be regarded as accurate.

Column 7 shows the variations in the thickness of the vulcanised test rings; but in these experiments no connection can be traced between the thickness of the test rings and combined sulphur content at optimum time of cure. Other experiments which have not yet been published show that a relationship does exist between the thickness of the test ring and the load-stretch curve, those for thicker rings appearing more curved.

In Diagram 1 the curves are our standard O.T.C. curve (X) and the curves of the two samples in the table showing the greatest deviations therefrom. The average rate of curing is also made clear, a maximum separation between curves of about a centimetre corresponding to 15 minutes' curing. This is conveniently measured near the breaking point, when the curves are approximately parallel.

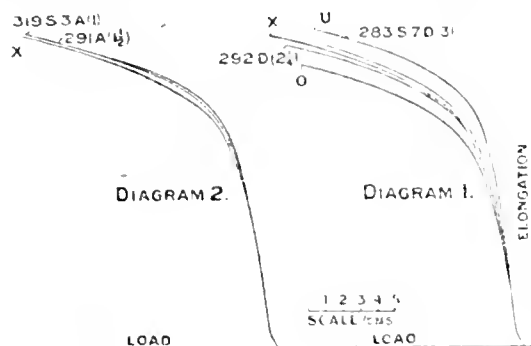
Diagram 2 shows two curves of somewhat irregular type and it may be noted that in the present samples, such irregularities as exist, lie in the direction of increased curvature. So far

TABLE I.

Ref. No.	Cure over + under - O.T.C. mm.	Hours vulcanised.	Percentage sulphur.		Thick-ness of rings. mm.	Break- ing load. (Kilos. per mm ²). A.	Elong- ation at break. (Orig. length = 100.) B.	Pro- duct. (A B)	Age of sample months.	Observations	Type, etc., of rubber.
			by analysis	as corrected for O.T.C.							
289B	-3	1½	4.42	4.60		5.15 5.2	1.34	945	1266	5	Slab, coag. sulphuric acid. Estate sample.
289C	-1½	21	4.42	4.49		5.3 5.2	1.33	1009	1341	5	Sheet, coag. acetic acid. Estate sample.
289D	-3	21	4.37	4.52		5.1 5.1	1.24	990	1227	5	Sheet, coag. sulphuric acid. Estate sample.
304A	-2	21	3.95	3.84		5.3 5.3	1.13	971	1097	3	Smoked sheet, diates latex. Estate sample.
304B	+½	21	4.31	4.28		5.1 5.15	1.05	956	1003	3	Pale crêpe, concentrated latex. Estate sample.
319S ₃ A	-3	1	4.05	4.23	4.37	5.3 5.3	1.20	1023	1227	½	Slab, coag. with 3 oz. acetic (5%) per gallon.
287S ₂ A	-1½	1½	4.33	4.42	4.30	5.2 5.15	1.33	1035	1376	1	Slab, coag. with 3 oz. acetic (5%) per gallon.
287S ₂ C	+1½	21	3.83	3.79	3.79	5.25 5.2	1.21	1011	1223	½	Sheet, coag. with 3 oz. acetic (5%) per gallon.
319S ₁ A	0	11	4.50	4.50		5.3 5.3	1.24	1020	1264	4	Slab, coag. with 3 oz. acetic (5%) per gallon.
297S ₁ F	+½	11	4.27	4.20	4.02	5.15 5.15	1.37	1020	1397	1	Thin sheet, rolled up wet; with 3 oz. acetic (5%) per gallon.
299A	+1½	11	4.74	4.65		5.25 5.2	1.38	998	1377	4	Slab, coag. with 3 oz. acetic (5%) per gallon.
299C	0	3½	4.20	4.20	4.31	5.25 5.25	1.20	990	1271	3	Slab, coag. with 3 oz. acetic (5%) per gallon. Soaked in running water 10 days; then crêped.
291A	-3	1½	4.38	4.56		5.15 5.1	1.27	1009	1281	4	Slab, coag. with 3 oz. acetic (5%) per gallon.
291C	-1½	21	4.54	4.63		5.15 5.15	1.12	979	1096	1	Slab, coag. with 3 oz. acetic (5%) per gallon. soaked 6 days in serum; then crêped.
291K	0	1½	4.51	4.51		5.5 5.55	1.26	1009	1271	4	Slab, coag. with 3 oz. acetic (5%) per gallon. In water 6 days, drained 6 days; then crêped.
292A	0	1½	4.63	4.63		5.25 5.3	1.36	990	1358		Slab, coag. with 3 oz. acetic (5%) per gallon. Kept for 6 days; then crêped.
292B	-1½	1½	4.60	4.69		5.35 5.25	1.22	990	1207	3	Slab, coag. with 3 oz. acetic (5%) per gallon. Kept for 12 days; then crêped.
292D	+3	21	4.75	4.57	4.70	5.05 4.95	1.35	977	1310	3	Slab, coag. with 3 oz. acetic (5%) per gallon; in running water 6 days, drained 6 days; then crêped.
301S ₁₀ B	-3	1½	4.66	4.86	4.70	5.2 5.2	1.27	1003	1273	1	Slab, coag. with excess tartaric acid.
283S ₂ D	0	3	4.16	4.16		5.1 5.05	1.17	975	1140	4	Crêpe, coag. with 3 oz. acetic (5%) per gallon.
283E	0	3	3.95	3.95		5.05 5.0	1.02	966	985	4	Crêpe, coag. with 1½ oz. acetic (5%) per gallon.
283C	0	1	4.35	4.35		5.25 5.3	1.16	981	1137	4	Slab, coag. with 1 oz. acetic (5%) per gallon.
283S ₆ B	-½	1	4.48	4.51		5.3 5.25	1.38	1012	1396	4	Slab, coag. with 1 oz. acetic (5%) per gallon.
283C	+3	1	4.55	4.37		5.25 5.25	1.36	992	1349	4	Slab, coag. with 1 oz. acetic (5%) per gallon.
283D	-3	21	3.89	4.00	4.02	5.05 5.05	1.16	977	1133	4	Crêpe, coag. with 3 oz. acetic (5%) per gallon.
283F	0	21	4.23	4.23		5.15 5.15	1.21	975	1179	4	Crêpe, coag. with 1 oz. acetic (5%) per gallon.
283S ₇ B	0	1½	4.64	4.64		5.2 5.3	1.30	1006	1307	4	Slab, coag. with 1 oz. acetic (5%) per gallon.
283D	-3½	3	3.69	3.82		5.3 5.3	1.10	991	1090	4	Crêpe, coag. with 3 oz. acetic (5%) per gallon.
283S ₈ B	-1½	1½	4.83	4.92	4.79	5.15 5.15	1.13	974	1100	3½	Slab, coag. with 1 oz. acetic (5%) per gallon.
283S ₂ D	-1½	3*	3.59	3.64		5.2 5.3	0.98	958	938	4	Crêpe, coag. with 3 oz. acetic (5%) per gallon.
283E	0	3	3.80	3.80		5.25 5.2	1.12	978	1095	4	Crêpe, coag. with 1 oz. acetic (5%) per gallon.
333A	0	11		4.46		5.35 5.4	1.30	1007	1300	1	Slab, coag. with 3 oz. acetic (5%) per gallon.
333B	0	3½		3.53		5.0 5.0	1.26	970	1222	1	Crêpe, coag. with 3 oz. acetic (5%) per gallon.
221S ₇ A	0	1		4.22		5.5 5.5	1.14	1031	1175	½	Slab, coag. with 3 oz. acetic (5%) per gallon.
185A	0	1½		4.50		—	—	—	—	1	Slab, coag. with 3 oz. acetic (5%) per gallon.
185B	0	21		4.20		4.9 4.6	1.49	986	1380	1	Sheet, coag. with 3 oz. acetic (5%) per gallon.
185C	0	3		4.00		4.7 4.9	1.28	975	1245	1	Crêpe, coag. with 3 oz. acetic (5%) per gallon.
244A	0	1½		4.48		4.9 —	—	—	—	1	Slab, coag. with 3 oz. acetic (5%) per gallon.
244B	0	21		4.35		—	—	—	—	1	Sheet, coag. with 3 oz. acetic (5%) per gallon.
244C	0	3½		3.80		—	—	—	—	1	Crêpe, coag. with 3 oz. acetic (5%) per gallon.

* Figures taken from standard combined-sulphur content curve (this J., 1917, Vol. XXXVI. No. 1).

this question of curve irregularity has not been followed up at all closely, but it is possible that the determination of the combined sulphur content of a fair number of samples showing irregularity in various directions, might throw considerable light on the problem of vulcanisation.



In Table II, the results are arranged according to the number of hours of vulcanisation, and, where more than one figure is available, the average percentage of sulphur is set out for each time of cure. Here the necessity of dealing with average, instead of separate figures was forced upon us by the comparatively large individual variations between the samples. The magnitude of these variations is sometimes nearly as great as the sulphur content differences at O.T.C. existing

TABLE II.

Period of vulcanisation required to give standard load-stretch curve, Hours.	Percentage of combined sulphur (from Table I).*							Mean value.
1	4.30	4.35	4.51	4.37	4.22			4.35
1 1/2	4.36	4.50	4.65	4.60	4.64	4.85		4.62
1 1/4	4.48							
1 3/4	4.50							
1 1/2	4.11	4.56	4.51	4.63	4.78	4.46		4.51
1 1/4	4.60							
2 1/2	4.49	4.52	3.78	4.63	4.63	4.20		4.37
2 1/4	4.28							
2 3/4	4.35							
2 1/2	3.84	4.01	4.23					4.03
3	4.16	3.95	3.82	3.64	3.80	4.00		3.90
3 1/2	3.80							
3 1/4	3.53							
3 1/2	4.25							

*Where original and repeat figures are available the mean value is brought forward from Table I.

between slab and crêpe, so that only by averaging is it possible to make these type-differences stand clearly out. Diagram 3 shows how the combined-sulphur content falls at an increasing rate as the optimum time of cure increases, the figure for one hour being the only important exception. While only average results are shown on the diagram (for it is not possible to attach much importance to individual figures when averages have been used as the basis of the curve), yet it will be seen that the one-figure results available fit into the curve fairly well. The large number of results now available enable us to widen our originally suggested limits for sulphur content, viz., from 1%—1 1/2% to 3.7%—4.6%. As against this extension of the limits it may now be stated that ordinary crêpe (optimum time of cure about 3 hours) falls between 3.7% and 4.1% and slab between 1.2% and 4.6%.

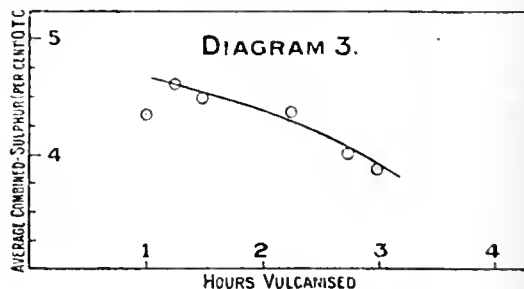
Other recently published results.

Schidrowitz and Goldsborough in a note in the India Rubber Journal (April, 1915, 51, 505; see this J., 1916, 550) gave nine results for combined sulphur at "correct cure," the figures ranging from 2.03 to 4.86%. Later, in the same journal, de Vries published further figures on the same subject (this J., 1916, 1226; 1917, 296); his figures, however, like our own, cover a range of about 1%. Further, of the nine figures published by de Vries, five relate to first latex crêpe and the range here is less than 0.5%; his other figures refer to samples coagulated by heat, smoking, etc. The fact that the range of de Vries' figures is similar to our own is important; the actual percentage of sulphur is of secondary importance, since de Vries vulcanises at a different temperature, viz., 148°C., and uses a different rubber-sulphur mixing, viz., one containing 7.5% of sulphur.

Relation of vulcanisation coefficient to physical properties.

De Vries claims "that he has definite proof that the percentage of combined sulphur is quite independent of the state of cure as expressed by the position of the stress-strain curve, and that it is possible to bring the rubber to the 'correct' or to any chosen standard cure (as judged by the curve) with other and quite arbitrary coefficients of vulcanisation." He produces, by vulcanising for one hour, a much undercured rubber containing only 2.85% of combined sulphur and subjects it to a temperature of 70°C. for 11 × 6 hours. In this way the sulphur content remains practically constant but the physical properties undergo a very marked change.

The stress-strain curve now indicates a correctly cured, instead of a much undercured rubber. "The same position of the curve (correct cure) is reached" in the ordinary way by curing for 1 hour 40 mins. but in this case the combined sulphur rises to about the ordinary figure, 4.49%. According to this treatment it appears that samples can be produced containing almost any percentage of sulphur up to, but not exceeding the normal figure obtained by direct curing; for from the experiments described it does not appear that samples can be made to contain more combined sulphur than their normal figure. We are not on the present evidence prepared to regard it as proved "that the mechanical properties (position of curve) and the coefficient of vulcanisation are two independent qualities of the vulcanised product." It may well be that two very different vulcanisation products are produced. The product with the abnormally low sulphur content is apparently an undercured rubber which has undergone what really amounts to an accelerated



ageing period. Instead of allowing vulcanised samples to stand for several months at ordinary temperatures de Vries employs a few days at 70°C. and instead of ageing a normal product he ages an undercured specimen. The ageing effect thus obtained, instead of deteriorating a correctly cured rubber, improves the physical

properties of an undercured one. A vulcanised product prepared in this way may or may not answer the ordinary purposes and fulfil the ordinary requirements of vulcanised rubber. De Vries does not publish the curves obtained from these low sulphur-content products, but one assumes by the expression "the same position of the curve is reached" that the curves are coincident, or, at any rate, are identical in type. Such identity even may be fortuitous and the mechanical properties in the wider sense of the term may be far from identical.

Our own work on ageing samples of crumbed vulcanised rubber indicates that the sulphur falls (possible loss of sulphur as SO_2 as well as ascertained accumulation of sulphuric acid in the rubber which means loss of sulphur as such), so that these low-content products may be produced by the decomposition of sulphur and rubber already combined while, *pari passu*, slow combination of free sulphur may proceed to an approximately equal extent thus keeping the combined sulphur content at the same level.

We have also stated in a previous paper (this J., 1916, 35, No. 20) that when the vulcanised product is tested almost six months after vulcanisation, the shifting of the curve, in the case of undercured, correctly cured, and slightly overcured samples (as determined by the load-stretch curve obtained by testing the samples three days after vulcanisation) represents an extra cure of about $\frac{1}{4}$ hour under the conditions of vulcanisation employed. Whether the combined-sulphur content changes, we have not yet determined in our own samples aged in this way. Experiments on a large number of samples containing different amounts of total sulphur and covering a large range of under and overcuring, are now being carried out, the samples being left at ordinary temperatures for periods of six months and one year. It is hoped by these experiments to throw more light on the question of ageing of the vulcanised product. De Vries' experiments are, in our opinion, essentially accelerated ageing experiments, and may be of considerable value from the point of view of a rapid method of conducting such tests. Our experiments, referred to above, indicate that, in order to obtain a vulcanised product which ages satisfactorily, a cure of about $\frac{1}{4}$ hour less than that given to the samples which yield maximum tensile figures when tested within three days after curing, should be employed. Very recent experiments, in which the vulcanised specimens were tested 2 hours, 1 day, 2 days, and 3 days after vulcanisation show that the shifting of the curve within these limits is slight and represents an extra cure of about 2–3 minutes under the conditions of vulcanisation employed. The last period, viz., three days' rest between vulcanisation and testing, is that adopted in all our experiments hitherto. It would be instructive to know whether the total sulphur content remains constant. Moreover from the purely theoretical standpoint, the fact that one cannot prepare an apparently correctly cured sample containing more than the normal amount of sulphur certainly indicates that some interdependence exists between physical properties and combined-sulphur content.

developments. The chemical industry in Japan has shown great expansion since the commencement of the war, during which period at least 20 new companies have been formed, with a combined capital of approximately £3,000,000. These new companies operate some 28 factories, and among the chief productions are ammonium sulphate, potassium chloride, caustic soda, bleaching powder, nitre, potassium sulphate, potassium carbonate, sodium sulphide, sodium chloride, sodium peroxide, iodine, stearic and other fatty acids, nitric acid, glycerin, oils, dyes, drugs, fertilisers, disinfectants, phosphorus, etc. It is estimated that there are 80 firms in Japan engaged in producing potassium chloride. Large stocks of this commodity are on hand, the market is overstocked, and prices have dropped during the present year. Formalin is now being produced in Japan; the output is devoted to home requirements. One company is producing soda by means of electricity, and is stated to be the first concern in Japan to use an electrical process in this connection.

A company is manufacturing indirect dyes exclusively for domestic needs, while direct dyes are to be produced for the export trade. This company is under the regis of the Government. Another company claims to have produced an ultramarine blue equal to that formerly imported into Japan from Germany.

Metals.—The future of the zinc industry in Japan is generally considered to be exceedingly good, and it is expected that a large export trade will be carried on after the war. One company is manufacturing zinc for the export trade. Much of the Japanese zinc ore contains other metals, such as gold, silver, and copper, and the refining of these metals is carried on in conjunction with the treatment of the ore. Five new companies, with a total combined capital of £760,000, have been organised, and operate six works for the treatment of zinc ore produced in the country.

A company, with a capital of £100,000, was formed in March, 1916, for the purpose of producing aluminium. The process to be used, it is stated, is different from that used in Europe and the United States. Alumina is obtained from a clay which is a special product of Japan, and is treated by an electrolytic process.

A company was formed in January, 1917, with a capital of £10,000 for the purpose of manufacturing sheet lead for use in chemical industries. The company is turning out sheets measuring 10 feet by 4 feet, and it claims that its product is superior to any hitherto manufactured in Japan.

Paints.—Three new companies, with a combined capital of £90,000, have been formed for the purpose of manufacturing paints, the chief products being zinc and house paints, paints for ships' bottoms, antiseptic paints, rust-preventing paints, and paint substitutes. One company is producing zinc powder successfully, there being a good local demand; paints for ships' bottoms were previously all imported from the United Kingdom.

Oils and grease.—Six companies have been established, with a total combined capital of £1,645,000, for the production, refining, etc., of mineral oils. A company has been formed, with a capital of £25,000, for the purpose of manufacturing fish grease, used in the manufacture of soap and glycerin.

Sulphuric acid.—The increased export of sulphuric acid from Japan to Russia and China since the beginning of this year has led to steadily advancing prices of this commodity in Japan, and a considerably increased output. Several manufacturers of fertilisers have reduced their output, and are devoting their energies to the production of sulphuric acid, while a number of companies have been established for the production of this chemical alone. It is estimated

Industrial Notes.

JAPANESE CHEMICAL INDUSTRIES.

H.M. Vice-Consul at Tokiō has forwarded the following particulars as to recent industrial developments in Japan:—

Chemicals and dyes.—In point of numbers, the chemical industry occupies the first place in recent

that the rate of production of sulphuric acid in Japan at present is some 582,500 tons per annum. Of this quantity about 421,000 tons is consumed by manufacturers in the production of sulphate of ammonia, hydrochloric acid, etc., leaving some 160,000 tons available for general requirements in the country, which is about 100,000 tons a year. Thus there is about 60,000 tons available for export. It is taken for granted that on the conclusion of the war the export trade will fall off, and it is also probable that there will be a considerable decline in domestic requirements. It is estimated that the output of sulphuric acid in Japan, if continued at the present rate of production, will be some 100,000 tons in excess of the demand on the resumption of normal conditions.

Miscellaneous.—The following companies have been formed in various industries, the capital of each being shown within brackets:—

A company (£200,000) has been organised for the manufacture of imitation celluloid. It is claimed that the product, besides serving the same purpose as celluloid, can also be used as a substitute for lacquer, artificial leather and rubber, and also as a water- and heat-resisting material in constructional work. The material used is bean cake, and as this is both cheap and plentiful it will be possible to supply the imitation celluloid at a lower price than the real article.

A company (£100,000) has been formed to produce plate glass, and another company will operate a glass factory.

A company was formed in July, 1916 (£100,000), for the purpose of manufacturing explosives, and will produce dynamite for industrial as well as military needs. It is controlled by the Government and has been granted special facilities.

TUNGSTEN MANUFACTURE AT WIDNES.

An interesting account of the works recently erected at Widnes for the manufacture of tungsten, appeared in the Oct. 26th issue of *Engineering*. Our sources of supply of tungsten from abroad having been closed owing to the war, the Government sanctioned the erection of works for the production of tungsten powder; these works were erected by the co-operative action of a number of makers of high-speed steel, of which tungsten is so important a constituent. In order to secure an adequate supply of raw material, the High Speed Steel Alloys, Limited (the company controlling the works), has purchased mines of tungsten ore at Tavoy in Burma, where active development is in progress.

The ore used at Widnes is wolframite, which is received in the form of small cubes, which will easily pass a one-inch mesh. The ore is first sampled and assayed, and is then raised to a series of bins on a higher floor, lots of ore of different quality being kept separate. From these bins it passes to grinding machines and thence to calcining furnaces, magnetic separators, or fine grinding mills, according to its nature. Ores containing tin or bismuth are subjected to magnetic separation, the tungsten mineral being slightly magnetic. The finely ground ore is now mixed with the calculated quantity of sodium carbonate and the mixture heated to about 1000° C. in hand fired reverberatory furnaces and at the same time subjected to constant rabbling.

The ore mixture is selected to yield a uniform furnace product, as far as is practicable. The furnace charge is drawn off into slag pots, and when cool is broken up by hammers and then fed to a jaw-breaker, where it is reduced to about

1 in. cubes, and is then finely ground and the sodium tungstate extracted in steam-heated circular vats. The solution is passed through filter-presses and is then decomposed by hydrochloric acid, the tungstic oxide being washed by decantation, passed through centrifuges in which it is obtained in the form of a thick, yellow paste, and dried. Schedite, tin-tungsten slimes, tin residues mixed with small quantities of tungsten ore, and other residues are treated in a separate plant and the impure sodium tungstate purified before it is used in the main process. The tungstic oxide is reduced (the procedure is not described) and the metal ground to powder, washed, and dried.

Given adequate supplies of ore, the works are capable of producing daily three tons of tungsten powder of 99% purity—a quality higher than that obtained in the German product.

OPEN-HEARTH STEEL WORKS.

At the September meeting of the Iron and Steel Institute, reports were received from the Committee appointed to inquire into metallurgical and mechanical practice in open hearth steel works. In order to investigate the causes of the smaller output of British furnaces as compared with foreign practice, the Metallurgical Section of the Committee submitted a number of questions, the replies to which indicated that in foreign practice the proportion of scrap used—up to 80%—helps output materially in cold-charged basic open-hearth practice, if used in conjunction with suitable pig iron, which is generally low in phosphorus and silicon. *e.g.*, Si not over 0.75, P 0.15, S 0.05, Mn 2.0—4.0%. For hot metal it does not appear necessary to have so low a phosphorus content. *e.g.*, Si 0.4, P 1.8, S 0.06, Mn 1.25%. The process employed and the size of furnace are not deciding factors. Output in this country is greatly inferior to that abroad under comparable conditions in either of these respects. The question of special design of furnace is considered of great importance, and steps are being taken to prepare a standard design. The importance of general lay-out is also emphasised. There is a general opinion that the gas-producers are responsible for loss of output in this country, and that more care is devoted to them abroad. An abundant and regular supply of gas containing less than 10% of carbon dioxide (preferably less than 5%) is necessary. Labour conditions in this country, as compared with the Continent, are generally agreed to be detrimental to output; in fact it is considered that this factor contributes more largely than any other to low output. The stricter specifications required or the poorer raw materials are also believed to affect output. The importance of a supply of suitable pig iron is also emphasised. The following have also been put forward as causes contributing to larger outputs abroad: improvement of refractories; use of larger tap-holes; less time occupied in fettling and cooling furnaces for fettling; quicker charging. Some instances of increased output due to slight alterations in design of the furnace are recorded. A method of working basic open-hearth charges of all molten metal is mentioned, by means of which a 50-ton charge has been tapped in 7 hrs. 20 mins. from starting to charge; very little limestone and oxide are put in the furnace before the metal, and after the molten metal is charged, oxide and lime are fed in rapidly and continuously, thus causing the first impure slag to flush off.

The question of labour is regarded as a most

important one. The wages are so high that it is useless to expect men to make extra exertion to gain more. It seems, therefore, that in order to increase the output it is necessary to reduce the effort required from the workman by every possible means, and this can only be done by a

well-laid-out and well-organised plant. Output might also be improved by getting better educated sample-passers and foremen, and by encouraging more highly educated men to go in for melting. In view of the very handsome remuneration this should not be difficult.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

English.—6d. each, to the Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London W.C.

United States.—1s. each, to the Secretary of the Society, who has to furnish the U.S. Patent Office with the following data:—

Patent number, date, name of patentee, and title of invention.

French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, Belin et Cie., 56, Rue Feron S. Paris (3e.).

Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

Extraction processes; Discontinuous.—L. F. Hawley. *J. Ind. Eng. Chem.*, 1917, 9, 866—871.

THE ratio between the volume of solvent drained off and that retained by the material to be extracted may be termed the *solvent ratio*. With any solvent ratio, a , a single washing will remove $a/(a+1)$ of the original substance, leaving behind $1/(a+1)$. In the case of n successive treatments with fresh solvent, the residual matter amounts to $1/(a+1)^n$ of the original. By means of these and other derived formulae, tables have been constructed showing the results respectively obtainable by repeated washings with fresh solvent, and by multiple series (counter-current) extraction. These results prove that the common belief is correct that in washing with a limited amount of solvent it is better to wash several times with small portions than once with the whole amount. For example, 4 vols. of solvent in 4 equal parts effect a better extraction (93.75% solvent ratio 1) than 10 vols. used all at once (90.9% solvent ratio 10). A greater proportion of soluble matter is removed per unit of solvent by multiple series extraction than by repeated extraction with fresh solvent. As a general rule, a somewhat less complete extraction, but greater concentration of solution, is obtained when the material is not saturated with solvent at the outset. In practice it has been found best to use sufficient solvent just to cover the material. If much more is used the portion above the charge is not utilised efficiently, and if much less is used the charge is unequally extracted. By giving two consecutive treatments with fresh solvent the concentrations of the solutions obtained will be essentially the same as those obtained by doubling the solvent ratio, but the percentage recovery is better. When high concentration is required, even at the expense of incomplete extraction, every alternate charge may be treated with fresh solvent, whilst every other charge is finally treated with solvent which has been used once before. The method in which each charge is treated with its own quantity of solvent independently, while shut off from the rest of the system, and the extractors subsequently connected while the solvent is pumped through the system, is essentially faulty. Mixing of the different lots of solvent takes place without concentration of the solution. To obtain a high solvent ratio, one charge of solvent must be drained off as completely as possible before the next is applied.—C. A. M.

Dryer; The Schilde "universal".—Parow. *Z. Spiritusind.*, 1917, 40, 13. *Bull. Agric. Intell.*, 1917, 8, 1034—1037.

A DRYING chamber containing a stack of ten

trays, one above another, is traversed by an upward current of hot air, drawn by a fan situated in the air-outlet at the top. Before entering the bottom of the chamber the air is warmed to 60° — 70° C. in a heater situated at one end of the apparatus. A second heater, situated between the fifth and sixth trays, divides the stack into two sets, and further heats the air to 85° — 95° C. before it passes through the upper set. The apparatus works continuously, each tray occupying in turn all positions from the top to the bottom. At intervals of about 20 mins. the lowest tray, containing the dried product, is withdrawn and after being re-charged with fresh material it is introduced into the top position. All the other trays then take up lower positions without being withdrawn, except the lowest one of the upper set which is transferred to the top position in the lower set; this affords an opportunity for turning the half-dried material. The withdrawal and transference of the trays is effected by means of an automatic hoist situated at one end of the apparatus and actuated by levers. The area of the trays is about 6 sq. metres and the drying of each tray-full of produce, *e.g.*, 120 kilos. of sliced swedes, occupies about $3\frac{1}{2}$ hours. The apparatus can be worked by one man and two women. Two are in use by the Berlin Corporation for the drying of vegetables (*cp.* this *J.*, 1917, 937).

—J. H. L.

Some theoretical aspects of electrical fume precipitation. Strong. *See* XI.

PATENTS.

Acids and other liquids; Vessels for containing.—W. Hayhurst, Accrington. Eng. Pat. 109,194, Jan. 6, 1917. (Appl. No. 310 of 1917.)

IN metal or other vessels lined with tiles, for containing acids, etc., the joints between the tiles are made with material capable of being vulcanised and are then vulcanised in position.

—W. H. C.

Sea-water evaporators for use on board ship. G. and J. Weir, Ltd., and J. G. Latta, Glasgow. Eng. Pat. 109,196, Jan. 15, 1917. (Appl. No. 705 of 1917.)

THE concentrated brine is discharged from the evaporator by an ejector actuated by a liquid, a valve being placed between the brine tank and the inlet to the ejector to enable the discharge of brine to be controlled.—W. H. C.

Fillers; Process for cleaning—in connection with the purification of sugar, oils, and chemicals. P. L. Wooster, Yonkers, N.Y. U.S. Pat. 1,240,290, Sep. 15, 1917. Date of appl. Aug. 17, 1916.

THE material clogging a deep filter bed is with-

drawn by vacuum from the lower portion, and the action is continued to withdraw the clogging material gradually from the upper portion of the bed through the previously treated lower portion.—J. H. P.

Filter. F. J. Sweetland, Montclair, N.J. U.S. Pat. 1,249,385, Sep. 18, 1917. Date of appl. May 9, 1914.

"METALLIC fibre" or "metallic wool" is woven into the filter cloth and extends across only a part of the sheet.—J. H. P.

Drying of hollow articles. E. Williams and W. H. Bunch, Birmingham. Eng. Pat. 109,715, Dec. 20, 1916. (Appl. No. 18,253 of 1916.)

In drying hollow articles which are closed at one end, the article, for example a projectile shell, is mounted with its mouth downwards on a support. A current of heated air is passed inside the shell by means of a pipe which extends nearly to the end of the shell.—J. H. P.

Dryer; Rotary — W. W. Swencel, Bloomburg, Pa. U.S. Pat. 1,240,386, Sep. 18, 1917. Date of appl. Oct. 12, 1916.

THE material to be dried passes through a number of inclined revolving drums, arranged one above another and enclosed in a housing. The drums communicate with a vertical conduit at one end and with a stack at the other. Hot air is drawn in at the top of the housing, circulates round the drums, leaves the housing at the bottom, and is then driven by a fan into the vertical conduit and through the drums to the stack.—J. H. P.

Concentrating liquids; Method and apparatus for — T. C. Oliver, Charlotte, N.C. U.S. Pat. 1,240,591, Sep. 18, 1917. Date of appl. Feb. 7, 1917.

THE liquid to be concentrated is sprayed down a tower and falls into a horizontal conduit or flue where it is agitated in a current of hot gases. The concentrated liquid passes out of the flue into another, situated at a lower level, where it is again agitated and any solid matter which may be deposited is removed. Means are provided for withdrawing waste gases and vapours from the tower.—J. H. P.

Air washing screen. W. N. and C. I. Haden, Trowbridge, Wilts. Eng. Pat. 109,213, Mar. 13, 1917. (Appl. No. 3660 of 1917.)

THE L-shaped laths of the screens between the ribs of which the air passes, have angular grooves or ribs with one side set at an angle of about 90° to the plane of the screen. Some or all of the L-shaped laths may have their two parts grooved on opposite sides, i.e., one on the outside and one on the inside.—W. H. C.

Centrifugal extractors; Safety mechanism for — W. Bartholomew, Assignor to Troy Laundry Machinery Co., Ltd., Chicago, Ill. U.S. Pat. 1,238,085, Aug. 28, 1917. Date of appl. Mar. 20, 1912.

THE casing of a centrifugal machine has a cover provided with a latch for locking it when closed. When the basket is rotating, the air current produced acts on a vane attached to an inclined oscillating rod on the casing and locks the latch, so that the cover cannot be opened while the drum is in motion. When the drum stops, the rod overbalances by gravity and unlocks the latch.—W. H. C.

Producing and condensing distillate; Apparatus for — G. Burton, Stapleton, Ala. U.S. Pat. 1,238,256, Aug. 28, 1917. Date of appl. Sept. 2, 1915.

THE condensing coil of a still has a pipe connection provided with a valve by means of which the cooling liquid in the condenser may be admitted to the interior of the coil.—W. H. C.

Licivator. J. M. Wilmer, Lancaster, Pa. U.S. Pat. 1,238,469, Aug. 28, 1917. Date of appl. May 5, 1916.

A SERIES of inclined pans are mounted step-wise and each is provided with a receiving basin in which is a rocking, grinding, and agitating cradle, means being provided for supplying compressed air to the cradle intermittently. The pans are also provided with perforated reciprocating, rubbing and scouring plates and are heated from below.—W. H. C.

Cooling apparatus. S. E. Seaman, Brooklyn, N.Y., Assignor to Seaman Waste Wood Chemical Co., Inc., New York. U.S. Pat. 1,240,609, Sep. 18, 1917. Date of appl. May 27, 1916.

A PIPE connecting a retort and cooling apparatus contains a valve which is held in position by a counter-weight. Excessive pressure from the retort opens the valve, and a seal is formed by the material passing through the pipe line, thus preventing any escape of gases.—J. H. P.

Condenser or cooler. A. E. L. Seanes, Ashton-upon-Mersey, Assignor to the British Westinghouse Electric and Manufacturing Co., Ltd., London. U.S. Pat. 1,238,574, Aug. 28, 1917. Date of appl. Nov. 26, 1915.

TO prevent corrosion a perforated plate is arranged in front of, parallel to, and spaced away from the tube-plate of a surface condenser, the perforations in the plate being opposite the ends of the tubes. The perforated plate is made of a metal which is electro-positive to the metal of the tubes, and plate and tubes are in metallic connection.—W. H. C.

Agglomerating finely-divided material; Method of — H. Redman, Edgewood, Pa., Assignor to The Redman Chemical Co. U.S. Pat. 1,239,221, Sep. 4, 1917. Date of appl. Sep. 5, 1916.

THE finely-divided material is agitated with suitable nuclei in a rotating grading device, the larger nodules or agglomerates are continuously removed, and a binding agent is continuously added to the smaller agglomerates.—W. F. F.

Separating solid matters from fluids or fluids from fluids; Apparatus for — F. E. Moss, Wigan. U.S. Pat. 1,240,081, Sept. 11, 1917. Date of appl. Feb. 15, 1917.

SEE Eng. Pat. 109,315 of 1916; this J., 1917, 1088.

Drying apparatus. G. H. and J. H. Stroband, Amsterdam, Netherlands. U.S. Pat. 1,241,299, Sept. 25, 1917. Date of appl. Apr. 5, 1916.

SEE Eng. Pat. 100,403 of 1916; this J., 1916, 1145.

IIA.—FUEL; GAS; MINERAL OILS AND WAXES.

Pyrites from coal; Recovery of — E. A. Holbrook, Univ. of Illinois Bull., Aug. 20, 1917. Eng. and Min. J., 1917, 104, 513—514.

IN experiments on Illinois coal containing 1—6%

of sulphur, mainly as pyrites, from 81 to 87% of the pyrites was recovered in marketable form. The hand-picked pyrites and washery refuse was crushed, screened, and concentrated by ordinary ore-dressing machinery, the concentrate obtained containing 40–47% S and the coal by-product about 8% S, partly in the form of pyrites.

—W. E. F. P.

Gas making: Substitutes for coal in —. J. des Usines à Gaz. Gas J., 1917, 140, 115.

VARIOUS substitutes for coal, and the methods of using them as applied in gas works in France and Switzerland, are described. At Geneva, sawdust is added to the extent of 10% to the normal charge of coal in Bueh vertical retorts. As an alternative, logs of wood, 3 ft. in length, are used, the charge then being 260 lb. as against 1240 lb. of coal. Wood and coal are worked alternately on two benches, with the result that the tars produced are not acid. The furnaces consume 25% more fuel than normally; the yield of gas is 8570 to 8830 cub. ft. per ton and the wood gas is not separated from the coal gas. At another Swiss works (La Chaux-de-Fonds, Neuchâtel) sawdust is carbonised in horizontal retorts, 375 lb. of sawdust being mixed with 60 lb. of coal, against a previous coal charge of 990 lb. The carbonising period in retorts of 14 ft. 8 in. is six hours. The calorific power of the gas is 4200 calories and the high proportion of water in the tar (30%) has given trouble. At Neuchâtel, wood is used to the extent of 28% of the coal. Horizontal retorts 9 ft. 6 in. in length are used, charges of 150 to 210 lb. being carbonised in 4 hrs., giving 10,600 cub. ft. of gas per ton of a calorific power averaging 4300 calories. The use of wood leads to the removal of carbon deposit and to a porous condition of the refractory, hence coal and wood are used alternately. Acid products from wood have caused some corrosion, and lime is required in purification. In France (Arcachon, Gironde) heath roots have been used, giving a yield of 23.78% of gas and 22.84% of charcoal. With a charge of 130 to 165 lb. the carbonising period is 2½ hours. The charcoal is superior to pine charcoal and the quality of the gas is satisfactory. At Royan (Charente Inférieure) a cargo of spoil flour has been used, giving 11,300 cub. ft. of gas and 1600 lb. of coke from 1 ton 7 cwt. of flour. The coke was of good quality with scarcely any ash.—J. E. C.

Gasoline from natural gas in the United States.

ACCORDING to statistics issued by the United States Geological Survey, the year 1916 was one of marked expansion in the natural-gas gasoline industry in the United States. The quantity of raw gasoline extracted from natural gas and sold in 1916 was 104,212,809 gals., valued at 14,408,201 dols., as compared with 65,364,665 gals. in 1915, valued at 5,150,823 dols. The volume of natural gas from which the 1916 output of gasoline was recovered is estimated at more than 208,800,000,000 cubic feet. The number of plants for extracting gasoline from natural gas in the United States increased from 414 at the beginning of 1916 to 594 at the end of the year, and the combined daily capacity of all plants increased from 232,336 galls. to 484,448 galls. in the year.

Note: U.S. gallon = 0.833 Imperial gallon.)

Lubricating oils: Method of testing [viscosity of] —. R. Dubrisay. Ann. Falsif., 1917, 10, 301–304.

THE viscosity of lubricating oils at different temperatures may be determined by means of a glass tube on which are blown two bulbs. Marks are made just above and below the upper bulb

and also above the lower bulb. The oil is drawn up into the tube, the top of the tube is closed by a piece of rubber tubing and a pinch-cock, and the apparatus is placed vertically in a water-bath of the desired temperature. When the oil has reached this temperature, the tube is raised until the water-level is at the mark above the lower bulb, the level of the oil is adjusted to the upper mark, and the pinch-cock is opened, the time required for the level of the oil to sink from the upper mark to the one below the top bulb being noted. If a sufficiently large water bath is employed, the difference in level due to the flow of oil from the tube is negligible. The change in fluidity of an oil with change of temperature is practically the same when measured by this method as it is when determined by the ordinary viscometers.—W. P. S.

Bitumens: Relations in composition of different forms of natural —. C. P. Mabery. J. Amer. Chem. Soc., 1917, 39, 2015–2027.

SAMPLES of bituminous (Deerfield) coal, gilsonite, and grahamite had the following proximate composition:—

	Gilsonite.	Grahamite.	Coal.
	%	%	%
Volatile matter	56.0	44.52	38.42
Fixed carbon	44.0	28.00	58.29
Ash	—	5.51	2.31
Sulphur	0.02	—	9.69
Nitrogen	1.05	2.7	0.05

The bituminous coal, when distilled *in vacuo* in an electrically heated iron still, yielded 5.6% of distillate, consisting largely of a number of hydrocarbons of the series C_nH_{2n-2} , which closely resembled those forming the larger part of the adjacent Mahone petroleum. No hydrocarbons of the series C_nH_{2n-2} were found in the coal distillates, but were present in the petroleum, whilst hydrocarbons of the series C_nH_{2n} , which are generally present in petroleum, although not in Mahone petroleum, were constituents of the coal distillates. The sample of gilsonite (from Utah) yielded from 50 to 56% of distillate containing hydrocarbons of the series C_nH_{2n} and C_nH_{2n-2} , which resembled the same hydrocarbons in petroleum, and also a series of unsaturated hydrocarbons, which readily absorbed oxygen and became of a dark colour. The deep colour of crude petroleum is probably due to absorption of oxygen by similar unsaturated hydrocarbons, such as nonylene found by Mabery and Quayle in Canadian petroleum. Most varieties of petroleum contain small proportions of these hydrocarbons, which have a peculiar odour, and can be readily extracted with sulphuric acid. The sample of grahamite resembled the bituminous coal in appearance. When distilled under reduced pressure of 20 mm. it yielded 13.5% of distillate with sp. gr. 0.85 at 20°C., which had an odour resembling that of petroleum distillates. It contained a series of hydrocarbons closely resembling those obtained from gilsonite, suggesting a common origin. The large proportion of nitrogen compounds present in gilsonite, however, indicates that it stands in closer relationship to petroleum than does grahamite, which only contains a trace of nitrogen bases.—C. A. M.

Toughness of bituminous aggregates. Reeve and Lewis. See 1X.

PATENTS.

Pulverised fuel: Employment of — in the furnaces of steam generators. J. G. Robinson, Manchester. Eng. Pat. 109,063, May 26, 1916. (Appl. No. 7516 of 1916.)

POWDERED fuel is conducted by worm conveyors

to nozzles and is blown thence into the furnace firebox by means of an air blast, the proportions of air and fuel being simultaneously controlled in synchronism with each other. Secondary air, induced by the chimney draught, is introduced into the furnace, and the products of combustion pass through small holes in the furnace crown to the water-jacketed portion of the boiler. Additional air may be admitted if necessary above the furnace crown, the products finally passing through the tubes of the boiler. Ignition openings are provided adjacent to the burner nozzles for starting up from the cold, being closed during normal operation. Normally the air blower and fuel conveyor are driven by steam from the boiler itself, but a secondary prime mover is provided for starting up or for abnormal conditions.—J. E. C.

Combustibles for domestic and industrial use. S. Fachini, Milan, Italy. Eng. Pat. 101,703, Sept. 14, 1916. (Appl. No. 13,072 of 1916.) Under Int. Conv., Oct. 2, 1915.

BONES freed from grease, gelatin, and moisture, and then saturated with liquid or liquefiable fuels, such as the residue of mineral oil, are burnt in a special receptacle, the liquid being added gradually and continuously.—J. E. C.

Coke ovens and other gas-heated furnaces; Method of introducing combustion gases into the heating flues of— D. and E. A. Bagley, Westminster. Eng. Pat. 109,752, Apr. 26, 1917. (Appl. No. 5920 of 1917.)

GAS is introduced into the heating flues of a coke oven by means of gas conduits impermeable to gases and composed of fused silica or vitreous porcelain, thus preventing the union of gas and air prior to their introduction to the heating flue. Cold air may be circulated round these conduits to maintain a temperature below 1200° C. The conduits are protected from direct radiation of heat from the heating flues by perforated caps, whilst packing devices connecting the conduits to the gas main allow movement through expansion.—J. E. C.

Gas generators or producers. Külnier Bros., Ltd., and F. W. Knowles, Dewsbury. Eng. Pat. 109,710, Dec. 11, 1916. (Appl. No. 17,772 of 1916.)

IN a gas producer, steam passes through flues or ducts round the periphery of the furnace doors and thence into a perforated steam-box passing across the furnace. The floor of the furnace slopes from front to back, and by means of two openings in the steam-box any surplus condensation water is conducted to the bottom of the steam-box, thus keeping the latter cool.—J. E. C.

Gas producers. E. A. W. Jefferies, Assignor to Morgan Construction Co., Worcester, Mass. U.S. Pat. 1,240,220, Sept. 18, 1917. Date of appl., Jan. 2, 1913.

THE main section of a gas producer is rotated, whilst a fuel magazine concentric to this section remains stationary. The lower and forward end of the fuel magazine acts as a scraper to level the charge, the rear end being at a higher level, allowing a continuous feed of material into the producer. The height of the scraping edge is adjustable.

—J. E. C.

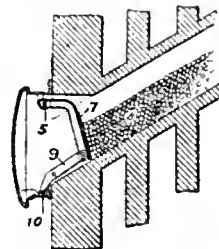
Hydraulic mains used in the manufacture of gas. Drakes, Ltd., and J. W. Drake, Halifax. Eng. Pat. 109,195, Jan. 8, 1917. (Appl. No. 338 of 1917.)

OVERFLOW connections and valves are fitted to a hydraulic main. In the event of the ordinary tar pipes becoming choked with tar or heavy

matter, these subsidiary overflow connections are brought into play by opening the necessary valves and closing valves on the normal tar outlet.—J. E. C.

Retort [; Gas —]. P. Plantinga, Cleveland, Ohio. U.S. Pat. 1,239,517, Sept. 11, 1917. Date of appl., Nov. 15, 1915.

AN inclined retort for coal distillation is provided with a stop plate, 7, pivoted at 5, so as to swing

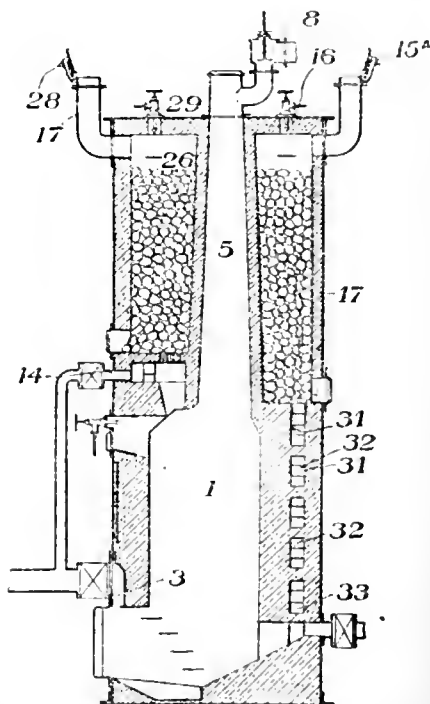


outwards away from the mouthpiece of the retort. The plate is locked in its normal position by a pivoted lever, 9, engaging in a depression, 10.

—W. F. F.

Gas producers. C. B. Tully and O. E. Yeo, Westminster. Eng. Pat. 109,323, Sep. 26, 1916. (Appl. No. 13,687 of 1916.)

A GAS producer comprises a lower generating chamber, 1, and an upper fuel supply chamber, 5, of smaller sectional area and having relatively thin walls. Chambers, 17, between the outer



wall and the supply chamber, are filled with refractory material and may be used for the generation of steam or for the cracking of oil. Thus during the "blow," air is admitted at 3 and 14. Completely burnt products pass upwards through the passages, 33, 32, and 31, and the chamber, 17, leaving the producer by way of the

valve, 15a, whilst producer gas from the chamber, 1, is burnt by the air from 14, and the products of combustion heat the refractory material in 26, passing out through valve, 28. During the "run," water is admitted at 16, and oil at 29, the steam entering the bottom of the producer; the fixed oil vapours mingle with the water-gas, and the carburetted water-gas passes through the section, 5, and is delivered through the valve, 8.—J. E. C.

Tar, tar vapours, and the like: Apparatus for extracting — from illuminating or other gases. J. W. Scott, G. F. H. Beard, and R. and J. Dempster, Ltd., Manchester. Eng. Pat. 109,152, Nov. 9, 1916. (Appl. No. 16,058 of 1916.)

APPARATUS for extracting tar, tar vapours, and the like from gases, comprises two concentric vertical cylinders, the inner vessel being provided in its lower part with horizontal scrubbing devices in the form of baffles, and a spray. The flow of gas is retarded in the annular space between the cylinders by means of baffles, which may be set vertically or in the form of a spiral; when vertical baffles are used, they are arranged so that the gas follows a tortuous path through the annular space. A series of vertical perforated screens is inserted at the top of the inner vessel, and the temperature may be regulated by means of an enclosed coil, fixed in the lower part of the inner vessel. The gas is introduced at the bottom of the inner cylinder, rises to the top, where the tar particles are caught on the vertical screens, and passes through apertures in the wall of the cylinder to the annular space, finally leaving the apparatus through an outlet at the bottom of the outer cylinder.—J. E. C.

Liquefied gas; Apparatus for producing —. L. Wolf, Chicago, Ill. U.S. Pat. 1,240,397, Sept. 18, 1917. Date of appl., Dec. 3, 1913.

GASES containing hydrocarbon constituents are passed through a cooling chamber, where easily liquefiable constituents are deposited, and are then subjected to high compression and severe refrigeration to liquefy further constituents. A portion of the liquefied gas is conducted to the first cooling chamber where by expansion it serves to cool the main stream of gases.—J. E. C.

Gas purifier. C. E. Reese, Caney, Kans. U.S. Pat. 1,240,368, Sept. 18, 1917. Date of appl., Jan. 10, 1916.

A GAS purifier comprises a casing, and a pair of intercoiled spiral walls in the casing forming a passage way between them. On the outer walls of the passage way is a series of spaced vertical baffles consisting of flanges curved in horizontal section to form pockets and provided with perforations which are not in alignment in adjacent baffles.—J. E. C.

Mineral oils; Method of converting highly viscous —, or highly viscous residues from the distillation of mineral oils, into hydrocarbons of less viscosity. I. Rosenberg, Berlin. Eng. Pat. 109,572, Feb. 8, 1917. (Appl. No. 1912 of 1917.)

HIGHLY viscous mineral oils are heated to about 400° C. under a pressure of 4–6 atmos. (carefully avoiding higher pressure) for $\frac{1}{2}$ –2 hours. Inter-molecular re-arrangement of the oil is thus brought about, but, under the prescribed conditions, decomposition is avoided. The product has approximately the same boiling point and specific gravity as the untreated oil, but has a much lower viscosity; it can therefore serve as fuel, or can be treated for the preparation of lubricating oil.

For example, Californian crude oil having a viscosity of 116 at 20° and 12 at 50° C. (Engler) is heated at 400°–415° C. under a pressure of $4\frac{1}{2}$ –5 $\frac{1}{2}$ atmos. for $\frac{1}{2}$ hr. The product has a viscosity of 22 at 20° and 4 at 50° C., and flash point 115° C. A current of steam is then passed through the oil, heated to 150° C., until a test specimen has a flash point of 160° C.—L. A. C.

Hydrocarbon product. Liquid fuel. W. A. Hall. New York. U.S. Pats. 1,239,999 and 1,239,100, Sept. 4, 1917. Dates of appl., May 7 and May 6, 1915.

A LIQUID fuel for internal combustion engines produced from mineral oil, has a composition approximately of carbon 85.9%, hydrogen 12.76%, and contains ethylenic and aromatic hydrocarbons. The sp. gr. is not less than 0.76, and the boiling point ranges from 33° C. to 110° C. Not less than 23% of the fuel is volatile below 100° C. A larger fraction boils below 80° C. than that of a paraffin distillate with a similar sp. gr., and the fuel is slow burning, ignites quickly, but is not liable to pre-ignition. Before refining the fuel is yellow, possesses an odour, and leaves a dark non-drying substance on evaporation, but the colour and odour may be removed by distilling with, or filtering through, fullers' earth, which removes the colloidal resinous matter.—W. F. F.

Gasoline; Manufacture of —. A. D. Smith. Vinita, Okla., Assignor to J. T. Milliken, St. Louis, Mo. U.S. Pat. 1,239,423, Sept. 4, 1917. Date of appl., Apr. 28, 1915.

GAS oil or fuel oil of the paraffin series having a boiling point above 500° F. (260° C.) is cracked and distilled while circulating rapidly in a closed system of tubes and receptacles. The pressure is maintained at 125–150 lb. per sq. in. and the temperature at 600°–700° F. (315°–370° C.). The system is heated throughout, and deposition of carbon on the inclined heating surfaces is prevented by circulating the liquid by mechanical means over the surfaces towards their lower ends. The lighter hydrocarbons are removed and condensed, and the liquid in the lowest part of the system is periodically removed, filtered to remove carbon, and returned to the system together with fresh oil.—W. F. F.

Paraffin powder and process of making it. A. E. Nienstadt, Bensonhurst, N.Y. U.S. Pat. 1,239,618, Sep. 11, 1917. Date of appl., Feb. 3, 1916.

MELTED paraffin is mixed with from 3 to 5% of an alkali stearate, such as the ammonium salt, in aqueous solution, the mixture stirred till cool, and the water removed, leaving the mixture of paraffin and stearate as a fine powder.—B. V. S.

Paraffinum liquidum; Process of making —. H. V. Dunham, Bainbridge, N.Y., Assignor to Hall Motor Fuel, Ltd., London. U.S. Pat. 1,240,792, Sept. 18, 1917. Date of appl., Mar. 16, 1916.

CYLINDER oil is treated with a relatively large amount of sulphuric acid and the sludge removed. The residual oil is treated with a mixture of ammonia and alcohol and allowed to settle. The oil is then separated, dried, and filtered through a column of fullers' earth.—L. A. C.

Coal; Process of obtaining coke and by-product from —. H. P. Bostaph, and Bostaph Engineering Co., Detroit, Mich., U.S.A. Eng. Pat. 109,523, Oct. 30, 1916. (Appl. No. 15,178 of 1916.)

SEE U.S. Pat. 1,204,617 of 1916; this J., 1916, 1253.

II.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

PATENTS.

Heat; Process of producing — C. Ellis, Montclair, N.J., Assignor to Radiant Heating, Ltd., Leeds. U.S. Pat. 1,239,776, Sept. 11, 1917. Date of appl. Dec. 6, 1911. Renewed Feb. 9, 1917.

IN a surface combustion furnace in which a combustible gaseous mixture is injected and burnt within a bed of porous refractory material, the combustible gas and air are pre-heated and injected separately so that combustion takes place at the meeting point of the two currents. The position of the meeting point of the gas and air is a'justed according to their initial temperatures and the chemical characteristics of the gas.—W. F. F.

Electrode: Arc-lamp — W. R. Mott, Lakewood, Ohio, Assignor to National Carbon Co., Inc. U.S. Pat. 1,239,810, Sept. 11, 1917. Date of appl. Jan. 4, 1916.

AN arc-lamp electrode contains fluorides of rare earths, and precipitated barium sulphate and zinc sulphide (lithopone).—B. N.

III.—TAR AND TAR PRODUCTS.

PATENTS.

Sulphonic acids or their salts; Methods of producing — L. M. Dennis, Ithaca, N.Y., U.S.A. Eng. Pat. 109,709, Dec. 7, 1916. (Appl. No. 17,605 of 1916.)

SEE U.S. Pats. 1,211,923, 1,228,414, and 1,229,593 of 1917; this J., 1917, 208, 866.

Amino-[hydr]oxy-compounds; Manufacture of aromatic — A. Pignet, E. Steinbach, and R. Stocker, Basel, Assignor to Soc. Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,239,822, Sept. 11, 1917. Date of appl., Oct. 27, 1916.

SEE Eng. Pat. 18,081 of 1915; this J., 1917, 129.

IV.—COLOURING MATTERS AND DYES.

Colour of dyes; Effect of additional auxochromes on the — Part II. Triphenylmethane and azo dyes. P. C. Ghosh and E. R. Watson. Chem. Soc. Trans., 1917, 111, 815—829. (See this J., 1915, 1243; 1916, 685.)

THE investigation has been extended to the spectroscopic examination of some azo- and triphenylmethane dyes, and some phenylfluorone dyes have been prepared. The positions of the edges of the absorption bands in solutions of different concentration were observed with an ordinary spectroscope; it is considered preferable to use a spectrophotometer. The mechanism by which additional auxochromes affect the absorption spectra is not as yet understood, varying effects being produced which have not been explained. In some cases the multiplication of auxochromes produces the comparatively small effect of strengthening and broadening the absorption bands without much effect on their positions, e.g., in the azobenzene series, whereas in other cases the bands are shifted to a considerable extent but remain of about the same breadth. In other cases the breadth may be considerably increased or diminished, or additional bands may appear. Even in the same series very diverse effects may be produced.—F. W. A.

PATENTS.

Disazo dyestuffs and process of making same. R. Schüle, Frankfurt, Germany. U.S. Pat. 1,211,153, Sept. 25, 1917. Date of appl., Mar. 20, 1916.

SEE Eng. Pat. 28,925 of 1913; this J., 1915, 899. Green shades may also be obtained by treating the disazo dyestuffs on the fibre with diazotised p-nitroaniline.

Indoxyl and derivatives; Method of making — L. E. H. Cone, Assignor to The Dow Chemical Co., Midland, Mich. Reissue 14,361, Sept. 25, 1917, of U.S. Pat. 1,211,413, Jan. 9, 1917. Date of appl., June 18, 1917.

SEE this J., 1917, 211.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

PATENTS.

Flax; Art of retting — B. S. Summers, Port Huron, Mich. U.S. Pat. 1,238,359, Aug. 28, 1917. Date of appl., Aug. 25, 1913.

RAW flax is heated in a dilute solution of a weak alkali, thereby producing a dilute solution of organic acids in which another batch of flax is retted by digestion in a closed vessel under pressure.—J. F. B.

Cotton, wool, rags, etc.; Dryer for drying — A. Solod, Worcester, Mass. U.S. Pat. 1,238,589, Aug. 28, 1917. Date of appl., Feb. 28, 1917.

THE machine comprises a rotary cylinder mounted on rolls in an inclined position, carriers at either end to feed and discharge the material into and out of the cylinder, and a perforated pipe in one side of the cylinder, through which heated air is forced from a hot air chamber.—J. F. B.

Wool; Method of purifying raw — G. H. Benjamin, New York. U.S. Pat. 1,238,873, Sept. 4, 1917. Date of appl., May 4, 1916.

THE wool grease is removed by the successive solvent action of a heated oil, and of a mixture containing approximately 90% of benzol and 10% of carbon tetrachloride. The remaining impurities are removed by the action of transmitted air currents between 90° and 130° F. (33° and 51° C.) and with a moisture content between 25 and 75%.—B. N.

Artificial silk; Apparatus used in the manufacture of — J. Clayton, Coventry, Assignor to Courtaulds, Ltd., London. U.S. Pat. 1,240,075, Sept. 18, 1917. Date of appl., Apr. 18, 1916.

THE apparatus is provided with a spinning box and means for moving it up and down while spinning.—F. Sp.

Paper sizing apparatus. W. H. Sanburn, Springfield, Mass., Assignor to Strathmore Paper Co., Mittineague, Mass. U.S. Pat. 1,240,154, Sept. 11, 1917. Date of appl., Sept. 24, 1915.

IN connection with a sizing trough and squeeze-rolls a pair of immersion rolls spaced apart is provided, each roll being mounted independently of the other in such a way that they can be swung down into and up out of the trough and nearer to or further apart from each other, whereby the paper passing beneath the rolls can be immersed for varying lengths and at varying depths; the squeeze rolls are situated between the two immersion rolls.—J. F. B.

Pulp-beating engines. J. Nuttall, Bury, Eng. Pat. 109,558, Jan. 9, 1917. (Appl. No. 434 of 1917.)

Paper; Manufacture [sizing] of—. H. M. Wheelwright, Wheelwright, Mass., and J. Traquair, Ayer, Mass., U.S.A. Eng. Pat. 109,458, July 13, 1916. (Appl. No. 9389 of 1916.)

See U.S. Pat. 1,195,888 of 1916; this J., 1916, 1009.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Emulsions; Solvent properties of—. *Theory of dyeing in a "broken" soap bath.* P. Sisley. Bull. Soc. Chim., 1917, 24, 155—157.

THE concentration of colloids in a foam is shown to have a parallel in the concentration of colloids in the emulsified portion of an immiscible solvent. Suitable colloids are pure azo dyestuffs derived from the Safranines, e.g., the dyestuff obtained by the action of sodium naphtholate on the azo derivative of commercial Phenosafranine. On agitating a solution of 0.02 gm. of this dyestuff in a litre of water containing 2 c.c. of glacial acetic acid with chloroform, the dyestuff accumulates in the emulsified chloroform, leaving the aqueous solution practically decolorised; on allowing to stand until the emulsion is destroyed, the dyestuff concentrates in the aqueous layer just above the chloroform and then gradually diffuses into the acidulated water. This property of an emulsified liquid to dissolve much more than the normal liquid is used to explain a number of dyeing processes involving the use of emulsions in fixing very slightly soluble dyestuffs; e.g., the tri- and tetranitrodiphenylamines do not dye silk from aqueous suspension but dye from a "broken" soap bath. The use of oil emulsions in dyeing cotton and the dyeing of leather are further applications of this phenomenon, which may also be of value in explaining certain facts in physiology and therapy.—F. W. A.

PATENT.

Weighting of silk. N. A. Laury, Camden, N.J., Assignor to General Chemical Co., New York. U.S. Pat. 1,238,307, Aug. 28, 1917. Date of appl., Aug. 24, 1914.

SILK is weighted with an antimony compound by treating with an antimony alkali metal double chloride, a fixing agent, and a clarifying agent.—F. W. A.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Recovery of pyrites from coal. Holbrook. See IIA.

- *Investigation of the wet thio-gen process for recovering sulphur from sulphur dioxide in smelter fumes.* Wells. See X.

PATENTS.

Lactic acid; Production of—. E. T. Olson, Ann Arbor, Assignor to Detroit Organic Chemical Co., Detroit, Mich. U.S. Pat. 1,240,766, Sep. 18, 1917. Date of appl., Oct. 19, 1916.

CRUDE lactic acid is treated with calcium hydroxide, the resulting lactate partially purified by separation and then treated in solution with

sulphuric acid. The mixture of calcium sulphate and lactic acid is dried and heated to 130° C. with the formation of lactide and lactic anhydride. After removal of soluble impurities pure lactic acid is obtained by hydrolysis in steam.—B. V. S.

Magnesia; Process of making—. L. Jesser, Vienna. U.S. Pat. 1,238,147, Aug. 28, 1917. Date of appl., Nov. 7, 1916.

MAGNESIUM carbonate is subjected in a revolving furnace to the action of burning gases at a temperature not higher than necessary for the effective removal of the carbon dioxide. Additional agitation is provided for. The temperature is regulated by the addition of air and steam to the burning gases, which are supplied to the furnace from a chamber in front of it.—H. J. II.

Alkalis; Process of producing— from kelp. H. L. Trumbull, Seattle, Wash. U.S. Pat. 1,228,600, Aug. 28, 1917. Date of appl., Mar. 22, 1917.

KELP is subjected to electrolytic or electro-osmotic action in a divided cell with a mercury cathode. The alkali amalgam produced is treated with water and the resulting alkali solution evaporated to yield an alkaline product containing caustic potash.—H. J. II.

Metal-hydroxide solutions; Process of making—. C. P. Hoover, Columbus, Ohio. U.S. Pat. 1,238,916, Sep. 4, 1917. Date of appl., Apr. 24, 1917.

SODIUM hydroxide solution is produced by passing a solution of another hydroxide, e.g., that of calcium, through a sodium-zeolite filter until the latter becomes practically inactive through loss of sodium. The exhausted zeolite is regenerated by washing it with a solution of sodium chloride, and the filter is then used again for the production of sodium hydroxide.—B. N.

Ammonia; Process of oxidising— and catalytic bodies therefor. C. L. Parsons, Washington, D.C. U.S. Pat. 1,239,125, Sept. 4, 1917. Date of appl., Apr. 20, 1917. (Dedicated to the public.)

NITROGEN oxides are produced by passing a mixture of ammonia and a gas containing oxygen over a heated composite material, comprising a catalyst, such as lead chromate, and a carrier which is not substantially affected by the lead chromate at 1000° C. e.g., bone ash.—B. N.

Alunite; Method of treating—. F. K. Cameron and J. A. Cullen, Washington, D.C. U.S. Pat. 1,239,768, Sep. 11, 1917. Date of appl., Nov. 11, 1916.

ALUNITE is treated with sufficient strong sulphuric acid to neutralise the basic compound, with formation of a cake which is largely soluble in water and from which alum and aluminium sulphate are obtained by solution and crystallisation.—B. V. S.

Felspar, felspathic rock, and similar material; Process for treating—. W. Glaeser, Brooklyn, N.Y., Assignor to G. T. Bishop, Macedonia, Ohio. U.S. Pat. 1,239,787, Sep. 11, 1917. Date of appl., Sep. 16, 1914.

FELSPAR or similar material is heated to a low red heat, suddenly cooled, mixed with anhydrous calcium chloride, and the mixture fused in presence of air at a temperature between 1200° and 1800° C.—B. V. S.

Alumina [and ferrosilicon and alkali compounds]: Manufacture of crystalline fused—F. J. Tone, Assignor to The Carborundum Co., Niagara Falls, N.Y. U.S. Pat. 1,230,984, Sep. 11, 1917. Date of appl. Feb. 26, 1916.

ORES containing alumina and a substantial amount of alkali compounds are heated electrically so as to volatilise the alkali, fuse the alumina, and reduce any excess of silica and iron oxide present to ferrosilicon. The alkali is recovered by condensing the fumes from the furnace.—A. B. S.

Carbon dioxide and sodium sulphate: Making—W. T. Mackey and J. S. Carroll, Dublin, Eng. Pat. 109,511, Oct. 11, 1916. (Appl. No. 14,128 of 1916.)

A GRANULATED mixture of saltcake (240 parts) and calcium carbonate, preferably whiting (about 160 parts, according to the acidity of the saltcake), is treated with cold or warm water, or with carbon dioxide saturated with moisture where a dry residue is desired. Carbon dioxide is evolved and sodium calcium sulphate left. This may be used in the manufacture of glass or as a flux in the extraction of metals, or the sodium sulphate may be extracted. A suitable apparatus for the treatment of the saltcake and whiting mixture is described.—B. V. S.

Aluminate: Production of—from alunit. P. R. Hershman, Assignor to Armour Fertilizer Works, Chicago, Ill. U.S. Pat. 1,240,570, Sep. 18, 1917. Date of appl. Oct. 21, 1916.

POTASSIUM aluminate, $K_2O \cdot 2Al_2O_3$, is produced by heating a mixture of alunit and calcium oxide to 1000° C. in the presence of steam and extracting the resulting mass with water.—B. V. S.

Barium aluminat and sulphur: Manufacture of—P. R. Hershman, Assignor to Armour Fertilizer Works, Chicago, Ill. U.S. Pat. 1,240,571, Sep. 18, 1917. Date of appl. Oct. 21, 1916.

BARIUM aluminat is produced by heating a mixture of a reducible barium compound, alumina, and carbon, in an atmosphere of reducing gas, or of reducing gas and steam. In the latter case, if barium sulphate is used, sulphur also is produced.—B. V. S.

Barium aluminat: Production of—P. R. Hershman, Assignor to Armour Fertilizer Works, Chicago, Ill. U.S. Pat. 1,240,572, Sep. 18, 1917. Date of appl. Oct. 21, 1916.

A REDUCIBLE barium compound, such as the sulphate, is heated with aluminium oxide in the presence of calcium oxide and steam.—B. V. S.

Kelp: Process for incinerating—G. A. Lamb, Los Angeles, Cal. U.S. Pat. 1,240,737, Sep. 18, 1917. Date of appl. Nov. 3, 1915; renewed Feb. 8, 1917.

KELP is continuously passed through a combustion chamber in which liquid or gaseous fuel is burnt in oxygen, both being supplied at intervals along the length of the chamber. The ash is continuously separated during passage of the kelp along the combustion chamber, the unburnt portion being passed on. Any unburnt kelp passing through the first combustion chamber is further treated in an auxiliary chamber in which also the ash may be further treated.—B. V. S.

Ceramic acid gas: Method of removing—from nitrogen gas. H. Philipp, Perth Amboy, N.J., Assignor to The Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,239,546, Sep. 11, 1917. Date of appl. June 30, 1914.

THE mixed gases are passed through milk of lime containing a small quantity of an alkali hydroxide, e.g. sodium hydroxide.—B. V. S.

Graphitic carbon from graphite scale: Method of recovering—F. W. Weissmann, Assignor to The Hill and Griffith Co., Cincinnati, Ohio. U.S. Pat. 1,239,992, Sep. 11, 1917. Date of appl. Apr. 28, 1916.

Dry artificial graphitic scale is screened, subjected to the action of an air separator, bolted, and treated in an electromagnetic separator. The resulting graphite is further purified by powdering, levigating, boiling with acid, washing, pressing, and drying.—B. V. S.

Vessels for containing acids and other liquids. Eng. Pat. 109,194. See I.

Recovering alkalis from cement materials. U.S. Pat. 1,239,610. See IX.

Process of making lampblack and hydrochloric acid. U.S. Pat. 1,238,734. See XIII.

VIII.—GLASS; CERAMICS.

Refractories and modern kilns. J. G. Maxwell. Ceramic Soc. (Refractory Materials Section), Glasgow, Oct. 2, 1917.

THE author details the advantages of gaseous fuel over solid fuel for firing kilns, and gives the preference to producer gas for the following reasons: Temperature is under complete control. High temperatures can be obtained more economically and speedily than with coal, and any given temperature reached is more easily maintained in the kiln than with coal, and with comparatively little fluctuation. There is great saving on wear and tear of kiln, and great cleanliness of burning if an adequate supply of air is provided. The three best known types of kiln for refractory goods are: the continuous annular, gas-fired kiln; the continuous annular, chamber type, gas-fired kiln; the continuous tunnel and car kiln. The author considers that the tunnel type is by far the best, and he believes it will be the kiln of the future for most kinds of high-class refractory ware on account of the ease of working, the low cost of handling the material, low fuel consumption, and large output, combined with small amount of structural work.—A. B. S.

Refractory materials: The testing of—J. W. Mellor. Ceramic Soc. (Refractory Materials Section), Glasgow, Oct. 2, 1917.

THE ultimate object in testing a firebrick is to determine how it will behave when in use, so that tests should as nearly as possible reproduce service conditions. A service trial is the ideal mode of testing, but usually requires too long a time and even then is not always consistent. The fire-stability of a refractory material as shown by the squatting temperature is perhaps its most important quality. In making this test, it is important to specify the rate at which the sample is heated, as the faster the rise in temperature the greater the difference between the true and apparent squatting temperature. The best results

are obtained with pieces of material shaped like Seger cones, $1\frac{1}{2}$ in. high and $\frac{1}{2}$ — $\frac{3}{4}$ in. base, Seger cones being placed close to the samples and heated at the same time. The results should be reported in "cones" rather than in degrees of temperature. Larger test pieces are not advantageous, as the first signs of fusion are connected with the surface tension. The atmosphere in which the samples are heated should be as nearly neutral as possible, though so many firebricks are used in a reducing atmosphere that it is sometimes desirable to use this in testing them; in this case, however, it is difficult to obtain constant results on account of variations in the rate at which the iron compounds present in the material are reduced. When refractory materials are heated under a load of (say) 30—50 lb. per sq. in. the results vary with the nature of the bricks. Aluminous bricks show a much lower squatting temperature and there is every reason to suppose that they could be vitrified by pressure alone. W. Spring has shown that pure alumina can be melted at ordinary temperature under a pressure of 5000 atmos. per sq. cm. Hence, it is logical to suppose that fire-clay bricks could be made without burning if the pressure were sufficiently great.

Refractory materials, when heated under a load, appear to contradict the well-known thermodynamic formula:—

$$\frac{dT}{dP} = \frac{T}{L} (v - v_0)$$

where P=pressure, T=absolute temperature of fusion, L=latent heat of fusion, v =volume after fusion, and v_0 =volume before fusion. Hence, if L is constant an increase in pressure should raise, not lower, the fusion point. The author considers the discrepancy is due to the formula not being applicable to bricks as the distribution of the pressure is not uniform in all directions.—A. B. S.

PATENTS.

Glass tank-furnace. W. G. Bergman, Assignor to The Toledo Glass Co., Toledo, Ohio. U.S. Pat. 1,237,282, Aug. 21, 1917. Date of appl., May 4, 1914.

THE combustion chamber of the furnace is built above the glass tank but independent of it and carried by a suitable system of iron work. The walls of the furnace are substantially flush with those of the tank but separated from them by a space which is closed by adjustable blocks of reverse wedge shape.—H. J. H.

Glass-tank. W. G. Bergman, Assignor to The Toledo Glass Co., Toledo, Ohio. U.S. Pat. 1,237,283, Oct. 21, 1917. Date of appl., June 4, 1914.

THE combustion chamber is supported over and independently of the glass tank by a suitable system of iron work. The tank is a little larger than the combustion chamber, the lowest course of which dips into the glass bath, thus leaving a margin of glass exposed to the air. The blocks of the lowest or sealing course are detachable and suspended by iron brackets from the abutment blocks supporting the arch of the furnace.—H. J. H.

Glass [tanks] and other reverberatory furnaces; Mean for heating. — The Tyne Glass Works, Ltd., Gateshead, and A. B. Roxburgh, Monk-seaton. Eng. Pat. 109,541, Nov. 24, 1916. (Appl. No. 16,865 of 1916.)

THE furnace is heated by producer gas which has previously been passed through a scrubber or filter to remove dust, etc. The gas is taken from the producer at a point below the top of the fuel-bed and is led through a dust-trap into the furnace. Hot air is supplied to the furnace through a flue,

and is heated by conduction from the furnace and from the waste heat flues. A flap-valve in the passage is normally closed but opens automatically if the back pressure in the dust chamber becomes excessive, as during back-firing or explosions.

—A. B. S.

Plate glass; Process of and apparatus for the manufacture of. — J. H. McKelvey, Kirkwood, Mo., and C. F. Ryan, St. Louis, Mo., U.S.A. Eng. Pat. 109,631, Aug. 15, 1916. (Appl. No. 11,525 of 1916.)

THE constituents are melted in a continuous melting tank, a portion of the metal being transferred to a second tank heated independently, where it is reheated and afterwards poured on to the casting table in the usual manner. The second tank, or conditioning chamber, is stationary except for a shallow collection receptacle in the base of the tank, which can be tilted to deposit the charge on the rolling table. In this way, the advantages of the usual method for making sheet glass are made available for the production of plate glass without the drawbacks experienced when the molten metal is ladled out previous to casting.

—A. B. S.

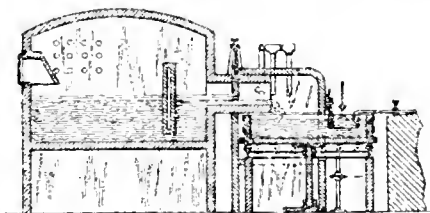
Cylindrical and tubular glass articles; Manufacture of. — D. Webb, Manchester. Eng. Pat. 109,711, Dec. 13, 1916. (Appl. No. 17,899 of 1916.)

THE closed end of a hollow ball or billet of glass blown in the customary manner, is opened and a tubular drawing iron attached, a current of compressed air being meanwhile passed through the tube so as to cool the interior as rapidly as the exterior of the article and thus produce a harder internal surface with small liability to fracture when exposed to changing temperatures.

—A. B. S.

Glass-drawing apparatus; Continuous. — R. G. Ewing, Toledo, Ohio. U.S. Pat. 1,240,185, Sept. 18, 1917. Date of appl., Apr. 9, 1917.

A CONTINUOUS glass-drawing apparatus (see fig.) comprises a continuous melting tank delivering a continuous supply of "metal" to a rotary



drawing supply tank, a stationary hood which forms a heating chamber above the drawing tank, means to keep part of the molten "metal" motionless during the drawing operation, and means to draw the glass continuously whilst it is in a suitable condition and free from any detrimental deposits.

—A. B. S.

Refractories; Production of. — P. R. Hershman, Chicago, Assignor to The Mineral Products Co., New York. U.S. Pat. 1,240,569, Sept. 18, 1917. Date of appl., July 19, 1915.

A MOULDED mixture of a refractory metallic oxide, such as alumina, with carbon and a binding agent is raised to a high temperature in a non-oxidising atmosphere. The binding agent acts as a cement until the particle of the mass begin to frit together, and is finally driven off. The proportion of carbon is arranged so that shrinkage and increase of density will result in the heating process.—B. V. S.

Abrasive composition containing alumina and zirconia. Aluminium abrasive and method of preparing the same. L. E. Saunders and R. H. White, Niagara Falls, N.Y., Assignors to Norton Co., Worcester, Mass. U.S. Pats. (A) 1,240,490 and (B) 1,240,491, Sept. 18, 1917. Date of appl. Feb. 12, 1917.

AN abrasive material made in an electric furnace consists of (A) crystalline grains composed chiefly of alumina and zirconia, with a ceramic bond; (B) grains containing crystalline alumina together with zirconia, silica, titanium oxide, and iron oxide, these grains being united by a ceramic bond. —A. B. S.

Bricks; Process of burning——. F. B. Lambert, Assignor to Lambert Process Co., Chicago. Ill. U.S. Pat. 1,239,189, Sept. 4, 1917. Date of appl., Mar. 20, 1915.

THE kiln is fitted with an internal forced-draught furnace which is heated in such a manner that any water present in the bricks is evaporated faster than it can escape from the kiln and therefore forms a damper of steam between the heat-zone and the outlet for the products of combustion. The firing is arranged to produce a zone of incandescence at right angles to the general travel of the products of combustion through the kiln, and the blanket or damper of steam lies above the zone of incandescence. The invention is described with particular reference to an up-draught oil-fired kiln, the burners being placed near the base and the lowest courses of bricks to be burned being first raised to the finishing temperature.—A. B. S.

Enamels or glazes; Process of producing well clouded—by means of substitutes for stannic oxide. H. Kretzer, Wallersheim, and A. Cappel, Coblenz, Germany, U.S. Pat. 1,239,112, Sep. 4, 1917. Date of appl., Sep. 9, 1914.

IN the manufacture of white clouded enamels or glazes, the opacifier, if a material other than stannic oxide, is added to the wet-mill towards the end of the grinding of the other ingredients, together with such substances (electrolytes) as will prevent its transformation into a colloidal form or will precipitate any colloid which may be produced.—A. B. S.

Glass blowing apparatus. British Thomson-Houston Co., Ltd., London. From General Electric Co., Schenectady, N.Y., U.S.A. Eng. Pat. 109,544, Dec. 5, 1916. (Appl. No. 17,464 of 1916.)

IX.—BUILDING MATERIALS.

Cement; Effect of sulphide on——. J. C. Witt. Philippine J. Sci., 1916. 11 A, 273—288.

THE author has investigated the basis of the widely held view that sulphur compounds have a deleterious action on cement. Five different typical brands of cement were subjected to trial in mixings containing sodium sulphide solutions of varying concentration. Experiments were made on the neat cements and on mixtures of cement and sand, and the physical properties of the products were determined. The results showed that sodium sulphide modifies greatly the setting time of a cement, with low concentration retarding the set, with high concentration accelerating it. Cements high in iron are specially sensitive. There is a marked decrease in the tensile strength, varying with the sulphide con-

centration and the iron content of the cement. A green coloration is produced. It is probable that the sulphide and iron oxide react to form a colloid which forms inert films in the mass, interfering with the cohesion. The colloid also removes some calcium hydroxide from solution and this also leads to reduced strength.—H. J. H.

Bituminous aggregates; Toughness of——. C. S. Reeve and R. H. Lewis. J. Agric. Res., 1917, 10, 349—350.

BITUMINOUS-CONCRETE roads in New England, in which the rock used was trap-rock or quartzite, the binder being a coal-tar product, were found to fail very rapidly compared with roads in which the rock used was a field-stone of granitic or gneissoid character, and compared also with roads in Jamaica, N.Y., in which trap-rock was used. The authors find that the difference in behaviour of the various types of rock cannot be directly attributed to any of the ordinary physical properties—such as hardness, toughness, specific gravity, etc., but that it appears to be largely due to differences in the surface character of the rock particles: the glassy surfaces of some rock particles fail to "hold" the bitumen as well as the rougher surfaces of others. They find also that whilst relatively soft or fluid bitumens may yield satisfactory results with some types of rock, their use with other types will lead to failure of the road surface. Laboratory tests can be directly correlated with the results obtained in actual service, and by means of the impact or toughness test of the aggregates, it may be possible to determine in advance their relative behaviour in actual service.—E. W. L.

PATENTS.

Slaking times and cements; Methods of and means for——. C. Candlot, Paris. Eng. Pat. 109,391, Feb. 27, 1917. (Appl. No. 2867 of 1917.)

IN the slaking of calcined lime and cements the use of an excess of water may lead to hydration of silicates and aluminates and consequent deterioration of the products. This is avoided by the use of a slaking machine having automatic arrangements for controlling the feed of calcined material and water and the removal of the slaked product. The calcined material falls into a vessel revolving about a vertical shaft. It is slaked by water delivered through orifices in a pipe arranged radially, and as the slaked material is at once covered by a fresh layer of material the heat produced in the reaction is conserved. The slaked material is discharged from the machine through a gap between the sides and the base, by self-adjusting blades which ensure the maintenance of a constant level in the apparatus. —H. J. H.

Hydrating lime; Process of——. W. E. Carson. Riverdon, Va. U.S. Pat. 1,239,256, Sept. 4, 1917. Date of appl., Dec. 15, 1916.

A HIGHLY plastic, dry hydrated lime is made by slaking two different portions of lime in the same manner, but with different proportions of water, and then mixing the products. The slaking may be effected by mixing the ground lime with water and storing it for at least 8 hours in a tall columnar chamber.—A. B. S.

Rotary [cement] furnace structure. B. E. Eldred, Assignor to Commercial Research Co., New York. U.S. Pat. 1,238,394, Aug. 28, 1917. Date of appl., June 18, 1913.

A ROTARY cement furnace is constructed with a

cylindrical revolving steel shell lined with refractory material and having a fan mounted on and forming part of the furnace body. Longitudinal channels are arranged in the refractory lining through which the fan drives a current of air, which is thus preheated and then fed into the furnace with the fuel at the firing end.—H. J. H.

White cement. W. C. Ewing, Los Angeles, Cal. U.S. Pat. 1,239,579, Sep. 11, 1917. Date of appl., June 29, 1916.

A WHITE cement is made by mixing 20 parts of commercial Portland cement with 1 part of silica (diatomaceous earth) and 1 part of calcium hydroxide.—A. B. S.

Alkalis from cement materials; Recovering——S. B. Newberry, Baybridge, Ohio. U.S. Pat. 1,239,616, Sep. 11, 1917. Date of appl., Apr. 11, 1916.

THE dust collected from rotary cement kilns is re-burned in a vertical kiln with a strong blast of air under 5–20 lb. pressure. The gases evolved are cooled and the alkalis therein are obtained in a soluble form.—A. B. S.

Basic brick. H. A. Kennedy, Clearfield, Pa. U.S. Pat. 1,240,148, Sep. 11, 1917. Date of appl., July 26, 1917.

PARTICLES containing lime and magnesia 78–92, and silica 2–13%, are mixed with a fluxing agent and the mixture is moulded and fritted so as to produce refractory basic bricks with a vitrified outer surface.—A. B. S.

[Paving material] plastics; Manufacture of——*Plastic composition and method of making the same.* (A) M. A. Popkess, Kansas City, Mo., Assignor to Bituminized Road Co. (B) M. A. Popkess, New York. U.S. Pats. (A) 1,240,252, and (B) 1,240,253, Sept. 18, 1917. Dates of appl., Apr. 11 and Dec. 13, 1916.

(A) A PAVING material is made by heating a moist, finely divided, earthy material to a temperature below 212° F. (100° C.) to vaporise part of the moisture. Liquid bitumen is then added, the mixture stirred to disintegrate it and impregnate the earthy material with bitumen, and the temperature then raised above 212° F. to expel the moisture. (B) A paving composition is made by producing an emulsion of asphalt, liquid at ordinary temperatures, with water and clayey material. The amount of asphalt is such as to give a dense, hard, and malleable composition, and the amount of water is such that the product can be easily worked during mixing. The mixture is agitated and disintegrated till it is reduced to fine particles, and the water is then removed.—W. F. F.

Porous blocks; Methods of treating [impregnating]——C. E. Fuller, Kansas City, Mo., U.S.A. Eng. Pat. 101,792, Sept. 12, 1916. (Appl. 12,921 of 1916.) Under Int. Conv., Oct. 9, 1915. SEE U.S. Pat. 1,176,281 of 1916; this J., 1916, 542.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Tantalum in alloy steels; Determination of——G. L. Kelley, F. B. Myers, and C. B. Hingworth. J. Ind. Eng. Chem., 1917, 9, 852–854.

In the absence of tungsten:—1 gm. (for 2 to 5% tantalum steels), 2 grms. (for 0.5 to 2% steels), or up to 10 grms. for lower proportions, is dissolved in hydrochloric acid (1:1), the solution evaporated to dryness, the residue boiled with dilute hydrochloric acid, and the solution filtered. The

filtrate is concentrated to a syrup, nitric acid being added during the evaporation, to oxidise the iron, and the residue is treated with 50 c.c. of strong hydrochloric acid and again evaporated. After cooling, the iron is extracted by means of ether, and the aqueous layer boiled to remove dissolved ether, and treated with ammonia in slight excess, to precipitate the tantalum. If chromium or vanadium are present in appreciable quantity, the solution is evaporated with 15 c.c. of sulphuric acid (sp. gr. 1.58) until fumes appear and is then made up to 200 c.c. with water, and boiled with 20 c.c. of 6–1% silver nitrate solution and 3 grms. of ammonium persulphate, to oxidise the chromium and vanadium to chromate and vanadate. A slight excess of ammonia is then added, and the solution again boiled. The precipitate, which will contain all the tantalum and aluminium, is washed, and added to the precipitate obtained in the first filtration, and the united precipitates ignited in a platinum crucible at a moderate temperature, and then fused with 2 to 5 grms. of fused potassium bisulphate. The melt is treated with hot dilute (1:1) hydrochloric acid, the liquid filtered, and the residue of silica and tantalum oxide (Ta_2O_5), is treated with a few drops of sulphuric acid and 2 to 5 c.c. of hydrofluoric acid in a platinum crucible, the acid evaporated, and the residue weighed as Ta_2O_5 .

In presence of tungsten:—The hot solution in hydrochloric acid, obtained as above, is oxidised by the addition of nitric acid, drop by drop, and then diluted with 4 vols. of water, and boiled for a few mins. The insoluble tungstic oxide is filtered off, and washed with water acidified with hydrochloric acid, and the filtrate and washings evaporated to a syrup, which is treated with 50 c.c. of strong hydrochloric acid and again evaporated, and the ferric iron extracted with ether, as described. The precipitate of tungstic oxide is treated with dilute ammonia solution to dissolve tungsten compounds, and the residue, which may contain tantalum and traces of iron, tungsten, chromium, etc., is reserved. The aqueous layer from the ether extraction is boiled, evaporated with sulphuric acid, and treated with silver nitrate and ammonium persulphate, as above. Ammonia will then precipitate an impure hydrated tantallic oxide, leaving most of the chromium and vanadium in solution. From this point the process is the same as in the absence of tungsten, except that the final residue from the fusion with potassium bisulphate may contain a little tungstic oxide. It should therefore be treated with dilute ammonia solution and washed with water prior to ignition with hydrofluoric acid and sulphuric acid to remove the silica.—C. A. M.

Zinc burning as a metallurgical process. W. R. Ingalls. Bull. Amer. Inst. Min. Eng., Sept., 1917. Eng. and Min. J., 1917, 104, 457–461.

THE Wetherill process for the manufacture of zinc oxide and zinc-lead pigments directly from the ore consists in heating the ore with carbonaceous fuel, the metallic vapour being at once burned to oxide by the furnace gases. This process can also be used for the igneous concentration of zinc ores; it can be carried out in blast smelting-furnaces, the gangue being slagged off and other minerals reduced to matte or metal. The smelting column in the blast furnaces at Canyon City, Colo., is only 18 in. high, to prevent the formation of accretions. Some iron blast furnaces in Virginia and the spiegel-eisen furnaces of the New Jersey Zinc Co. afford examples of zinc burning as an incidental operation in blast-furnace smelting. The reverberatory furnace is better adapted for the work, as no accretions are formed; at Anaconda, the residues from the leaching for electrolytic zinc extraction are thus worked up. In the Wetherill process a grate-furnace is used, there being no run

of slag. In using the method for concentrating zinc, no attention need be paid to the colour of the resulting fume as in pigment-making; hence the process is very simple, and low-grade ores would be made available. In the electrolytic leaching process, it may be found more economical to burn the ore on grates and leach the product obtained by condensing the fume. Lead is even more easily burned off than zinc. The choice between a smelting or grate furnace would depend on the nature of the ore: if copper and silver are present, a smelting furnace would be adopted. In such a case the slag would have to be very silicious so as to maintain a low zinc slag-loss (i.e., little over 3%).—W. R. S.

Tin and tungsten; Separation of—*in tin-bearing tungsten ores.* Travers. *Comptes rend.* 1917, 165, 108—110.

The very finely ground ore is fused with anhydrous sodium sulphate at a bright red heat in a porcelain crucible, the melt treated with boiling water and diluted to 700—800 c.c., and the solution treated with a small excess of sulphuric acid. The precipitated stannous sulphide is purified by solution in yellow ammonium sulphide, re-precipitated, and ignited to stannic oxide. Tungsten is determined by fusing another portion in a similar manner and decomposing the melt directly with strong *aqua regia*; if titanium is also to be determined, sulphuric acid is used. The bulk of the tungstic acid separates, mixed with silica. The filtrate is treated with ammonia in quantity insufficient to dissolve tungstic acid: the ferric hydroxide precipitate containing the balance of the tungstic acid is washed free from sodium salts and dissolved in hydrochloric acid (1:1). The solution is evaporated to dryness to remove the tungstic acid insoluble, and the latter is separated from silica by the usual method.—W. R. S.

Nickel and zirconium; Analysis of alloys of—*G. L. Kelley and F. B. Myers. J. Ind. Eng. Chem.* 1917, 9, 851.

ONE gram. of the finely divided sample is dissolved in a mixture of 40 c.c. of hydrochloric acid and 20 c.c. of nitric acid, and the solution evaporated with 20 c.c. of sulphuric acid until white fumes appear. On diluting the liquid with water nearly all the tungsten separates as tungstic oxide together with the silica, whilst practically the whole of the zirconium will be found in the filtrate. The precipitate is ignited in a platinum crucible and weighed (SiO_2 , WO_3 , and impurities), then treated with hydrofluoric and sulphuric acids to remove silica (determined by loss in weight), and subsequently fused with sodium carbonate, and extracted with water. Any residue is deducted

from the weight of impure tungstic oxide left in the crucible after removal of the silica. The solution, containing the iron, nickel, aluminium, and zirconium, is made up to a definite volume, and half is taken for the determination of the iron, by precipitation with ammonia, solution of the precipitate in sulphuric acid, addition of an excess of 10 c.c. of acid (sp. gr. 1.58), reduction of the solution, and titration of the iron with standard permanganate solution. The other half of the solution is treated with ammonia in excess, and the nickel removed electrolytically, and, after removal of iron and aluminium if necessary, determined electrolytically or by precipitation with dimethylglyoxime. The solution containing aluminium, iron, and zirconium is boiled to remove most of the ammonia, and allowed to stand, the precipitate separated, washed with water, and dissolved in the smallest possible amount of hydrochloric acid, and the solution treated with an excess of solid potassium hydroxide, to precipitate iron and zirconium, boiled for 1 min., allowed to stand, and filtered. The filtrate is acidified with hydrochloric acid, and then made faintly alkaline with ammonia, boiled, and filtered, and the precipitate washed and dissolved in hydrochloric acid. The solution is evaporated with 7 to 10 c.c. of sulphuric acid (sp. gr. 1.58), until white fumes appear, then diluted, filtered from silica, and the aluminium precipitated with ammonia. The precipitate of iron and zirconium hydroxides is dissolved in dilute (1:1) hydrochloric acid and reprecipitated with ammonia from the boiling solution. The ignited precipitate consists of Fe_2O_3 and ZrO_2 , and its weight, less the amount of iron (as Fe_2O_3) found by titration, gives the amount of zirconia. If a determination of manganese is required, 1.5 gm. of the alloy is taken, and a third of the filtrate from the tungstic oxide is treated with ammonia and ammonium persulphate, before boiling. The precipitate is washed, dissolved in nitric acid, with the addition of a little sodium sulphite or hydrogen peroxide to aid solution, and the manganese oxidised by means of sodium bismuthate, and determined by one of the usual methods.

—C. A. M.

Metals of high boiling point; Vapour pressure and volatility of several—*J. Johnston. J. Ind. Eng. Chem.* 1917, 9, 873—878.

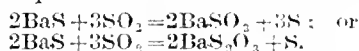
THE various published data on the vapour pressure and volatility of metals have been collated, and formulae have been worked out for calculating the vapour pressure at any temperature. The following table gives the approximate boiling points of the principal metals at various pressures, the figures for those in italics having been calculated from a single observation:—

Metal.	Melting point	p in m.m. of mercury.							
		10 ⁻²	10 ⁻¹	1	10	50	100	760	
	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.
Cadmium	321	220	270	330	410	500	590	630	740
Zinc	419	290	350	420	500	610	700	750	920
Magnesium	651	380	440	520	620	750	860	920	1150
Thallium	302	500	570	660	770	910	1030	1090	1300
Bismuth	271	540	620	720	840	960	1130	1200	1440
Antimony	630	540	620	720	840	960	1130	1200	1410
Lead	327	620	710	820	960	1130	1290	1360	1640
Aluminium	630	730	830	950	1090	1280	1440	1520	1800
Manganese	1225	790	890	1020	1170	1360	1550	1610	1900
Silver	960	920	1050	1160	1320	1520	1700	1780	2080
Chromium	1510	980	1090	1230	1400	1610	1800	1860	2200
Tin	232	1010	1130	1270	1440	1660	1850	1940	2260
Copper	1083	1050	1200	1340	1520	1740	1930	2030	2350
Nickel	1452	1100	1220	1370	1550	1780	1970	2070	2400
Iron	1520	1130	1250	1400	1590	1820	2010	2110	2450
Arsenic	830	220	280	310	390	430	490	510	610

—C. A. M.

Sulphur from sulphur dioxide in smelter gases; Investigation of the wet "thiogen" process for recovering—A. E. Wells, U.S. Bureau of Mines Tech. Paper 133. J. Ind. Eng. Chem., 1917, 9, 872—873.

THE wet "thiogen" process for recovering sulphur from sulphur dioxide in smelter gases is based upon the fact that barium sulphide suspended in water reacts with sulphur dioxide in accordance with the equation:



The gases are cooled, freed from dust, and passed through an absorption tower, in which the sulphur dioxide is absorbed by water. This solution is treated with powdered barium sulphide, the precipitate of barium sulphite, thiosulphate, and sulphur is allowed to settle and then filtered off and dried, whilst the mother liquor is returned to the absorption tower. The free sulphur and half of the sulphur from the thiosulphate is distilled, and the sulphur vapour condensed, whilst the residual barium sulphite or sulphate

in canvas filters with the aid of a vacuum pump, and then by means of steam coils. The sulphur distils from the precipitate at 450° C. and the distillate is practically pure. The reduction of the barium sulphite or sulphate is effected by heating the residue with carbon, coke, or coal at 750° to 1200° C., preferably with carbon of high purity, at a high temperature in an externally heated furnace so as to avoid the introduction of inert substances, such as ash, etc. Any oxide or carbonate formed is converted into sulphate by treatment with sulphuric acid or into sulphite by agitation with sulphur dioxide solution. When coal is used for the reduction it may be necessary to extract the barium sulphide with water, and reject the insoluble matter. It is estimated that in certain localities the cost of producing sulphur by this method would be about \$12 per ton.—C. A. M.

Mineral and metal output of Japan in 1916.

THE Japanese Bureau of Mines reports that the quantity and value of minerals and metals produced in Japan in 1915 and 1916 were as follows:—

		1914.		1915.		1916.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
			Yen.		Yen.		Yen.
Gold	monime	1,016,763	9,398,449	2,211,931	10,894,516	2,104,441	10,412,845
Silver	monime	40,252,268	3,370,273	42,460,615	3,287,024	48,180,006	7,135,060
Copper	metric ton.	71,046	39,067,387	76,039	53,731,708	101,167	109,812,610
Lead	kin	7,693,854	827,282	7,910,593	976,380	18,931,514	3,755,932
Tin, refined	kin	161,189	130,224	569,494	591,482	421,185	401,557
Tin, unrefined	kin	77,088	151,610				
Zinc, refined	metric tons	5,966	1,369,017	21,206	12,952,591	39,316	27,215,753
Zinc, unrefined	metric tons	14,138	232,353	6,121	369,774	2,187	183,064
Pig-iron	metric tons	74,376	2,155,649	65,970	2,565,091	77,275	4,099,291
Steel	metric tons	15,514	841,006	17,969	1,296,503	29,859	3,413,845
Iron sulphide	kwan	30,873,543	600,603	18,003,321	379,613	24,271,369	707,391
Antimony, crude	kin	41,436	2,790	45,510	15,386	42,862	14,450
Antimony, refined	kin	6,420,250	967,058	13,867,961	8,189,988	18,006,880	8,565,508
Manganese ore	kwan	4,551,202	159,371	6,898,895	313,532	13,149,416	951,113
Tungsten ore	kwan	2,652	187,712	89,354	477,950	186,144	2,393,666
Phosphate ore	metric tons	38,259	508,182	57,716	599,381	114,810	1,259,795
Coal	metric tons	22,298,419	80,350,387	20,430,747	65,068,894	22,901,580	86,325,582
Peat	metric tons	105,198	198,068	100,107	195,878	108,718	240,098
Kerosene oil	koku	2,358,094	9,631,049	2,613,281	10,070,820	2,692,707	14,996,695
Natural gas	1000 cub. ft.					50,685	215,639
Sulphur, refined	metric tons	74,115	2,092,738	72,206	1,992,219	106,387	4,295,539
Sulphur, crude	metric tons	8,835	49,876	17,172	92,447	21,478	199,853
Other			115,066		211,576		375,943
Total value			155,030,245		175,959,048		281,505,276

100 monime = 1 kin = 1.323 lb. (av.); kwan = 8.297 lb.; koku = 47.65 Imperial gallons; metric ton = 2204.6 lb.

is reduced to sulphide and used for a fresh operation. In experiments on a large scale it was found that with the mother liquor as absorbent it was possible to obtain solutions containing 30% more sulphur dioxide than is theoretically possible with water, and which also retained the bulk of the sulphur dioxide. For a commercial operation the cases should contain at least 5% of sulphur dioxide, and the temperature of the absorbing liquid should be less than 25° C. The principal barium product is the thiosulphate rather than the sulphite. If sufficient barium sulphide is added to combine with most of the sulphur dioxide, but little barium salt remains in solution, and the sp. gr. of the liquid does not exceed 1.03. In presence of a large excess of sulphur dioxide after the reaction, part of the barium is dissolved as thiosulphate. The best method of incorporating the barium sulphide is to emulsify it with a portion of the sulphur dioxide solution, and to mix this emulsion with the bulk of the solution in a tank containing an agitator. The precipitate settles readily and does not contain more than 50% of water, and it can be dried by draining

A deposit of molybdenite was recently discovered at Iwanezawa Kamitsuga-gori, Tochigi Prefecture, and a company with headquarters at Tokio has been formed to carry on mining operations and the refining of the ore. The capital of the company is 1,000,000 yen.

Mineral exports from New Zealand. Board of Trade J., Oct. 11, 1917.

THE Mines Statement for the year 1916 by the Dominion Minister of Mines, shows that the total value of minerals exported, together with the coal consumed in New Zealand, in 1916 amounted to £2,978,436, as compared with £3,374,523 in 1915, a decrease of £396,087. The decrease is confined almost entirely to gold, the export in 1915 having been larger than usual owing to shipments of much of the output of 1914, when the export of gold was prohibited during the later months. The following table shows the quantity and value of the various minerals exported from the Dominion in 1915 and 1916, and the quantity and value of the coal consumed in the country:—

	1915.		1916	
	Quantity.	Value.	Quantity.	Value.
Gold	oz. 122,825	£ 1,691,583	oz. 292,620	£ 1,199,212*
Silver	597,511	75,583	587,053	75,111
	tons.		tons.	
Tungsten ore	194	27,784	266	49,070
Coal Exported	323,992	329,731	328,187	326,553
Coal Consumed	1,881,632	942,316	1,928,652	964,476
Kauri gum	775	279,133	3,448	339,343
Other minerals	3,473	5,423	7,368	11,671

* The value of bullion produced, as stated in the official returns from the mines, was £1,192,107.

In the gold-mining industry there was a revival of interest during 1916 in West Coast alluvial mining, as the result of payable prospects being obtained at Rima Falls by an Australian company, and a number of claims were taken up by strong proprietaries. Gold dredging continues to decline. The quantity and value of the exports of tungsten ore during 1916 constituted a record for the Dominion.

By-products from the manufacture of tin plate [as feeding stuffs]. See XIXA.

PATENTS.

Iron; Refining of — A. Rollason, Nottingham. Eng. Pat. 109,178, Dec. 12, 1916. (Appl. No. 17,825 of 1916.)

SILICON and carbon are first removed from the pig-iron by running the molten metal from a blast or cupola furnace into an ordinary acid-lined converter, where it is blown by a blast delivered through side tuyères and also subjected to surface oxidation. The metal is then run into a basic-lined converter fitted with an extra set of tuyères and, after adding lime, the metal is blown to remove phosphorus and sulphur. Deoxidation and the final refining of the metal are effected by transferring to an electric furnace together with the silicious slag from the acid-lined converter and any other material necessary for the refining. A low-voltage alternating current is employed for the heating and to cause circulation and intimate contact of the metal with the slag. The refined metal is run into ladles and cast into ingots.—J. N. P.

Iron and steel; Process for manufacturing from oxygen-containing baths. A. Klinkenberg, Dortmund, Germany. U.S. Pat. 1,238,409, Aug. 28, 1917. Date of appl., Apr. 6, 1917.

PACKAGES of cellulose or other carbohydrate material in a finely divided condition are introduced into the ingot mould, so that the oxides are reduced when the molten metal is poured into the mould.—J. N. P.

Titaniferous-iron ores; Process of reducing — W. A. Loke, The Hague, Holland. Eng. Pat. 109,328, Oct. 1, 1916. (Appl. No. 14,116 of 1916.)

TITANIFEROUS iron ore and pyrites are finely ground and well mixed in such proportions that the oxygen of the former is slightly in excess of the quantity required to combine with the sulphur of the pyrites, and the mixture is heated in an electric furnace to a temperature sufficiently high to effect a slight reduction of the titanium oxide, so that the liberated titanium may purify the iron. The sulphur dioxide which is evolved may be used for the manufacture of sulphuric acid, and the slag, consisting of titanous acid and other titaniferous compounds, is used for further desulphurising the iron. If after the reduction

the iron still contains sulphur, fluorspar and ferrosilicon are added to free the slag from iron, and the desulphurisation continued.—J. N. P.

Hardening or tempering and brazing steel; Compound for use in — C. Buckler, Leeds. Eng. Pat. 109,566, Jan. 22, 1917. (Appl. No. 1049 of 1917.)

A COMPOSITION for use in hardening, tempering, or brazing steel, to prevent surface oxidation, consists of boric acid 186 parts, flour 2 parts, salt 2 parts, sal ammoniac 3 parts, sugar of lead 3 parts, blue stone 1 part, and rouge 3 parts. The composition may be used as a powder, or, mixed with soft soap, as a paste.—W. F. F.

Ferro-uranium alloy. Nickel-uranium alloy. Process of manufacturing ferro-uranium. R. M. Keeney and L. F. Vogt, Washington, Pa. Assignors to Standard Chemical Co., Pittsburgh, Pa. U.S. Pats. (A) 1,210,054, (B) 1,240,055, and (C) 1,210,056, Sept. 11, 1917. Dates of appl., (A) and (B) Dec. 21, and (C) Dec. 28, 1915.

(A) A FERRO-URANIUM alloy contains 25–30 % uranium and more than 60 % iron. (B). The iron in (A) is replaced by nickel. (C) The alloy described in (A) is made by mixing subdivided iron with uranium oxide, a carbonaceous reducing agent, and a neutral slag-forming material such as fluorspar, and heating the mixture to a temperature above the melting point of iron.—W. F. F.

[Palladium-gold] alloy. Electro Metals Products Co., Assignees of H. S. Cooper, Cleveland, Ohio, U.S.A. Eng. Pat. 109,176, Dec. 8, 1916. (Appl. No. 17,669 of 1916.) Under Int. Conv., Sept. 29, 1916.

AN alloy composed of 60 % palladium and 40 % gold has a melting point approximating to that of pure palladium and higher than that of the alloy containing equal weights of the metals. It resists the action of acids and gases and high temperatures, thus forming a useful substitute for platinum in the preparation of laboratory ware and for dental purposes.—J. N. P.

Metallic bodies; Improvements in — [Modification of crystal structure.] J. Pintsch Akt.-Ges., Berlin. Eng. Pat. 109,298, Sept. 5, 1916. (Appl. No. 12,583 of 1916.) Addition to Eng. Pat. 16,620 of 1914 (see Fr. Pat. 469,212 of 1914; this J., 1915, 36).

THE crystal structure of metal rods, wires, filaments, or ribbons, is modified so that a single crystal extends throughout the whole length and cross section of the metal, by passing the body through a source of heat either *in vacuo* or in an enclosed space filled with a reducing or inert gas, at a speed which is not greater than the rate of growth of the crystal formation. The apparatus is arranged to give a gradual preheating of the metal, followed by a rapid rise to the maximum temperature, a sudden fall, and then gradual cooling. The wires or rods are passed down a thin-walled tube at the lower end of which is a spherical or rectangular chamber, and through the centre of a loop of wire which is arranged in the interior of the chamber in a plane at right angles to the axis of the travelling metal, and can be raised to a high temperature by the passage of an electric current. In alignment with the top tube, and passing through the lower part of the chamber, is the second tube, the upper part of which extends into the chamber to a distance which can be adjusted. The tubes and chamber are insulated in such a manner that the heat radiated from the spiral of wire in the centre produces the necessary gradient of temperature throughout the apparatus. Auxiliary heating of the metal can also be arranged by passing a current through the

rod or wire under treatment. For this purpose the ends of the tubes are closed by plates provided at their centres with fine borings at the upper ends of which mercury wells form air-tight seals between the plates and the travelling metal. The mercury seals serve as contacts for introducing a heating current through the wires, etc., and are cooled and the formation of arcs checked by causing a current of gas to impinge on the surface. Intermediate contacts of this nature may be arranged at intervals in the tube so as to limit or vary this auxiliary heating to a certain section of the metal. Several wires may be passed parallel to each other and thus treated simultaneously in this apparatus, without extra consumption of current. Wires and filaments prepared by this method may be worked or even drawn cold through dies without breaking down the crystal structure. —J. N. P.

Depositing metal by an electric arc: Method of and means for —, E. H. Jones, London. Eng. Pat. 109,321. (Appl. Nos. 13,342, Sep. 20, 1916, and 3864, Mar. 16, 1917.)

In the production of metal deposits by sustained deposition by means of an electric arc, heat is applied to the deposited metal to render it homogeneous and free from blow-holes and similar defects. In order to confine the fused metal during deposition, the part of the article to be treated is surrounded by a refractory mould, which is conveniently prepared from a mixture of slaked lime or the residue from the manufacture of acetylene from calcium carbide with 5–10% sodium silicate. The process may be applied to the production of a cutting edge of high-speed steel on a base of mild steel by local deposition of metal, or to the deposition of hardened metal on bearing surfaces. —J. N. P.

Metal electrodes used in electric arc soldering and deposition of metals: Method of forming —, E. H. Jones, London. Eng. Pat. 109,652, Sept. 20, 1916. (Appl. No. 13,343 of 1916.)

A METAL electrode for electric arc soldering or deposition of metals, e.g., high-speed steel, comprises one or more mild steel or cast iron cases of channel section, in one of which a rod containing carbon, e.g., of cast iron, carbon, or ferro-chrome, is placed. The remainder of the case is filled with the material to form the high-speed alloy, such as vanadium, cobalt, tungsten, molybdenum, chromium, with or without aluminium, mixed with a suitable binding agent such as sodium silicate. These materials may be previously moulded in the desired shape by extrusion and allowed to set. The electrode is enclosed in a suitable covering such as asbestos yarn soaked in sodium silicate solution, and powdered aluminium. —W. F. F.

Nickel-copper matte; Process for refining —, C. Langer, Clydach, Glamorgan. Eng. Pats. (A) 109,401 and (B) 109,402, Mar. 17, 1917. (Appl. Nos. 3904 and 3905 of 1917.)

(A) BESSEMERISED nickel-copper matte is reduced to a fine powder, and calcined so as to convert the nickel and copper into oxides, which are then leached with a solution of about 10% sulphuric acid at about 80° C., when 60–80% of the copper oxide is dissolved as sulphate. The solution is filtered off, the residue is dried, reduced to a powder containing about 60–65% of nickel, and used to displace copper from the copper sulphate solution. The nickel can be recovered from the solution by electrolysis with insoluble anodes, or the sulphate can be recovered as such by crystallisation, while the precipitated copper can be cast into anodes and refined by electrolysis, or converted into oxide by calcination and dissolved in

dilute sulphuric acid to form copper sulphate. (B) After treatment of the finely ground calcined nickel-copper matte with dilute sulphuric acid so as to dissolve the bulk of the copper, the residue is treated with strong sulphuric acid at about 150° C. and the sulphates produced are separated by dissolving in water, precipitating the copper from the solution by finely divided metallic nickel, and finally recovering the nickel from its solution by electrolysis. —J. N. P.

Copper-nickel pyrrhotite; Treatment of —, W. McA. Johnson, Assignor to Continuous Zinc Furnace Co., Hartford, Conn. U.S. Pat. 1,238,298, Aug. 28, 1917. Date of appl. Oct. 22, 1913.

THE material is crushed to a fine powder and subjected to the action of chlorine in closed chambers, whereby sulphur is displaced and volatilised. The resulting chlorides are dissolved in water, and after removal of copper and precious metals by adding scrap iron, iron and cobalt are precipitated as hydroxides, the hydroxides are dissolved, and the iron and cobalt precipitated separately. Nickel is separated as chloride from the remaining solution by evaporation and crystallisation, and the chloride is reduced to the metal by heating with hydrogen in a closed retort. —J. N. P.

Metallic debris; Preventing corrosion or waste in —, F. E. Whitham, Sowerby Bridge, Yorks. Eng. Pat. 109,749, Apr. 17, 1917. (Appl. No. 5375 of 1917.)

METAL turnings, especially aluminium, which have been subjected to the action of an alkaline liquid used as a lubricant for the cutting tool, are treated with an acid bath to neutralise the alkali and prevent corrosion. If the metallic debris has been subjected to the action of acid, an alkaline bath is used. —W. F. F.

Hardening metal articles; Apparatus for —, L. Renault, Billancourt, France. Eng. Pat. 109,596, June 20, 1917. (Appl. No. 8866 of 1917.) Under Int. Conv., Sept. 13, 1916.

APPARATUS for hardening a succession of similar articles comprises a vertical cylinder in the bottom of which the article is supported on a rotating stand provided with helical grooves. For each hardening operation, liquid from a measuring tank is poured through a funnel into the cylinder, and falling on the grooved stand, causes it to rotate. If the article is hollow an additional funnel and pipe are provided leading into its interior, the funnel receiving a proportion of the liquid from the tank. The main cylinder is raised and lowered as each article is replaced, and the tank is automatically refilled to a predetermined level at the same time by a float actuating an electrical device which controls the liquid supply. —W. F. F.

Annealing and like furnaces; Doors of gas-heated —, Dowson and Mason Gas Plant Co., Ltd., T. Wright, and E. W. Mawby, Manchester. Eng. Pat. 109,755, May 1, 1917. (Appl. No. 6353 of 1917.)

IN a gas-heated annealing or like furnace, the inlet door is hinged horizontally on a part of the door frame which projects forward. When closed the door is slightly inclined, with its lower edge resting on the lower part of the frame, and it can only open inwards. Cold air is prevented from entering and hot air from leaving the annealing chamber at the sides of the door when opened by the projecting part of the door frame. In a modification having three adjacent doors which open outwards, side plates are provided projecting

outwards from the door frames at the two outer ends, and similar plates are attached to the inner edges of the two side doors. These two doors or all three doors may thus be opened without allowing air to enter or leave at the sides.

W. F. F.

Furnaces of the crucible or like type. Richmond Gas Stove and Meter Co., Ltd., and H. Hartley, Warrington, Eng. Pat. 109,586, Apr. 16, 1917. (Appl. No. 5536 of 1917.)

A GAS-HEATED crucible furnace is divided by a vertical wall into two parts, one of which constitutes the crucible chamber, whilst the other part is divided into two compartments, the upper of which is used for preheating the metal or other substance. The lower compartment is fitted with two sets of U-pipes, through which passes the air required by the gas-burner. These pipes are heated by the products of combustion of the furnace and thus heat the incoming air recuperatively.

A. B. S.

Magnetic separator. The Hardy Patent Pick Co., Ltd., and G. J. McD. Smith, Sheffield, Eng. Pat. 109,766, June 4, 1917. (Appl. No. 7473 of 1917.)

A MAGNETIC separator comprises a horizontal brass cylinder containing the material to be separated, surrounded by radial electromagnets, the whole being rotatable. Each magnet as it reaches its highest point is demagnetised and the magnetic particles on the wall of the cylinder fall into a discharge shoot. To prevent the magnet at this point from being influenced by adjacent energised magnets, and the retention of the magnetic particles in consequence, intermediate radial iron arms are provided which are magnetised by induction with an opposite polarity. The radial arms also increase the intensity of the magnetic fields of the electro-magnets. W. F. F.

Ores; Process of extracting metals from — E. T. Stannard, Kennecott, Alaska, Assignor to Kennecott Copper Corporation, New York. U.S. Pat. 1,238,951, Sept. 4, 1917. Date of appl., Aug. 7, 1916.

THE ore is leached with a volatile solvent, the solution withdrawn, and the metal and volatile reagent recovered; steam is then passed through the charge; the condensed water removes any remaining metal-bearing solution, and the volatile reagent is recovered from the liquid. The treatment with steam may be continued until the charge is hot and condensation no longer takes place; the escaping steam is condensed and treated separately for recovery of volatile reagent. By washing the ore partly with the condensed liquid and partly with live steam, smaller volumes of stronger leaching solutions may be obtained.

W. R. S.

Electrolytic cell [for deposition of copper]. N. V. Hybinette, Christiania, Norway. U.S. Pat. 1,239,612, Sept. 4, 1917. Date of appl., May 22, 1913.

AN electrolytic cell for use in the deposition of copper from copper sulphate solutions containing iron sulphate, is composed of a tank in which anodes are suspended. A number of vessels are also suspended in the tank in such a manner that they can be removed, each vessel having a lower porous portion below the top of the tank separating the anodes from the cathodes, and an upper non-porous portion extending above the tank. A cathode is suspended in each vessel, with means for supplying the electrolyte directly to the

vessels; the non-porous portion co-operates with the supply means to maintain the solution in each cathode chamber under atmospheric pressure, but above the level of the solution in the anode chamber. Means are provided for regulating the difference between the levels, so as to control the amount of solution passing through the porous portions of the vessels. The solution is withdrawn from the anode chamber by suitable means, and overflow channels, passing over the edge of the tank, are arranged for withdrawing solution from the cathode chamber.—B. N.

Electrolytic deposition; Apparatus for — P. L. Antisell, Perth Amboy, N.J. U.S. Pat. 1,239,443, Sept. 11, 1917. Date of appl., Oct. 31, 1913.

THE cathode sheets are suspended from conducting members connected to the electrolytic tank, and a receptacle is arranged between the cathode sheets to act as anode, with an open top for the passage of particles of conducting material and solution. The receptacle is provided with a bottom for supporting the particles of conducting material, but permitting the passage of liquid, and conducting members, extending into the receptacle, are arranged to form a wet contact with the material. The anode receptacle has closed ends and open sides, the latter being covered with "rotary cut veneer" porous diaphragms, supported by the sides and by rods attached to the receptacle. Electrolyte is supplied to the tank and receptacle, and means are provided for circulating the solution through the anode and removing it from the tank.—B. N.

Ores; Process for treating — N. C. Christensen, jun., Assignor to Holt-Christensen Process Co., Salt Lake City, Utah. U.S. Pat. 1,239,167, Sep. 4, 1917. Date of appl., Mar. 10, 1915.

IN roasting ores, the coarser particles are screened out and a portion spread uniformly over the roaster grate; a moistened mixture of ore, salt, and sulphides is spread uniformly upon the coarse material, and the upper layer is loosened by disturbing the lower one. The upper portion of the top layer is heated to ignite the sulphides, the roasting being accomplished by a downward current of air. The coarse particles are again screened out of the roasted mixture and used over again. The whole process is carried out continuously.—W. R. S.

Alkali-earth metals [magnesium]; Process for obtaining — W. M. Grosvenor, Ridgewood, N.J. U.S. Pat. 1,239,178, Sep. 4, 1917. Date of appl., Feb. 3, 1916.

MATERIAL containing magnesium oxide is heated for a long time in a current of inert gas, e.g., hydrogen, nearly to the temperature at which magnesium vapour would be liberated, so as to remove volatile impurities, then heated with a suitable reducing agent to a point not far above the temperature at which metallic magnesium is formed, to avoid volatilisation of more refractory impurities; the magnesium vapour is condensed. The material must be sufficiently basic to have a melting point above the volatilising point of magnesium.—W. R. S.

Agglomerating ore; Machinery for — P. O. Harding, Rancagua, Chile. U.S. Pat. 1,239,179, Sep. 4, 1917. Date of appl., Jan. 15, 1917.

A SINTERING machine comprises a vertical tubular sintering-chamber, and above it a stationary conveyor with a tapered, radial delivery orifice and a spreader beneath the conveyor. A rotary shoot is provided between the delivery orifice and the top of the sintering-chamber.—W. R. S.

Ores and substances; Process for the treatment of — F. L. McGrahan, Los Angeles, Cal. U.S. Pat. 1,239,282, Sep. 4, 1917. Date of appl. Feb. 26, 1914.

THE process consists in smelting the ore, drawing off the liberated gases and partly condensing them, superheating the remainder, and returning it to the furnace. The condensed portion is separated into its constituent products.—W. R. S.

[*Solder.*] *Composition of matter.* W. A. Day, Bellingham, Wash. U.S. Pat. 1,239,465, Sept. 11, 1917. Date of appl. Mar. 12, 1917.

A SOLDER for cast iron, mild steel, pot-metal, aluminium, lead, and the like is composed of lead, 5 parts, tin, 5 parts, and zinc, 1 part.—W. F. F.

Soldering compound. G. Gardiner, East Cleveland, Ohio. U.S. Pat. 1,239,785, Sept. 11, 1917. Date of appl. May 1, 1916.

A SOLDERING compound consists of tin, 35 parts, zinc, 17.5 parts, copper 1 part, and antimony, 0.02 part.—W. F. F.

Welding and soldering of articles constructed of aluminium; Composition of matter for the — O. C. Wells, Fort Worth, Tex. U.S. Pat. 1,239,854, Sep. 11, 1917. Date of appl. June 23, 1917.

A COMPOSITION for welding and soldering aluminium consists of aluminium, 1 part, lead, 3 parts, block tin, 7 parts, and zinc, 2 parts.—W. F. F.

[*Iron tungstate*] *ores; Process for treating* — H. E. Cleaves, Washington, D.C. U.S. Pat. 1,239,885, Sep. 11, 1917. Date of appl. Mar. 9, 1917.

ORES or compounds containing one or more of the metals of the fifth and sixth groups, e.g., an ore containing an iron tungstate mixed with undesirable metals or metalloids, are treated at a temperature above red heat with non-oxidising gas containing hydrogen chloride and a reducing agent. Iron and tungsten chlorides are formed and volatilised, and the stream of gas containing them is passed into water where tungsten oxide is precipitated. The hydrogen liberated combines with part of the metalloids, and the reducing agent is present only in such quantity as is necessary to prevent the formation of free chlorine by reacting with the excess of metalloids not combined with hydrogen.—W. F. F.

Minerals; Flotation of — C. L. Perkins, Pittsburgh, Pa., Assignor to Metals Recovery Co., New York. U.S. Pats. (A) 1,240,597, (B) 1,240,598, and (C) 1,240,599, Sept. 18, 1917. Date of appl. Aug. 2, 1917.

A SMALL amount of (A) β -naphthylamine or (B) xylydine and other agents, with sufficient alkali to give a distinct alkaline reaction, is added to the mineral pulp, and the resulting mixture subjected to flotation. (C) A mixture of α - and β -naphthols and other agents is added to the mineral pulp, and the whole subjected to flotation.—T. H. B.

Carnotite ores; Concentrating — H. Schlundt, Columbia, Mo. U.S. Pat. 1,240,607, Sept. 18, 1917. Date of appl. June 16, 1916.

CARNOTITE ores and other materials containing radium are heated with nitre cake at a temperature sufficient to dissolve the radium together with barium as sulphates. The resulting solution is poured into water while still liquid; the radium barium sulphate is thus precipitated in a finely divided condition, and is afterwards separated from the undissolved material.—T. H. B.

Magnetic material (iron); Process for making — British Thomson-Houston Co., Ltd., London. From General Electric Co., Ltd., Schenectady, N.Y., U.S.A. Eng. Pat. 109,528, Nov. 8, 1916. (Appl. No. 16,008 of 1916.)

SEE U.S. Pat. 1,291,623 of 1916; this J., 1916, 1222.

Aluminium shavings, screenings, dross, slags, or analogous materials; Process for treating — H. A. Gill, London. From W. F. Jobbins, Inc., Aurora, Ill., U.S.A. Eng. Pat. 109,716, Mar. 23, 1917. (Appl. No. 1295 of 1917.)

SEE U.S. Pat. 1,228,119 of 1917; this J., 1917, 888.

Crucible furnace. G. and J. Keith, London. U.S. Pat. 1,241,597, Sept. 25, 1917. Date of appl. Oct. 23, 1916.

SEE Eng. Pats. 17,902 of 1915 and 8793 of 1916; this J., 1917, 88.

Method of agglomerating finely-divided material — U.S. Pat. 1,239,221. See 1.

Manufacture of crystalline fused alumina (and ferrosilicon and alkali compounds). U.S. Pat. 1,239,984. See VII.

XI.—ELECTRO-CHEMISTRY.

Electrical fume precipitation; Some theoretical aspects of — W. W. Strong. Joint meeting of Amer. Electrochem. Soc. and Amer. Inst. Min. Eng., Jan. and May, 1917. [Advance copy.] 16 pages.

THE rapid progress which has been made in the past few years in the application of electrical fume precipitation is due largely to the technical advances in the construction of apparatus for the production of high-voltage electric currents, the theoretical side of the process having received comparatively little attention. In the simplest form of electrical precipitation apparatus, namely a wire (charged negatively) arranged axially within a cylinder, with a high difference of electrical potential between the two, three different regions may be distinguished: the inner zone is the region of active electrode rays or positive ion rays and positive space charges, whilst the outer zone is the region of passive electrode rays and negative space charges; intermediate is the zone where the gas molecules become charged by collision with ions. In electrical precipitation it is important to keep the fumes as far as possible within the region of passive electrode rays and negative space charges. The space charge effects of the small ions of the corona discharge do not interfere with electrical precipitation, any choking of corona currents by space charges being due to the large ions. If the effect of space charges be neglected, the formation of ions in a gas is probably not greatly affected by fumes and smoke, but the nature of the fume particles probably greatly affects the ease with which they hold ions. Some substances, such as zinc oxide, may reflect ions that collide with them, but in such cases formation of a thin layer of some conducting substance over the surface of the particles may make it possible to charge them. The greater the space charge in a treater the less is the voltage that can be applied. In practice a pipe having a diameter about 30 times the diameter of the corona is used. It is suggested that in the future development of the process, in addition to advances in regard to the more efficient charging of the suspended particles and the maintenance of the corona at its maximum value more continuously and uniformly, the practicability of utilising the chemical power of the corona discharge as well as its precipitating power will have to be considered.

PATENTS.

Electric discharge apparatus. C. Field-Frank, New York. Assignor to General Electric Co. U.S. Pat. 1,238,660, Aug. 28, 1917. Date of appl., Jan. 27, 1916.

ELECTRODES consisting of two metallic plates are arranged parallel to one another in a case of insulating material which is filled with a dry flocculent oxide of lead prepared by heating the precipitated peroxide. A conducting path of high resistance is thus formed between the electrodes, the passage of a large current being checked by an increase in resistance of the material in the path between the electrodes, due to the change produced in the oxide on elevation of temperature.—J. N. P.

Furnace; Electric——. E. F. Price, Port Chester, N.Y.. Assignor to Electro-Metallurgical Co., New York. U.S. Pats. (A) 1,239,211 and (B) 1,239,215, Sep. 4, 1917. Date of appl., Feb. 1, 1917.

(A) A CAST-METAL base, made in segments, is provided with a cooling arrangement, and with a hearth or bed of carbonaceous material, the hearth and the base being separated by a series of overlapping metal sheets. (B) The furnace has a movable electrode, with a flexible conductor in the circuit leading to it, and a flexible shield is disposed between the flexible conductor and the furnace, the shield being movable with the conductor but insulated from it.—B. N.

Electrolytic apparatus. H. T. Shriver, West Orange, N.J. U.S. Pat. 1,239,530, Sept. 11, 1917. Date of appl., May 25, 1915. Renewed Apr. 17, 1916.

AN electrolytic apparatus of the filter-press type is composed of a number of cells in series, formed from vertical parallel recessed plates, held face to face. A diaphragm is arranged between each pair of recessed plates, and means are provided for maintaining the electrolyte, which is heavier than water, at approximately a predetermined level, the diaphragm being porous below and non-porous above the normal level of the liquid. A horizontal diluent supply duct is connected by means of auxiliary ducts with the lower parts of the cells, and means are provided for placing the diluent in the various ducts under pressure, the pressure means and the auxiliary ducts being constructed and arranged so that the diluent flows from the supply duct to the cells and not in the reverse direction. Main gas ducts, extending through the plates, are connected to each of the cells to carry away the gas formed at the anodes and cathodes respectively. The pressure is sufficient to cause water, as a diluent, to flow into the cells when the level of the electrolyte falls below the normal, but is insufficient to cause the electrolyte to flow into the main gas ducts.—B. N.

Insulating compound and method of producing the same. J. W. Harris, Montclair, N.J.. Assignor to Western Electric Co. U.S. Pats. (A) 1,240,565, (B) 1,240,566, and (C) 1,240,567, Sept. 18, 1917. Date of appl., Mar. 5, 1915.

(A) A MIXTURE of resin and castor oil is heated at 250° to 310° C. until from 5 % to 15 % of the decomposition products of the castor oil has been distilled off. The article to be protected is coated with the residue and heated to 300° C. (B) A mixture of castor oil and a metallic soap of castor oil or (C) a mixture of a metallic resinate and castor oil, is subjected to destructive distillation at a temperature, about 300° C., sufficiently high to produce a solid, insoluble substance. The mixture is heated either on the article to be protected or in the desired shape of the insulating material.—B. V. S.

Electric furnace. J. L. Dixon, Sheffield. U.S. Pat. 1,241,351, Sept. 25, 1917. Date of appl., Feb. 23, 1915.

See Eng. Pats. 4742, 8513, 16,263, and 17,909 of 1914; this J., 1915, 233.

Process of producing alkalis from kelp. U.S. Pat. 1,238,600. See VII.

Electrolytic cell. U.S. Pat. 1,239,012. See X.

Apparatus for electrolytic deposition. U.S. Pat. 1,239,413. See X.

XII.—FATS; OILS; WAXES.

Fats and oils; Method for fractionating——. A. Seidenberg. J. Ind. Eng. Chem., 1917, 9, 855—858.

THE fat is dissolved in two or more solvents (e.g. alcohol and ether), one of which is more volatile than the other and has a greater solvent action upon the glycerides. Air is aspirated through the solution, causing a gradual evaporation and considerable decrease in the temperature, and the glycerides which successively separate are removed. In this way a fractionation of the glycerides in the order of their insolubility is effected, and pure products may be obtained by combining similar fractions and repeating the fractionation as many times as is necessary. By thus fractionating 100 grms. of tallow dissolved in 1000 c.c. of a mixture of ether and absolute alcohol (1:1), and re-fractionating the deposits from mixtures of alcohol and ether, about 0.98 grm. of a mixed glyceride (oleodistearin), and about 20.6 grms. of a more soluble glyceride, dioleopalmitin were isolated. No evidence of the presence of triolein was obtained. The method may be adapted to the detection of beef or mutton fat in butter fat. Thus a sample of pure butter fat when fractionated from mixtures of ether and 95 % alcohol yielded 3.8 % of insoluble glycerides, whilst the same fat to which 20 % of tallow had been added, yielded under the same conditions, 0.9 % of insoluble glycerides.—C. A. M.

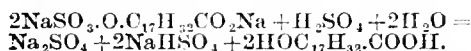
Fats and oils; Thermal values of——. II. The sulphuric acid or Maumené value. J. W. Marden and M. V. Dover. J. Ind. Eng. Chem., 1917, 9, 858—860. (See also this J., 1916, 477.)

THE apparatus consists of a Dewar vacuum tube, through the cork of which is passed a large test-tube, in which the oil and acid are stirred by means of an agitator. The calorimeter is standardised by mixing therein a weighed quantity of sulphuric acid of known strength with a weighed quantity of water, and calculating the heat liberated after the temperature has become constant. If the same weights of acid, oil, and water are always used, the heat capacity of the system may be considered constant. The rise in temperature, multiplied by the heat capacity of the system divided by the weight of oil, gives the Maumené value in cal. per grm. of oil. Variations in concentration of the acid have a considerable effect upon the results, but the amount of acid may be varied without greatly affecting the thermal value. The specific heats of a number of fats and oils were determined by a method similar to that used for determining the heat capacity of the apparatus. They showed only slight variations (0.438 to 0.551). Duplicate determinations of the Maumené value agreed within 0.5 %. The values obtained by treating

typical oils with an excess of 95.1 % sulphuric acid were of the same order of magnitude as the corresponding iodine values.—C. A. M.

Sulphonated oils: Analysis of — R. Hart.
J. Ind. Eng. Chem., 1917, 9, 850—852.

THE fat is determined by titrating a solution of the oil with N/2 sulphuric acid, using methyl orange as indicator, and the alkalinity (from the soap) is expressed in mgrms. of KOH per gram. Another portion of the sample is used for the determination of the saponification value in the usual way, and the sum of the two results divided by the neutralisation value of the fatty acids of the original castor oil gives the percentage of fat. In cases where the neutralisation values of the fatty acids are not known, the average value of 190 may be taken. Ammonia is determined by boiling a portion of the solution with a measured excess of N/2 alcoholic sodium hydroxide to expel ammonia and titrating the liquid with N/2 sulphuric acid. The alkalinity of a second portion is then determined, omitting the boiling with caustic soda, and the difference between the two results corresponds to the ammonia. In calculating the saponification value allowance must be made for the fat corresponding to the ammonium soap, which acts like fatty acids during the saponification. *Combined sulphuric anhydride*:—The oil is boiled with a measured quantity of standard sulphuric acid until completely decomposed:



It is then titrated with standard alkali solution, using methyl orange as indicator, and the net change in the acidity is equal to the difference between the total alkalinity due to the soap, and the acidity due to the sodium bisulphate. The total alkalinity of the original sample is determined as described, and from these data the acidity corresponding to the sodium bisulphate, or combined sulphuric anhydride, may be calculated. The results agree closely with those obtained by the usual gravimetric method.—C.A.M.

Method of testing [viscosity of] lubricating oils.
Dubrisay. See IIA.

PATENT.

Catalyser for hydrogenating oils and the like. M. H. Ittner, Jersey City, N.J. U.S. Pat. 1,238,774, Sept. 4, 1917. Date of appl., May 14, 1914.

A CATALYST comprises a catalytic material, viz., a metal (nickel) coated with catalytic oxide (a low oxide of nickel), associated with charcoal impregnated with a catalytically activating inorganic compound, e.g., a silicate, or oxygen compound of aluminium.—E. W. L.

Process for cleaning filters in connection with the purification of sugar, oils, and chemicals. U.S. Pat. 1,240,290. See I.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

PATENTS.

Titanic acid pigment products; Manufacture of — H. Wade, London. From The Titanium Alloy Manufacturing Co., New York. Eng. Pat. 108,875, June 15, 1916. (Appl. No. 8464 of 1916.)

A COMPOSITE pigment is obtained by adding a

solution or suspension of an alkaline-earth base or sulphide to a titanic sulphate solution, whereby orthotitanic acid is precipitated coalesced with insoluble alkaline-earth sulphate. The alkaline-earth sulphate may be replaced by a so-called "extender pigment" (barites, silica, china clay, etc.) by adding a solution of alkali hydroxide, carbonate, or sulphide to a suspension of such "extender pigment" in a titanic solution. The composite precipitate is subsequently calcined. The titanic solution is previously freed from metallic compounds of the copper group by treatment with hydrogen sulphide and filtering off the precipitated sulphides. Iron as an impurity is removed by employing a soluble sulphide for precipitation of the pigment: the iron sulphide formed is dissolved by passing sulphur dioxide into the solution.—A. DE W.

Decorative surfaces; Treatment of — G. H. Hadfield, Merton, and A. E. Baytree, Sutton, Surrey. Eng. Pat. 109,857, Sept. 21, 1916. (Appl. No. 13,437 of 1916.)

SURFACES coated with varnishes containing Chinese wood oil, linseed oil, or other drying oil, are subjected to the action of vapours of nitric acid "or its equivalent" whereby a crystalline, matt, or honeycombed structure in the surface is formed, or the film hardened or coloured according to the conditions of temperature, etc., and the particular gases or vapours employed. A "nitric acid equivalent" is defined as any gas or vapour capable of modifying the colour, hardness, or structure of the uniform glossy film obtained under the ordinary conditions of drying in pure air at ordinary or elevated temperatures. The vapour in an internally heated gas oven which causes certain wood oil varnish films to assume crystalline structure is not claimed as a "nitric acid equivalent." Several methods of producing variations of surface are quoted, e.g., the presence of sulphur dioxide in the gas is claimed as being responsible for deepening of colour at ordinary temperatures: local effects are obtained by superimposing layers of varnishes with no tendency to crystallise, etc., under any conditions; the flash point of the thinner employed governs the size of the mesh or crystal obtained.—A. DE W.

Paint; Luminous — G. A. H. Muller, Montreal, Canada. U.S. Pat. 1,237,368, Aug. 21, 1917. Date of appl., June 8, 1916.

A BASE of luminous calcium sulphide is prepared by heating caustic lime with sulphur, and is purified by heating it with calcium fluoride, which forms volatile compounds with the impurities. Other substances may be added for colouring purposes.—E. W. L.

Lampblack and hydrochloric acid; Process of making — C. C. Averill, Trees, La. U.S. Pat. 1,238,734, Sept. 4, 1917. Date of appl., Apr. 6, 1917.

A HYDROCARBON, e.g., natural gas, is burned in an atmosphere of chlorine in a closed chamber from which air is excluded; the carbon is allowed to settle and the hydrochloric acid is drawn off.

—E. W. L.

Sealing wax. W. O. Snelling, Pittsburgh, Pa. U.S. Pat. 1,239,629, Sept. 11, 1917. Date of appl., Oct. 14, 1915.

THE sealing wax is composed of resin, a filling material, a colouring material, and a vaporisable, solid or semi-solid, fire-extinguishing, halogenated carbon compound, such as hexachloroethane.

—B. N.

Titanic oxide products (pigments); Method for producing composite—L. E. Barton, Niagara Falls, N.Y., Assignor to The Titanium Alloy Manufacturing Co., New York, U.S. Pat. 1,240,405, Sept. 18, 1917. Date of appl. June 8, 1916.

See Eng. Pat. 108,875: preceding.

Process for making a filler for rubber or paint.—U.S. Pat. 1,237,701. See XIV.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Rubber: Influence of the amount of acetic acid [used for coagulation] on the qualities of—O. de Vries, P. Arens, and N. L. Swart. Communication from the Central Rubber Station at Buitenzorg, No. 2. *Archief voor de Rubbercultuur in Ned. Indie*, 1917, 1, No. 1.

THE slight variation in the proportion of acetic acid used in estate practice is not likely to be a factor affecting the inner qualities of the rubber; with varying quantities of acetic acid ranging from the minimum to four times as much, the tensile strength and "type" were found to be unaffected, whilst the rate of vulcanisation was reduced, e.g., by 10 minutes on 135 with the quadruple amount of acid, and the viscosity was also decreased somewhat.—D. F. T.

Cripe rubber; Influence of rolling on—O. de Vries and N. L. Swart. Communication from the Central Rubber Station at Buitenzorg, No. 2. *Archief voor de Rubbercultuur in Ned. Indie*, 1917, 1, No. 1.

A CONFIRMATION of the results of Eaton and Grantham (this J., 1910, 263), and Campbell (Bull. Depart. Agric. Ceylon, 24,) that creping of much longer duration than that practised on rubber estates, either with smooth or grooved rolls, causes no appreciable diminution in tensile strength, viscosity, or rate of vulcanisation. As long as the rolls are kept cool, a reasonable variation in the number of times for which the rubber is passed through the rolls is without influence on the internal qualities of the rubber, although, for the sake of cheapness in production, it is desirable to roll as little as is consistent with a good external appearance.—D. F. T.

Vulcanisation; The most practical accelerator of—A. Hutin. *Monit. Scient.*, 1917, 61, 193—196.

EXAMINATION of an accelerator placed on the market by a German firm before the war, showed it to be dimethylamine dimethylaminodithiocarbamate. The method of preparation of this substance by the formation of dimethylamine by the action of a 4% solution of potassium hydroxide on *p*-nitrosodimethylaniline and its further combination with carbon bisulphide to form the desired product is outlined; the cost of the materials required for these processes is estimated to be about 4.5 fr. per kilo. (pre-war prices). Using 1% of this accelerator in a rubber mixing the duration of the vulcanisation process is stated to be reduced in the proportion of 8:3.—D. F. T.

Rubber compounds for wire and cable insulation. Rubber Age, 1917. *India Rubber J.*, 1917, 54, 412—425.

AFTER indicating the principal mineral fillers, pigments, and organic additions to mixings for wire and cable insulation, particulars are given of a

large number of mixings by way of indicating how a good insulation may be made up. Good results do not, however, depend only upon the use of good materials, since the manner in which the raw rubber is handled and the compounds worked together have also much to do with the success of the operations.—E. W. L.

PATENTS.

Vulcanisable elastic masses suitable for use as rubber substitutes; Production of—E. S. Ali-Cohen. The Hague, Holland. Eng. Pat. 103,824, Jan. 22, 1917. (Appl. No. 1076 of 1917.) Under Int. Conv., Jan. 29, 1916.

AN elastic mass free from sulphur, which can be vulcanised like rubber, and which is not liquid at the temperature of vulcanisation, is prepared by mixing an aluminium, iron, or other earth or heavy metal salt of a higher fatty acid, dissolved or not in a high-boiling hydrocarbon, with a drying oil at 250° C., the drying oil having previously been heated for a considerable time with an oxidising agent such as manganese dioxide. *Example*. One part of aluminium stearate is dissolved in one part of ozokerite, and mixed with 4—10 parts of oxidised linseed oil at 200°—250° C. An elastic mass is produced which can be vulcanised with sulphur or certain compounds of sulphur, and can be mixed with filling materials as used in the rubber industry. When mixed with an appropriate substance, e.g., asphaltum, it forms an electrical insulator suitable for cables, etc.—F. St.

Rubber; Method of vulcanising—R. B. Price. New York, Assignor to Rubber Regenerating Co. U.S. Pat. 1,237,554, Aug. 21, 1917. Date of appl., Dec. 13, 1913.

SHEET rubber is interleaved with homogeneous conducting material, and a current of electricity of suitable intensity is passed through the latter for a length of time sufficient to vulcanise the rubber.—E. W. L.

Rubber or paint; Process of making a filler for—W. B. Rosevear, jun., Detroit, Mich. U.S. Pat. 1,237,704, Aug. 21, 1917. Date of appl., Dec. 9, 1916.

THE precipitate produced in clarifying the juice in sugar manufacture is heated, with free access of air, to a temperature sufficiently high to drive off the moisture and volatile organic matter without discolouring the product, and the latter is used as a filler.—E. W. L.

XV.—LEATHER; BONE; HORN; GLUE.

Chrome [tanning] liquors; Action of neutral salts on—J. A. Wilson and E. J. Kern. J. Amer. Leather Chem. Assoc., 1917, 12, 415—460.

THE amount of alkali necessary to produce a permanent precipitate in a chrome liquor is increased by the addition of certain neutral salts. The authors believe this to be due to the hydration of the ions of the added salts. The water thus bound is, in a sense, removed, and the liquor behaves like one of greater concentration. This view is borne out by experiment, the amount of alkali necessary to start precipitation being larger the greater the degree of hydration of the ions of the added salt.—F. C. T.

Chrome [tanning] liquors; Analysis of one-bath—D. McCandlish. J. Amer. Leather Chem. Assoc., 1917, 12, 440—445.

USED one-bath chrome liquors cannot always be

oxidised readily by sodium peroxide, owing to the presence of soluble protein which in hot acid solution acts as a reducing agent. No difficulties arise, however, if the protein present does not exceed 1.25%. When larger quantities are present, the chromium may be estimated gravimetrically. Another method is to evaporate the liquor to dryness in a platinum basin with a mixture of 60% of magnesia and 40% of sodium carbonate, and subsequently to heat the residue strongly. By this means all chromium compounds are oxidised to chromate. The author urges the importance of determining the point at which chrome liquors begin to give a permanent precipitate on the addition of N/10 alkali (such as borax or sodium carbonate).—P. C. T.

PATENTS.

Oil-tanning; Materials for oiling leather and for —. O. Röhm, Darmstadt, Germany. Eng. Pat. 103,668, Jan. 23, 1917. (Appl. No. 1128 of 1917.) Under Int. Conv., June 16, 1915.

PARTLY sulphonated oils are very suitable for oiling leather and for oil-tanning, provided that when neutralised they are easily soluble in water and do not separate from solution on standing. Castor oil may be sulphonated with 0.5% only of sulphuric acid, which is slowly run into the oil whilst stirring, the temperature being kept at about 40° C. The product is then neutralised. —P. C. T.

Glue leather; Process for the conversion of — into glue and the like. O. Röhm, Darmstadt, Germany. Eng. Pat. 104,181, Feb. 15, 1917. (Appl. No. 1267 of 1917.) Under Int. Conv., Feb. 21, 1916.

THE preliminary extended treatment with lime, followed by washing with hydrochloric acid, used in the conversion of glue-leather into edible gelatin or glue, is replaced by treatment for a few hours with pancreatic or similar enzymes which are capable of splitting up or digesting albumin. Acids, ammonium salts, or other substances capable of neutralising lime or other alkali, or amino-acids or other decomposition products of albumin may be used in addition to the enzymes, if necessary. After the scrap or waste has been subjected to this treatment it is boiled. In treating glue-leather which is slowly attacked by the enzymes, it is advantageous to effect a preliminary swelling with 0.5% caustic soda solution.

Leather waste; Compositions utilising —. J. S. Campbell, London. Eng. Pat. 109,530, Nov. 13, 1916. (Appl. No. 16,227 of 1916.) (See also Eng. Pat. 9370 of 1914; this J., 1915, 624.)

POWDERED leather is boiled for 1½ hrs. with water containing sufficient caustic alkali to saponify fats present. Filling material (e.g., chalk or magnesia), and colouring, preserving, and vulcanisable material may then be added, and the boiling continued for ½ hr. The mass is dried and rolled between heated rollers, together with sulphur or other vulcanising agent. The filling material, etc., may be added during rolling instead of when boiling. The product may be immediately vulcanised, or first made liquid by a solvent, applied to a backing such as canvas, and then vulcanised.—P. C. T.

Plastic masses; Process of making — [from brewery by-products]. E. Krause, Steglitz, and H. Blücher, Leipzig-Gohlis, Germany. U.S. Pat. 1,238,528, Aug. 28, 1917. Date of appl. June 12, 1917.

ALBUMINOUS waste products from the manu-

facture of alcoholic beverages, e.g., the cooler sediment from hopped worts, are treated with formaldehyde, and the resulting mass dried and subjected to heat and pressure. (See also Eng. Pat. 76 of 1911; this J., 1915, 972.) —P. C. T.

Plastic compositions; Manufacture of — [from brewery by-products]. E. Krause, Berlin-Steglitz, and H. Blücher, Leipzig-Gohlis, Germany. Eng. Pat. 106,270, Mar. 6, 1917. (Appl. No. 3311 of 1917.) Under Int. Conv., May 11, 1916.

See U.S. Pat. 1,238,528; preceding.

XVI.—SOILS; FERTILISERS.

Alkali [in soils]; Origin of —. R. Stewart and W. Peterson. J. Agric. Res., 1917, 10, 331—353.

THE natural incrustation on the soils of Utah, Colorado, Wyoming, Montana, Alberta, and parts of Canada contains the sulphates, chlorides, bicarbonates and nitrates of calcium, magnesium, and sodium. Extensive field studies of these areas, undertaken by the authors more particularly in connection with so-called "nitre spots," have given results which lend support to the hypothesis that the "alkali" is derived from the soluble salts pre-existing in the country rock. This rock, rich in alkali, not only contributes to soil formation, but is adjacent to and underneath the agricultural soils in the affected areas. There may not be sufficient alkali salts present in the original soil to prevent crop production, but upon the application of irrigation water the "alkali" salts existing in the country rock are leached out and concentrated in the surface soil. Leaky irrigation canals and the rise of the ground water give greatest and quickest concentration. Enormous deposits of soluble salts exist in the shales and sandstones of the Cretaceous and Tertiary strata of Utah, Colorado, and Wyoming. In certain local areas these salts become concentrated so as to produce native "alkali" or "nitre spots" by the movement of the underground water, without irrigation. Wherever the shale is highly impregnated with the salts, evaporation of the water deposits the "alkali" salts on the surface in the form of an ash-like powder.—E. W. L.

Ammonia and nitrates in the soil; Effect of paraffin on the accumulation of —. L. P. Gainey. J. Agric. Res., 1917, 10, 355—364.

PARAFFIN, whether in the form of the commercial "Parowax," or of a prepared paraffin wax (m.p. 50° C.) or of paraffin oil, is found not only to exercise a strong inhibitory effect upon the accumulation of ammonia and nitrate nitrogen in soils, but also to bring about an actual reduction in the quantity of active nitrogen (nitrate nitrogen plus ammonia nitrogen) present. This is not not only the case when the paraffin is mixed with the soil, but also occurs when a column of soil is surrounded by a layer of paraffin wax, thus vitiating results on soil-fertility obtained by the so-called "paraffin wire basket method." Parallel with the disappearance of active nitrogen there is also disappearance of paraffin and enormous development of saprophytic fungi, and the authors suggest that the paraffin is utilised as a stimulant, or source of carbon and energy, by the fungi, which at the same time consume nitrogen in their metabolism.—E. W. L.

Nitrites and ammonia in diseased plants [e.g., sugar beets]; Presence of—. II. *Relation of oxidases and diastases to the disturbance*. P. A. and M. Bonequet. J. Amer. Chem. Soc., 1917, 39, 2088—2093. (See this J., 1917, 41.)

FURTHER observations have supported the conclusion that in certain diseases of plants nitrogen starvation is caused by the bacterial reduction of nitrates to nitrites and ammonia, after they have been taken up by the roots. The first effect of the reducing organisms is to cause a decrease in the oxidising enzymes, but subsequently there is an increase, especially in the new leaves. Plants affected with nitrogen starvation, due to the action of reducing bacteria, showed a vigorous increase in diastatic activity, the tissues of an abnormal deep green colour being 5 or 6 times more active than normal tissues. Conversely, tissues which were yellowing were sometimes devoid of starch-hydrolysing power. In the case of beets affected with "curly leaf" an increased amount of formaldehyde was found in the juice of the leaves. The tissues richest in diastases were also found to be the most active in the formation and storage of starch. Sugar beets affected with "curly leaf" usually contain much more sugar in the roots than normal beets growing under the same conditions. This is attributable to the increased production of chlorophyll under the stimulus of the reducing bacteria. The increased development of diastases appears to be due to the need of an increased hydrolysis of starch, and subsequent transfer of the product to storage cells in the roots. Plants affected with nitrogen starvation always show a higher percentage of ash than normal plants. The maximum increase was observed in plants which had responded most to the stimulus of the bacteria. The total nitrogen in plants thus affected is always lower than that found in healthy plants. Plants infected with nitrate-reducing bacteria lose ammonia by volatilisation. Thus the loss of from 0.15 to 0.19 gm. of ammonia per sq. m. of leaf surface has been observed during 10 hours' sunshine, whereas normal healthy plants apparently lose no ammonia with their transpiration water. —C. A. M.

Soil sulphur: Divergent effects of lime and magnesia upon the conservation of—. W. H. MacIntire, L. G. Willis, and W. A. Holding. Soil Sci., 1917, 4, 231—237.

PRELIMINARY results of an investigation as to the removal of sulphates from soil by rainfall, in the case of a sandy loam soil from Tennessee River, United States, are given. The soil samples mixed with quantities of lime corresponding to 8, 32, and 100 tons per acre, and equivalent amounts of magnesia, precipitated calcium and magnesium carbonates, and ground limestone, dolomite, and magnesite, were placed on sand beds in tanks and leached naturally with the rainfall between July, 1914, and, July 1916. A duplicate lot with 144 lb. of clay subsoil under the soil sample was also operated. The initial SO_4 in the soil was 0.129 %, and the SO_4 in the rainfall was 121 lb. per acre per annum. It was found that all the sulphur was removed as sulphate. The loss of sulphate was heavier from the tanks containing only the surface soil than from the tanks containing subsoil also. Magnesia and magnesium carbonate were exceptions, in that the results during the second year were higher with the subsoil, and also an equivalent amount of magnesium was removed with the sulphate. The treatment with lime at the 32- and 100-ton rates almost inhibited the removal of sulphate. The natural carbonates caused an increased removal of sulphate when compared with untreated soil, and the removal of sulphate during the second year was less than during the first. It is concluded that a

continued loss of sulphates in the amounts found would effect a speedy and absolute depletion of the initial organic sulphur content of the soil, except in the case of the lime treatment.—J. H. J.

Nitrification: Effects of alkali salts on—. P. E. Brown and E. B. Hitchcock. Soil Sci., 1917, 4, 207—229.

THE purpose of the experiments described was to determine the concentration at which alkali salts became toxic to nitrifying bacteria, with special reference to the alkali soils of Wyoming, United States. It was found that in normal soil nitrification was stimulated by small amounts of sodium chloride, sodium sulphate, magnesium sulphate, and calcium carbonate. With larger amounts, the salts became toxic; sodium chloride at 0.02 %, sodium sulphate at 2 %, and calcium carbonate at 1.5—6 %. In alkali soils nitrification was increased by small amounts of sodium carbonate and bicarbonate and of calcium carbonate, while calcium sulphate had no effect. With larger amounts toxicity was produced by 0.3 % of sodium carbonate and bicarbonate, and by 6 % of calcium carbonate. The addition, however, of the calculated amount of calcium sulphate to the two former salts neutralised their toxicity. With both normal and alkali greenhouse soils similar results were obtained, except that sodium sulphate became toxic much sooner, namely, at 0.5 %. The effects on the crops grown on normal soil under the above conditions were parallel to the effects on nitrification. No crops could be secured on the alkali soil.—J. H. J.

Nitric nitrogen in the soil: Some factors influencing the quantitative determination of—. J. E. Greaves and C. T. Hirst. Soil Sci., 1917, 4, 179—205.

AN account of an investigation into the determination of nitrates in soils, especially in those rich in soluble salts and colloids. A clear soil extract can be obtained by adding a flocculant to the soil-water mixture, shaking, and then allowing to stand. The best flocculants were lime, ferric sulphate, ferric alum, sodium alum, and potassium alum, although with lime the amount of nitrate found in the clear extract was lower than that known to have been present in the soil. A clear solution could also be obtained by filtration through a Pasteur-Chamberland filter and by centrifuging. The amount of water used for making the extract could be varied without detriment within the limits of 5—25 times the weight of soil. A finely powdered soil did not require shaking for more than five minutes in making the extract. A slight loss of nitrate occurred in the soil-water extract on standing, but this was prevented by the addition of anti-septics, of which chloroform proved the best when used in the proportion of 1 in 1000. In testing Ciesch's method of determining nitrates (reduction with iron and sulphuric acid), it was found that none of the salts likely to be present in soil interfered with its accuracy. If urea and glycogen were present, it was necessary to evaporate the alkaline solution to dryness before reduction. The presence of dried blood caused the results to be low. The aluminium reduction method gave low results, and the authors replaced it by an iron reduction method, as follows: An aliquot part of the clear extract is evaporated to a quarter of its volume, after addition of 2 c.c. of a saturated solution of caustic soda; then 50 c.c. of ammonia-free distilled water is added, together with 5 grs. of pure iron and 30 c.c. of sulphuric acid (sp. gr. 1.35). The flask is closed with a two-holed stopper carrying a separatory funnel and a side tube bent to dip

below the surface of water in a beaker. The acid is added slowly, and when the rapid evolution is over the flask is heated to boiling for 10 mins. The water in the beaker is added to the flask before boiling. After boiling, the solution is made alkaline and distilled into standard acid, the excess of acid being determined with lacmoid as indicator.—J. H. J.

Peat; Isolation from — of certain nucleic acid derivatives. W. B. Bottomley. Proc. Roy. Soc., 1917, B, 90, 39–44. (See also Eng. Pat. 105,416 of 1916; this J., 1917, 611.)

AN aqueous extract of "bacterised" peat has a stimulating effect on the growth of *Lemna minor* in water culture and contains purine and pyrimidine bases and phosphoric acid, but no nucleic acid. Hence it was thought that nucleic acid might be present in raw peat. To determine this point, an alkaline extract of raw peat was precipitated with hydrochloric acid, as in the extraction of nucleic acid from soil; but the method proved laborious on account of the large amount of humic acid brought into solution. It was found better to saturate the peat with 1% sodium bicarbonate solution for 24 hrs., which left the humic acid undissolved, and then to express the liquid, to concentrate it in a vacuum to a small volume, and to pour it into absolute alcohol containing sodium acetate and hydrochloric acid. The precipitate was filtered off and dried in a vacuum, and both filtrate and precipitate were examined. The precipitate contained phosphoric acid and gave reactions for carbohydrates, but mild hydrolysis with a mineral acid failed to yield a purine base. The precipitate was heated, therefore, with 25% sulphuric acid in an autoclave at 140° C. for 5 hrs. From the hydrolysed product, silver-purine and silver-pyrimidine precipitates were obtained. The latter was found to contain uracil, and the former adenine. These results proved that the precipitate from the peat contained an adenine-uracil dinucleotide. The examination of the alcoholic filtrate showed the presence of a guanine-cytosine dinucleotide. From these results it is concluded that the nucleic acid of the plants from which the peat was formed, had been decomposed by bacteria or other agencies, during the formation of the peat, into dinucleotides.—J. H. J.

PATENT.

Fertilisers [from refuse, sewage sludge, etc.]. A. D. Furse, Beckenham. Eng. Pat. 109,575, Feb. 14, 1917. (Appl. No. 2184 of 1917.)

HOUSE refuse or sewage cake or a mixture of these is incorporated with 15% to 20% of fish or animal refuse, 15% to 20% of pulverised bones, preferably deglutinised, and 15% to 20% of vegetable refuse containing potash, such as that obtained from beetroot, sugar-cane, tobacco, or banana. If odour is of no consequence the proportion of both fish refuse and bones may be increased. The mixture is disintegrated and then, preferably after treatment with dilute sulphuric acid, left to dry, powdered, and screened.—B. V. S.

XVII.—SUGARS; STARCHES; GUMS.

Presence of nitrites and ammonia in diseased plants [e.g., sugar beets]. Relation of oxidases and diastases to the disturbance. Bonequet and Bonequet. See XVI.

Fermentation of sugar-cane juice. Kayser. See XVIII.

PATENTS.

Maple sugar and the like; Evaporator for —. C. M. Brown, Burlington, Vt. U.S. Pat. 1,238,489, Aug. 28, 1917. Date of appl. July 1, 1915.

An open evaporator comprises in one frame, channelled front and rear pans separated by a wall and with external pipe communication, and a preliminary heating pan divided by a partition into a feed compartment and a delivery compartment, the latter emptying into the front pan by overflow orifices. A float valve mechanism controlling the feed pipe to the preliminary heating pan, is transferable from one side of the apparatus to the other, for the reversal of the flow of juice through the apparatus.—J. H. L.

Process of making a filler for rubber or paint. U.S. Pat. 1,237,704. See XIV.

Process for cleaning filters in connection with the purification of sugar, oils, and chemicals. U.S. Pat. 1,240,290. See I.

XVIII.—FERMENTATION INDUSTRIES.

Sugar-cane juice; Fermentation of —. Kayser. Ann. Falsif., 1917, 10, 296–301.

EXPERIMENTAL fermentations showed that the quality of a rum depends largely on the manner in which the juice is extracted, the method of fermentation, kind of yeast, temperature, etc. The following results were obtained in the analysis of rums prepared under different conditions from various juices (see below); the figures express mgrms. per 100 c.c. of absolute alcohol:—

	A.	B.	C.	D.	E.	F.
Volatile acid	1.43	55.0	138.0	187.0	15.3	32.2
Aldehyde ..	9	57.6	14.8	22.6	52.5	43.0
Furfural	trace	0.35	0.13	0.13	5.7	2.4
Esters	424.0	128.0	45.0	95.0	92.8	42.4
Higher alcohol	30.9	200.0	50.7	33.0	182.0	245.0

Juice A was allowed to ferment spontaneously, the juice being expressed from the cane; B was a thick juice fermented with selected yeasts; C and D, normal juices fermented with selected yeasts; E and F were diffusion juices also fermented with selected yeasts. The temperature of fermentation was 25° C.—W. P. S.

PATENTS.

Beverages; Extract for carbonated —. L. Stein, Newark, N.J., Assignor to J. C. Dehls, Brooklyn, N.Y. U.S. Pat. 1,237,723, Aug. 21, 1917. Date of appl. May 5, 1917.

THE preparation claimed contains the products of the action of proteolytic enzymes, e.g., those of yeast, on a mixture of animal and vegetable protein, together with an acid phosphate. Sugar and flavouring matters may also be added.—J. H. L.

Malt beverage; Unfermented — and process of preparing the same. W. A. Steinmann, Los Angeles, Cal. U.S. Pat. 1,237,724, Aug. 21, 1917. Date of appl. Oct. 21, 1916.

CRUSHED malt containing a substantial amount of insoluble starch is mixed with water at temperatures favourable to peptonisation, so as to obtain

an extract whilst leaving a considerable amount of starch undissolved. This extract may then be saccharified, and afterwards boiled to destroy the diastase.—J. H. L.

Fermented beverages; Process of treating —. J. Schneible, Chicago, Ill. U.S. Pat. 1,238,577, Aug. 28, 1917. Date of appl. Jan. 11, 1916.

FERMENTED beverages containing albuminous matters in solution, are subjected to reduced pressure, e.g., 2–3 lb. per sq. in., at comparatively low temperatures, e.g., 58°–62° C., to volatilise practically the whole of the higher alcohols present, whilst the ethyl alcohol and albuminous matters are retained. The claims also cover the introduction of a current of steam during the treatment, and the exclusion of air before, during, and after the treatment.—J. H. L.

Non-alcoholic, chill-proof beverage; Process of preparing a —. J. Beerhalter, Duluth, Minn. U.S. Pat. 1,210,016, Sept. 11, 1917. Date of appl. Nov. 18, 1914.

IN the preparation of non-alcoholic beverages from malted grain and vegetable flavouring substances, charged with carbon dioxide, a proteolytic enzyme, active in faintly acid media, is added to the wort after cooling. Such an enzyme may be extracted from malt, and remains active in the finished beverage; it prevents the coagulation of proteins and renders the beverage chill-proof and more stable at ordinary temperatures.—J. F. B.

Hops; Drying of —. G. H. Benjamin, New York. Eng. Pat. 109,584, Apr. 4, 1917. (Appl. No. 4878 of 1917.)

SEE U.S. Pat. 1,226,052 of 1917; this J., 1917, 731.

Process of making plastic masses [from brewery by-products]. U. S. Pat. 1,238,528. See XV.

XIXA.—FOODS.

Bread making; Use of calcium gluconate in —. G. A. Le Roy. Comptes rend., 1917, 165, 416.

CALCIUM gluconate can be employed instead of lime water for improving the flavour of bread made from 85% flour as at present in use in France. It is prepared in the usual way by digesting a solution of commercial glucose with milk of lime and filtering. It is more convenient than calcium succrate and lime as it is more soluble. The gluconate should be used in quantity representing 100 grms. of glucose and 50 grms. of lime for each 100 kilos. of flour, and added along with the yeast and salt. This quantity will yield bread containing 1 gm. of glucose and 0.5 gm. of lime per kilo. The gluconate has been found to facilitate rather than retard fermentation.—J. H. L.

Flour and bread; Determination of bran in —. R. Legendre. Ann. Falsif., 1917, 10, 293–296.

To ascertain whether a bread has been prepared from a particular flour, 2 grms. of the flour and 3 grms. of the bread crumb are placed in separate test-tubes, 10 c.c. of water and 10 c.c. of phosphoric acid (sp. gr. 1.514) are added to each tube, and the mixtures are heated at 120° C. in an auto-lave for 1 hour. After cooling, the sediments are collected on a silk sieve (120-mesh), washed with water, alcohol, and ether, and then dried and weighed. The two weights should be equal after allowance has been made for the different quantities

of water present and the different amounts of the flour and bread taken. The moisture content is determined on separate quantities of the flour and bread. For rapid work, it is sufficient to centrifuge the two sediments with water and to note the volumes; when 2 grms. of flour and 3 grms. of bread are taken for the experiment, the volumes of the sediments should be equal.—W. P. S.

Fat in certain milk products; Determination of —. C. K. Francis and D. G. Morgan. Bull. 114, Oklahoma Agric. Expt. Stat. J. Ind. Eng. Chem., 1917, 9, 861–862.

For the determination of fat in ice cream, evaporated milk, malted milk, etc., a modification of the Babcock test is recommended, in which mixtures of glacial acetic acid, nitric and sulphuric acids replace the sulphuric acid. For example, in the case of ice cream, 9 grms. of the sample is treated in a Babcock bottle with 4 to 5 c.c. of a mixture of glacial acetic acid and sulphuric acid (1 : 1), and then, drop by drop, with strong nitric acid until a light yellow colour is produced. The bottle is then immersed for 4 to 5 minutes in boiling water and centrifuged.—C. A. M.

Butter; Effects of feeding cottonseed products on the composition and properties of —. C. M. Eckles and L. S. Palmer. Missouri Agric. Exp. Station Research Bull. No. 27, Dec., 1916, pp. 1–44. Bull. Agric. Intell., 1917, 8, 1021–1022.

THE feeding of cottonseed products causes in general a decrease in the saponification and Reichert-Meissl values, and a rise in the iodine value and the melting point of the butter fat. The butter becomes firmer and frequently has a gummy consistency; it withstands higher temperatures without losing its "body," and acquires a flat, oily flavour and increased keeping quality. These effects are attributed to the cottonseed oil, and depend on the amount of the seeds present in the feed. A factor of great importance, however, is the nature of the raw foodstuffs which form the base of the rations. The effects mentioned are most pronounced when dry roughage (timothy hay, etc.) is fed with the cottonseed products, whilst if a fairly large proportion of corn (maize) silage is fed the effects are more or less neutralised. Small amounts of cottonseed products, fed to cows on fresh pasture, improve the "body" and keeping properties of the butter produced. The effect of feeding cottonseed meal on certain of the constants of butter fat, particularly the Reichert-Meissl and iodine values, may be somewhat modified by continuous feeding, but the effects on the melting point of the fat and the other properties of the butter continue as long as the meal is fed. The authors accordingly deprecate the feeding of large quantities of cottonseed meal, and also the use of the whole seed owing to its high oil-content.—J. H. L.

Silage; Contribution to the bacteriology of —. J. M. Sherman, J. Bacteriol., Baltimore, 1916, 1, 415–451. Bull. Agric. Intell., 1917, 8, 1020–1021.

OBSERVATIONS made on silage during 1915, indicated that an important part in the curing of corn (maize) silage is played by an acid-tolerant, acid-producing organism closely related to the *Bac. bulgaricus* and *B. acidophilus* groups but differing somewhat from the typical members of these groups by its comparatively abundant growth on ordinary laboratory media. The number of bacteria present in silage juices is very great, always more than a "billion" per c.c., and most of them resemble the one referred to

above. These are abundantly present in maize fodder, so that ensilage made from maize is always amply seeded with them.—J. H. L.

Mannitol; Occurrence and significance of — in silage. A. W. Dox and G. P. Plaisance. J. Amer. Chem. Soc., 1917, 39, 2078—2087.

MANNITOL is a normal constituent of corn (maize) silage, eight samples of which contained from 1.47 to 2.51% calculated on the dry substance (28.0 to 38.1%). Sugar cane silage contained 3.30% and sunflower silage 5.61% of mannitol on the dry substance, but none was present in the silage from cow peas or sweet clover. The mannitol is formed from the sucrose in the plants by bacterial reduction. It is produced simultaneously with acetic acid, lactic acid, carbon dioxide, and alcohol, and then partly disappears. By expressing the juice from silage, evaporating it, filtering off the magnesium lactate and adding alcohol to the filtrate until the alcoholic strength was about 75%, 30 grms. of pure mannitol was obtained from 6670 grms. of silage. The expressed residue would be suitable for feeding purposes, whilst the mannitol could be utilised in the manufacture of explosives. It could be readily extracted on a large scale by this method, and would probably be cheaper than glycerol.—C. A. M.

L-Leucine; Occurrence of — in sweet clover silage. G. P. Plaisance. J. Amer. Chem. Soc., 1917, 39, 2087—2088.

SAMPLES of sweet clover silage contained from 0.4 to 1.0% of L-leucine, calculated on the dry material. It could be readily extracted from the dried substance with 95% alcohol.—C. A. M.

[Feeding stuffs]. *By-products from the manufacture of tin plate.* Board of Agric., Ohio, 1917, 7, 65—66. Bull. Agric. Intell., 1917, 8, 1020.

CEREAL middlings (usually wheat) and palm oil are used in the polishing of tin plate. After use the mixture of middlings and oil was, until a few years ago, discarded; but cattle eat it readily and it is now sold in the United States as a feeding stuff, under the name of "Palmo Midds," after treatment to remove pieces of metal. This treatment at first consisted in a simple sifting operation by hand, but a new electro-magnetic process has been found to give better results.—J. H. L.

The Schilde "universal" dryer. Parow. See I. Method for fractionating fats and oils. Seidenberg. See XII.

PATENTS.

Freezing fish and other food substances. N. Dahl, Trondhjem, Norway. Eng. Pat. 109,238, May 31, 1917. (Appl. No. 7785 of 1917.)

FREEZING by means of circulating fluid is so conducted that the direction of flow of the liquid is longitudinal with respect to the fishes or other pieces of food, instead of transverse as hitherto. Export cases containing fish, for example, are preferably placed during refrigeration so that the fish are in a vertical position, the horizontal walls of the cases being provided with one or more openings (which can be closed after refrigeration) to serve as inlets and outlets for the cooling liquid. It is claimed that this facilitates the circulation of the liquid between the fish or pieces of food and produces more rapid and complete refrigeration.—J. H. L.

Wheat; Method of treating [cleaning and sterilising] —. A. C. von Hagen, Kansas City, Mo. U.S. Pat. 1,237,425, Aug. 21, 1917. Date of appl., Sept. 1, 1916.

GRAIN is moistened, e.g., with alkali (lime) and

hypochlorite solution or with the latter alone, and the solution, which may be distributed over the surface of the grain by agitation, is finally forced through the husk by pressure, e.g., air-pressure. Before this last operation the moistened grain may be treated with carbon dioxide.—J. H. L.

Dryer for alimentary paste. P. De Martini, Jamaica, N.Y. U.S. Pat. 1,237,871, Aug. 21, 1917. Date of appl., Nov. 13, 1916.

A MAIN compartment, containing racks for the material to be dried, has means (louvre boards) for controlling the passage of air through its two ends over substantially their whole area, vertical rotary fans between the racks to produce a current of air through the compartment, and further means (transverse partitions with louver boards) for controlling and directing the air current through each rack.—J. H. L.

Sweet potatoes or yams; Food product manufactured from — and process for producing the same. J. H. Williams, Assignor to Williams Co., Greenville, S.C. U.S. Pats. (A) 1,238,371, (B) 1,238,372, and (C) 1,238,373, Aug. 28, 1917. Dates of appl., (A) Sept. 28, 1916, (B) and (C), Nov. 17, 1916; (B) renewed July 26, 1917.

SWEET potatoes are partly dehydrated and then cooked by steaming, and after they have been cooled, peeled, and mixed, flour, salt, and flavouring matters are added as required. The dough is mixed with yeast and allowed to ferment for a considerable time, then worked, mixed with more steamed potatoes, allowed to rise, and baked. The loaves obtained are sliced and passed through a pug-mill and the product is thoroughly dried or toasted. In (A) it is passed through a mill and crushed into nut-like particles for marketing, in (B) it is ground to a flour for culinary purposes, and in (C) it is milled into small particles which are converted into flakes by passing between heavy steel rollers under high pressure, and then toasted.—J. H. L.

Milk-powdering machine. I. J. Felleman, Gridley, Cal. U.S. Pat. 1,239,471, Sept. 11, 1917. Date of appl., Apr. 30, 1917.

THE machine comprises a pair of heated rolls, means for spraying milk thereon, and a carriage centrally beneath the rolls mounted to travel longitudinally thereof, and carrying planer knives which project in opposite directions and engage the rolls. A receptacle moves with the carriage in such a manner that the products discharged by the knives are received by the receptacle, which is automatically emptied at the ends of the travel, at which points also a plunger is automatically moved so as to throw the planer knives into and out of engagement with the roll.—J. F. B.

Rice; Process of treating — and product thereof. M. M. Baumgartner, Freeport, Ill. U.S. Pat. 1,239,555, Sept. 11, 1917. Date of appl., Dec. 13, 1916.

WHOLE rice including the germ and hull is steeped in water and cooked with live steam, while in the hull, to dextrinise the starch and stabilise the fats and proteins; the rice is then dried and parched to produce a product not differing materially in form and bulk from the natural rice, and the hulls are finally removed from the kernels.

—J. F. B.

Casein; Process of drying —. W. M. Brownell, Brooklyn, N.Y., Assignor to A. N. Flood, Newton, Mass., and J. T. Nightingale, Boston, Mass. U.S. Pat. 1,239,766, Sept. 11, 1917. Date of appl., May 1, 1916.

THE curd of wet casein is heated at 135°—180° F.

(57°—82° C.) to form a plastic, sticky, homogeneous mass; the material is formed into small pieces, or into continuous ribbons which are subsequently cut into small pieces; the pieces are immersed in water at a lower temperature than that mentioned above, to render the surface non-adhesive, and then dried with agitation.

—J. F. B.

Flesh of animals of the bovine genus: Process for the preparation of —, J. Balzani, Buenos Aires, Argentina. U.S. Pat. 1,240,165, Sept. 18, 1917. Date of appl. Nov. 1, 1915.

SEE Eng. Pat. 15,559 of 1915; this J., 1916, 1175.

XIXB.—WATER PURIFICATION; SANITATION.

Sewage; Purification of — by aeration in the presence of activated sludge. III. E. Bartow. J. Ind. Eng. Chem., 1917, 9, 845—850. (See this J., 1916, 555.)

A CONTINUOUS-FLOW plant, designed to deal with 200,000 galls. of sewage and sludge, was started in 1916 at the Sewage Experimental Station, University of Illinois. The sewage flows from the grit chamber into the aeration chamber, which is a rectangular concrete tank 17×36½ ft., and 9½ ft. deep. It is divided by longitudinal baffles into 4 compartments through which the sewage flows down sloping sides into a central channel, above which are "filtros" plates. This chamber has a capacity of 36,000 galls., and is capable of aerating 144,000 galls. of sewage during 6 hours. From the aeration chamber the sewage passes to a settling chamber, and thence over a weir, and is either returned to the sewer or discharged into a pond. Air is supplied by a rotary pressure blower with a capacity of 300 cub. ft. per min., and is filtered through cheesecloth stretched over the wire sides of a box. This plant was in continuous use for 3 months, and dealt with 61,000 to 177,600 galls. per day. Approximately 2 cub. ft. of air per gall. of sewage was required to obtain a stable effluent. Comparative tests with different methods of diffusing the air in tanks operated on the fill and draw system showed that "filtros" plates gave better aeration results than perforated pipes, but little or no difference could be observed between the action of coarse or fine grades of plates. The best method of separating water from the sludge was by centrifuging it in a basket type of centrifugal machine and in a modified cream separator, working at a speed of 1500 r.p.m. Under these conditions sludge containing 97.5% moisture yielded sludge cakes with 85 to 86% moisture. A large (10 in.) machine would be capable of dealing with the sludge from 2,000,000 galls. of sewage per day, producing sludge cake in a condition suitable for a drying plant. A drying test applied to 220 lb. of 88% sludge cake showed that the method was practicable.—C. A. M.

Quassia extract as a contact insecticide. N. E. McIndoo and A. F. Sievers. J. Agric. Res., 1917, 10, 197—531.

THE authors describe numerous experiments to determine the efficiency of various extracts of Jamaica quassia wood and the effect of these extracts upon aphids. Medium-sized quassia chips soaked for 2 hours in water yielded 60% of their total soluble matter, and during a second extraction, 15%. Extraction for 24 hours did not increase the yield. The first extract was slightly more effective than the second in killing aphids. If the chips are boiled for 4 hours the yield of

extract is half as much again. The yield of extract is greater, the larger the volume of water used: 3 grms. of chips yielded one-third more extract to 3 litres of water than to a quarter litre. The solubility of commercial quassia powder is 1 in 3000 of water, and 3—5 times as much in very dilute alkali and soap solutions. In testing the various extracts obtained upon aphids, it was found that soap solution extract, prepared at ordinary temperature, was the most effective and economical. Commercial quassia powder contains quassol, an inert and tasteless substance, and quassia, an effective insecticide and intensely bitter. Exhalations from quassia powder killed aphids, as also did the powder itself when dusted on them, whereas quassia powder and chips were ineffective. Quassia and quassia spray solutions kill aphids when applied sufficiently strong, the solutions containing soap being the most effective. The spray is breathed into the spiracles of the insects and reaches the nerve tissue where it slowly affects the nerve cells, causing a state of coma. The general conclusion is that quassia extracts can never become general insecticides owing to the poor insecticidal properties of quassia. The formula which yielded the most effective extract was 22 lb. of quassia chips soaked in 100 galls. of fish-oil soap solution for 24 hours. This extract was effective on two out of six species of aphids. Nicotine sulphate is a more reliable insecticide.—J. H. J.

Volatility of organic compounds as an index of the toxicity of the vapours to insects. W. Moore. J. Agric. Res., 1917, 10, 365—371. (See also this J., 1917, 939.)

THE toxicity towards the house-fly of a large number of organic compounds, including representatives of the following classes, was determined: esters, acids, ethers, hydroxy compounds, aldehydes, ketones; halogen, sulphur, and nitrogen derivatives; terpenes or terpene derivatives, and alkaloids. In general, toxicity was found to be closely correlated with volatility; decreasing volatility is accompanied by increased toxicity up to a certain point, but compounds with boiling-points of 225° C. to 250° C. are usually so slightly volatile that they produce death only after very long exposures. The explanation of the main result obtained by the author is that the vapour of the compound condenses on the finer divisions of the trachea of the insect. Readily volatile compounds will evaporate and rapidly pass out of the insect, whereas less volatile ones will remain, penetrating the tissues and producing the poisonous effects resulting in death.—E. W. L.

Ultra-violet radiation; Germicidal action of —, and its correlation with selective absorption. C. H. Browning and S. Russ. Proc. Roy. Soc., 1917, B, 90, 33—38.

IN the experiments a tungsten lamp and a quartz spectrometer, giving wave lengths of 7000—2100 Angström units, were used. A glass plate coated with nutrient agar was painted with an emulsion of *Staphylococcus pyogenes aureus*, and a narrow strip of the plate was exposed to the rays from the lamp for 6, 12, or 24 mins. The plate was then incubated. It was found that there was a germicidal action on that part of the strip exposed to rays of wave lengths 2910—2380 units. The longer exposures only very slightly increased the range of germicidal action. Exposures of 3½ hrs. gave a sharp line of demarcation at 2960 units; the other limit was 2150 units. Plates of other organisms were exposed to the rays, and the range of action was found to be nearly the same, although there were small and definite differences in each

case. Emulsions of the organisms were also exposed to the rays and photographs of the radiations transmitted were taken. It was found that absorption of the rays took place over the same range that gave the germicidal action.—J. H. J.

PATENTS.

Gas [hydrogen cyanide for fumigating]; Apparatus for generating —. C. J. Marvin, Los Angeles, Cal., U.S.A. Eng. Pat. 108,889, Aug. 23, 1916. (Appl. No. 11,973 of 1916.)

A PORTABLE apparatus specially adapted to the generation of hydrogen cyanide for fumigating trees, etc.—J. H. L.

Refuse-furnace. E. Kidwell, Washington, D.C., Assignor to Waste Utilities Co. of Delaware, New York. U.S. Pat. 1,239,403, Sept. 1, 1917. Date of appl., Nov. 6, 1912.

THE furnace has a main grate with a non-perforated bottom, and a fore-grate situated at a lower level and arranged to receive slagged material from the main grate. A wall separates the two grates; and a power-actuated pusher passes through a hole in the wall for the purpose of removing slagged material from the fore-grate and out of the furnace. The two grates are provided with separate air supplies and the main grate may be provided with an air jacket. In this case the pusher operates through the air jacket.—J. H. J.

Water; Purification of —. C. P. Hoover, Columbus, Ohio, U.S.A. Eng. Pat. 107,967, June 22, 1917. (Appl. No. 8988 of 1917.) Under Int. Conv., July 11, 1916.

SEE U.S. Pat. 1,197,123 of 1916; this J., 1916, 1079.

Fertilisers [from refuse, sewage sludge, etc.]. Eng. Pat. 109,575. See XVI.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Alkaloids; A theory of the mechanism of the phytochemical synthesis of certain —. R. Robinson. Chem. Soc. Trans., 1917, 111, 876—899.

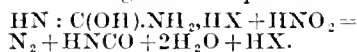
SYNTHESIS of alkaloid skeletons may be carried out by building up from simple compounds such as formaldehyde, ammonia, simple amino-acids as arginine and lysine, and degradation products of carbohydrates, typified chiefly by acetonedicarboxylic acid. Further modifications are usually made by means of oxidation or reduction and by elimination of water with the formation of an aromatic nucleus or occasionally of an ethylene derivative. Several schemes are discussed for the synthetic formation of the base groups of different classes of alkaloids. Linking of carbon to carbon is traced to two processes only: the aldol condensation and the very similar condensation of carbinolamines, resulting from the combination of an aldehyde or ketone and ammonia or an amine, and containing the group $:C(OH)N:$, with substances containing the group $:CH.CO:$. The reactive acetone derivative which undergoes condensation with formaldehyde and ammonia has been formulated in the majority of cases as acetonedicarboxylic acid, but in other cases, as a starting point both for quinoline and isoquinoline bases, it has been found convenient to assume the intervention of acetylglcollic aldehyde, which may be derived from a pentose or methylpentose by loss of water and oxidation. Substances

accompanying quinine and cinchonine in cinchona bark have been found to be suitable starting points for a synthesis of the quinoline half of these alkaloids.—J. F. B.

Carbamides; Constitution of —. IV. Mechanism of the interaction of urea and nitrous acid. E. A. Werner. Chem. Soc. Trans., 1917, 111, 863—876.

THE reaction between urea and nitrous acid with evolution of carbon dioxide and nitrogen is not practically available for the determination of urea but is useful for the estimation of nitrous acid. As a matter of fact, no reaction takes place between urea and pure nitrous acid in aqueous solution: even in presence of a weak acid, such as acetic acid, the reaction is very slow and only apparent at high concentrations. On the other hand, the presence of a strong acid, such as hydrochloric or nitric acid in dilute solutions, is sufficient to produce a brisk evolution of gas, but the volume of nitrogen evolved is not a direct measure of the quantity of urea decomposed as calculated on the usual equation, the amount of urea decomposed being much greater than that indicated by the evolved nitrogen. Only when the urea is present in considerable excess is the volume of nitrogen approximately equivalent to the amount of nitrous acid decomposed. The volume ratio of carbon dioxide to nitrogen (1:2) required by the equation is never obtained, the amount of carbon dioxide being always greater; the composition of the gases is liable to variation with small changes in concentration. The above apparent anomalies are explained by the fact that urea is not carbamide, as was commonly supposed, but a derivative of cyanic acid, $HN:C\overset{\overset{NH}{|}}{O}$; in presence of a strong

acid a salt, $NH:C(OH)NH_2.HX$, is formed, and an amino group is thus rendered open to attack by nitrous acid. The first stage of the reaction takes place according to the equation

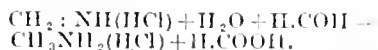


The cyanic acid is decomposed in two ways as fast as it is generated. It is hydrolysed, thus: $HNCO + H_2O = NH_3 + CO_2$ and it is directly attacked by nitrous acid, thus: $HNCO + HNO_2 = CO_2 + N_2 + H_2O$. The two last reactions proceed simultaneously in variable proportions according to the conditions of concentration, acidity, etc., prevailing. With an excess of urea present at the outset, a low concentration of nitrous acid, and the presence of an excess of mineral acid to combine with the ammonia, the reaction may be practically confined to equimolecular proportions of urea and nitrous acid, instead of 1:2 mols. as required by the supposed carbamide structure of urea.—J. F. B.

Methylation by means of formaldehyde. I. Mechanism of the interaction of formaldehyde and ammonium chloride. Preparation of methylamine and dimethylamine. E. A. Werner. Chem. Soc. Trans. 1917, 111, 841—853.

THE products of the action of formaldehyde on ammonium chloride comprise carbon dioxide, a volatile liquid, and the hydrochlorides of methylamine and dimethylamine. The volatile liquid distils between 50° and 101° C. The distillation residue contains methylamine and dimethylamine hydrochlorides, and the reaction may be used for the preparation of these substances. The mechanism of the reaction between formaldehyde and ammonium chloride depends on the formation at the first stage of methylene-imine, the hydrochloride of which, $CH_2:NH(HCl)$, undergoes hydrogenation at the expense of the formaldehyde, which yields formic acid, part of which is esterified

and part oxidised to carbon dioxide and water, thus:



The formation of dimethylamine from monomethylamine follows an analogous course through the intermediary production of methylenemethylamine. Trimethylamine is not formed in the main reaction but some may be produced by prolonged heating of the final mother liquors. As a preparatory method the following procedure gives satisfactory yields: 250 grms. of ammonium chloride and 500 grms. of commercial 40% "formalin" solution are heated slowly in a distillation flask up to 104° C. until no more liquid distils over; the operation requires about 1½ hours. The distillate (110 grms.) has the composition: methyl formate, 30.0; methylal, 31.6; free formic acid, 1.6; water, 24.8%. On cooling the residue in the flask, ammonium chloride (62 grms.) crystallises out; the filtrate is concentrated at 100° C. to about half its bulk and a further crop of ammonium chloride (19 grms.) is recovered. Ammonium chloride is very sparingly soluble in a concentrated solution of methylamine hydrochloride. Evaporation of the filtrate is then continued until a crystalline scum forms at the surface of the hot liquid and the monomethylamine salt (96 grms.) crystallises out on cooling; a second crop (18 grms.) is obtained by further evaporation. The filtrate is evaporated as far as possible at 100° C., left for 24 hours *in vacuo* over sodium hydroxide, and the semi-solid residue digested with chloroform, in which the dimethylamine salt is soluble. The total yield of monomethylamine salt is 128 grms. For the preparation of dimethylamine hydrochloride, 200 grms. of ammonium chloride and 400 grms. of "formalin" are heated at 104° C. as before; the excess of ammonium chloride which separates on cooling is filtered off and the filtrate is again heated with 300 grms. of "formalin" in a distillation flask up to 115° C. until no more liquid distils. The distillate this time contains a much larger proportion of water. The fractional crystallisation of the products is carried out as before but the final liquor is evaporated at 120° C. Extraction of the dried mass with chloroform yields 122 grms. of dimethylamine salt.—J. F. B.

Organic compounds; Removal of nitric acid from solutions of —. P. A. Levene and G. M. Meyer. *J. Biol. Chem.*, 1917, **31**, 599—601.

In the preparation of certain organic compounds it is frequently necessary to separate nitric acid from solutions without acting deleteriously on the organic compounds present. The removal of nitric acid from neutral aqueous solution by reduction by means of zinc dust or a zinc-copper couple is never complete, but with aluminium amalgam the reduction easily proceeds to completion. The procedure is to neutralise the solution by means of barium hydroxide and then to add 2 grms. of freshly prepared aluminium amalgam for each gram of nitric acid. After standing for 8 hours or overnight, during which time the solution is continuously aerated, the liquid is filtered and a slight excess of barium hydroxide added; ammonia is removed by repeated evaporation under reduced pressure, and the excess of baryta is then quantitatively precipitated. Under these conditions only about 40% of the nitric acid is converted into ammonia, the remainder probably escaping in the form of lower oxides of nitrogen.—D. F. T.

Volatile acids; Possibilities and limitations of the Duclaux method of determining —. L. J. Gillespie and E. H. Walters. *J. Amer. Chem. Soc.*, 1917, **39**, 2027—2055. (See also this J., 1917, 236, 520, 568.)

TEST determinations of the volatile acids in

known mixtures by Duclaux's method (*Ann. chim. phys.*, 1874, [5], **2**, 289) have shown that for mixtures of three acids quantitative results may be obtained by either algebraic or graphic methods of calculation, but that in the case of mixtures of four acids the errors are, as a rule, too great. These errors are not proportional to the quantities of acids, and when four or more acids are present the mixture must be fractionated, before applying the method, into two mixtures each containing substantially only three acids. The methods of calculation do not depend upon the laws which govern the rates of distillation of aqueous solutions of pure acids, and may therefore be applied to distillations made in various ways, provided that the distillations of pure acids and of mixtures are carried out in the same way (see also this J., 1908, 897).—C. A. M.

Isolation from peat of certain nucleic acid derivatives. Bottomley. See XVI.

Occurrence and significance of mannitol in silage. Dox and Plaisance. See XIXA.

Determination of silver in organic compounds. Lucas and Kemp. See XXIII.

PATENTS.

Opium: Process for extracting alkaloids from —. O. Imray, London. From Soc. Chem. Ind. in Basle, Switzerland. Eng. Pat. 109,468, Sept. 8, 1916. (Appl. No. 12,747 of 1916.)

ONE part of powdered opium is mixed with about two parts of concentrated formic acid (95—100%) at the ordinary temperature, and the mixture stirred until solution is complete with the exception of some fibrous and foreign matter; the mass is then stirred into about twenty parts of water, and the insoluble substances (resin, etc.) filtered off and washed until free from alkaloids. The alkaloids are then separated from the aqueous solution by precipitation or extraction.—L. A. C.

Vitamine preparations; Process for obtaining —. Ges. für Chem. Ind. in Basel, Switzerland. Eng. Pat. 103,294, Jan. 4, 1917. (Appl. No. 224 of 1917.) Under Int. Conv., Jan. 7, 1916.

SEE U.S. Pat. 1,235,198 of 1917; this J., 1917, 1064.

Lipoid-like blood-clotting substance, and a process of making same. A. Fonio, Langnau, and W. Föhrenbach, Basle, Assignors to Soc. of Chem. Ind. in Basle, Switzerland. U.S. Pat. 1,240,694, Sept. 18, 1917. Date of appl., June 8, 1915.

SEE Eng. Pat. 11,215 of 1915; this J., 1916, 72.

Process of making Paraffinum liquidum. U.S. Pat. 1,240,792. See IIA.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

PATENTS.

Photographic film. F. E. Ives, Philadelphia, Pa. U.S. Pat. 1,240,344, Sept. 18, 1917. Date of appl., Sept. 21, 1915.

A SENSITIVE photographic film on a base impervious to water is protected by a coating of waterproof varnish, such as gum dammar, which is

easily removed before development by a solvent such as benzene without injury to the sensitive layer.—B. V. S.

Flash powder [for photography]. J. I. Crabtree. Assignor to Eastman Kodak Co., Rochester, N.Y. U.S. Pat. 1,240,027, Sept. 11, 1917. Date of appl., Dec. 11, 1916.

The flash powder contains sodium oxalate 4 parts, red phosphorus 3 to 5 parts, a combustible metal or metals of high actinic value, such as a mixture of magnesium 5 parts and aluminium 10 parts, and an alkaline-earth nitrate, such as strontium nitrate, 10 parts.—B. V. S.

XXII.—EXPLOSIVES; MATCHES.

Occurrence and significance of mannitol in silage. Dox and Plaisance. See XIXA.

PATENTS.

Polishing explosive powder: Process of and apparatus for —. F. I. du Pont. Assignor to Ball Grain Explosives Co., Wilmington, Del. U.S. Pat. 1,239,368, Sept. 4, 1917. Date of appl., July 28, 1915.

GRANULAR explosive powder is fed into one end of a horizontal rotating tube, the length of which is at least fourteen times the depth of the layer of powder in the tube. The powder is propelled along the tube by a short helix at the inlet end, and means are provided at the outlet end to restrict the discharge and regulate the depth. —W. F. F.

Explosive powder; Process for finishing —. F. du Pont, Assignor to Ball Grain Explosives Co., Wilmington, Del. U.S. Pat. 1,240,549, Sept. 18, 1917. Date of appl., July 28, 1915.

GRANULAR explosive powder is passed through an apparatus in which it is continuously moved forward and also given a transverse rolling motion. A polishing material is continuously added to the moving powder, and a blast of hot air is directed over the powder in a direction opposite to the movement of the grains so as to smooth them, blow away the dust, and then polish the grains. —F. Sp.

Chlorate explosive of the Sprengel class. W. C. Wain. North Sydney, N.S.W. U.S. Pat. 1,240,272, Sept. 18, 1917. Date of appl., Mar. 19, 1915.

A SATURATING liquid for chlorate explosives of the Sprengel class is produced by dissolving 20 vols. of castor oil and 20 vols. of raw linseed oil in 320 vols. of petroleum, and treating the solution with 10 vols. of fuming nitric acid (sp. gr. 1.5) so as to nitrate the oils without leaving free acid present. The product is a brown transparent liquid having a specific gravity of approximately 0.816 and a rate of diffusion approximately double that of nitrobenzene.—F. Sp.

Trinitrotoluene; Process for the manufacture of —. F. Quartieri, Milan, Italy. U.S. Pat. 1,241,017, Sep. 25, 1917. Date of appl., Aug. 31, 1914.

SEE Eng. Pat. 19,566 of 1914; this J., 1915, 1118.

XXIII.—ANALYSIS.

Corks used in Soxhlet and other extraction apparatus; Treatment of —. T. J. Ward. Analyst, 1917. 42, 326—327.

THE difficulties arising from the porosity of cork and the solubility of certain of its constituents, when used in extraction apparatus, may be overcome by heating the corks in a gelatin solution (see below) at 100° C. for two hours, wiping and drying them, and then using them in a Soxhlet extractor for an hour. The gelatin solution is prepared by soaking gelatin in cold water for five or six hours, pouring off the water, melting the gelatin, and adding $\frac{1}{4}$ vol. of glycerol and 2 vols. of water. Corks treated thus must not be used with solvents in the vapour of which water and glycerol are readily soluble.

Carbon and hydrogen; Simplified micro-combustion method for the determination of —. L. E. Wise. J. Amer. Chem. Soc., 1917, 39, 2055—2068.

THE method devised by Pregl (Abderhalden's Handbuch der Biochem. Arbeitsmethoden [ii.], 5, 1307) has been simplified as follows:—The combustion tube consists of a hard glass tube 1.5 cm. in diam. (with a bore of 1.2 cm.) and 38 cm. in length, and at about 4 cm. from the end is drawn out to about 3 mm. in diam., whilst the other end of the tube is fitted with a rubber cork through which passes a capillary tube. The tube is packed successively with a plug of glass wool, a 2.5 cm. layer of asbestos treated with cupric oxide, containing a few lengths of cupric oxide wire; a 0.5 cm. layer of asbestos; a 1.5 cm. layer of platinised asbestos; 0.5 cm. of plain asbestos; 3.5 cm. of asbestos treated with cupric oxide and containing cupric oxide wire; 0.5 cm. of plain asbestos; 1.5 cm. of platinised asbestos; and finally 0.5 cm. of plain asbestos. From 11 to 22 mgrms. of the substance is used for the combustion, which is effected in a flat platinum boat. In place of the usual carbon dioxide absorption tube, a tube with a ground-in joint is used, and soda-lime replaces caustic potash as absorbent. For drying the air admitted to the apparatus a train of absorption vessels charged respectively with sulphuric acid, soda-lime, and calcium chloride saturated with carbon dioxide is used. It is advisable to make "blank" determinations under the same conditions as the actual combustion, and to correct the amounts of hydrogen from the results. In some cases the uncorrected values are 0.1 to 0.15% higher than the corresponding corrected values. The use of a micro-balance would increase the accuracy of the carbon determinations, but by the use of the larger quantities mentioned above the results agree well with those obtained by the ordinary methods of combustion on a larger scale—C. A. M.

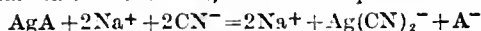
Halogens in organic compounds; Method for the determination of —. J. F. Lemp and H. J. Broderson. J. Amer. Chem. Soc., 1917, 39, 2069—2074.

ABOUT 10 grms. of sodium peroxide is thoroughly mixed with 1 to 1.5 gm. of finely ground potassium nitrate in the fusion cup of a Parr's sulphur bomb (see this J., 1908, 594). From 0.4 to 0.45 gm. of finely powdered benzoic acid or sucrose is then added, the mass again thoroughly mixed, and finally 0.2 to 0.25 gm. of the finely-ground organic compound is introduced, and the whole thoroughly mixed, care being taken to prevent spontaneous ignition. In the case of volatile liquids 0.2 gm. of the sample is weighed in a small sealed bulb of thin glass, which is broken after

the bomb has been screwed down. Ignition is effected by heating the bomb in the hottest part of a Bunsen flame, the heating being continued until at least a fourth of the cup is at a red heat. The bomb is cooled under a water-tap, the tap opened, and the cup placed in 200 c.c. of hot water, the beaker being meanwhile covered with a watch glass. After decomposition of the sodium peroxide, the liquid is acidified with nitric acid, boiled for a few mins., cooled, treated with a measured excess of $N/10$ silver nitrate solution, and again cooled, and the excess of silver titrated with standard thiocyanate solution. In the case of bromine and iodine compounds, it was found that a loss of halogen, especially iodine, might occur upon boiling the acidified solution. To obviate this an excess of silver nitrate is added to the alkaline solution, which is then digested for 15 mins. to insure complete precipitation of the silver halide, and the solution may then be acidified with nitric acid, without any loss of halogens. The addition of compounds rich in carbon and hydrogen is advisable in all cases to insure a thorough and uniform fusion. The addition of a reducing agent to the hot acidified solution containing the precipitated silver halide causes rapid and complete reduction of any oxy-acid of bromine or iodine, with the precipitation of silver bromide or iodide. Hydrazine sulphate was found to be the most suitable reagent for this purpose.—C. A. M.

Silver in organic compounds; Determination of —. H. J. Lucas and A. R. Kemp. J. Amer. Chem. Soc., 1917, 39, 2074—2078.

The method depends upon the interaction of solutions of alkali cyanides and silver salts to form the soluble argenticyanide compound and the alkali salt of the acid, as in the equation:—



The silver in the cyanide solution may be determined by precipitation as metallic silver or as an insoluble salt, such as the sulphide, as in the following method:—About 0.3 gm. of the organic compound is warmed with a quantity of $N/4$ sodium cyanide solution two or three drops in excess of the theoretical amount, and the solution treated with 10 c.c. of $N/1$ sodium hydroxide solution, and diluted to 300 c.c. About 25 c.c. of $N/4$ sodium sulphide solution in excess of that required for complete precipitation of the silver is then slowly added, with constant stirring, and the solution heated to 60°C ., and stirred until the silver sulphide has coagulated. The precipitate is collected in a Gooch crucible, washed with water, alcohol, and ether, dried for 30 mins. at 100° to 110°C ., and weighed, the heating being repeated at intervals of 15 mins. until the weight is constant. The method is applicable to all silver salts which are soluble in alkali cyanide solutions. Of the compounds tried the only one yet found to be insoluble in $N/4$ sodium cyanide solution was the silver salt of diazoaminobenzene.—C. A. M.

Method of testing [viscosity of] lubricating oils. Dubrisay. See IIa.

Testing of refractory materials. Mellor. See VIII.

Determination of tantalum in alloy steels. Kelley and others. See X.

Separation of tin and tungsten in tin-bearing tungsten ores. Travers. See X.

Analysis of alloys of nickel and zirconium. Kelley and Myers. See X.

Method for fractionating fats and oils. Seidenberg. See XII.

Thermal values of fats and oils. II. The sulphuric acid or Mauméné values. Marden and Dover. See XII.

Analysis of sulphonated oils. Hart. See XII.

Analysis of one-bath chrome [tanning] liquors. McCandlish. See XV.

Some factors influencing the quantitative determination of nitric nitrogen in the soil. Greaves and Hirst. See XVI.

Determination of bran in flour and bread. Legendre. See XIXa.

Determination of fat in certain milk products. Francis and Morgan. See XIXa.

Possibilities and limitations of the Duclaux method of determining volatile acids. Gillespie and Walters. See XX.

PATENT.

Analytical pipettes. P. E. Spielmann, London. Eng. Pat. 109,753, Apr. 30, 1917. (Appl. No. 6107 of 1917.)

AN analytical pipette is provided with a tap, the barrel of which opens above into a suction tube, and into an opening to the atmosphere which may be in the form of a cup, and below into the pipette proper and into a draining tube. The key of the tap is so grooved or drilled that the suction tube may be connected with the pipette while the latter is being filled. By turning the tap through 90° , the suction tube is brought into connection with the draining tube, so that any excess of liquid drawn into the suction tube may be drained off. By turning the tap again through 90° , the pipette is brought into connection with the atmosphere through the small cup, and delivers its contents. The pipette may be washed by filling the cup with water and allowing it to run through the pipette.—F. Sp.

Books Received.

NATIONAL PHYSICAL LABORATORY. COLLECTED RESEARCHES. Vol. XIII. 1916. Harrison & Sons, St. Martin's Lane, London, W.C. 299 pages. Price 20s.

THIS volume contains seventeen papers by members of the staff of the Laboratory, including the following: "On obtaining and maintaining a bright hydrogen spectrum, with special reference to the 4341 line," by J. Guild. "Notes on the analysis of aluminium and its alloys," by W. H. Withey (this J., 1916, 472). "The constitution of the alloys of copper with tin," by J. L. Haughton (this J., 1915, 358). "The choice of glass for cemented objectives," by T. Smith (a mathematical treatment of the subject). "Report on the tests of fuel oils, carried out for the Royal Commission on Oil Fuel, June, 1914. Part I. By J. R. Pannell. Part II. By W. F. Higgins (an abstract of this Report will appear later).

NATIONAL PHYSICAL LABORATORY REPORT FOR THE YEAR 1916—17. W. F. Parrott, Teddington. 07 pages.

Journal of the Society of Chemical Industry.

No. 22. Vol. XXXVI.

NOVEMBER 30, 1917.

No. 22, Vol. XXXVI.

Official Notices.

CROSS AND BEVAN ESSAY PRIZE OF £20 AND LATHAM RESEARCH GRANT OF £300.

The Council desires to remind intending competitors for the Cross and Bevan prize that Essays must be received at the offices of the Society before the close of the present year.

The Essay prize is open to all members of the Society who are British subjects. The Research Grant is limited to competitors under 25 years of age at the time of sending in the essay.

Full particulars were published in the issues of the Journal for 15th January and 15th and 28th February, 1917.

THE OIL SPLITTING ORDER, 1917.

Under an Order entitled as above, which is dated 9th November, no person may, after 12th November, split (otherwise than in the due course of manufacture into soap) any of the oils specified below, or any of the acid oils arising from refining any of such oils into their component parts of fatty acid and glycerine, except under and in accordance with the terms of a licence issued by or under the authority of the Food Controller.

The following are the oils specified:—Coconut oil, cotton oil, gingly (sesamé) seed oil, groundnut oil, soya oil, kapok-seed oil, niger-seed oil, palm-kernel oil, rape-seed oil.

IMPORTATION OF RESIN FROM FRANCE.

The French Government have decided to allow the export to the United Kingdom of a limited quantity of resin for commercial purposes, provided that the applications for export licences are supported by the British Government. In this connection importers of resin from France are invited to furnish to the Assistant Secretary, Commercial Department, Board of Trade, Gwydyr House, Whitehall, London, S.W.1, not later than 28th November, a statutory declaration setting out the respective quantities of (a) light resin (*colophane*) and (b) dark resin (*brai*) which they imported from France in 1916, and to communicate with the Department in regard to their future requirements.

AMMONITE AS A PERMITTED EXPLOSIVE.

The Home Secretary has given notice that, on 5th November, 1917, he made an Order under Section 61 of the Coal Mines Act, 1911, entitled "The Explosives in Coal Mines Order of the 5th November, 1917." The effect of the Order is to add the explosive ammonite to the permitted explosives named and defined in the First Schedule to the Explosives in Coal Mines Order of 1st September, 1913.

ALCOHOL FROM POTATOES.

Preliminary tests having proved satisfactory, the Food Production Department has arranged for an extensive experiment in the making of commercial alcohol from damaged or undersized potatoes at a distillery in Scotland.

VEGETABLE DRYING.

Preparations are being made by the Food Production Department for installing vegetable drying plant in Selby, Pershore, Formby, Cheltenham, and Kidderminster.

THE NITROGEN PROBLEM (*see page 1196*).

London Section.

Meeting held at Burlington House on Monday, November 5th, 1917.

DR. CHARLES A. KEANE IN THE CHAIR.

The CHAIRMAN referred to the great loss the Section had sustained in the death, on October 24th, of Mr. George T. Holloway. Mr. Holloway was Chairman of the Section in 1912-13 and was Vice-Chairman in 1911-12 and 1913-14. A vote of condolence passed by the Committee was confirmed by the meeting.

PATENT LAW IN RELATION TO BRITISH CHEMICAL INDUSTRY.

BY DR. F. W. HAY.

The object of this paper is not merely to criticise and point out certain deficiencies of our patent system, but rather to submit certain data for discussion and to establish with the support of this Society a programme of reconstruction that after mature consideration might be found to encompass the requirements of chemical industry.

It is well known that Great Britain more than most countries depends to a large extent on its industries for its very existence. It will hardly be denied, moreover, that no industry can maintain its reputation and commercial success in the markets of the world without constant improvement; it therefore in turn depends upon the ingenuity and inventive activity of the people who carry it on. In view of these circumstances it is undoubtedly of primary importance to the nation that the inventive talent of the people should be encouraged in the fullest possible measure and the question whether the interests of inventors and those of manufacturers receive the support they deserve under the present system of patent legislation therefore appears well worthy of careful investigation.

The advisability of having a patent system of any description for the protection of inventions has sometimes been questioned. The opinion has even been expressed that patents are a hindrance to the free development of trade. There can be little doubt, however, that patents have on the whole been a very great stimulant to industrial development and that a reward of some kind must evidently be given. No chemist or engineer can be expected to burn his midnight oil and apply his best efforts in the pursuit of some new process or ingenious construction, if after months or years of toil and labour, disappointment and renewed effort, he eventually gets no reward whatever for the invention he may have conceived; and I am not aware that any system for the encouragement of invention has been found that is as equitable as that of granting a limited period of protection by means of Letters Patent, for if the invention turns out to be useless the public is at no expense. I may be allowed to adduce two opinions on this

subject that are of particular interest. Herbert Spencer says in his "Social Statics": "They fall into serious error who suppose that the exclusive right assumed by a discoverer is something taken from the public. He who in any way increases the power of production is deemed by all to be a general benefactor, who gives rather than takes. The successful inventor makes a further conquest over nature, by him the laws of matter are rendered more subservient to mankind," etc. A no less eminent authority on political economy, John Stuart Mill, expresses himself as follows: "The condemnation of monopolies ought not to extend to the patents by which the originator of an improved process is allowed to enjoy for a limited period the exclusive privilege of using his own improvement. This is not making the necessity dear for his benefit, but merely postponing a part of the increased cheapness, which the public owes to the inventor, in order to compensate and reward him for the service. That he ought to be both compensated and rewarded will not be denied, and also that, if all were at once allowed to avail themselves of his ingenuity, without having shared the labours or expense which he had to incur in bringing his idea into practical shape, either such expenses and labours would be undergone by nobody except very opulent and very public-spirited persons, or the State must put a value on the service rendered by an inventor and make him a pecuniary grant. This has been done in some instances and may be done without inconvenience in cases of very conspicuous public benefit, but in general an exclusive privilege of temporary duration is preferable, because it leaves nothing to anyone's discretion, because the reward conferred by it depends upon the invention being found useful, and the greater the usefulness the greater the reward, and because it is paid by the very persons to whom the service is rendered—the consumers of the commodity. I have seen with alarm several recent attempts, in quarters carrying some authority, to impugn the principle of patents altogether—attempts which, if practically successful, would enthrone free stealing under the prostituted name of free trade, and make the men of brains still more than at present the needy retainers and dependents of the men of money-bags."

We have a pretty highly developed patent system in this country. It is by far the oldest system of its kind and dates back to the Statute of Monopolies of 1623. This Statute was enacted under the reign of James I. and saved out of the abolition of the vast number of monopolies that were granted at that time as the result of corruption and which included many of the ordinary necessities of life, such as glass, paper, salt, potashes, iron, lead, tin, etc., those monopolies only that were granted in the form of letters patent for inventions. A very interesting account of the history of the Statute of Monopolies is given in one of the works of J. W. Gordon, K.C., entitled "Monopolies by Patents," to which I must refer for further particulars.

In its fundamental conceptions, as revealed in the Statute, our patent law has been incorporated in the patent codes of almost all other countries, the oldest of which date back about a hundred years, and it cannot be denied that even at the present time the governing principle of our patent law is still on a sound basis. This principle provides that patents should be granted for the introduction of any manner of new manufacture within this realm, so as to promote the industrial development of the country. The new manufacture was supposed to be taught by the inventor to his apprentices during the period of protection granted and thereby made available for subsequent public use. By the Act of 1852 it then became necessary to supply a specification of the invention

when applying for a patent and this specification was intended to enable the public to make use of the invention after the expiration of the patent. The specification afterwards came to be looked upon as the consideration of the grant to the obscurity of the earlier view that a patent was granted for actually setting up a new manufacture within the realm. This state of affairs subsisted until it was corrected to some extent by the Act of 1883, which provided that compulsory licences should be given whenever the patentee neglected to work his invention. In order further to prevent the obstructive use of patents, particularly on the part of foreigners, who instead of working their inventions in this country generally preferred to import the finished article to the detriment of our own industry, Mr. Lloyd George finally introduced the Patents and Designs Act of 1907, which contains provisions for compulsory working in addition to various other enactments. I have still to add to the above brief enumeration of our patent laws the Act of 1902, which instituted a system of preliminary examination as to novelty, based on a search among the English patents issued during the last fifty years.

The Patents and Designs Act of 1907, which consolidates all previous legislation and now governs the law and procedure in regard to patents, says in Sect. 1: "An application for a patent may be made by any person who claims to be the true and first inventor of an *invention*," and towards the end of the Act, in Sect. 93, we find the word *invention* defined as follows: "*Invention means any manner of new manufacture the subject of letters patent and grant of privilege within Sect. 6 of the Statute of Monopolies.*" This Sect. 6 of the Statute saved the granting of letters patent to inventors in the following words: "Provided also that any declaration before mentioned shall not extend to any letters patent and grants of privilege, for the term of fourteen years or under, hereafter to be made of the sole working or making of any manner of new manufactures within this Realm to the true and first inventor and inventors of such manufactures which others at the time of making such letters patents and grants shall not use, so as also they be not contrary to the law or mischievous to the State by raising prices of commodities at home, or hurt of trade or generally inconvenient."

We see therefore that in order to comply with the law and be what we call a valid patent a letters patent must cover an invention, that is to say some manner of new manufacture. This is the law and consequently the attitude of the courts with regard to patents.

The next question that presents itself may be put as follows. Do we deliver patents for inventions, i.e., for some new manufacture? And the answer is: We do so sometimes but not usually. All we do is prescribed in Sect. 7 of the Act of 1907 which says: "Where an application for a patent has been left the examiner shall in addition to the other inquiries which he is directed to make by this Act (i.e., enquiries relating to form), make a further investigation for the purpose of ascertaining whether the invention claimed has been wholly or in part claimed or described in any specification published before the date of application and left pursuant to any application for a patent made in the United Kingdom within fifty years next before the date of application." In other words, the Patent Office examines whether the applicant's invention is disclosed in any of the prior British patents of the last 50 years and if this is not or only partly the case the patent asked for is delivered, a reference to one or more of these prior British patents being sometimes required in the specification issued by way of notice to the public.

This is no doubt a step in the right direction, but it is not enough. An inquiry into prior British patents is totally inadequate for the purpose of establishing the novelty of the invention claimed. If we were the only country in which inventions are made and industries are developed this reference to prior British patents of the last 50 years would indeed be sufficient, but this is of course far from being the case. I admit that these prior British patents also comprise many inventions that have been made in other countries, but for all that they are far from forming an exhaustive record of what has been done before. The result is that the patent issued by the Patent Office may cover an invention, i.e., some new manufacture, or it may (and this is more frequently the case) merely cover an invention that is new with regard to prior British patents but not new with regard to the numerous discoveries made elsewhere. The law, however, as we have seen, grants a valid patent only for an invention that is entirely new.

This weakness in the administration of our Patent Law, which is due to the incomplete system of examination allotted to the Patent Office by the Act of 1902, is in my opinion by far the gravest inconvenience we have to contend with. Compared with the injurious effects of this failing of our patent system all its other deficiencies fade into insignificance. I am convinced in fact that it is this weakness chiefly which throughout the past has prevented our patent laws from exercising their full beneficial effect. The situation amounts to this, that the public can have no faith in the patent issued until the Law Courts have examined it with reference to all prior publications and have declared the patent to contain a new invention.

The consequences of this state of affairs are so notorious among people concerned with manufacture and in fact all industries that they hardly require much illustration. It may not as a rule be very difficult to invent some useful improvement; but, as every inventor knows, it is exceedingly difficult to get an invention introduced into manufacture. Years generally go by before a new invention is applied in the arts. Now if in addition to these difficulties the inventor has to overcome the general distrust of patents due to the fact that so many of them merely cover an old improvement, his task is little to be envied, and it is hardly to be surprised at if, after his fruitless efforts to introduce his invention, he becomes discouraged and allows his patent to lapse rather than pay the renewal fees required to keep it in force. On the side of manufacturers the situation is not much better. The industrial application of any invention generally entails considerable expenditure and is always associated with a certain amount of risk as regards cost of manufacture, the demand that may arise for the new article, etc.; if then in addition to such risk the manufacturer is not sure that the invention he is going to apply is protected by a sound patent, on which he can rely for protection during at any rate a limited space of time, his position is exceedingly difficult, and he can hardly be blamed for looking askance at inventions.

When in 1900 a Committee appointed by the Board of Trade and comprising Sir Edward Fry, Lord Alverstone, Lord Moulton, and other eminent lawyers, investigated the working of the Patents Acts, they readily recognised the serious objections that prevail against a system of granting patents indiscriminately, as was the case prior to the Act of 1902, and if their deliberations, which covered a good many subjects and seemed to favour an extensive system of examination, did not lead to a result of this kind, it may be presumed that this was due mainly to the fact that the question of a general system of examination was placed

outside the scope of enquiry the Committee was asked to make. The Committee stated in its Report (page 4): "Both from the evidence before us and from the knowledge possessed by members of our Committee, we are of opinion that the grant of invalid patents is a serious evil, inasmuch as it tends to the restraint of trade and to the embarrassment of honest traders and inventors, and this fact, coupled with the result of the foregoing enquiry, is in our opinion, a cogent argument in favour of same enquiry as to anticipation by prior Letters Patent."

All that was done at the time was the introduction of the Act of 1902, which established a system of examination covering the British patents of the last 50 years. I have attempted to show that unless the scope of this examination is enlarged very considerably, the result obtained will always be unsatisfactory and of little value to either the inventor or the manufacturer, and I submit as a first proposition in any programme of reconstruction, that the field of preliminary examination as to novelty should be extended to all prior publications, whether English or foreign, as this is the only means of ascertaining the novelty of the invention described in the specification.

Apart from the greater encouragement that would be given to industrial enterprise by the introduction of a general system of examination and the issue of more reliable patents, a very appreciable advantage would accrue by this system to scientific research. Whenever a research chemist, or an engineer engaged in design, would apply for a patent to cover an invention, he would, as soon as a search has been completed at the Patent Office, be informed of the several British, German, American or other patents that most closely approach his invention or appear to anticipate it. He would thus know at once how he stands, he would get the very information he wants, and if he finds that his invention is not new he would be able to strike out on a new line of investigation without further delay and without incurring the expense of acquiring patents in other countries.

There are many who will say that a comprehensive system of preliminary examination on the lines set forth is a task of such magnitude that it cannot be carried out. It will be remembered, however, that both Germany and the United States carry out a general system of examination, and that in a certain sense our Law Courts do so as well, for whenever the validity of a patent is questioned in litigation the courts take all prior publications into account when deciding whether the patent is valid or not. Surely if our judges, who, brilliant though they may be in judicial matters, are not as a rule familiar with technical questions, can determine whether an invention is new or old, our Patent Office with the help of a competent staff can be expected to do so. I admit that a scheme of this kind would require a greatly increased staff of competent examiners at the Patent Office and would entail considerable expenditure, but I suppose we can afford to spend some money on our Patent Office instead of making it a source of revenue, if the bulk of the nation is to benefit by an improved system of patent administration.

My contention is that the standard of a British patent should be at least equal to that of the United States patent, and that the scheme of examination proposed would not necessarily involve a more rigorous system of rejection than is applied in the States. I do not wish to advocate the German system of rejection according to which a patent is refused whenever the invention does not comply with a certain criterion of novelty. A considerably firmer attitude towards inventions that are obviously old would, however, be very

desirable, and in order to prevent hardship in all cases of rejection the applicant should have the right of appeal to a Board of Appeal comprising, say, the Comptroller-General or his delegate and three experts who are engaged in the industry to which the invention relates, each member of the Board to have one vote and the Comptroller to decide the issue when votes are equal. It would perhaps be advisable to allow a further appeal to the High Court if the applicant thinks that his case has not been fairly dealt with.

All the patents issued by the Patent Office would then carry with them the presumption of novelty as to what is claimed and there seems little doubt that their value as instruments of industrial enterprise would be infinitely greater than that of patents to which no such legal presumption can be attached.

In addition to the above general system of examination, some supplementary control of the issue of patents relating to chemical industry would seem necessary. It is well known that inventions relating to engineering, the mechanical arts, etc., can be illustrated and verified to a considerable extent by means of drawings and that no such illustration is possible as a rule in patents connected with chemical manufacture. Many inventors, and more particularly German manufacturers and chemists, have made use of this peculiarity of chemical patents in order to obtain protection for purely theoretical conceptions and speculations of a rather nebulous character. These patents are intended to obstruct and prevent subsequent inventors from receiving protection who have first conceived means of bringing such ideas to practical success. Many chemical patents moreover contain statements that are designedly misleading and sometimes the few data that contain the invention are drowned in a mass of more or less plausible statements that are intended to obscure the nature of the invention. Such patents might, of course, be attacked in court, but the expenses of legal proceedings connected with patents are much too high, and the period of opposing the grant of such a patent (two months) or of obtaining revocation (two years) has generally expired, when the patent is cited at the Patent Office as an anticipation of a new invention.

Anybody who has carried on research relating to chemical industry knows how heavily we are encumbered in this country with patents of this kind.

The new Act of 1907 has provided that samples of the products alleged to be obtained should be supplied, but these samples generally do not reveal much and are not submitted to any further examination and if the invention relates to an improved process of manufacture of a known product, samples are, of course, of no use whatever.

In order to establish some means of control it would seem advisable that in specific cases, in which the invention is highly problematical and the description is obviously quite inadequate, the Comptroller-General should have power to order a verification by experiment before granting the patent. If any statements are found that are obviously misleading or if it is found that in the hands of a skilled chemist the results claimed cannot be obtained, the Comptroller should be entitled to call for a fuller description, and should the applicant decline to give further particulars, the Comptroller should have power to refuse the grant of a patent, after allowing the applicant to offer explanations at a hearing. This rejection should be subject to an appeal to the Board of Appeal of the Patent Office. Possibly some measure of this kind might enable the Patent Office to prevent the delivery of obstructive patents. I do not, of course, mean to suggest that

all chemical inventions should be examined in this manner.

As an alternative to the experimental verification referred to, the system of granting patents in Switzerland deserves to be considered. In order to avoid patents with a vague description and claims covering more or less speculative data, the Swiss Patent Office has tied down the inventor to the description of one particular and clearly defined process and will not allow claims for a general method leading to the formation of various bodies. Section 6 of the new Swiss Patent Law is worded as follows: "Un brevet ne peut comprendre plusieurs inventions. En particulier les brevets ayant pour objet la fabrication de substances chimiques ne peuvent être délivrés que pour un seul procédé, qui, par la mise en œuvre de matières premières nettement déterminées, aboutit à une seule substance." This solution of the difficulty would appear to have considerable merit, but whether it works out well in practice I am not prepared to say. The obvious drawback of the Swiss scheme is that it is so easy for infringers to alter to some extent the particular process described and then claim to have made a new invention.

After having established our patents on a sound basis, i.e., that of the novelty of the invention, by means of the general system of examination proposed, we might think of making these patents permanently valid after allowing a period of several years, say five years, during which the public could obtain revocation of the patent on the grounds of anticipation, inadequate description, or prior use. During these five years the public would have an opportunity of adding any disseminated knowledge or information to the thorough investigation carried out by the Patent Office during the period of examination and the validity of the patent could then be looked upon as firmly established and no longer open to attack in court. The fact that it would be desirable for the Patent Office to establish the validity of British patents after a given number of years has already been advocated by Dr. E. F. Ehrhardt (see this Journal, 1916, 1249). It seems to me that this would indeed be quite feasible if a general system of preliminary examination on the lines I have proposed were adopted, but not otherwise. It stands to reason that a provision of this kind would greatly increase the stability of any new manufacture depending on patent rights and would enable the manufacturer to defend himself against infringers with greater confidence. It would, moreover, be impossible under these circumstances for some wealthy company to intimidate an inventor by telling him that his patent was not valid as the invention it disclosed was old, that they possessed prior patents and were entitled to make use of his invention without exposing themselves to an attack for infringement. No remedy for cases of this kind exists so far other than that of risking an action in court.

The above question of validity brings me to the second important proposition, which I venture to think ought to be included in a programme of reconstruction, and that is a revision of the procedure in court in cases of infringement.

It is well known that few actions in a court of justice prove as costly and uncertain in their issue as proceedings connected with patents. Many a manufacturer is deterred from taking up a new invention because he thinks that infringers are sure to turn up and that he will be unable to fight them. Others who have started some new line of manufacture based on patent rights prefer to put up with a certain amount of infringement rather than risk an action in court, their sales diminish and the royalties paid to the inventor fall in proportion, so that the latter does not get the full benefit of his invention.

All this detrimentally affects the interests of industrial development.

In chemical industry the situation is particularly bad. Any action brought against an infringer is dragged from court to court and the decision on the main issue, i.e. whether there is infringement or an improvement on the part of defendant, is often reversed over and over again.

Owing to the extraordinary condition of the law, a judge is expected to form an opinion on chemical questions that are often exceedingly intricate and would in some cases be puzzling even to a trained chemist. The judge, although very learned in the law, is unfamiliar as a rule even with the rudiments of chemistry and is therefore compelled to rely on the evidence of experts for guidance. But the very terms in which the experts speak may be almost as strange to him as the words of an unknown language, and make it an exceedingly arduous task for the judge to follow the dialogue between counsel and experts. We would hardly expect a chemist, no matter how distinguished he might be in his calling, to decide satisfactorily difficult questions of law. Yet we do expect lawyers who sit upon the bench as judges to pass an opinion upon equally difficult questions of chemistry. It is not surprising under these circumstances that the courts find it exceedingly embarrassing to do justice to all the highly technical evidence brought forward and that a tremendous amount of evidence has to be collected before a more or less satisfactory solution of the problem of infringement is arrived at.

In order to establish a more efficient and economical tribunal for the settlement of patent cases, it would seem preferable that no experts should be allowed to assist either plaintiff or defendant, but that they should sit on the bench with the judge and form a kind of "technical jury," that would be called upon to assist the judge in deciding the issue of infringement. This would greatly reduce the cost and duration of the action and a great deal of the uncertainty of patent litigation would disappear. A manufacturer or inventor whose patent rights have been infringed could bring his action in confidence and we should be spared the painful avowal of incompetence that can be found in so many decisions relating to patents.

By way of illustration of the manner in which actions for infringement relating to chemical industry are dealt with in court the following three cases may be cited, which have been selected after a perusal of the Law Reports and the Reports of Patent Cases of the last thirty years and may be taken as fairly typical.

One of the earlier actions for alleged infringement and at the same time one of the most notorious cases fought out in connection with the dye industry is the so-called "Blackley Red" case in which the Badische Anilin und Soda Fabrik brought an action against Levinstein Limited for infringement of their patent No. 786 of 1878 (R.P.C. 1885, p. 73—118). Sir Henry Roscoe, Dr. Caro, Dr. Peter Griess, Professors Dewar, Armstrong, and Odling, and other prominent chemists appeared in the action as expert witnesses. The patent referred to related to "Improvements in the production of colouring matters suitable for dyeing and printing" invented by Dr. Caro, and comprised the following results set forth in Claim (1): "The production of red and brown colouring matters which may be termed the sulpho acids of oxyazonaphthalene by the action of diazo compounds, which may be prepared from naphthylamine or from the sulpho acids of naphthylamine, upon any of the isomeric naphthols or of mixtures of the same, or upon any of the sulpho acids which may be prepared from either alpha-naphthol or beta-naphthol or from

mixtures of the same." Claim (2) referred to the use of dioxyazonaphthalene derivatives. The plaintiffs in their action claimed the usual relief (injunction, etc.) for an infringement of this patent and complained in particular of the sale by defendants of a colouring matter called "Fast Blackley Red." The defendants disputed the validity of the patent in view of prior publications in the "Berichte," etc., and they denied infringement. Professor Roscoe was asked by the judge to verify by experiment the first of the four methods described in the specification for obtaining the dyes in question, which consisted in combining diazotised naphthylamine with α - or β -naphthol and then sulphonating the product by heating with oleum. Professor Roscoe reported that the dyes claimed were obtainable according to this method. The process used by the defendant for obtaining Blackley Red, however, resembled the third method, which consisted in sulphonating naphthylamine, diazotising the product obtained and combining it with α - or β -naphthol. It turned out that this third method was the only one which led to the formation of a dyestuff of commercial value. The proceedings revealed that the defendant Levinstein used a process which differed in several respects from the third method described by Caro. Both parties started from naphthylamine but Caro sulphonated with 80% oleum, while the defendant used ordinary sulphuric acid; Caro used caustic alkali in the process of producing the oxyazonaphthalene, while the defendant used sodium carbonate; other differences in the process of manufacture were explained. The judge on rendering his decision defined the third process as follows (p. 84, lines 41—44): "The third process consists first of all in the manufacture of sulpho acids of naphthylamine, and after having got that those are mixed with beta-naphthol, and the sulphur therefore is to be found in the naphthylamine and not in the naphthol." Passing on to a comparison between the two processes under consideration the judge continued as follows: "There is no dispute whatever between the parties that, as regards the materials, Mr. Levinstein uses the same materials, that in his process in which he wants to obtain the sulpho acids of naphthylamine he does not use fuming sulphuric acid, but using what I consider to be a known equivalent to that, which he mixes with the naphthylamine, his process results in the production of naphthionic acid in the form of crystals; and I have no hesitation in saying that, so far as I am capable of judging, the process he has used is a process which is much cheaper and much simpler and results in giving you naphthionic acid in a much purer form, than it would do according to the process in the patent. It is said that this is an entirely new discovery of Mr. Levinstein's. I have said already and I repeat, although I am very diffident of expressing any opinion on a chemical matter, that, judging as well as I can from the information before me, I do not entertain a doubt that that naphthionic acid is produced by a chemical operation equivalent and known to be equivalent at the time the patent was taken out." Here the learned judge made a serious mistake, as oleum and ordinary sulphuric acid are far from being equivalent in their action on naphthylamine. While the former, particularly in the high state of concentration referred to (80%) and at a raised temperature, will, in addition to a certain proportion of monosulphonic acid, produce mainly various isomers of disulphonic and trisulphonic acids, which may or may not be valuable dyestuff components, ordinary sulphuric acid can be made to produce the single monosulphonic acid required, i.e., naphthionic acid, as was evidently the case according to Levinstein's process. The judge continued: "Having obtained this he then

proceeds to produce the diazo compounds. So far as I am capable of judging, I incline to the opinion that Clève's method was the only one that was known. In this case also Mr. Levinstein, by experiment, has found out a cheaper method, and I suppose a better method, than that of Clève for producing this diazo compound, and I will even assume for a moment in favour of Mr. Levinstein that he might be able, if a patent could be taken out for such a matter, to take out a patent for what he has done. But at the same time my own impression is this, that in what he has done he has simply, by experiment, and by pursuing courses well known in chemistry, adapted this particular naphthionic acid process to the processes which have been used for other subject matters, but for which it had not been found, possibly because they were not wanted, could be used with regard to naphthionic acid." (It is submitted that this argument would be fatal to a great many valuable chemical inventions.) "He has then got his diazo compound. Having got his diazo compound of naphthylamine and having got his beta-naphthol both in solid forms, he has to combine them. He does not use caustic soda, he uses another vehicle (sodium carbonate) and he says that there is a great difference in using that other vehicle from using the caustic alkali solution which is mentioned in the patent, and of the difference he says that whereas the caustic alkali solution spoils his colour, the vehicle that he uses keeps it perfectly good and in fact improves it, the result is that the diazo compound combines with the beta-naphthol and you then get the colouring matter you want."

The judge concluded that the two processes were the same, and decided the issue of infringement in favour of the plaintiffs. An injunction, prohibiting further manufacture, was granted against the defendant.

On appeal, the Court of Appeal reversed this decision, declaring Caro's patent to be invalid, because the specification did not differentiate between the useful and the useless processes described, all the processes being presented to the reader as of equal value, and the Appeal Court further declared that if the patent had been good, defendant's process would have been an improvement on plaintiff's process.

On appeal to the House of Lords, the latter reversed the decision of the Court of Appeal and restored the order of the High Court that "plaintiff's patent was valid and that defendant had infringed."

That the solution thus finally arrived at after several years of litigation is rather unsatisfactory will hardly be denied. After reading all the evidence disclosed in the proceedings (as far as it was made public) it would appear that the defendant's process closely approached Caro's invention, that the latter first pointed out the oxyazaphthalene derivatives referred to, that there was distinct merit in this, that Caro's specification was drawn up in good faith, that he probably did not wish to discriminate between the various isomers and final products obtainable as they were not sufficiently known at the time, that his patent should never have been demolished, that Levinstein's process should have been disclosed before a competent jury—as indeed the whole case—that both plaintiff's and defendant's processes should have been verified by experts and the dyestuffs obtained compared, that the question of infringement should then have been decided, and that, if Levinstein's process was found to be an improvement, the question of infringement should either have been waived or, if defendant's process depended on Caro's patent the defendant should have been ordered to obtain a licence to use that patent. A patentee cannot, in addition to the monopoly which is granted to

him, claim the right of being alone entitled to improve his process during the fourteen years of the life of his patent, as such a provision would have a retarding effect on inventive activity, which is contrary to the object of all patent legislation. Certain accounts tend to show that Mr. Levinstein's red dye was superior to any of the products placed on the market by plaintiffs, and that he successfully worked his process afterwards in Holland.

Another interesting action is that of Vidal Dyes Syndicate v. Read Holliday and Sons, Ltd., and Levinstein, Ltd. (R.P.C. 1911, p. 541—561, 1912, p. 245—284), which related to the manufacture of black sulphur dyes according to patent No. 16,449 of 1896 to H. R. Vidal. The patentee claimed the manufacture of black dyestuffs by "causing sulphur to react, either alone or in the presence of sodium sulphide, upon diamidophenols and dianidonaphthols or upon dinitrophenols and dinitronaphthols." The proceedings showed that the dyes produced by Vidal and those of defendants did not correspond, that according to the expert evidence of Professors Green and Morgan the directions in the specifications were insufficient to produce a black dye from dinitrophenol, and that under no conditions could a black dye be obtained from dinitronaphthol even applying all modern knowledge. Overruling this evidence, the judge decided that any chemist could find out by experiment the conditions necessary for obtaining black dyestuffs from each of the four substances referred to in the patent. The judge laid aside the principle, which is well established at law, that the specification should be sufficiently clear and precise to render further experiment unnecessary. The issue of infringement was decided in favour of the plaintiff. The defendants appealed and obtained redress from the Court of Appeal, which reversed the decision of the High Court and decided that Vidal's patent was bad because the processes claimed were not properly described and ascertained. The Appeal Court also held that defendants' dyestuffs were not produced by the process claimed and that there was no infringement.

In Nobel's Explosive Co., Ltd., v. Anderson (R.P.C. 1894, p. 115-129, 519-534, 1893, p. 164-169) the action related to A. Nobel's patent No. 1471 of 1888 for the manufacture of explosives having a horny or semi-horny character by mixing nitroglycerin with soluble nitrocellulose (i.e., dinitrocellulose). The defendant, Dr. W. Anderson, Director-General of Ordnance Factories, used insoluble nitrocellulose (i.e., trinitrocellulose). It was proved at the trial that, at the date of the patent, soluble (in ether-alcohol mixture) nitrocellulose and insoluble nitrocellulose were both well known and that each, as usually made, contained about 10% of the other. The processes described in the specification were equally applicable to both substances, and the results were horny or semi-horny explosives. The judge decided that as insoluble nitrocellulose was not mentioned in the claim this derivative was not within the scope of the invention described and that there was no infringement. On appeal the Court of Appeal confirmed this decision, and on appeal to the House of Lords the decision rendered in the first instance was likewise confirmed. It would appear that the question whether the use of insoluble nitrocellulose involved a distinct improvement, that could have been looked upon as a separate invention, should have been decided in the first place and that if no marked improvement could be established defendant's process should have been taken to be a colourable imitation. As the numerous experts arrayed on both sides could not agree, no decision was arrived at in this respect.

There is one further action to which I will

briefly refer, *i.e.*, *Crosfield and Sons v. Techno-Chemical Laboratories* (Brunner, Mond and Co. v. Lever Bros.) (R.P.C. 1913, p. 297), as in this case the judge himself points out the inconvenience of allowing experts to support the opposing parties. In this action Mr. Justice Neville refers in his decision about the well-known Normann patent for converting unsaturated aliphatic acids into saturated compounds, to the fabulous amount of time devoted to eliciting the opinions of expert witnesses upon the issues of the case, which the court alone should be left to decide, and says that "whereas the expert witnesses called for the plaintiff almost invariably take a strong view in his favour on each and all of the issues of the action, the expert witnesses for the defendant are equally confident the other way. It is rare to find any substantial difference of opinion between eminent experts upon matters of science whenever it is possible to dissociate the questions from immediate connection with the issues of the action."

I am aware that our courts sometimes summon an expert to assist and instruct the judge upon scientific issues, but this expert has no voice with regard to the real issue of the case, *i.e.*, whether there is infringement or not. This arrangement is certainly better than leaving the whole technical side of the case in the hands of the judge, but it entails serious objections. It may be easy to secure an honest expert, but it is difficult to find a truly impartial one. The more learned he is the more likely he is to have some previous knowledge of the very questions at issue and to have formed a previous opinion upon the matter at stake. No matter how conscientious he is, he is likely to approach the subject with a certain amount of bias, which may result in great injustice.

CONCLUSIONS.

The patents issued in our country contain no reliable evidence of novelty. Those that are granted for genuine inventions are inundated by a large proportion of worthless patents delivered for old inventions. A serious anomaly exists between the attitude of the Patent Office, which considers the fraction of industrial development only that is covered by the British Patents of the last 50 years, and the attitude of the courts, which in accordance with the law, consider all prior publications. A patent sealed by the Patent Office is liable to be upset in court on the grounds of anticipation as soon as it is issued. The inventor finds it exceedingly difficult to introduce his invention owing to the lack of consideration given to patents and the manufacturer is deterred from using a new invention because the patent he is offered may or may not be a valid instrument of defence against infringers.

It does not seem expedient to leave the novelty of the invention to be determined by the courts. The novelty of all inventions to be protected by patents should be investigated by the Patent Office by means of a general system of examination, covering all prior British and foreign publications. Without demanding any particular standard of novelty or applying the criterion of a "new practical effect" adopted in Germany, patents should be granted only for inventions that contain some novel feature over and above the inventions disclosed in the prior publications. All other applications for patents should be refused.

Specifications relating to chemical industry should, whenever the invention seems problematical or obscured by irrelevant or misleading statements, be verified by skilled chemists in suitable laboratories, so as to avoid the delivery of patents that are intended to obstruct. The supply of samples is deemed insufficient for this purpose.

The public should be allowed five years within which the patent could be revoked on the grounds

of anticipation, inadequate description or prior use, and the validity of the patent should then no longer be open to attack in court, so as to give greater security to any new manufacture depending on patent rights.

The courts find great difficulty in dealing with litigation relating to chemical industry and frequently fall into serious scientific error. The judge has to rely on expert evidence which he is unable to understand, because years of scientific training are required to be able to cope with the highly technical evidence brought forward. No demonstration *ad oculos* can, as a rule, be made. Great uncertainty, therefore, prevails with regard to patent litigation relating to chemical manufacture and even wealthy companies often prefer to put up with a certain amount of infringement rather than defend their rights. It is therefore proposed that all actions in court connected with infringement of patent rights should be tried in the presence of a "Technical jury," consisting of experts engaged in the industry or science to which the action relates, and assembled in the manner of a "Special jury."

DISCUSSION.

Mr. WALTER F. REID said that he considered there were a great many difficulties in the way of the inventor. The existing patent laws had, however, certain facilities for the inventor, and these should not be lost. With respect to the suggested jury of technical experts, he doubted its being a success owing to the difficulty which would be experienced in obtaining a panel who would view a patent in the same light as the inventor. He had known many inventions which had not been put to use because the technical experts did not believe in them, but which had proved to be useful inventions. He considered that our Patent Office fleeced inventors, deriving a profit from them of more than £100,000 a year, which was not to the advantage of the patentee or the public. It would be better for the country to spend the money paid for patents in the development of inventions. The 50 years' search had proved to be a complete farce; nobody wanted it and the practical results were worth nothing either to the investor or to the inventor. A complete search might be of more service. In the countries where a complete search was made the patentee obtained a patent which was as liable to be upset as the patents granted in this country. Inventors defeated their own ends by over-estimating the value of their inventions before they had actually been tested; no business man would spend money on an invention before it had been really tried. He considered the proposal to establish a laboratory for the testing of patents would not be a success and would be detrimental to the inventor. He thought the author was a little severe on expert witnesses when he said they were biased in favour of their clients. To put a limit on the period in which an invention was proved to be useful would be a disadvantage to the inventor, who ought to be secure in every way and ought not to have his patent turned down because someone did not agree with him. It was not generally known that on only 4% of the patents taken out were the fees paid up to the end of the term, and only 52% were kept going after the end of the fourth year. From the commercial point of view, therefore, it was quite clear that the fees charged were far too high, as it did not pay the patentees to continue their patents.

Mr. ARNOLD PHILIP said he would prefer a patent granted on the French system, under which the value of the patent was frankly left to be fought out in the courts; but for that a single fee should be charged, which should cover all payments, as was the case with American patents. A patent granted after a most thorough search by

the English Patent Office might be upset by information which had never formed the subject of a patent but had been published in some little-known book. The real value of a British patent, however careful a search might have been made, had to be decided by the courts, and therefore a search prior to granting a patent was of little real use. An author was very much better off than a patentee. The term of copyright covered a much greater number of years for a much smaller fee than a patent, whilst the patentee had to pay heavy renewal fees for short terms, always being liable to an action for infringement or declaration of invalidity.

Mr. J. W. GORDON said that if he understood Dr. Hay's suggestion, it was that an expert jury should be empanelled to assist the judge in the trial of an infringement action, whilst reference had been made to the expert body which assisted the Patent Office in Germany in deciding upon the merits of an application for the grant of a patent; these were two totally different things. His own view for many years had been that an expert jury to assist the judge at a trial would be an extremely useful innovation in our system of the administration of the patent law, but there were obvious difficulties in it, which he thought, however, could be successfully overcome. He believed that the author suggested taking the decision in the case out of the hands of the judge and placing the decision as to the attempt to infringe in the hands of the jury. That would not, in his (the speaker's) judgment, be an improvement at all. The expert jury should perform the same functions in these trials which the special or common jury, as the case might be, performed in the trial of an ordinary action at law. That, he thought, would be a useful innovation. It would secure the assistance of experts to the judge and that was a thing which it was extremely difficult to secure as matters stood, and in addition he thought it would tend to exercise a very valuable control over the evidence given by expert witnesses. The expert witness when called was entitled to answer questions that were put to him but he was not entitled to offer opinions of his own nor to introduce his own views except in so far as they were elicited from him by the questions put to him. Of course, neither party put questions which were calculated to produce an answer unfavourable to the party in question, and the consequence was that many points were not elicited at all which were of very great importance to a decision in the case, and through no fault of the expert witness but through the fault of the system, the opportunity was not given to the expert witness to disclose the whole of his knowledge bearing on the subject. The remedy for that in an ordinary case was, that over and above the questions which were put in the interests of the parties, the judge could, if he thought proper, put questions for himself in the interests of and to clear his own mind. The judge, if he were sufficiently familiar with the subject matter, might do that in the case of expert witnesses in, for instance, patent actions, but it happened very often that by reason of the technical character of the evidence given and of the very special nature of the subject matter under discussion, the judge did not feel sufficiently at home to take up the line of examination of expert witnesses on his own account and he rested satisfied with the examination and cross-examination, although it might by no means have cleared the matter satisfactorily to his own mind, for fear of making matters worse if he attempted to deal with it on his own responsibility. He thought that kind of difficulty would be almost completely eliminated in the trial of a patent action if there were an expert jury which could suggest to the judge the questions which were necessary to complete the evidence,

or even to put these questions for themselves. There was an obvious difficulty to which allusion had been made about providing the experts for a jury of this sort. The experts would probably be connected with the industry which was concerned in the action and they therefore would, in all probability, be more or less committed either to the one party or the other or to some view upon the subject. That, he agreed, was very largely true if the expert jury were confined to the particular craft with which the case was concerned. But in the case of a chemical question, for example, an expert jury might consist of engineers, metallurgists, and geologists. He did not suggest excluding the chemist by any means, but he thought it would be extremely unwise to exclude other experts and scientists. After all, what was wanted for the purpose of the investigation of such questions was the mind not of a person who knew already what was going to be said about it, but a person who could readily apprehend and pick up the evidence which actually was given. The question had to be decided and ought to be decided by the evidence adduced in the court of law, and therefore it was a disadvantage to have on the part of the body which adjudicated thereon, an opinion already formed. There was matter which was not brought forward in the evidence but which did bear upon the decision, and if the question of infringement were to be decided by something which had never been disclosed to either party they could not of course put their case fairly before the Court. The whole evidence upon which the case was to be decided ought to be laid before them in order that they might deal with it. If a decision were entrusted to experts who did not have to derive their information from the evidence, the persons who were responsible for putting the evidence before the Court did not have a fair chance of stating their case, because they were met in the mind of those constituting the Court with matters that had not been disclosed to them. It was of the very elements of the administration of justice that the decision of any case, whether scientific or otherwise, should depend exclusively upon the evidence which was adduced in the Court and submitted for the criticism and observations of the parties who were going to give the decision. It was the greatest mistake to suppose that one could proceed properly according to the German system of entrusting a decision to people who could follow the case independently of the evidence. The persons who were deciding should be people who had to take into consideration the evidence that was put before them, and it should be decided on that evidence alone. It was a very great advantage to have persons who had had a scientific training and who were accustomed to deal with scientific matters, but there was, so far as he could see, no object to be gained by choosing experts to decide the questions which had to be decided in a court of law, who would be able to decide them by the light of their own knowledge and independently of the matters which were brought forward in the actual discussion.

Dr. Hay had advocated a very extended search before the granting of a patent. He (Mr. Gordon) thought that he over-estimated its value. In Germany and America, where extended search was made, a very elaborate process was gone through before a patent could be granted, especially in Germany, and that was a real hardship to an applicant for a patent. At the time the applicant came forward, he was not in the fortunate position of a man who had a valuable property to uphold. He was in the position of an adventurer who was coming forward with something he hoped might prove to be a very great success, but up to this stage he had had nothing but trouble and expense in connection with it. If he were to be

exposed at the commencement to the same kind of opposition which he had under our system, five or ten years afterwards, when his patent had proved a success and he had put up a sum of money to deal with the contingency of litigation, he would be exposed to a very great hardship. He would be obliged to run the gauntlet of the German Office, but there was much more in the case of this country to be said than that. In that connection he drew attention to one very important and significant circumstance. We had some half dozen or more autonomous colonies with patent laws of their own, and these colonies always keep their eye on our legislation and what we did they usually did also. If there were to be established in this country an extended search through all kinds of literature, that extended search would be introduced in the legislation of all those colonies in two or three years' time, and then the unhappy patentee who wanted to take out a patent throughout the British Empire would have to submit to this search and expenditure over and over again, and he would have to fight half a dozen patent actions before he could get a patent for the British Empire. That seemed to be retrogressive. It was possible to suggest a unified British Imperial patent system. Thereby a patent, wherever it were granted, would be capable of being made effective throughout the British Empire without repeated examination and without a repetition of this elaborate machinery and costly expenditure. The innovations which were introduced in 1883 had had the effect of practically sub-dividing the British Empire into something like ten or a dozen different countries for the purpose of patent law. There had been a period in our history when we had made a very serious attempt to unify the British Empire for this purpose. That was in 1852 when under the generous impulse of the gathering brought together by the Great Exhibition of 1851 a system had been introduced by which patents could be taken out in this country and would have been regarded as valid in the dependencies. Unfortunately, that promise of an Imperial system had not ripened. The legislators of 1853 had not been so sympathetic as their predecessors, and they had introduced the system by which the colonies were placed on exactly the same footing as foreign countries for the purpose of reciprocal patent rights and had divided the British Empire up into a number of different countries for this purpose, with the result that at the present moment the cost of getting a patent throughout the whole Empire was prohibitive except for those with a long purse or an invention of proved value.

Mr. JACQUES ABADY said that necessarily chemical patents involving a great deal of investigation, a great deal of obscurity, and a great deal of uncertainty as to their future development offered greater scope for uncertainty in subsequent contests with rivals, and in proportion as a patent was simple, so was it less likely to be the subject of litigation. In regard to the question of the extended search suggested by Dr. Hay, he would apparently be satisfied with Section 7 of the Patent Act of 1907 if it were enlarged in its scope so as to take in specifications for patents which had been granted in foreign countries. He did not think that was likely to prove more conclusive than the present system, as it was not always prior specifications that were cited as objections to validity. Prior publications in various technical journals and various other matters were mentioned very frequently, and in proportion as an inventor leant upon an official examination, so he thought he would take less care in looking after himself, and would suffer a greater disappointment if in an action in

the Courts his anticipation of the stability of his patent proved to be false. After all, the Patent Office fees, covering what was a monopoly, if there were merit in the invention, for 14 years were only £100 or thereabouts, and it seemed to him that a patentee should take steps to see whether there was, in fact, anticipation before settling his final specification. A little more information from that standpoint would be worth 50-fold the most stringent public examination of anticipation. Dr. Hay appeared to be under the impression, and the discussion had proceeded as if it were a fact, that if a patent were tested in the courts, the novelty was guaranteed by the courts. That was not so; the court did not make any search as to novelty, but only dealt with anticipations referred to in the pleadings in the action. The discussion had proceeded as if in an action the question of infringement were the only issue. It might be so indirectly, but in nine cases out of ten the question of infringement was relegated to the background, and the point was, in fact, whether the invention was valid and the specification "sufficient."

In regard to the question of expert witnesses and infringement, he was sure that no counsel would ask an expert witness whether he considered one specification was an infringement of another. It was necessary to consider the state of the art and what was the invention that the inventor had made, at the time that he made it, and for such purpose experts were not wanted. Also, it seemed to him that if the functions of a jury were such as suggested, the jury would be deciding the action, and not the judge. Such a jury, as Mr. Gordon said, should consist of men who had the training and were capable of sifting the evidence placed before them. He failed to see what better training there could be than the training of the judges.

Dr. Hay had suggested that there should be a close time for patent actions, and that after a specification had been published five years an action should not be possible. But it was precisely in the first five years that the inventor did not want an action because he was then speculating money and getting together his commercial organisation. He believed that there was not one invention in 10,000 that came before the Patent Office that was worth bothering about, because it called for the use of no extensive amount of capital.

Mr. P. C. H. WEST considered that an extended search would result in delay in grant of patents and therefore an applicant would for a considerable time, possibly several years, be uncertain whether he would obtain a patent. In the United States and Germany, where the search was more extended, anticipations brought to light in this country were not infrequently overlooked. The search upon which decisions based upon the question of validity were come to were usually carried out by competent persons at the instance of patentee or manufacturer or other interested party. Amendment of the specification might in this country be effected at any time by applying for leave to amend and thus defects due to the official search might be removed.

In Germany there was no definite criterion of novelty; certainly it was required that an invention should produce a "new technical effect," but whether in a particular case an invention was deemed to possess this qualification depended largely upon the capacity of the patent agent. The extended search carried out in America resulted in the patentee presuming that his patent was unassailable, yet neither the number nor cost of patent actions had been reduced. It had been suggested that patents might be obtained for theoretical matter, but though broad claims might be obtained they did not cover theory only.

The suggestion of a laboratory for investigating the statements made by applicants was impracticable; it would involve heavy expenditure, and by whom would the expense be borne? He feared to contemplate the results of such establishment. Engineering inventions could not, as had been suggested, be verified from the drawings. With regard to the question of expert juries in chemical cases it had been suggested that the jury might consist of engineers. If engineers were to be left to decide the case, why not leave the matter to a judge, who certainly was accustomed to sift and weigh evidence? If in present conditions a case were properly fought, and the expert witnesses properly examined, the judge could decide the matter. In most patent actions justice was done.

Mr. G. E. PEARSON wondered how practical effect could be given to the various suggestions submitted for some modification, alteration, or adjustment of the Patents and Designs Act, 1907. That opened up a very large subject, and it seemed desirable to deal with it in a systematic manner from the point of view of the needs of chemical industry. He suggested that a competent committee should be formed of manufacturers engaged in chemical industry and who had practical experience of the taking out of patents and the working of them. Inventors associated with chemical industry who were not manufacturers should have an opportunity of joining this committee. The Act would be examined by this committee with the object of selecting those sections which in their working had proved unsatisfactory to the needs of chemical industry in this country. It would then be necessary to determine in what respect each of the selected sections had proved unsatisfactory and to suggest what modification, adjustment, etc., would be necessary to remedy the faults found. At this stage the committee would perhaps decide to co-opt the services of counsel experienced in the practice of patent law to advise upon the re-wording of the sections in order to give effect to the committee's recommendations and to safeguard any pitfalls resulting from such recommendations. If other industries largely interested in patent law reform, such as the engineering industry, tackled the subject on the same lines and the recommendations of the industries concerned were assembled and again reviewed by a fresh committee composed of the most expert men who had served on the industries committees, the considered opinion and recommendation of those industries chiefly affected ought to be arrived at. The opinions submitted that evening by various speakers would have the careful consideration of the Patent Law Committee of the industry with which he (the speaker) was associated, and no doubt there were many other members of the industry who would be only too pleased to appear before such a committee to render any assistance arising out of their own experience. In all recommendations made for modifications, adjustments, etc., of the Act, it would be necessary to consider the effect of reprisals from countries whose interests were unfavourably affected. Therefore the international arrangements would require careful attention.

In conclusion he mentioned a few items which might engage the attention of a committee formed on the lines suggested: (1) The attitude of Parliament in regard to any recommendation which appeared to aid the "inventor-manufacturer" in restricting the working of the monopoly granted him as opposed to the interests of the "inventor-non-manufacturer" who was naturally anxious to get his invention worked as widely as possible. (2) The alteration or repeal of Section 27, or alternatively the amalgamation of Sections 24 and 27 with suitable modifications,

to render it possible for Section 24 to achieve what had been expected from Section 27. (3) The revelation of a positive working formula for any protected substance. (4) Some means of revoking "blocking" patents after a short term.

Dr. F. B. DEHN said that no British patent had been declared valid by the courts. All the courts did was to declare it valid with respect to some particular point, but that would not prevent an attack from another point of view. The bearing of the objects of a patent on the public and the right of the public to redress must be carefully considered. He thought that as a rule British judges did not often go wrong and that justice was usually dealt out in this country.

Dr. HAY, in reply to the remarks made by Mr. J. W. Gordon, said he quite agreed that the jury of experts could be assembled on the lines of a common or a special jury, but although he admitted that experts who belonged to the profession to which the action related would be liable to form their opinion in advance and might disregard some of the evidence produced at the trial, yet it seemed to him that the more essential elements of the evidence would nevertheless be brought home to them by the pleadings and that a deficient appreciation of the minor points on the part of some of the experts would have to be allowed for in the hope that all the experts would not show a lack of attention to the same details, and that the main issue as well as all the more important subsidiary considerations would be properly dealt with. In any case, he hardly thought that experts who belonged to a different profession would be able to weigh up all the technical data of the evidence in a reliable manner. As an alternative to a technical jury, possibly two or three professional chemists, who had had practical experience in various branches of chemical manufacture, might be called upon to assist the judge in the capacity of assessors. These experts would have the advantage over a jury of being able to put questions themselves and at the same time the danger of having trade rivals sitting on the bench with the judge would be eliminated. With due deference to what had been said by other speakers, he did not think that the judge alone could be expected to do justice to the highly technical evidence brought forward in litigation relating to chemical industry.

Mr. Gordon's proposition that a British patent should be made to cover the whole Empire was a very valuable one. The adoption by the mother-country and all the colonies of a uniform system of patent legislation would, he thought, form a powerful stimulant to the development of the industrial resources of the Empire.

With regard to Mr. Abady's remarks, he was under a misapprehension if he thought he (Dr. Hay) meant to imply that the Courts carried out a search. The Courts did nothing of the kind, but they did take all prior publications into account that were submitted by the parties of the action, whether these publications were patent specifications or not, and whether they were in English, German, or other language, and in that respect the attitude of the Courts differed very considerably from that of the Patent Office, which granted a patent for anything that was not fully disclosed in the British patents of the last fifty years. He was not aware that he had suggested a time limit for patent actions. What he said was that the validity of a patent should not be questioned in court after a period of five years; that did not mean, of course, that a valid patent could not form the basis of an action for infringement throughout its duration.

Mr. Reid, Mr. West, and other speakers had admitted that the search carried out by the Patent Office was unsatisfactory, but they did

not favour a comprehensive examination by the Patent Office of all prior publications, which would of course include the journals. It was contended that such a search could be carried out privately before or after applying for a patent. In the criticism of the proposition of an extended search, the inconvenience or "hardship" to the inventor had, in his opinion, been over-estimated, and the advantage of having a patent that could be handed round with a certain amount of confidence, because it was known to contain something new and would therefore be treated with respect, had been perhaps under-estimated. There would no doubt be more trouble in obtaining a patent under the new system than hitherto, but it must be remembered that improvements of old inventions had to be differentiated from old inventions some day or other, if an invention were to be turned to account, and the sooner that was done the better. The prior patents and the journals were there in the archives of the Patent Office, and nothing was gained by ignoring them and putting off the day on which one would have to make sure whether the invention was new or old. If there were anticipations of the invention it was as well to know them at once, and the inconvenience that would arise, owing to a prolonged discussion with the Patent Office, would be small compared with the hardship experienced by an inventor who tried to introduce into manufacture a patent obtained under the present system of examination. Both from the point of view of the manufacturer and of the inventor the difficulties that presented themselves at this stage could only as a rule be overcome by having an extensive and costly search made with the help of an agent. Until such a search had been carried out the patent would always remain a very doubtful instrument of defence against infringers. As matters stood at present, nobody with any experience in patent matters would undertake to build up a new industry on the mere evidence of a British patent, as an undertaking of that kind would be little better than a gamble. The assertion finally that no absolute security would be gained by means of an extensive search could hardly, he thought, be considered an argument.

Manchester Section.

THE MANUFACTURE OF NITRIC ACID FROM NITRE CAKE.

BY DR. J. GROSSMANN.

(See this J. 1917, 1035.)

DISCUSSION.

In a written contribution to the discussion, Captain C. J. GOODWIN submitted that Dr. Grossmann's experiments would unfortunately, owing to existing conditions, be unlikely to lead to the working of the process on a practical scale. The process might be remunerative only while the war lasted, since the bulk of the sulphuric acid supplies, at present diverted for war purposes, would be released after the war, while at the same time a price corresponding to the value of the sulphuric acid would still have to be paid for nitre cake. Saltcake was not always saleable profitably, and it was not safe to rely upon a good market for it. It was known that practically the whole of the sulphuric acid charged into a nitric acid retort could be decomposed in the retort, forming slightly acid sodium sulphate, as described by Dr. Grossmann, but as the residue, being solid, was in an inconvenient form for removal, it was necessary

to restrict the reaction to the formation of a nitre cake sufficiently liquid for easy removal. The experiments showed that there was no advantage in the use of added carbonaceous matter, as decomposition of nitric fumes was less when no carbon was added. This was fortunate as such a mixture might easily lead to fires. A large-scale plant to work the process would, in addition to a suitable mechanically operated muffle furnace and grinding plant, require plant and towers of greater capacity than for the usual type of nitric acid plant in which only about 5% of the yield was recovered in the towers. A suitable form of muffle furnace would be that described in English Patent No. 4226 of 1915 (this Journal, 1916, 821), which is in operation for converting nitre cake and salt into hydrochloric acid and saltcake. For use in this furnace no difficulty was found in grinding the nitre cake sufficiently either by means of a disintegrator or under edge runners. Later it was found that, provided the salt was finely ground, it was not necessary to reduce the nitre cake below pea size. This would probably apply equally to the interaction of sodium nitrate and nitre cake, and he suggested that it should be tried. The saltcake obtained by Dr. Grossmann contained rather more free acid than was specified by users, but working continuously under conditions equivalent to those obtaining in a mechanical muffle-furnace in a properly designed plant, it should be possible to reduce the content to below 2%. As stated previously, he thought that no manufacturer would be prepared under present conditions to instal a plant to work this process, as it was not likely to be remunerative after the war, and there would be little opportunity, owing to the excess profits duty and similar financial measures, of making an adequate profit during the war. The rational utilisation of nitre cake lay, in his opinion, in the manufacture of hydrochloric acid of high strength such as would be obtained in a good mechanical furnace, and which would displace both nitre cake and sulphuric acid now being used for various non-essential manufactures. This process was in use prior to the war and would still be remunerative after the war, so that firms installing it would not be speculating unduly on the probable duration of the war.

Faraday Society.

PYROMETERS AND PYROMETRY.

Sir Richard Glazebrook presided at the first meeting of the Session of the Faraday Society, held at the House of the Royal Society of Arts on November 7th. The subject of the evening was "Pyrometers and pyrometry," and in opening the proceedings the Chairman referred to the great importance of the subject in industrial work, and alluded to the early days of high-temperature work at Teddington.

The following are abstracts of the papers read:—

PRODUCTION OF HIGH TEMPERATURE AND ITS MEASUREMENT.

BY E. F. NORTHROP.

Very high temperatures can be produced in the electric furnace when carbon or graphite is used as resistor, but the chemical activity of carbon at high temperatures renders it necessary to use a reducing atmosphere, and even then the products under treatment are subject to attack. Tungsten may be used as resistor at high temperatures, but a reducing atmosphere is necessary in this case also. Another disadvantage of the resistor type of furnace is its inherent thermal

inefficiency when used for fusing substances of high melting point. The author's conception of an ideal furnace is one in which the substance, contained in a cylindrical crucible, is able to absorb by induction alone a large proportion of the power supplied. The heat should make its appearance only in the walls of the crucible, or, better, in the substance itself. A 20-kw. furnace has been constructed on these lines, having in view the known limitations of the ordinary induction furnace. Heating is obtained by inducing, with comparatively high frequency currents in an inductor coil which surrounds the crucible, very large currents in the walls of the crucible or in its contents, if these are electrically conducting. The induction is obtained by electromagnetic induction without the use of any iron. The furnace differs radically from all other types of induction furnace by the entire absence of any interlinkage of a magnetic with an electric circuit. The necessary high frequency of the inducing current may be obtained in more ways than one. The simplest and most obvious method is to employ oscillatory currents obtained from the discharge of condensers. These oscillatory currents pass through an inductor coil of about fifty turns which surrounds the crucible, and is sufficiently separated from it to permit of both electrical and heat insulation. There is thus in effect a Tesla coil arrangement in which the voltage is transformed down and the current transformed up. It is to be noted that when a condenser of capacity C is charged to voltage V , energy is stored in the dielectric in potential form and in amount $\frac{1}{2}CV^2$. When the condenser is discharged this potential energy is released, and, becoming kinetic, may take the form of electric radiation as utilised in radio practice, or it may take the form of thermal energy or heat. When this principle is once recognised it becomes purely a question of design and engineering practice so to construct apparatus and select conditions that very little energy is spent in radiation and a large percentage of energy is converted into heat within a crucible and its contents—the necessity of the interlinkage of an iron magnetic circuit with an electric circuit being entirely obviated. Apparatus consisting of adjustable reactances, high tension transformers, and an entirely new type of discharge gap (which is nearly silent and operates without moving parts), two banks of condensers and a furnace inductor winding, constitutes a complete outfit for operation on a two-phase, 60-cycle, 220-volt supply circuit. The results so far obtained with this furnace are as follows:—1. It operates on a two-phase circuit, drawing an equal load from each phase. 2. It operates at full load with unity power factor for the supply circuit or with a slightly leading current. 3. It operates at any small fraction of full load without appreciable reduction in efficiency. 4. The metal-melting furnace will melt, starting at room temperature, about 45 lb. of brass in 35 minutes when watt-hour meters in the supply mains register a total power supplied of 18 kw. 5. The vacuum-type furnace will bring a crucible of Acheson graphite 14 cm. in diameter and 18 cm. high, filled with tin or glass, to a temperature of well over 1600° C. in 40 to 50 minutes, and a vacuum of not less than 1 cm. of mercury can be maintained during the process. Certain kinds of glass evolve a vapour under reduced pressure which diminishes the vacuum and makes the glass frothy. 6. Cylinders or crucibles of the above dimensions, or smaller, made of graphite, can be raised to a temperature of 1600° C. with an almost perfect uniformity in their temperature distribution. Cylinders of other materials, as of iron, nickel, or nichrome, may be raised in temperature until they start to melt. 7. The thermal efficiency, defined as the ratio of heat energy developed

within the crucible and its contents to kilowatt-hours supplied at switch terminals (both expressed in like units), may be made as high as 60% with the 20-kw. furnace described, and it is thought that a greater thermal efficiency may be obtained in a furnace of larger power capacity.

The furnace has been operated at 5400 and at 7200 volts at the condenser terminals. The frequency is the natural period of the oscillatory circuit of either phase. About equally good results have been obtained when working with 25,400 cycles and with 12,500 cycles per second. Protection from the high voltage is secured by surrounding the furnace casing with a grounded metal cage, and the crucible, in addition to being electrically insulated from the inductor coil with a cylinder of quartz glass, is likewise grounded.

It has been shown experimentally that by means of electromagnetic induction at high frequency, metal scrap, borings, turnings, etc., may be quickly raised to a melting temperature, then fused and superheated, even when contained in a refractory crucible of non-conducting material. Currents circulate in the subdivided mass, jumping with innumerable small arcs the contact resistances between particles. In this manner pure electrolytic iron, contained in a magnesia crucible, has been fused in a vacuum, carbon and presumably every other source of contamination being entirely absent.

This method of heating gives a type of furnace which it is impossible to destroy by burning out, as the only parts which get at all hot are the crucible, its contents, and the immediate layers of refractory lining. A layer of heat insulation of "silox" about 1 cm. thick surrounds the crucible, and this has been found quite sufficient to maintain the inductor coil below a red heat when the crucible and its contents are above 1400° C.

It is hoped that eventually, by using greater power input, it will be possible to melt metals belonging to the tungsten group in vacuum, and therefore make it possible to produce any kind of very high melting alloy free from carbon.

As regards the measurement of high temperature the author confined his remarks to the use of direct insertion pyrometers. The limits to accuracy set for high-temperature direct-insertion pyrometers are determined chiefly by the inevitable chemical modification of the pyrometric substance rather than by its fusion or destruction. With the best types of pyrometer-casing tubes at present obtainable, at a temperature in the neighbourhood of 1350° C. gases obtain access to the thermocouple wires, and contamination is produced. If the pyrometer is inserted in a reducing atmosphere, this contamination is particularly marked. Thus the author has never been able to use successfully, except for very intermittent service, a platinum-rhodium thermocouple in a reducing atmosphere much above the melting-point of nickel. A thermocouple of tungsten-molybdenum, though giving but a feeble e.m.f., can be used to measure extreme temperatures if it can be protected from access of hot gases.

Up to about 1300° C. the accurate measurement of temperature in any kind of atmosphere has been satisfactorily solved by properly constructed and protected platinum-rhodium thermocouples, the e.m.f. of which is determined by a potentiometer method. As a potentiometer is a somewhat delicate instrument, and as a direct deflection galvanometer, or millivoltmeter, must be intrinsically sensitive to measure the feeble e.m.f. of a platinum-rhodium couple, a robust portable instrument has been devised which operates on the potentiometer principle, but gives readings in millivolts or degrees by the deflection of a pointer. The accuracy and permanence of the instrument depend upon a permanent magnet

rather than upon a standard cell, in that the "current constant" of the instrument is all that affects the readings, the resistance being once fixed.

The author has also devised a direct-insertion pyrometer which reads high temperatures accurately. The instrument is constructed on the general lines of a very large mercury thermometer. The tin is contained in a "bulb" of close-grained graphite, and it expands, when the temperature exceeds about 700°C. , into the graphite "stem." The height at which the column of tin stands is determined by electrical contact. The scale is laid off or calibrated by noting the height of the column of tin at some two temperatures chosen within the range of a platinum-rhodium couple. The scale is extended above the higher temperature upon the assumption that the expansion continues linear to the highest temperature for which the combination, graphite and tin, is suitable. The upper obtainable limit of temperature to which it is practical to go has not been actually determined, but it is known that this limit is higher than 1680°C. , and it is thought to lie well above 1890°C. This pyrometer does not indicate, as a thermocouple does, a point-temperature, but registers the mean temperature over the space occupied by the pyrometer bulb. There does not appear to be any serious difficulty in preventing the graphite from oxidising and slowly wasting away. To prevent this it is proposed to inclose the bulb and a portion of the stem in a tube of a carborundum composition closed at the bottom. In the small clearance space between the bulb and the inside of this tube there may be inserted a filling of molten tin or a high melting glass. This jacket of molten tin or glass is expected to make a perfect shield against the attack of oxidising gases upon the graphite of the bulb.

In conclusion, the author emphasises the great possibilities of tin for extending the fundamental temperature scale above 1550°C. , the present limit of the gas thermometer. Only chemical contamination and temperature can affect either its resistance-change or its volume-expansion, and its chemical purity is easily controlled. Its resistance-increase and its expansion characteristics are, it is believed, as regular as is the increase in pressure of a gas of constant volume when its temperature is increased. Pure graphite, which makes an ideal container for tin, has an almost negligible expansion, and it is certain that both tin and graphite are undisturbed by a temperature elevation which goes far beyond that at which any gas can be used pyrometrically.

PYROMETER STANDARDISATION.

BY E. GRIFFITHS AND F. H. SCHOFIELD.

It is now generally agreed upon that the standard scale of temperature should be the thermodynamic. The corrections required to convert the scale of the constant volume nitrogen thermometer to the thermodynamic increase with temperature, amounting to about $+0.7^{\circ}$ at 1000°C. They are, in fact, almost within the limits of the possible error of experiment in gas-thermometer observations. Hence the problem of pyrometer standardisation resolves itself to an empirical calibration of the pyrometer, whether mercurial, thermo-electrical, or radiation, by comparison with a gas thermometer.

Comparison cannot be a direct one for each instrument requiring a temperature scale, so that the scale of the gas thermometer is preserved by means of auxiliary standards—the mercurial thermometer, thermo-element, or resistance thermometer, or by a series of freezing-points or boiling-points of pure substances.

The steps by which the scale of a pyrometer is obtained are generally as follows:—(1) The gas-thermometer worker compares his instrument with a thermo-element. (2) This calibrated thermo-element is then employed to determine the freezing-points of a number of pure metals. (3) A thermo-element is standardised by freezing-point determinations, assuming the values given by the gas-thermometer worker for these transition points. (4) The pyrometer and thermo-element are then compared under suitable conditions.

Gas thermometer work at high temperatures presents considerable difficulties, particularly in connection with design of furnaces for obtaining uniformity of temperature over the space occupied by the bulb. The National Physical Laboratory has adopted the following alternative methods for attaining a practical scale of temperature:—The hydrogen scale (0° to 100°C.); platinum resistance thermometer (-38.9° to 444.5°C.); the fixed-point scale, e.g., b.pt. of oxygen (-182.9°C.) and of carbon dioxide (-78.5°C.) to m.pt. or freezing point of gold (1063°C.) or copper (1083°C.); the uncertainty of the latter point probably does not exceed 2°C. Other fixed points have been determined, up to the melting point of platinum (1755°C.).

For thermo-electric pyrometers the working standards are calibrated by determining their e.m.f.s. at a number of well-established temperatures. The scale above 1000°C. at present depends on the freezing points of gold (1063°), copper (1083°), nickel (1452°), and palladium (1549°C.). Another point is suggested, viz., the freezing point of the eutectic of nickel and graphite, to which a value of 1330°C. is tentatively assigned. For the range 0° to 1600°C. there is no single expression which gives the relationship between temperature and e.m.f.; the simplest method is to construct a table which represents a smooth curve through the experimental points. Calibration by comparison with a standard thermo-element is simple and expeditious. Errors in thermo-electric pyrometry due to contamination, lag, and oxidation are considered, and apparatus for detecting contamination is described.

The resistance pyrometer, standardised in ice, steam, and sulphur vapour, gives a scale identical with that of the gas thermometer. This type of instrument is very free from liability to give false readings, and probably its greatest defect is the time lag.

The total radiation pyrometer is calibrated by means of electric furnaces, the pyrometer being focussed on a plug of refractory material and the temperature measured on a platinum-rhodium thermo-element. The range of standardisation is 500° — 1400°C. , whilst extrapolation gives points beyond this temperature. The total-radiation pyrometer is of very limited use with molten metals, owing to the haze or fog, and radiation from the walls of the crucible or furnace is likely to introduce serious errors.

Three types of optical pyrometer are in common use, viz., the disappearing filament type, the polarising type, and the wedge absorption type. Theoretically the polarising type is the best. The optical pyrometer is standardised by sighting on a "black body" furnace the temperature of which is determined by a thermo-couple. A tungsten-arc lamp is also suitable for calibration, e.g., over temperatures between 1350° and 2400°C.

BURYING THE COLD-JUNCTION OF A THERMO-COUPLE.

BY R. S. WHIPPLE.

The cold-junction of a thermo-couple in a research laboratory is usually immersed in melting

ice, but this is impracticable in the works, and the use of the "Thermos" flask has been resorted to: by this means it is possible to maintain the daily temperature within a range of 2°C . The author advocates the burying of the cold-junction; if this is done to a depth of 10 ft. beneath the floor of a fairly large building, the temperature will remain constant to within less than 2°C . throughout the year. There is no difficulty in burying the junction if Peake's compensating leads are used with Pt—PtRh couples. The method has been applied successfully to works practice.

AUTOMATIC CONTROL AND MEASUREMENT OF HIGH TEMPERATURE.

BY R. P. BROWN.

For temperatures up to 425°C ., and where the gauge is not more than 100 ft. from the instrument, it is preferable to use for industrial work a copper bulb filled with nitrogen and connected by capillary tubing to a helical expansive spring; the capacity of the bulb must be about fifty times that of the tubing. For higher temperatures the thermo-electric pyrometer has been almost universally adopted in the United States: for temperatures up to 1100°C ., a base-metal couple, one wire Ni 90, Cr 10%, the other Ni 98, Al 2%, is preferred, whilst for temperatures up to 1500°C . a platinum-rhodium thermo-couple is most satisfactory. For higher temperatures a radiation instrument is used. For measuring the voltage produced by the thermo-couple, millivoltmeters are available up to 1000 ohms or more; the weight of the moving element has been reduced to a minimum, e.g., to 526 mgrms., including pointer and spring, by the use of an enamelled aluminium alloy wire 0.003 in. in diameter. The pointer tubing is of aluminium with walls 0.002 in. thick. For greater precision of temperature measurement, the "Brown heat meter" has been devised; this consists of a high resistance millivoltmeter combined with a small dry cell and suitable rheostats to reduce the voltage of the cell from $1\frac{1}{2}$ volts to 0 to 60 millivolts. The thermo-couple is first balanced against the dry cell; the voltage of the latter is then determined by deflection, and the couple is then joined to the meter, so that by switching back and forth rapidly the voltage from couple or cell can be noted. A rheostat may then be used if necessary to bring the indication of the couple circuit to that of the cell circuit. To obviate errors due to sticking of the pointer, spring fatigue, etc., a standard cell with suitable resistors is supplied. The temperature of the instrument should be between 5° and 40°C .

An automatic control pyrometer is described in which the temperature in an electric furnace is measured by a Ni-Cr alloy thermo-couple which actuates a high resistance millivoltmeter. The pointer is depressed at regular intervals, and when the temperature rises or falls, makes contact with devices whereby the current is shut off or increased until the correct temperature is reached again. A similar device can be used to control the valves of a gas or oil furnace. An instrument has also been devised whereby it can be seen by coloured lights whether the temperature under observation is correct or not. It works on the same principle as the automatic control apparatus, except that the contact of the pointer with the contact pieces operates lamps of different colours according to whether the temperature is high, correct, or low.

In the discussion which followed these papers, Dr. W. Rosenhain suggested that the iron-carbon

eutectic might be used for a fixed point near 1130°C ., similarly to the nickel-carbon eutectic mentioned by Dr. Griffiths. Mr. S. N. Brayshaw said that he had found the eutectic Cu 60, Sn 40, very useful for standardising pyrometers for workmen.

PYROMETRY APPLIED TO THE HARDENING OF HIGH-SPEED STEEL.

BY J. O. ARNOLD.

High-speed steel is best hardened from a temperature of 1300°C . produced in a bath of barium chloride fused by the aid of iron electrodes. At Sheffield University simultaneous observations have been taken with five instruments: a Fery radiation pyrometer, a Fery spiral spring pyrometer, a Foster practical immersed pyrometer (containing a thermo-couple of nichrome and some other nickel alloy for a range from 500° to 1400°), the twisted end of the couple being immersed, a Leskole pyrometer (a modified Wanner), and a Mesuré-Neuel (a polarisation pyrometer). All these instruments are reliable only for temperatures above 900°C . Many discrepancies are due to want of skill of the observers. The mean of the bath observations was 1296°C ., a few extremes ranging from 1270° to 1310° . Another set of observations, with three instruments, gave the grand mean 1305° . When first using the 2-ton Siemens electric furnace in 1910, it was charged with $\frac{1}{2}$ ton of pig-melt of hematite iron, the metal cooled a little in the ladle for casting floor plates, and the casting temperature of the five consecutive plates taken, which yielded 1300° , 1280° , 1243° , 1258° , and 1208° : there was thus a fairly rapid fall (radiation loss) of temperature, the mean fall being 18° per plate. In 1914 Leskole and Mesuré instruments gave a suspiciously high casting temperature of 1525° . Later experiments yielded first-heat tapping temperatures of 1600° , 1550° , 1630° , 1670° , and 1620° , and in another series 1625° , 1600° , 1600° , 1600° , 1590° , and 1600° . Two solid points have been proved: the temperature inside the Siemens furnace is 1700° — 1750°C ., the tapping temperature of the molten metal 1575° — 1525°C .

THE DETERMINATION OF THE TEMPERATURE OF LIQUID STEEL UNDER INDUSTRIAL CONDITIONS.

BY C. JOHNS.

There is a marked thermal effect when liquid steel issuing from the tap hole of an acid open hearth is succeeded by the first flush of slag. Viewed through blue glass the slag is much brighter than the steel. The steel reflects the light of the sun or an arc lamp, while the slag is less efficient as a reflector; as good reflectors are poor radiators, the differences in emissivity have to be taken into consideration. The thermal effects can be studied with a Fery radiation pyrometer, but marked corrections must be made when different parts of the stream of metal are in the field. Optical pyrometers for monochromatic light have proved most useful, provided special precautions are observed. Liquid steel is best observed from a distance of about 12 ft. at nearly a constant angle, and to avoid fumes, from the clear side to the windward of the stream. Experienced observers can estimate temperature differences of 15° and even 10°C . merely by watching the steel through blue glass as it is poured into the ladle. Pyrometers should be able to give higher accuracy, and trained observers can indeed obtain readings agreeing within $\pm 2.5^{\circ}$ or at any rate $\pm 5^{\circ}$. For

each particular casting method of a class of steel it is only necessary to determine the "normal" temperature when the steel is tapped from the furnace; deviations from the normal by more than $\pm 10^\circ$ are avoidable in practice, at least for special steels.

In the furnace hearth there is a layer of, say, 4 in. of liquid slag between the flame and the liquid steel, 15 in. deep, and all the heat has to pass through this layer, which is therefore hotter. In correcting the apparent temperature readings, assumptions have to be made for the emissivities. The surface layer of slag consists of fused iron peroxide, which is assumed to have an emissivity of 0.50; the emissivity of the liquid steel is probably 0.40. Insertion of a patch of new silica brick in a seasoned wall may make a difference of 20°C . There is a temperature gradient in the liquid steel bath, which can be estimated by observing the stream, first of steel and then of slag, as it flows from the taphole into the launder. Nine consecutive determinations, taken at intervals of one minute, gave the following temperatures: clear steel, 1465° , 1470° , 1470° , 1475° , 1475° ; last steel, 1480° ; clear slag, 1495° , 1505° ; last slag, 1510°C . There is thus a rise of 15° in the first 5 minutes, and a sharper rise in 2 minutes as the slag appears. When the temperatures are determined at the top, middle, and bottom of a stream of steel and slag, the top of the steel is cooler than the bottom by about 15° , except when the metal is deoxidised in the ladle, in which case the top is hotter by 5° or 10° ; the bottom of the slag is always hotter than the top by about 5° . All these temperatures are remarkably concordant in many determinations, but uncorrected. Assuming an emissivity of 0.50 for the steel and making measurements with red light of $\lambda = 0.70 \mu$, the following apparent (and corrected) temperatures have been found: Centre of hearth, 1600° (1704°), centre of roof 1585° (1607°), tapping side wall 1625° (1732°), port block where gas last entered 1645° (1755°), exit port block 1635° (1745°), surface of bath before tapping 1625° (1754°). As regards thermal losses there is a sharp drop in the readings when the clean surface of the steel in the ladle is compared with the stream flowing from the tap hole; but once the steel has been covered by its protecting layer of slag, after five minutes, the thermal losses rapidly diminish.

TEMPERATURE DETERMINATIONS OF LIQUID STEEL.

BY W. MCCANCE.

In controlling the temperature in an open-hearth furnace the Siemens optical pyrometer is used, but it is difficult to keep the milliamperemeter constant, and this therefore requires frequent standardising. Testing a heated object by means of a thermo-couple and the optical pyrometer with different screens, the following differences were observed: thermo-couple, 1188°C ; Siemens optical, 1186° ; using three Wratten screens 750°C . In other recent tests of three new instruments, readings on the same opening (black-body conditions) have given in the three cases the values: correct, 15° low, and 20° low, the comparison standard being a thermo-couple. As regards the temperature inside an open hearth, the apparent temperature recorded by the optical pyrometer is the true temperature plus an amount which will depend upon the temperature of the flame, the uniformity of the furnace walls, and the reflective emissivity of the slag surface, all insufficiently known. As it is not advisable to shut off the furnace every time a determination is taken, it was decided that the best places to focus the instrument² on were the slag surface opposite the

port that the gas was entering and the furnace roof immediately above it. At first widely varying temperatures, 1500° to 1700°C . and over, were recorded. Towards the end of the operation, when the slag was thickening up, seems to be the time when there is the greatest tendency to put more heat into the furnace than the brick-work could stand. Ultimately it was found that the temperature could, by means of temperature observations, be kept between fairly close limits running from about 1630° to 1650°C . apparent temperature, with advantage to the life of the furnaces. When the metal is running out of the furnace, the observer should stand to the windward of the stream to avoid smoke; the diameter of the stream is also of influence, but that is generally within the limits of experimental error, as are also the differences in different parts of the stream. For practical purposes an accuracy of $\pm 5^\circ$ is all that is required. The presence of carbon, manganese, and chromium alters the apparent temperature of the steel, probably by altering the emissivity. An average apparent temperature of liquid steel is 1500° which, accepting Burgess' doubtful value for the emissivity of iron 0.40, gives a true temperature of about 1600°C ; casting temperatures below that figure are considered as cold heats. Although taking the furnace temperature seems to ensure that all casts will have the same degree of heat, other factors enter, of greater importance even than surface temperature. There is the amount of heat carried forward in the bottom of the hearth by the previous charge; the temperature of the bottom just before putting in the charge is no indication; as the surface is easily chilled by cold air from the door. The rate at which the charge has been melted, and the rate at which the bath boils also determine the heat put into the charge, and these problems have not yet been solved quantitatively. Flat surfaces of steel are always covered with slag or oxide which has a higher emissivity than the clean steel surface, and give too high readings; therefore the instrument should be focussed on a moving part of the stream of metal.

OPTICAL PYROMETRY IN NON-FERROUS METALS.

BY F. G. DONNAN.

When the radiation issuing from a hole is sighted, the conditions of "full radiation" (black-body radiation) are fulfilled, but when an open bath or stream of metal is observed, correction must be applied. In the case of molten copper and gold, the appearance of an open bath differs much more from full radiation than in the case of steel. The two metals have a strong selective reflection when cold not changing very much with temperature. The relation between selective emissivity and selective reflectivity is given by Kirchhoff's law: $E_1/E = A$, where E_1 is the emissivity of the substance, E the emissivity of a full radiator at the same temperature, and A the absorptivity—all for a particular wave-length λ . The quotient E_1/E , or absorptivity, may also be called "relative emissivity." If R is the reflectivity, then $E_1/E = A = 1 - R$. Plotting the E_1/E or A against λ (from 0.45μ to 0.7μ) and making temperature determinations by means of thermo-couples, a sharp discontinuity has been found in the emissivity at the melting points of copper, gold, and silver; liquid gold emits more in the red and yellow, and less in the blue, than solid, and the curves for the liquid and solid metals are quite different, but no temperature coefficient of relative emissivity has been discovered for the liquid metal over a range of 190°C . Similar relations hold for copper. Fused silver has a very low emissivity all through the range. The relation between

apparent temperature and true (black-body) temperature is not simple, and has to be referred to a definite wave-length λ ; the true temperature is that of a full radiator (black-body) emitting light of the same intensity as the substance. As the λ decreases from 0.784μ to 0.416μ , the black-body temperature of solid gold at its melting point rises from 891.5° to 1023.5° , and of the liquid gold from 931° to 1019° C. Similarly with copper; as the wave-length decreases from 0.7 to 0.5μ , the black-body temperature of the solid copper at its melting point rises from 896° to 1028° , and that of the liquid copper from 717° to 1026° C. The accepted thermo-couple melting-point of gold is 1063.2° , that of copper 1083.4° , and of silver 960.7° C. The experiments were conducted in reducing atmospheres; incipient crystallisation of the liquid and polishing difficulties of the solid are among the disturbing factors. The use of glasses, which are not monochromatic as assumed, probably accounts for the divergent observations of Burgess on copper. In using an optical pyrometer the light should always be observed at right angles to the surface, otherwise it will be polarised.

PYROMETRY FROM THE STANDPOINT OF FERROUS METALLURGY.

BY W. H. MATFIELD.

No ready and really reliable method for measuring temperatures at which steels are cast from the works standpoint is available. An optical pyrometer directed on to the slag, or on to the walls and roof of a furnace, will give indications of the temperatures of the areas sighted upon, but the author agrees with Burgess that there is no satisfactory relationship between the temperature of the furnace chamber and slag, and the metal lying in the hearth.

In experiments carried out with a number of heats, the optical pyrometer was sighted upon the steel running into the ladle, and in one instance the values obtained were about 1400° C. to 1410° C. A thermo-couple was also placed in position in the empty ladle prior to the steel being run in. As the steel gradually filled the ladle the temperature indicated by the thermo-couple increased until the couple was thoroughly immersed in the molten steel. The steel now was tapped from the ladle until the couple was quite free from the molten steel. A time-temperature curve was obtained in which a flat maximum range was observed, corresponding to the temperature of the steel whilst in the ladle. The values so obtained ranged from 1600° to 1625° C. With the thermo-couple method the freezing temperatures of steels have been industrially determined; with a 0.1% carbon steel the temperatures so obtained were 1480° to 1485° C., values in sufficient conformity with the present iron-carbon diagram.

For re-heating work platinum-platinum-rhodium thermo-couples in vitreous tubes are generally used at Sheffield University for temperatures up to 1100° C. The Cambridge optical pyrometer is also employed. This optical pyrometer gives results strictly comparable with thermo-couple readings when the steel body is in the furnace, but reads low when the object sighted upon is placed in the open air, owing to the black body conditions not being realised. If the conditions of the tests are kept consistent the readings from the optical instrument, whilst they must be checked by transposition to absolute temperatures, yield a ready means of checking temperature in such works operations. If considerable care is exercised the temperature of a mass of steel in the furnace will be recorded as 60° to 100° higher than the temperature of the same mass of steel when taken outside the furnace.

Determination of the temperatures of steel bodies undergoing forging and rolling operations presents another interesting problem. In forging, particularly, the hot body has a large area in intimate contact with the large masses of steel forming the hammer and die, and as the body is rotated during the forging operation the outside becomes considerably cooled.

Whilst the thermo-electric pyrometer forms an accurate, convenient, and easily adjustable instrument for use in annealing operations, sufficient attention is not always given to the manner in which the couple is placed relative to the steel. Either an optical pyrometer intelligently used or a properly standardised platinum-platinum-rhodium thermo-couple is adequate. Silver-constantan and nickel and nickel-chrome couples may safely be employed in low temperature work.

The following results for thermal conductivity have been obtained by supplying a known amount of heat at the centre of a bar 1 cm. in diameter, the ends being kept at a constant low temperature, and the temperature gradient measured. The fall of temperature along the bar was measured by copper-eureka thermo-couples. These results are at room temperature over a range of 10° C. to 40° C., and the electrical conductivities are given for comparison.

Material.	Relative thermal conductivity.	Relative electrical conductivity.
Wrought iron	100.0	100.0
0.9 % carbon steel, as rolled ..	65.3	58.4
25 % nickel steel	25.6	12.25
Air-hardening nickel-chrome steel, as rolled	40.6	34.5
High-speed steel, as rolled ..	38.0	36.2
High-speed steel, hardened ..	28.8	17.2

It has been suggested that the ratio between the two conductivities should be constant at a given temperature, and increase in proportion to the absolute temperature. Experiments by Jaeger and Dieselsdorff show that the relation is only very approximately satisfied in a comparison of different metals. The above figures emphasise this and indicate only rough agreement among different kinds and conditions of steel.

A NEW TYPE OF THERMO-COUPLE.

BY F. ROGERS.

The author described a thermo-couple the ends of which have refractory material moulded around them and in firm contact with the end of the sheath. The wire-ends are not united to a hot junction, but were placed in contact with the molten metal. A steady reading is instantly obtained, and the pyrometer can be withdrawn before the stem is damaged by the heat. The tip is alone heated to the temperature to be measured; possibly the wires melt or alloy with metal over a length of $\frac{1}{16}$ in., but the electric circuit remains continuous. The air enters the sheath near the head and blows out through holes a little above the end; the cold-junction trouble is avoided by placing the cold-junction inside the sheath near the air-blast inlet. The following temperatures have been calculated from the resistance ratios: solidification of cobalt-chrome high-speed steel in crucible, 1530° C.; solidification of copper in open furnace, 1062° ; temperature in a 70-ton open-hearth steel furnace during melting down, 1450° C. In these trials the end of the pyrometer was actually immersed in the metal, for $3\frac{1}{2}$ minutes in the last case, in which the stem was 9 ft. long, air-cooled, and clad with heavy clay sleeves.

Immersion of the pyrometer tip for from 2 to 10 seconds is sufficient and a layer can be ground off the tip if contamination is suspected.

THE MEASUREMENT OF HIGH TEMPERATURES BY MEANS OF POTTERY MATERIALS.

BY H. WATKIN.

The discovery that the contraction of pottery materials which takes place during the firing could be conveniently measured was made by Josiah Wedgwood in 1772. The Wedgwood pyrometer, based on the principle of the contraction of clay under the influence of heat, was then probably the best instrument in existence for the measurement of high temperatures. Its usefulness, however, was limited to the degree of heat needed to bring about the maximum contraction of the clay or body used for the test-pieces; nevertheless, as this temperature was much higher than the English potters then required, it was negligible from the potter's point of view. In recent years it has been considerably improved, first, in the materials of which the test-pieces are made; second, in the form and method by which they are made; and third, in the instruments by which the test-pieces are measured.

An improvement has been effected by the adoption of a round disc made under pressure from steel tools, with a hole through the centre for the purpose of being readily withdrawn by an iron rod during intervals of firing, and made of materials which contract progressively and regularly through a much wider range of temperature. The steel gauge used for these pieces is made in such a manner as to measure accurately to $\frac{1}{100}$ in., and also shows the percentage contraction of the piece corresponding to this.

Buller's trial-rings are also based on the principle of the contraction of clay. This system, which has been adopted by all the leading potters throughout Great Britain, consists of a specially made clay ring, measuring $2\frac{1}{2}$ in. in diameter. As the ring contracts during the different stages of firing, the changes as shown on the gauge are noted on special charts provided for the purpose, and a practical guide and check upon the firing is thereby obtained.

In 1826 Voight and Light perceived the advantage of observing the fusibility of pottery materials. They made a series of mixtures of china clay, felspar, and lime, etc., with different softening-points, made up into cones, which distorted in such a manner as to be easily observed when they reached certain temperatures. In 1886 Seger made a series of cones having melting-points from 1150° to 1390° , which he numbered 1 to 35; these were subsequently increased by Cramer, who produced a series with lower melting-points from 590° to 1130° , and which were numbered 022 to 01. These cones were introduced to the English potters about 1892, and about 1898 they were made in England for the first time by Messrs. Holderoft and Co., who made the mixtures up into bars instead of cones, which, suitably suspended in a refractory cage, are more easily read or observed by the sagging which takes place during firing, unlike the Seger cones, which sometimes lean in the direction of vision, and consequently the distortion is concealed.

A still further use was made of this principle by the introduction of heat recorders and discoverers by the author in 1899. The recorder is simply a block of very refractory ware, with five circular recesses sunk into its top face. In these recesses are placed little pellets of fusible materials of definite composition and melting-point. The fusion-point of each mixture has been determined by comparison with a standard electrical pyrometer. While specially designed

for simply recording temperatures attained in parts of ovens, etc., inaccessible to observation, the recorders may also be used with advantage as pyrometers. They have proved very useful as such to many industries, including pottery and porcelain manufacture, brick-tile making, gasworks, glassworks, annealing furnaces, smelting furnaces, rolling mills, enamellers, etc. By the use of these the firing-points of the pottery and porcelain manufacture, both at home and abroad, were obtained, and are given in a table which was published in 1902.

All the colours, golds, lustres, etc., usually fired in enamel kilns, are fired at temperatures below 910° C. Many of these are fired up at 690° to 730° , and if taken to about 800° are faulty or completely spoiled. A coral red colour which was good at No. 3 to 4 recorder= 670° to 690° , was faulty at No. 5= 710° C., and completely spoiled at No. 6= 730° C.; the bright gold usually called liquid gold was not fastened on the glaze by the fire at No. 2= 650° , was good at No. 3= 670° , hard at No. 4= 690° , and spoiled at No. 5= 710° , etc. Hard glaze kilns for tiles are usually fired up at below No. 19= 1020° C., and glost ovens below No. 23= 1100° C. The effects of temperature on the colour given to a glaze by certain metallic oxides show how important it is that these points should be known with accuracy. Thus, an orange-red glaze produced by uranium oxide at 950° C. is turned to a brown at 1050° C.; a purple glaze produced by manganese at 950° C. is turned to a brown at 1050° C.; a red-brown glaze produced from chromium at 950° C. is turned into a green at 1050° C.; a turquoise glaze produced from copper at 950° C. is turned into a green at 1050° C.; a yellow glaze from chromium at 950° C. is turned into a green at 1050° C.; a black glaze produced from iridium at 950° C. is turned into a grey at 1050° C.

All these forms of pyrometer based on the principle of the softening-points of ceramic mixtures are very extensively used for industrial operations where high temperatures are necessary. They have, however, a serious limitation, since they do not register the length of time at which the temperature remains at any particular point during the firing.

BASE-METAL THERMO-ELECTRIC PYROMETERS.

BY C. R. DARLING.

Base-metal couples possess distinct advantages, one of which is the development of an e.m.f. several times as great as that given by a Le Chatelier couple of platinum and platinum-rhodium alloy, which enables more robust indicators and recorders to be used, or a more exact reading to be taken over a given range. Another is that the pyrometer itself may be strongly constructed. Although inferior to the Le Chatelier couple with respect to the temperature range over which they may be used—the upper limit being 1000° C. for continuous use—base-metal couples still enable temperatures to be measured which comprise many industrial processes, such as hardening, tempering, and annealing, and have proved satisfactory in practice for such purposes.

The couples commonly employed are iron-constantan; two iron-nickel alloys of different composition; and two different nickel-chrome alloys, known as Hoskins' alloys. In some cases iron alloys containing aluminium are also used, the couples chosen being such as to yield a relatively high e.m.f., increasing uniformly with temperature. Some of these alloys tend to change on heating continuously, in such a manner as to alter the e.m.f. of the couple. This danger may be reduced to a minimum by the careful selection of the alloys used, and due care in their manufacture. Pro-

longed heating near the limiting temperature appears to affect all alloys, even those of platinum and rhodium, and thermo-electric stability can only be ensured when the common working temperature is well below the limit to which the couple may be used for an occasional reading.

Up to the present, no base-metal couple has been brought into use capable of being used continuously at temperatures above 1000°C. ; and it has consequently been necessary to use a Le Chatelier couple, or a different type of pyrometer, for higher ranges of temperature. The author suggests a means of extending the range over which base-metal couples may be used, by utilising the e.m.f. developed by a junction in which one or both of the metals may be in the liquid state. As shown below, the boiling-points of many common metals are sufficiently high to indicate that a temperature of at least 1500°C. might easily be read by the aid of liquid couples:—Al 1800° , Ag 1955° , Sn 2270° , Cu 2310° , Ni 2330° , Fe 2450°C. Investigation indicates that in general the thermo-electric properties are unaffected by fusion, and that a temperature-e.m.f. curve shows no discontinuity at the fusion point. Exceptions to this rule are furnished by bismuth and antimony, both of which show an abrupt bend in the curve at the melting-point. Generally speaking, however, change of state from solid to liquid does not affect the thermo-electric properties, and it would therefore appear possible to measure temperatures by the aid of fused couples, and that all that is necessary to apply the method in practice is to produce a working pyrometer on these lines.

To test the feasibility of such a pyrometer, a graphite block was made with two holes drilled into its upper surface so as to contain the ends of two silica tubes, down which slack-fitting rods of the metals forming the couple were passed so as to make contact with the graphite block. When one of the elements was known not to fuse at the temperature employed, it was threaded at the end and screwed into the graphite to make a sure contact. The arrangement was inserted in the tube of an electric furnace; and on fusion of one or both of the elements the circuit was maintained, the liquid portion in the furnace being continuous with the solid part outside. The ends of the metals were connected to a millivoltmeter by wires of the same material, and readings of e.m.f. taken at various temperatures measured either by a calibrated thermal couple or a radiation pyrometer sighted on the lower end of the graphite block; the latter serves to prevent the mixing of the fused metals, and the e.m.f. developed is the same as if the metals were actually in contact. At present results up to 1000°C. only are available, this being the limiting temperature of the furnace used, but the regularity of the increase in e.m.f. with temperature with a number of couples would appear to justify the assumption that the method might be used up to 1500°C. , or even higher. This arrangement has proved satisfactory for experimental work, and no great difficulties are anticipated in designing a workshop pyrometer on these lines.

REMEDIAL CAUSES OF UNRELIABILITY ENCOUNTERED IN THERMO-ELECTRIC PYROMETRY, ESPECIALLY IN SYSTEMS OF THE BASE-METAL TYPE.

BY G. E. M. STONE.

A reliability within 10°C. can often be obtained

in base metal thermo-couples; but when more than one instrument is in use, combined with various recording instruments, readings fairly correct at first, may fluctuate by 50° after a few hours. The non-homogeneity of the materials is a first serious obstacle to the working of such couples. Iron-constantan couples which are much in use, fail owing to particular changes at the critical points, and when the furnace temperature is not uniform or the rates of heating and cooling are varied, the readings fluctuate. It is the same with nickel. Owing to this want of homogeneity the "cold-junction error" is quite an uncertain quantity as well, and that cannot be cured by compensating leads.

In fire-rods, in which one element of the couple surrounds the other in the form of a tube, two faults are often noticed at an early stage. The central wire is electrically welded to the tip of the tube; the two materials have different expansion-coefficients, and the friction between the insulating sheaths of fireclay or porcelain and the wire is often sufficient to force the tips out from the weld. Secondly, the central wire is frequently overheated during the welding and turns spongy and mechanically weak. A cure can be effected by adopting small beads of fireclay for the insulation. A common fault of all couples (not only of base-metal) is that the ohmic resistance of the two parts is not rigorously the same. The principal source of error is that the terminal resistance of the measuring instrument is made too small. In such a case an imperfect contact, a little dirt getting between the contacts at the heads of the fire-rods, or between the prongs of an electric switch, an addition to the length of the leads by a few inches, wires getting locally hot by radiation from the furnace or by lying on the ground, may set up appreciable errors. When the total resistance of the pyrometer is about equal to that of the recording instrument, an increase of the connection resistance by 0.12 ohm may lower the reading by 15°C. Warping wooden bases for instruments and their leaning against masses of iron, which cause magnetic leakage, are other remediable causes of trouble; vertical needles with depressors bearing against pads, which vary in moisture, are also objectionable; hollows develop in the depressor and catch the needles, and the central holes of circular charts are not accurately punched. Again in concentric connection for the heads of fire-rods the central connection and its insulation are not always sufficiently secured.

The author exhibited a pyrometer of the stem pattern, the tube consisting of two parts; the lower portion is a silica tube closed below; the upper portion an open brass tube, the junction being effected by means of slots and set screws for adjusting the design. The rod inside the tube is also two-part; the lower portion consists of fused silica, the upper of an iron rod; the silica rod is cemented into the junction piece, which is slotted to allow for expansion; the iron emerges through the cap of the tube and is joined above to a lever. The silica rod rests on a mass of metal or alloy (the charge) placed in the bottom of the silica tube, the metal being the same as that which is to be melted in a crucible. The stem is inserted into the crucible, and when the metal there fuses, the charge in the stem also fuses and the rod in the stem sinks, forcing the lever up. To prevent the silica rod from being caught by the solidifying charge, the lever is pressed by a spring catch into a recess and held there; the charge thus solidifies level and the instrument is ready for re-use. A sheath is pushed over the lower end of the stem to prevent contamination of the silica tube with clay.

Obituary.

GEORGE THOMAS HOLLOWAY.

The death of G. T. Holloway on October 24th deprives this Society of a member who had been for many years closely connected with its activities in several directions. He served on the Publication Committee since 1907, attending the meetings regularly until ill-health prevented this. He was also Chairman of the London Section from 1912 to 1913.

Born in Battersea on October 19, 1863, he received his early training at the Royal School of Mines. In 1884 he became Junior Assistant in Chemistry under Sir Edward Frankland and later under Professor (now Sir Edward) Thorpe. Two years later he commenced practice as a consulting metallurgist and assayer, in Chancery Lane, London, and in 1889 opened testing works at Limehouse for the examination of chemical and metallurgical processes and for treating ores on a small commercial scale. In 1910 he removed his laboratories and office to Limehouse, where additional premises were taken for necessary extensions.

From 1889 to 1897 he was an Assistant Examiner to the Board of Education and from 1912 to 1914 Examiner in Metallurgy to Birmingham University. In 1908-9 he served as Juror on the Metallurgical Sections of the Franco-British and Imperial International Exhibitions.

In 1915 Holloway was appointed Chairman of the Royal Ontario Nickel Commission, and to this work he devoted practically the whole

of his time during the last two years. This commission was appointed to enquire into and report upon the resources, industries, and capacities in connection with nickel and its ores in the province of Ontario. The Report of the Commission, issued during the present year, is a volume of over 800 pages, and testifies to the immense amount of work carried out by the Commission. It is generally acknowledged to the most valuable and complete monograph on the subject that has ever been printed (see this Journal, 1917, 490.)

In addition to his connection with this Society, already mentioned, Holloway was a member of the Councils of several other Societies, including the Institute of Chemistry, Institution of Mining and Metallurgy, Society of Public Analysts, and Chemical, Metallurgical, and Mining Society of South Africa. He was a very active worker on many Committees of these Societies, and also served on the Imperial Institute Advisory and similar Committees which were the outcome of the special conditions arising out of the War.

He made numerous contributions to technical literature, among which mention may be made of the paper before this Society on the Relations between the Chemical and Metallurgical Industries (this Journal, 1910, 53), which clearly shows his earnest desire for a closer co-operation between chemistry and metallurgy.

He assisted Sir Beverton Redwood in the preparation of the first edition of "Petroleum," and contributed several articles to the first and second editions of Thorpe's "Dictionary of Applied Chemistry."

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

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Patent number, date, name of patentee, and title of invention.

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Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

Hazardous chemicals [acids]; Packing and plant handling of.—N. A. Laury. National Safety Council, New York. Met. and Chem. Eng., 1917, 17, 407—408.

THE best method of safe and economical packing of one or two hundred pounds of corrosive liquid for transport is in wood-packed glass carboys. It is dangerous to empty carboys by means of compressed air as they are apt to burst. Breakage of carboys is often caused by partial crystallisation of the contents, for example, concentrated sulphuric acid or glacial acetic acid. Stoppers of carboys are often secured by coating with plaster of Paris and fastening down with cloth, but the shaking in transport causes splashing and the acid very soon attacks the plaster and causes it to crumble. The safest practical stopper is a glass or earthenware plate held in position by a wire clip. The plate is made to fit by grinding or using a rubber or asbestos washer. If this form of stopper is used care must be taken to leave an air space in the carboy, usually about 10%, to allow for increase of pressure due to variations of temperature. The greatest danger in handling carboys in wooden boxes arises from the sudden falling away of the bottom or sides of the box, owing to corrosion of the nails or weakening of the wood by acid, but this can be prevented by treating the wood with a preservative.—J. H. P.

Contact catalysis; Theory of.—W. D. Bancroft. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 16 pages.

A REVIEW of various facts and theories of catalytic action has led the author to regard the adsorption of one or more of the reacting substances by the catalyst as the determining factor controlling catalytic action, so that a solid catalytic agent may be considered as equivalent to a solvent and may therefore displace the position of equilibrium in the system. The general cognate conclusions are also drawn, that only substances which are adsorbed by a solid are catalysed by it, but that the catalytic influence of a solid may not in all cases result wholly from the increased surface concentration. As a result of selective adsorption, different catalysts may give rise to different reaction products and a catalytic agent will tend to produce the system which it adsorbs the more strongly.

—D. F. T.

Catalytic agents; Poisoning of.—W. D. Bancroft. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 26 pages.

THE various cases of the poisoning of catalysts are discussed, e.g., in the Deacon process for chlorine, the Haber ammonia process, the Sabatier process for hydrogenating oils, and the effect of platinum on the decomposition of hydrogen peroxide and on other reactions. The question of the adsorption of gases by the catalyst is considered

and it is pointed out that, as contact catalysis involves adsorption (see preceding abstract), a decrease in this adsorption, due to the presence of a film of solid, liquid, or gas on the catalyst, will cause a reduction in the reaction velocity; the action of "poisons" on catalysts is believed to be exerted in this manner by the occurrence of such an adsorption process which interferes with the normal adsorption of the reagents; this normal adsorption may also be affected by the reaction-products, the presence of which may, therefore, also cause a decrease in the reaction velocity, as indeed is the case in the combination of carbon monoxide or sulphur dioxide with oxygen in the presence of platinum. The influence of mercuric cyanide and other "poisons" on the catalysis of the decomposition of hydrogen peroxide by platinum is due to selective adsorption of the "poison" by the platinum; the action of mercuric cyanide in decreasing the electrolytic oxidation of sodium thiosulphate at a platinum anode is probably due, at least in part, to reduction of the adsorption of the thiosulphate by the anode. The effect of fluoride ions, chloride ions, etc., in increasing the over-voltage at a platinum anode is attributed to a diminution of the activity of the metal of the anode in accelerating the conversion of atomic oxygen into the molecular condition.—D. F. T.

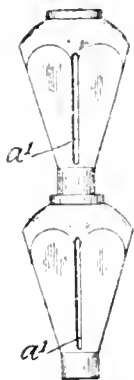
The sub-station problem of electrochemical plant. Yardley. See XI.

PATENTS.

Fractional distillation of liquids, washing of gases by liquids, and cooling of gases and liquids [; Filling material for apparatus for —]. G. E. Darier, Chêne, Switzerland. Eng. Pat. 104,163, Dec. 14, 1916. (Appl. No. 17,994 of 1916.) Under Int. Conv., Jan. 29, 1916.

CLOSELY wound coils of wire, rod, or thread of metal, glass, or other suitable material are used as a filling for apparatus for the fractional distillation of liquids, washing of gases with liquids, etc. The drops of liquid which collect on the coils extend by capillarity between adjacent convolutions and wet their outer and inner surfaces so as to form in the case of each coil a cylinder with continuous liquid walls.—J. H. P.

Packing or filling for absorption, recovery, or scrubbing towers or the like. W. Oates, Leeds, and E. B. Robinson, Newcastle-on-Tyne. Eng. Pat. 109,915, Jan. 23, 1917. (Appl. No. 1107 of 1917.)



HOLLOW packing pieces are so constructed that the bulk of the absorbing or scrubbing liquid passes through lateral slots in the pieces in one row into the interiors of the pieces of the row next below. The accompanying figure illustrates a section of such filling material, the slots being shown at *a'*. The lower ends of each section are open; the upper ends may be open or closed.—W. H. C.

Desiccating liquors containing matter in solution or suspension (milk and the like); Means for —. H. C. Booth, London, J. L. Baker, Maidenhead, and Solva Ltd., London. Eng. Pat. 109,471, Sept. 11, 1916. (Appl. No. 12,829 of 1916.)

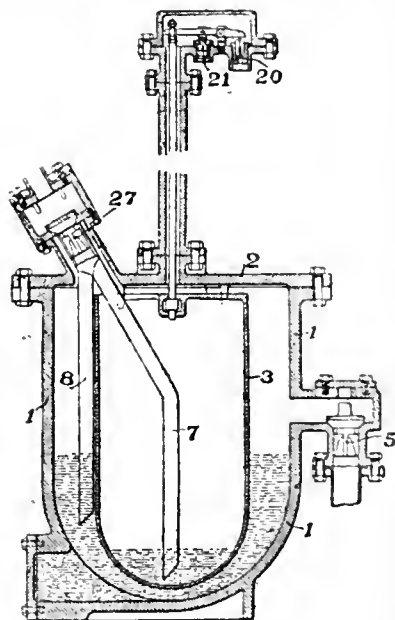
THE liquid is sprayed downwards into a drying

chamber by a jet operated by compressed air, and fixed centrally in a supply pipe for heated air. The hot air and atomised liquid enter a bag filter within the drying chamber. The air and moisture pass away through the bag, and the solid particles are caught by the fabric and fall into a receptacle at the bottom, when the bag is periodically shaken. The liquid enters the jet by a central pipe which is surrounded by the compressed air pipe. The two pipes are so connected together by means of a stuffing-box, that although the central pipe is left free to expand, the relative positions of the nozzles are not affected. By adjusting the compressed air nozzle vertically with respect to the liquid nozzle, the fineness of the spray, and hence the size of granules produced, may be controlled.

—W. H. C.

Elevating or lifting apparatus for acids or the like. T. Bradbear, Birmingham. Eng. Pat. 109,522, Oct. 30, 1916. (Appl. No. 15,425 of 1916.)

THE liquid enters the vessel, 1, through the non-return valve, 5, and fills the space outside the float, 3. The float rises, opens the air escape



valve, 21, and closes the compressed air inlet valve, 20. When the space outside the float is filled, the liquid overflows into the float so that it sinks and reverses the valves. Compressed air then enters and forces the liquid through the pipes, 7, 8, into the rising main through the non-return valve, 27. The pipe, 7, dips relatively lower into the acid in the float than the pipe, 8, does into the acid in the surrounding space, so that some liquid is always left in the outer space. When the float is empty it rises and reverses the valves, so that the operation begins again.—W. H. C.

Drying and aerating machines. J. A. Sparks, C. E. and W. M. Clark, Elk City, Kans., U.S.A. Eng. Pat. 109,595, Aug. 8, 1916. (Appl. No. 8780 of 1917.)

THE shaft of the machine described in Eng. Pat. 108,520 of 1916 (this J., 1917, 996), is provided with a thrust collar supported on co-acting bearing rings, having ball bearings or other anti-friction devices between them and contained in a casing.

—W. H. C.

Drying materials in sacks or the like; Apparatus for —. H. P. Dinesen, Herlev, Denmark. Eng. Pat. 109,965, July 30, 1917. (Appl. No. 10,934 of 1917.) Addition to Eng. Pat. 100,697 (this J., 1916, 915).

A SACK containing the material to be dried, e.g., corn or seeds, is supported in a frame over an air shaft. Hot air may be either drawn through the sack into the shaft or blown from the shaft through the sack. The grating on which the sack rests may be arranged to hold sacks of any size.

—J. H. P.

Treating and cooling air and gas; Apparatus for —. Heenan and Froude, Ltd., and L. Cruyt, Manchester. Eng. Pat. 109,648, Sept. 19, 1916. (Appl. No. 13,260 of 1906.)

THE air is passed through a casing in which annular rotating deflectors are either partly immersed in liquid or sprayed with liquid. The deflectors consist of a number of curved blades so formed that the liquid is spread as a film over the blades and is not atomised. Cooling drums, as described in Eng. Pat. 11,183 of 1911, may be arranged alternately with the deflectors, and the outlet of the casing is provided with an annular rotary eliminator against the blades of which the air strikes and deposits its moisture.—W. H. C.

Heating water or other liquids; Apparatus for —. H. Hocking, Liverpool. Eng. Pat. 109,926, Feb. 12, 1917. (Appl. No. 2069 of 1917.)

THE apparatus comprises two sets of U-tubes, one on each side of a vertical partition in a casing and fastened to a tube plate. Low-pressure steam is passed through the casing and the liquid to be heated through the tubes.—W. H. C.

Drying, mixing, and grinding apparatus. G. Calvert, London. Eng. Pat. 109,838, Sept. 26, 1916. (Appl. No. 13,643 of 1916.)

IN apparatus similar to a ball mill, the grinding chamber, which may be of stoneware, is made independent of, and is clamped to, the rotating frame which carries the hollow trunnion and rotating gear. The grinding chamber has an opening which registers with the hollow trunnion, and the latter has an extension provided with a brush for clearing the passage.—W. H. C.

Grinding or crushing pan mills. J. Twaddle, Coatbridge. Eng. Pat. 109,855, Oct. 9, 1916. (Appl. No. 14,306 of 1916.)

A PAN mill in which the pan rotates about a central axis whilst the rolls revolve upon a horizontal shaft, is provided with a scraper resting on the bottom and held in position by two pins which are fixed to a bracket and project downwards into two corresponding holes in the scraper. The bracket is preferably attached to an upper cross rail or angle iron in such a manner that the position of the scraper can be adjusted.—W. H. C.

Compressors for ice making or refrigerating machines. K. Lightfoot, and The Lightfoot Refrigeration Co., Ltd., London. Eng. Pat. 109,851, Apr. 2, 1917. (Appl. No. 14,032 of 1916.)

THE compressor is directly coupled to the engine and is operated at a high speed, the valves being operated positively by springs and tappets.

—W. H. C.

Impregnating liquids with carbonic acid or other gases; Apparatus for —. A. A. Pindstoffe, Copenhagen, Denmark. Eng. Pat. 109,958, June 21, 1917. (Appl. No. 8950 of 1917.)

THE impregnating chamber has a sliding valve connected to the liquid-supply pipe and actuated by a regulating device placed in the impregnated liquid in the lower part of the apparatus. A

number of pipes lead from this valve to compartments from which the incoming liquid flows down in thin films along wires, chains, gauze or the like, and meets an ascending stream of carbon dioxide. The impregnated liquid is collected in the lower part of the chamber.—J. H. P.

Impellers or fans; Earthenware —. Kestner Evaporator and Engineering Co., Ltd., J. A. Reavell, and W. G. Mann, London. Eng. Pat. 110,025, Oct. 5, 1916. (Appl. No. 14,171 of 1916.)

THE boss of the impeller is provided with a central conical opening which fits upon a corresponding conical portion on the shaft, the taper in both cases being of the order No. 5 Morse. The shaft is fitted with a collar, and the impeller is fixed to the shaft by means of a metal bearing-plate at the front of the boss and draw bolts connecting the plate and the collar and passing through slots in the boss. The free end of the shaft may be provided with a tongue which enters a slot in the bearing plate.—J. H. P.

Mixing-machine. G. A. Welzenbach, Peoria, Ill. U.S. Pat. 1,240,274, Sept. 18, 1917. Date of appl., Apr. 18, 1917.

A TILTING mixing hopper provided with an agitator is mounted on a frame, which also carries two shafts. One of the shafts is driven by external gear and the second shaft is driven from the first by gear operated by a clutch. By means of clutch gear one shaft drives the agitator and the other the tilting mechanism, each being operated independently.—W. H. C.

[Gas] filtering apparatus. G. S. Brooks and L. G. Duncan, Depue, Ill., Assignors to New Jersey Zinc Co., New York. U.S. Pat. 1,240,305, Sept. 18, 1917. Date of appl., Nov. 1, 1916.

A BAG, connected with a flue through which the dust-laden gas to be filtered is supplied to the bag, is provided with external mechanical means, operating at several points, for shaking the bag by causing it alternately to collapse and expand, to detach the collected particles.—W. H. C.

Leaching apparatus. L. C. Trent, Los Angeles, Cal. U.S. Pat. 1,240,904, Sept. 25, 1917. Date of appl., Aug. 24, 1914.

A RECEIVING vessel is provided with a filter bed at the bottom covering a vacuum chamber which is connected to the suction of a pump, and the liquid withdrawn is returned under pressure through a rotary agitator in the vessel. Liquid may also be forced by the pump in the reverse direction through the filter bed. A discharge outlet is also provided in the receiving vessel for the withdrawal of settled tailings.—W. F. F.

Separation of liquids from solids; Process of and apparatus for the continuous —. H. C. Behr, New York. U.S. Pat. 1,241,905, Oct. 2, 1917. Date of appl., Aug. 13, 1914. Renewed Mar. 26, 1917.

COMPRESSED air is supplied by a fan through a hollow shaft to air chambers within a pulley having a perforated rim with annular flanges. A travelling foraminous belt wider than the pulley passes round it, and mixed liquid and solid is fed between the pulley rim and the band so that it is carried round in a thin layer. The liquid and solid are separated by the combined action of the compressed air and centrifugal force.

—W. F. F.

Gas filtering apparatus. New Jersey Zinc Co., New York, Assignees of G. S. Brooks and L. G. Duncan, De Pue, Ill., U.S.A. Eng. Pat. 109,742, Mar. 9, 1917. (Appl. No. 3516 of 1917.) Under Int. Conv., Nov. 1, 1916.

SEE U.S. Pat. 1,240,305 of 1917; preceding.

Grinding-mill. E. F. McCool, Assignor to The McCool Mfg. and Trading Co., Victor, Colo. U.S. Pat. 1,241,749, Oct. 2, 1917. Date of appl., Dec. 16, 1913.

SEE Eng. Pat. 19,982 of 1911; this J., 1915, 1077.

Method of sealing glass bulbs [containing a gas in solution]. U.S. Pat. 1,241,229. See XVIII.

Digesters [for boiling materials under pressure]. Eng. Pat. 110,015. See XVIII.

IIA.—FUEL; GAS; MINERAL OILS AND WAXES.

Vertical [gas] retorts; Experiments on steaming in continuously operated —. J. E. Blundell. Manchester District Inst. Gas Eng., Oct. 27, 1917. Gas J., 1917, 140, 213—217. (See also this J., 1917, 860.)

THE experiments were carried out at an installation of Glover-West vertical retorts at Macclesfield, of a normal capacity of one million cubic feet of coal gas per 24 hours. The productive capacity has been increased 20% by passing steam into the charge in the retort, the yield of tar and ammonia being also improved. The plant was already provided with means for admitting a moderate amount of steam to the coke chambers during the discharging operations, and by modifying the conditions water-gas could be made *in situ*, thus obviating the inconvenience of a separate "blue" water-gas plant, with its attendant fluctuations in quality of gas produced, etc. The heating arrangements were altered by a readjustment of the waste gas and secondary-air dampers, and the settings were worked with a minimum amount of chimney draught. The rate of travel of the products of combustion through the chambers was retarded. The temperature in the lower combustion chambers was raised to between 1300° and 1400° C., and in order that the body of coke should be sufficiently heated for the water-gas reaction, the speed of extraction of the coke was reduced by about 10%. Chimney dampers and waste-gas dampers had to be cleaned regularly or the heat dropped sufficiently to increase the CO₂ content of the gas. The temperature of the gas in the off-take pipe was 200° C., in the gas-collecting main 95° C., and at the outlet of the retort-house governor 70° C. The pressure of steam varied with the different classes of coal, a hard, dense coke requiring a greater pressure of steam than a more open and friable one. Steam from Lancashire boilers at 100 lb. pressure was supplied by passing it first through a reducing valve and then through a nozzle of 1-inch bore. The following results are given, for the ordinary method and for the new method with steaming. Cub. ft. gas per ton at N.T.P., 12,049 and 15,358 respectively. Gross calorific value, 530 and 509 B.Th.U. per cub. ft. Total incombustibles, 10.7 and 10.9%. Coke made per ton of coal, 13.6 and 13.36 cwt. Analysis of gas collected over 24 hrs. gave the following results: CO₂, 2.9; C₂H₆, 2.2; O₂, 0.2; CO, 13.9; CH₄, 22.8; H₂, 53.23; N₂, 4.77%. Calorific value of coke, 12,700 B.Th.U. per lb. Liquor (10-oz.) made 25.3 galls. and 32.68 galls., tar 10.9 galls. and 16.61 galls. under the old and new conditions respectively. The tar under the new conditions was of better quality, showing an increase in benzol, toluol, naphtha, creosote, etc., and a decrease in pitch. Steaming does not appear to have exercised a very deleterious effect on the material of the retort. No doubt more fuel is consumed when producing water-gas, an approximate estimate being an addition of 1 lb. of coke per 100 lb. of coal carbonised. The loss in coke for sale per ton of coal is made up as follows:—

Carbon converted into water-gas in the retort, 25 lb.; extra fuel supply to the producer to effect the water-gas reaction, 25 lb.; fuel supply to boilers to generate steam, 24 lb.; total, 74 lb. The saving effected by steaming on an annual output of 200 million cu. ft. is given as 30% in cost of coal, and in weight of coal as 3577 tons.

—J. E. C.

Combustion; Fractional —. W. D. Bancroft. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 10 pages.

THE present knowledge of the relative rates of combustion of various gases, especially in the presence of catalysts, is reviewed, reference being made to the work of Henry, Hempel, Bone, Landolt, and Calvert. The following are some of the conclusions drawn. At low temperatures the nature of the catalyst may determine which of two combustible gases will burn more rapidly; in the presence of platinum, hydrogen burns more readily than methane or ethylene; in the presence of copper oxide at 250° C. all the free hydrogen, in a mixture of this gas and methane, can be burned without the decomposition of any of the methane; in the presence of fireclay ["chamotte"] at 500° C. hydrogen burns more readily than methane; in borosilicate glass bulbs at 300°—400° C., methane, ethane, ethylene, and acetylene undergo oxidation much more rapidly than hydrogen or carbon monoxide. The relative rates of combustion of hydrogen and carbon monoxide depend on the conditions, and in a mixture of methane and oxygen with hydrogen or carbon monoxide exploded by an electric spark, the methane burns more rapidly than either hydrogen or carbon monoxide. By suitable selection of the catalyst with a mixture of methane, hydrogen, and oxygen, it should be possible to obtain all intermediate stages from complete combustion of methane to that of hydrogen, and it appears probable that in the absence of solid catalysts and at high temperatures methane burns more readily than hydrogen. At very high temperatures, also, the specific effect of the solid catalytic agent will become negligible.—D. F. T.

Oils and tars; Studies in the production of — from bituminous materials. J. C. Ingram. School of Mines and Met., Univ. of Missouri. Bull. No. 4, Vol. 3, May, 1917.

FOUR cannel coals (from Missouri and Illinois) and two bituminous coals were distilled in a horizontal gas-fired retort under similar conditions, the charge in each case weighing from 25 to 35 lb. The gas produced was measured and collected after passing successively through two condensers, and three gas-washers containing water. Tables are given showing the amounts of gas and oil (or tar) obtained, and the temperature of the retort, at half-hourly intervals during the tests. The oils obtained from the cannel coals were fractionated to yield gasoline (up to 150° C.), kerosene (150°—300° C.), and lubricating oil (above 300° C.), and coke. The bituminous coals yielded small quantities of tar (5.35 to 12.5 gall. per ton) composed of paraffins, olefines, aromatic substances, and a large proportion of bitumens. The cannel coals gave comparatively large amounts (28.1 to 69.7 gall. per ton) of oils, composed chiefly of liquid and solid hydrocarbons of the methane and olefine series, together with cresols and asphaltic bodies. The cannel oils averaged about 11% gasoline (similar to that produced commercially by the cracking process), 40% kerosene, and 40% lubricating oil containing 25% of solid paraffins. Maximum gasoline production was obtained by distilling between 450° and 550° C. Hard paraffin and kerosene were formed in largest quantity between 550° and 650° C., while above 650° C. soft paraffins, heavy oils, kerosene, and bitumens

were the main products. A yield of between 3500 and 8100 cub. ft. per ton of very rich gas was obtained from the canal coals, the time of maximum production being between the fifth and sixth half-hours. Only one sample gave a saleable coke.—T. St.

Action of coal gas on plants. III. Action of coal gas, whilst passing through soil or water, on roots and leafy branches. Wehmer. See XVI.

PATENTS.

Solid fuel. R. Bowen, Cheltenham. Eng. Pat. 109,995, Sept. 30, 1916. (Appl. No. 13,914 of 1916.)

IN the manufacture of an artificial fuel, the mixed materials are submitted to pressure between successive additions of the mixture, and are heated to form stratified blocks, the face of each layer being treated to prevent perfect adhesion; *e.g.*, it may be cooled by treatment with compressed air, a fine spray of water, or a suitable powder, or the successive layers may be separated by layers of hydrated lime, fine coke dust, etc.—J. E. C.

Fuel; Process for manufacturing —. J. Miller, Seattle, Assignor to N. and H. Krantz, King County, Wash. U.S. Pat. 1,241,648, Oct. 2, 1917. Date of appl., Apr. 18, 1916.

COMBUSTIBLE refuse is dried and ground into particles of substantially uniform size, and is then heated and mixed with crude oil (20 parts), pitch (20 parts), and a mixture of rosin, charcoal, and gasoline (10 parts to 50 parts of the refuse). The product is moulded into blocks.—W. F. F.

Gas generators; Device for preventing escape of gas from —. W. J. Mellersh-Jackson, London. From C. M. Stein et Cie., Paris. Eng. Pat. 109,933, Mar. 14, 1917. (Appl. No. 3716 of 1917.)

A MOVABLE member, adapted to be placed around or adjacent to a slice hole, is fitted with a nozzle and a flexible tube for supplying gaseous fluid under pressure, or a stream of gaseous fluid may be directed across the mouth of the slice hole to form a screen and to prevent escape of gas.—J. E. C.

Liquid fuels for firing furnaces and for high compression oil engines. G. E. Heyl, London. Eng. Pat. 110,023, Oct. 5, 1916. (Appl. No. 14,148 of 1916.)

MINERAL oil is treated with solid caustic alkali to neutralise any acids and to form compounds with any sulphur present. The oil is cooled to eliminate naphthalene, and then heated to promote the solution of pitch, which is added to the extent of up to 50%.—J. E. C.

Hydrocarbons; Combining liquid — to render them suitable as fuel when used in internal combustion engines. J. A. Stoneham, London. Eng. Pat. 110,132, July 10, 1917. (Appl. No. 9954 of 1917.)

PETROLEUM derivatives having a flash point above 120° F. (48° C.) and coal tar distillates having a flash point between 80° and 90° F. (27°–32° C.) are mixed, generally in equal quantities, and to the mixture is added about 25% of benzine, with or without 0.5% of ether.—J. E. C.

Hydrocarbons; Process of and apparatus for producing light —. J. E. Holmes, Cushing, Okla. U.S. Pat. 1,241,979, Oct. 2, 1917. Date of appl., Aug. 31, 1915.

MEASURED quantities of petroleum oil or distillate and natural gas are heated to a high temperature

in a retort which communicates with an expansion chamber, means being provided for maintaining a predetermined pressure in the retort, and for permitting the mixture to flow to the expansion chamber when this pressure is exceeded. A high pressure is developed by vaporisation of the oil, and the mixture is then caused to expand under adiabatic conditions, whereby the heavier constituents are condensed, thus permitting the separation of the lighter constituents by subsequent condensation.—T. St.

IIb.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

PATENTS.

Electrode; Arc light —. K. Tornberg, Lynn, Mass., Assignor to General Electric Co. U.S. Pat. 1,240,628, Sep. 18, 1917. Date of appl., Mar. 13, 1916.

ARC lamp electrodes are made by filling a conducting tube with a powdered mixture of barium peroxide and titanium carbide, and heating the top of the filled tube until oxygen is liberated from the peroxide to enter into exothermic reaction with the carbide. The action is propagated throughout the whole length of the tube, and the mass is then allowed to cool.—B. N.

Tungsten lamp; Incandescent —. E. Friedrich, Berlin, Assignor to General Electric Co., New York. U.S. Pat. 1,240,700, Sep. 18, 1917. Date of appl., June 11, 1913.

A SEALED lamp bulb is provided with a tungsten filament, and a solid inorganic compound containing oxygen, such as barium chlorate, which is placed in a position so as to be heated by the filament. The compound, at the temperature attained by the lamp, has an oxygen-dissociation pressure not greater than that of a first-class vacuum, thus maintaining an oxygen atmosphere at this pressure during the life of the lamp. The oxygen reacts with the vaporised tungsten to form solid and substantially transparent, non-volatile reaction products, which do not increase the pressure in the bulb.—B. N.

Distillation of materials containing cellulose; Process for the dry —. H. Von Hochstetter, Assignor to Holzverkohlungs-Ind. A.-G., Constance, Germany. U.S. Pat. 1,241,789, Oct. 2, 1917. Date of appl., Apr. 2, 1913.

SEE Fr. Pat. 455,345 of 1913; this J., 1913, 937.

III.—TAR AND TAR PRODUCTS.

Studies in the production of oils and tars from bituminous materials. Ingram. See IIA.

PATENT.

Naphthalene from [coal-tar] hydrocarbons; Process for removing —. G. E. Heyl, London. Eng. Pat. 109,836, Sept. 25, 1916. (Appl. No. 13,589 of 1916.)

AFTER the usual treatment of hydrocarbon liquids with dilute alkali, the bulk of the naphthalene is separated by cooling, and a quantity of concentrated or solid caustic alkali sufficient to neutralise the residual tar acids is added before or during distillation. When the alkali is added before distillation, the naphthalene separates on cooling or standing; when it is added during distillation the naphthalene separates in the condenser.—F. W. A.

IV.—COLOURING MATTERS AND DYES.

PATENTS.

Tetrazisazo dyestuffs; Blue—. Akt.-Ges. f. Anilinfabr., Berlin. Eng. Pat. 101,967, Oct. 5, 1916. (Appl. No. 14,170 of 1916.) Under Int. Conv., Oct. 22, 1915. Addition to Eng. Pat. 14,789 of 1915 (this J., 1916, 171).

1 MOL. of a diazotised naphthylaminesulphonic acid, other than 2-naphthylamine-4,8-disulphonic acid claimed in the main patent, or a diazotised aniline-sulphonic acid is combined with 1 mol. of a middle component, the intermediate product is diazotised and combined with 1 mol. of a second middle component, the product is diazotised and combined with 1 mol. of 2-amino-5-naphthol-7-sulphonic acid, and again diazotised and combined with 1 mol. of resorcinol. *m*-Toluidine, *p*-xylydine, 3-amino-4-methoxy-1-methylbenzene, 1-naphthylamine or its 6- or 7-sulphonic acid, 1-amino-2-naphthol ethyl ether or its 6- or 7-sulphonic acid, and 2-amino-5-naphthol-7-sulphonic acid are specially suitable middle components.—F. W. A.

Azo dyestuffs; Manufacture of new—and metal compounds thereof, and application of the dyestuffs and compounds in dyeing. O. Imray, London. From Society of Chemical Industry in Basle, Switzerland. Eng. Pat. 110,066, Dec. 19, 1916. (Appl. No. 18,206 of 1916.)

A DIAZO-COMPOUND of the benzene or naphthalene series (particularly an *o*-hydroxy-diazo-compound, a diazo-salicylic acid or other diazo-carboxylic acid) is combined with a condensation product of a phenol (particularly resorcinol) or a naphthol (particularly a dihydroxynaphthalene) with aceto- or oxalo-acetic ester. The mordant dyestuffs produced give fast dyeings on animal fibres, and may be after-chromed, etc., and give valuable water-soluble metal compounds with copper, chromium, etc., compounds.—F. W. A.

[*Dyestuffs of the anthraquinone series; Manufacture of condensation products*—. A. G. Bloxam, London. From Durand et Huguenin S.A., Basle, Switzerland. Eng. Pat. 110,042, Oct. 31, 1916. (Appl. No. 15,533 of 1916.)

SEE Ger. Pat. 294,447 of 1913; this J., 1916, 1214. The amino compounds specified are dialkyl-phenylenediamines having no substituent in one amino group.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Various modes of combination of methyl alcohol in plants. Determination of pectin- and lignin-methyl alcohol in roots. Von Fellenberg. See XIXA.

PATENTS.

Yarns; Apparatus for moistening—. R. Jacobi, Nijmegen, Holland. Eng. Pat. 109,686, Oct. 31, 1916. (Appl. No. 15,509 of 1916.)

THE cops or cheeses of yarn are secured on pins mounted on carriers placed in frames, which can be pushed into the yarn-moistening chamber; this chamber is so constructed that the end walls of the frames form closures for the chamber when they are either pushed in or withdrawn from it. Air is moistened by means of a "Jacobine," and distributed through the yarn in the chamber, either by pressure or vacuum induced through the water sprays.—J. F. B.

Woollen and other textile fabrics; Waterproofing of—. J. L. Wahnrow, London. Eng. Pat. 109,691, Nov. 8, 1916. (Appl. No. 16,003 of 1916.)

A SOLUTION consisting of powdered alum, 2 lb.; sugar of lead, 2 lb.; gum arabic, 2 oz.; powdered lime, 2 oz.; washing soda, 2 oz., and water, 18 quarts, is filtered; the woollen or other fabric is dipped in the solution and dried, preferably by heated calender rolls.—J. F. B.

Coating fabrics or materials; Apparatus for—. S. Davies, London. Eng. Pat. 110,050, Nov. 21, 1916. (Appl. No. 16,675 of 1916.)

THE material, supported on an endless band, is coated by passing against the opening of a transverse container holding the coating liquid and provided with a knife or scraper. The container may be movable, and the apparatus may also include a receptacle and scraper for the removal of coating agent which may pass on to the endless band after the material to be coated has passed through the machine. In addition, the apparatus may include suitable dressing devices for the preliminary treatment of the material.—D. F. T.

Fabrics; Solution for waterproofing—. T. C. James, Chicago, Ill. U.S. Pat. 1,240,345, Sept. 18, 1917. Date of appl., Sep. 30, 1914.

ONE part each of lead acetate and powdered alum are dissolved in 25 times their combined weight of water and 3/8 part of gum arabic dissolved in an alcoholic medium is mixed with the solution.

—J. F. B.

Sulphite cellulose; Method of preparing—. C. Bache-Wüg, Portland, Me. U.S. Pat. 1,240,920, Sep. 25, 1917. Date of appl., Nov. 7, 1914.

WOOD in small pieces is boiled in a solution of calcium, sodium, or magnesium bisulphite, and a small quantity of sodium chloride (e.g., less than 5%) is injected during the boiling.—F. SP.

Cellulose; Process of preparing solutions of—. Z. Ostenberg, San Francisco, Cal., Assignor to International Cellulose Co., Reno, Nev. U.S. Pat. 1,242,030, Oct. 2, 1917. Date of appl., Apr. 7, 1916.

CELLULOSE is treated with a mixture of a chloride and sulphuric acid of more than 60% concentration.—F. SP.

Pulp for papermaking purposes and the like; Apparatus for washing—. S. Milne, Edinburgh. Eng. Pat. 109,594, June 19, 1917. (Appl. No. 8778 of 1917.) Addition to Eng. Pat. 107,410 of 1916 (this J., 1917, 959).

THE principle of washing described in the original specification, which consists in passing the pulp over one side of a wire cloth while applying sprays of water to the other side, is adapted to the washing drum of a hollander. The trough of ordinary construction is provided with a washing drum covered with wire cloth. The inner end of the drum is closed, while the outer end is open and abuts against a flange fixed to the side of the trough, the joint being packed with suitable material. The drum is mounted on a hollow trunnion at the outer end and a water pipe passes through the bearing, from which sprays of water are directed against the inner periphery at the portion where it is in contact with the pulp. The waste water flows out through a drain outlet in the flange.—J. F. B.

Acetylcelluloses; Modifying—. F. Knoevenagel, Heidelberg, Assignor to Knoll und Co., Ludwigshafen, Germany. U.S. Pat. 1,241,995, Oct. 2, 1917. Date of appl., Jan. 29, 1913.

SEE Fr. Pat. 453,835 of 1913; this J., 1913, 785.

Washing detergent compounds and modes of using the same. Eng. Pat. 109,846. See XII.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

PATENT.

Manufacture of new azo dyestuffs and metal compounds thereof and their application in dyeing. Eng. Pat. 110,066. See IV.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Nitrous acid; Velocity of decomposition and dissociation constant of— P. O. Rây, M. L. Dey, and J. C. Ghosh. Chem. Soc. Trans., 1917, 111, 413—417.

A solution of nitrous acid of $N/32$ concentration was prepared by double decomposition of $N/16$ solutions of barium nitrite and sulphuric acid at 0°C ., and the velocity of decomposition was determined at 0° , 21° , and 40°C . respectively. The decomposition follows the course of a unimolecular reaction, the velocity constant being 0.00014 at 0° , 0.00022 at 21° , and 0.00057 at 40°C . The maximum concentration of nitrous acid obtainable at 0°C . is 0.185 N . Determinations of electrical conductivity at 0°C . gave a value of 6×10^{-4} for the dissociation constant of nitrous acid at this temperature. For the determination of nitrous acid the permanganate method was found to be more trustworthy than the urea method (compare Werner, this J., 1917, 1147).

Pyrophosphoric acid; Structure of— E. Balareff. Z. anorg. Chem., 1917, 99, 190—194. J. Chem. Soc., 1917, 112, ii., 467.

FURTHER evidence is given in favour of an unsymmetrical structure for pyrophosphoric acid. When orthophosphoric acid is dehydrated by boiling with SOCl_2 , the pyro-acid formed is always accompanied by metaphosphoric acid, whilst when SO_2Cl_2 is used, only the pyro-acid is obtained. Ethyl metaphosphate, prepared from ether and phosphoric oxide without heating, combines with ethyl orthophosphate at 185° — 190°C . forming the pyrophosphate. Ethyl metaphosphate does not combine with methyl orthophosphate, but methyl metaphosphate is formed by heating methyl pyrophosphate. Calcium pyrophosphate reacts with phosphorus pentachloride according to the equation $2\text{Ca}_2\text{P}_2\text{O}_7 + 6\text{PCl}_5 = \text{Ca}(\text{PO}_3)_2 + 8\text{POCl}_3 + 3\text{CaCl}_2$, and the strontium salt behaves in a similar manner.

Pyrophosphoric acid; Volumetric determination of— D. Balareff. Z. anorg. Chem., 1917, 99, 184—186. J. Chem. Soc., 1917, 112, ii., 506.

A SOLUTION of sodium pyrophosphate, acidified with a known quantity of sulphuric or hydrochloric acid, may be titrated with sodium hydroxide, the maximum redness of phenolphthalein being taken as the end-point. The indication is sharper in presence of sodium chloride. Sodium pyrophosphate solution may also be estimated by adding it to an excess of silver nitrate solution, collecting and washing the precipitate of silver pyrophosphate, and titrating the filtrate with thiocyanate. The silver cannot be replaced by lead. Formulae are given for the titration of ortho-, pyro-, and metaphosphoric acids in the same solution with sodium hydroxide, the indicators used being methyl orange, phenolphthalein, and silver nitrate-lacmoid (compare this J., 1917, 336).

Phosphates of calcium. Part IV. The basic phosphates. H. Bassett, jun. Chem. Soc. Trans., 1917, 111, 620—642. (See this J., 1907, 199, 317; 1909, 722.)

THE author gives the results of a phase-rule examination at 25°C ., and also at 100°C . and higher temperatures, of that portion of the system, $\text{CaO}-\text{P}_2\text{O}_5-\text{H}_2\text{O}$, lying between the regions where dicalcium phosphate and calcium hydroxide respectively are the stable solid phases. The chief experimental difficulties were due to the extreme slowness with which equilibrium is attained. It was found that two, and only two, phosphates of calcium more basic than dicalcium phosphate exist which can be in stable equilibrium with an aqueous solution at 25°C . (and probably at any temperature). These are tricalcium phosphate and hydroxyapatite ($\text{Ca}_3\text{P}_2\text{O}_7$) $_2\text{Ca}(\text{OH})_2$. The view of Cameron, Seidell, and Bell (this J., 1906, 120) that a series of solid solutions exists in this region of the system is shown to be incorrect. The range of existence of hydroxyapatite extends from markedly acid through neutral to markedly alkaline solutions. The nature of bone phosphate is discussed, and it is concluded that this is a mixture of hydroxyapatite and calcium carbonate with small amounts of adsorbed bicarbonates of sodium, potassium, and magnesium. It is probable that hydroxyapatite is the only calcium phosphate which can exist permanently under normal soil conditions. When superphosphate is added to the soil the hydroxyapatite formed by the "reversion" of the monocalcium phosphate is produced in a finely-divided state. Finely ground basic slag when added to the soil will also yield hydroxyapatite fairly quickly whether it contains tetracalcium phosphate, as has been suggested, or some other compound more closely related to hydroxyapatite. Earthy phosphorites and coprolites are most probably impure mixtures of hydroxyapatite and calcium carbonate, and this is in accord with the known fact that when extremely finely ground they give satisfactory results when used directly as fertilisers. Under the conditions which have led to the accumulation of phosphatic deposits, a certain amount of replacement of the hydroxyl of hydroxyapatite by chlorine or fluorine has occurred.

Potassium stannichloride; Simple method of preparing— J. G. F. Druce. Chem. Soc. Trans., 1917, 111, 418—419.

POTASSIUM stannichloride may be obtained by oxidising with chlorine a concentrated solution of potassium stannochloride or a solution of stannous chloride in a concentrated solution of potassium chloride made slightly acid with hydrochloric acid. 22 grms. of stannous chloride is dissolved in a concentrated solution of 16 grms. of potassium chloride, with addition of a few drops of concentrated hydrochloric acid. A slow stream of chlorine is passed into the solution for about 3 hours, a small quantity of concentrated hydrochloric acid is added, the solution is concentrated on a water-bath at 50° — 70°C ., and allowed to crystallise.

Hydrogen oxalates of the alkaline-earth metals. G. Bruhns. Z. anorg. Chem., 1916, 95, 191—224. J. Chem. Soc., 1917, 112, i., 534—535.

IN view of the uses of oxalic acid in analysis, and of the advantages of pure oxalic acid as a standard for volumetric solutions (this J., 1916, 908; 1917, 545), the conditions under which acid salts of the alkaline-earths are formed have been investigated. Dilute solutions of barium chloride yield with 2 mols. of oxalic acid a crystalline precipitate of the salt $\text{BaH}_2(\text{C}_2\text{O}_4)_2 \cdot 2\text{H}_2\text{O}$, which is rapidly decomposed by cold water. One mol. H_2O is readily lost, even at atmospheric temperature in a

vacuum, whilst the other molecule is only driven off at 125° C. Solutions of progressively diminishing acidity yield the salts $\text{Ba}_2\text{H}_2(\text{C}_2\text{O}_4)_3 \cdot 3\text{H}_2\text{O}$ and $\text{Ba}_3\text{H}_2(\text{C}_2\text{O}_4)_4 \cdot 3\text{H}_2\text{O}$, all being similar in appearance. Titration with *N*/10-sodium hydroxide shows that a small part of the oxalic acid remains combined with the normal oxalate, even after prolonged boiling. When barium hydroxide solution is in excess, the precipitated barium oxalate contains an excess of barium. The error in titrating barium with oxalic acid, and conversely, is therefore considerable. Normal barium oxalate may contain more than $11\text{H}_2\text{O}$ when precipitated cold from barium hydroxide and oxalic acid, whilst the product from barium chloride and sodium oxalate may contain less than 1 mol., even from dilute solution. At 100° C. it only contains $\frac{1}{2}\text{H}_2\text{O}$. Strontium has less tendency to form acid salts. A salt, $\text{Sr}_2\text{H}_2(\text{C}_2\text{O}_4)_3 \cdot 2\text{H}_2\text{O}$, is obtained which is decomposed completely by cold water. Slow crystallisation from slightly acid solution, however, yields homogeneous crystals containing an excess of acid, which are only very slowly decomposed by water. Strontium chloride is more suitable than calcium chloride for addition in titration of oxalic acid under conditions which cause rapid precipitation. A *N*/10-solution of strontium hydroxide is very suitable for volumetric estimations of oxalic acid, care being taken that the alkaline solution is not in excess, which would cause the precipitate to retain strontium. The water of crystallisation varies, as in the case of other oxalates, with the conditions of preparation. The titration of oxalic acid in nitric acid solution is quite satisfactory in the presence of barium nitrate, and even of barium chloride.

Manganese salts; Reaction of—V. Macri. *Boll. Chim. Farm.*, 1917, 56, 377. *J. Chem. Soc.*, 1917, 112, ii., 511.

WHEN a solution containing manganese, even in very small proportion, is rendered slightly alkaline and shaken and treated successively with a few drops of alkali oxalate solution and of acetic acid, the liquid assumes a distinct and persistent rose red colour. The reaction is rendered more sensitive if the alkaline solution is boiled and then allowed to cool before the addition of oxalate and acetic acid, and also if one or two drops of hydrogen peroxide solution are added before the liquid is made alkaline. Salts of other metals do not interfere with the reaction, except that those giving coloured solutions, especially if present in marked proportion, may mask it.

Ferric hydroxide; Adsorption of sulphuric acid by—, and *formation of colloidal sulphur from sulphides*. E. Dittler. *Kolloid Zeits.*, 1917, 21, 27–28. *J. Chem. Soc.*, 1917, 112, ii., 443.

EXPERIMENTAL results are recorded which show that sulphuric acid is adsorbed by ferric hydroxide to such an extent that errors may be introduced in the estimation of sulphur in pyrites by Lunge's method. By the action of steam on pyrites and marcassite for prolonged periods, small quantities of colloidal sulphur are produced. It is suggested that native sulphur may in some cases have been formed by a similar action.

Silver peroxide and the valence of silver. H. C. P. Weber. *Amer. Electrochem. Soc.*, Oct., 1917. [Advance copy.] 10 pages.

THE brownish-black "silver peroxide" to which the formula $2\text{Ag}_2\text{O}_4 \cdot \text{AgNO}_3$ has been ascribed (Brown, this *J.*, 1916, 1217) forms a dark coloured solution in nitric acid. This solution retains its colour for 24–36 hours in the cold but at once decomposes on warming or on dilution; when cooled in liquid air it gives a yellowish crystalline mass which on melting reproduces a black liquid.

The addition of soluble chlorides induces rapid decomposition of the solution even at very low temperatures; the solution is without action on a solution of permanganate, persulphate, or chromate, but converts lead nitrate gradually into lead dioxide and manganese sulphate instantly into permanganic acid; ammonium salts, with the exception of the nitrate, cause the decomposition of dilute solutions of the "peroxide." The formula $2\text{Ag}_2\text{O}_4 \cdot \text{AgNO}_3$ accords satisfactorily with these facts if it is assumed that the silver in the former constituent is present in a form of high valency corresponding with such compounds as permanganates, chromates, and persulphates, and this assumption receives confirmation from experiments on the migration of the ions during electrolysis. When the nitric acid solution is electrolysed in a suitable apparatus, the dark coloured "peroxynitrate" ions are found to move towards the anode whilst simultaneously silver ions migrate towards the cathode; the relation between the amounts of silver travelling towards the anode and cathode respectively suggests that the oxidic compound is the silver salt of an argentic acid probably containing trivalent silver, a likely formula for the compound being $\text{Ag}(\text{AgO}_2)_2$, in which the silver in the cation and anion is respectively di- and tri-valent. The fact that no hydrogen peroxide is formed in the decomposition of the "peroxide" excludes the possibility of the double compound being a pernitrate or of its containing a true peroxide, and is in agreement with the structure now suggested.—D. F. T.

Hydrogen peroxide; Sensitive reaction of—depending on the formation of dihydroxytartaric acid. G. Denigès. *Ann. Chim. Analyt.*, 1917, 22, 193.

Two c.c. of 5% tartaric acid solution is mixed with 2 drops of 5% ferrous ammonium sulphate solution, from 0.1 to 2.0 c.c. of the solution to be tested is then added, and the mixture is treated with 5 drops of sodium hydroxide solution. If the test solution contained hydrogen peroxide, a violet coloration appears immediately. The reaction may be obtained with as little as 0.05 mgrm. of hydrogen peroxide.—W. P. S.

Packing and plant handling of hazardous chemicals Laury. *See I.*

Theory of contact catalysis. Poisoning of catalytic agents. Bancroft. *See I.*

Action of oxygen on rhodium. Gutbier and others. *See X.*

PATENTS.

Alkaline peroxide; Manufacture of—G. F. Jaubert. *Paris. Eng. Pat.* 101,709, Sept. 28, 1916. (*Appl. No.* 13,813 of 1916.) Under Int. Conv., Oct. 2, 1915.

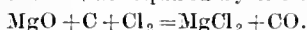
ALKALINE peroxide, more particularly sodium peroxide, is obtained in very porous masses or lumps of low density, by slow oxidation of the melted metal. For instance, sodium is heated to about 300° C. in aluminium boats in a suitable retort through which passes a slow stream of a mixture of 90–95% of nitrogen and 5 to 10% of oxygen, free from carbon dioxide. It is necessary that the metal shall not actually burn, otherwise the peroxide is melted and formed in compact lumps. In this porous form the peroxide is particularly suitable for the treatment of vitiated air, in respirators, etc.; the activity of the sodium salt in this respect is increased by addition of a little potassium and still more by the addition of small quantities of catalysts such as nickel, copper, cobalt, or manganese oxides. (Reference is directed in pursuance of Sect. 7, Sub-sect. 4, of the

Patents and Designs Act, 1907, to Eng. Pats. 20,003 of 1891, 8865 of 1904, and 7641 of 1907; this J., 1892, 1005; 1904, 833; 1907, 1008.)

—B. V. S.

Magnesium chloride; Production and utilisation of —. G. H. Bailey, G. W. A. Foster, and The British Aluminium Co., Ltd., London, Eng. Pat. 109,996, Sept. 30, 1916. (Appl. No. 13,934 of 1916.)

ANHYDROUS magnesium chloride is prepared by the action of chlorine or of waste gases containing chlorine on a mixture of magnesium and carbon at 750° to 800° C. The magnesia-carbon mixture is prepared in briquette form by moulding a mixture of magnesite or magnesia and carbon, cemented together with tar, and heating to 1000°—1200° C., out of contact with oxygen. The proportions are such as to leave 40 parts of magnesium oxide to 12 parts of carbon, as required by the equation:—



The magnesium chloride is formed in molten condition and may be collected as such or used for maintaining the supply of chloride to an electrolytic apparatus for the production of metallic magnesium; in the latter case the chlorine produced by the electrolysis is utilised to react with fresh supplies of the magnesia-carbon mixture. A suitable apparatus for continuous working of the process is described.—B. V. S.

Aluminous compounds; Treatment of —. H. Spence, W. B. Llewellyn, and P. Spence and Sons, Ltd., Manchester, Eng. Pat. 109,998, Oct. 2, 1916. (Appl. No. 13,958 of 1916.)

POWDERED ignited alunite is mixed with water and treated with sulphur dioxide, preferably at about 40° C. In order to prevent the formation of double basic aluminium-alkali sulphate the solution is treated if necessary with milk of lime to reduce the excess of acid, above what is required by the alkalis and alkaline-earths present, to a proportion of about 0.9 mol. of acid to 1 mol. of alumina; it is then filtered and boiled to drive off sulphur dioxide; air is excluded to avoid oxidation and precipitation of iron salts. A pure basic aluminium sulphate separates, easily soluble in acids and yielding practically pure alumina on heating.—B. V. S.

Calcium or other metal cyanamide; Process of making —. J. H. Reid, Newark, N.J. U.S. Pat. 1,241,020, Sept. 25, 1917. Date of appl., June 28, 1915.

A MOLTEN carbide, e.g., calcium carbide, is introduced into an atmosphere of nitrogen and the association of the ingredients maintained until combination to cyanamide is complete.—F. Sr.

Iodine; Manufacture of —. V. Vincent, Quimper, France. Eng. Pat. 101,871, Oct. 2, 1916. (Appl. No. 13,979 of 1916.) Under Int. Conv., Oct. 16, 1915.

SEE Fr. Pat. 480,014 of 1915; this J., 1917, 137.

Elevating or lifting apparatus for acids or the like. Eng. Pat. 109,522. See I.

Electric arc furnace [for nitrogen fixation]. U.S. Pat. 1,241,655. See XI.

Washing-crystal. U.S. Pat. 1,241,044. See XII.

VIII.—GLASS; CERAMICS.

Kaolinite; Molecular destruction of —by heat. A. M. Sokolov. Kryst. Min., 1915, 55, 195—196. J. Chem. Soc., 1917, 112, ii., 492.

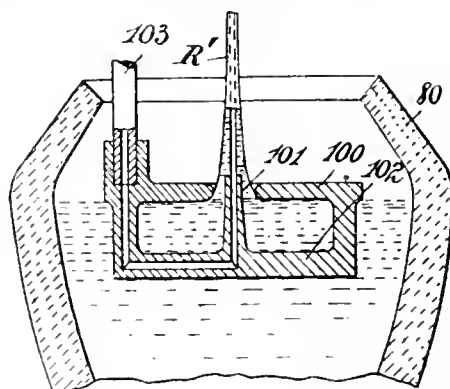
KAOLINITE from Gluchov was heated for periods

of one to five hours at temperatures from 200° to 1000° C., and the loss of water determined. The residue was digested for two hours with 16% hydrochloric acid, and the soluble alumina determined. The quantities of soluble alumina formed after ignition for one hour at the temperatures mentioned were: 300°, 2.12; 400°, 2.08; 600°, 28.46; 700°, 32.30; 800° C., 31.66%. The quantities of waterlost were: 300°, 0.72; 400°, 0.67; 600°, 10.49; 700°, 11.92; 800° C., 12.99%. With more prolonged heating, slightly higher results were obtained. From the residue a weak alkali solution extracts soluble silica. At 800° C., the kaolin molecule is completely broken down into its component oxides.

PATENTS.

Glass tubes; Manufacture of —. The British Thomson-Houston Co., Ltd., London, From General Electric Co., Schenectady, N.Y., U.S.A. Eng. Pat. 109,813, Sept. 27, 1916. (Appl. No. 13,741 of 1916.)

IN an apparatus of the type described in Eng. Pat. 17,602 of 1913 (this J., 1914, 831), for the continuous manufacture of glass tubing, a float, 100, in the crucible, 80, is provided with depending arms



carrying a cross-bar, 102, through which compressed air is supplied by the pipe, 103, to the nozzle, 101, and thence to the tubing, R', which is drawn through the annular opening in the float. —W. F. F.

Glass bulbs [containing a gas in solution]; Method of sealing —. A. J. Loopsinger, Providence, R.I., Assignor to General Fire Extinguisher Co., New York. U.S. Pat. 1,241,229, Sept. 25, 1917. Date of appl., Mar. 11, 1916.

A GLASS bulb having a long neck and containing a gas in solution, is placed in a closed receptacle and sealed under pressure.—F. Sr.

IX.—BUILDING MATERIALS.

PATENTS.

Limckiln. P. J. Dauernheim, St. Louis, Mo. U.S. Pat. 1,240,950, Sept. 25, 1917. Date of appl., June 21, 1915.

AN internal furnace of ceramic material is provided with a fuel opening, grate bars, and ashpit, and a series of fire-holes extend through its walls into the annular space between the furnace and the outer casing of the kiln. A horizontal water drum is provided in each side wall of the furnace just below the grate bars, and a larger drum in the crown of the furnace. The drums are connected by vertical tubes adjacent to the fire openings

to reinforce the walls and protect them from excessive heat. A steam drum located outside the kiln at a higher level is connected by pipes to the water drums.—W. F. F.

Plaster and mortar; Process of making—

W. C. Hay, Los Angeles, Cal. U.S. Pat. 1,241,211, Sept. 25, 1917. Date of appl., Oct. 19, 1916.

SLAKED lime is aged to form lime putty, which is then thinned with water and violently agitated to aerate it. Sand is caused to move in a continuous stream and a "hardening agent" is fed into it at a predetermined rate. The thinned lime putty is then added at a predetermined rate, and finely-divided fibre is blown into the mixture. —W. F. F.

Cement paint. Eng. Pat. 109,951. See XIII.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Soft gray iron; High sulphur in—T. Mauland. Amer. Foundrymen's Assoc., Sept., 1917. Met. and Chem. Eng., 1917, 17, 383.

CASTINGS containing 0.12% S may be good, strong and soft, while others containing less than 0.09% are hard; in the former cases, the oxygen content is usually low.—T. H. B.

Iron castings; Porosity of—R. Namias. Monit. Scient. 1917, 61, 217–218.

POROSITY of castings is caused by the imperfect escape of gases from the metal. High phosphorus content in cast iron conduces to fluidity and thus to the easy escape of gases. Samples cut from two castings which were sound in the lower and porous in the upper parts, contained in the porous parts 0.382% and 0.775% P and in the sound parts 0.462% and 1.166% respectively. All other constituents were present in substantially the same amounts in both parts of the castings. The differences observed are attributed to liquation or preferably to the removal of phosphorus by the action of the basic constituents of the slag. The slag should have a high degree of fluidity to permit rapid separation, as the evolution of gas might be due to the oxidation of carbon by oxides of iron and manganese in the slag, and this would be intensified by longer contact. Quicklime is preferable to limestone as an addition in the cupola to obtain a suitable slag.—H. J. H.

Malleable iron annealing; Carbon losses in—

J. B. Deisher. Amer. Foundrymen's Assoc., Sept., 1917. Met. and Chem. Eng., 1917, 17, 383.

THE safe annealing temperatures are from 1450° to 1650° F. (about 790° to 900° C.) for pot ovens and from 1500° to 1700° F. (about 820° to 930° C.) for muffle ovens. The best practice is to bring the castings to the highest temperature at the beginning of the anneal and maintain that temperature until the carbide is dissolved, then drop to 1400° F. (760° C.) to precipitate graphitic carbon. The conversion rather than removal of carbon produces ductility.—T. H. B.

Electrolytic pickling process and its effect on the physical properties of iron and steel. J. Coulson. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 7 pages.

TEST specimens of steel springs, drill rod, tempered steel, Bessemer and cold-rolled steel rods were exposed either as anode or cathode, or to ordinary chemical action, in a solution of 27% sulphuric acid at 60° C. On submitting to oscillating stresses all the springs pickled chemically and electrolytically as cathode broke during the preliminary test,

which consisted of a continuous strain for 12 hours, and gave a fracture showing a crystalline structure resembling that of glass-hard steel. No difference appeared to exist in the properties of anodically treated samples and the original tempered metal either before or after a sand-blasting treatment. On submitting to bending tests, samples which had been pickled chemically and electrolytically as cathode showed fatigue and cracks much sooner than untreated test pieces or than those treated electrolytically as anode. The Brinell test for hardness indicated an increase of about 5% for specimens pickled as cathode, while no material change was noticeable with any of the others. The tensile strength, percentage elongation, and reduction of area under stress were also unfavourably affected by the chemical treatment or electrolytic treatment as cathode, the greatest modification being obtained with high carbon steel, whereas anodic pickling did not impair the physical properties. The fractures were similar in the cases of the original metal and that anodically pickled, while the cathodically treated samples gave an irregular break with a dark centre encircled by a well-defined bright band showing the depth to which the hydrogen penetrated the metal. The hydrogen appears to form an alloy with the metal, the rate of penetration increasing with the current density, and in the case of ordinary chemical pickling absorption takes place more slowly. Test specimens made brittle by pickling either chemically or electrolytically as cathode were restored to their original condition by annealing or by repickling electrolytically as anode, thus indicating that anodic treatment either alone or after electrolysis as cathode is the most effective way of cleaning iron and steel without impairing the physical properties.—J. N. P.

Steels; Heterogeneity of—G. Charpy and S. Bonnerot. Comptes rend., 1917, 165, 536–540.

By etching steel with a cupric reagent and dissolving the deposited copper in ammonia, pearlite shows in white, and ferrite in dark patches; hence the specimens give a "negative" image compared with that produced by iodine, or nitric or picric acid. The progressive deformation of the dendritic structure of steel in the rolling process was investigated by means of the cupric etching solution, which gives sharper contours than the other reagents. As heat treatment does not modify the microstructure of steel to any extent, the degree of rolling can be ascertained approximately even after heat treatment, if the original dimensions of the dendrites are known. The finer dendrites found near the surface of cast steel do not vary much in size, but those formed in the central zone of ingots increase considerably with the size of the ingot. Even in medium size ingots of pure steels which do not exhibit pronounced segregation, very large variations may frequently be observed in the size of the dendrites of the peripheral and the central zones.—W. R. S.

Vanadium in alloy steels; Role of—G. L. Norris. Amer. Soc. for Testing Materials, June, 1917. Eng. and Min. J., 1917, 104, 557–558.

THE author contends that the beneficial effects of vanadium in steel are not due to its power of removing oxygen and nitrogen, but that its value is due to its presence as an alloying element and to its influence on the other constituents. Only a few hundredths per cent. combine with the ferrite; nevertheless the mechanical properties of the latter are thereby improved. Nearly all the vanadium is found in the pearlite as an iron vanadium carbide in ternary, and as more complex carbides in quaternary steels. Vanadium progressively replaces iron in cementite until, with 5% vanadium in the steel, the whole of the iron has been replaced. Vanadium carbide has a

strong tendency to produce sorbitic and even troostitic pearlite. It is not so soluble as iron carbide, hence a higher temperature is required to ensure an austenitic condition prior to quenching. The effects of vanadium increase until about 1% is present; with 3% carbon steel is actually softened by quenching. High-speed steel tools withstand higher temperatures if 0.3 to 2.5% of vanadium is present; 0.2% is greatly beneficial in carbon-steel tools. As regards cast steel, 0.15% increases the elastic limit of annealed castings 25–30% without lowering their ductility; this proportion is now frequently added to locomotive frame metal. For heat treatment, vanadium steel has shown its superiority over ordinary steel. There is probably a great future for quaternary vanadium-steel (especially heat-treated) castings.—W. R. S.

Steel springs; Prevention of brittleness in electroplated—. T. S. Fuller. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 9 pages.

THE breaking strength of untreated test springs was found to vary from 319 to 439 lb., while before breaking the springs stretched to two or three times their original length; after plating in a copper cyanide solution for $\frac{1}{2}$ hour, the value fell to 69–137 lb., and there was very little stretching before breaking; after pickling for 3 mins. in 20% sulphuric acid solution, the value was 198 lb., and after a treatment of one hour, 29 lb. Samples which were coated with tin by dipping in rosin and then in the molten metal at 260–300° C., and afterwards copper-plated, showed a breaking strength of 300–352 lb., but when pickled in acid before tinning, a value of 22–31 lb. resulted. Preliminary treatment by sand-blasting did not, however, lower the breaking strength. The protective action of the tin in preventing embrittlement is apparently due to its being impervious to atomic hydrogen.—J. N. P.

Iron-copper; The system—. R. Ruer and F. Goerens. Ferrum, 1916, 14, 49–61. J. Chem. Soc., 1917, 112, ii., 474. (Compare Ruer and Fick, this J., 1913, 1111.)

WITH the object of elucidating certain discrepancies, particularly in regard to the behaviour of the molten metals, the authors have melted electrolytic copper and iron (m. pt. 1528° C.) in porcelain tubes in an atmosphere of nitrogen, and have investigated the alloys thermally, micrographically, and magnetically. A separation of layers actually occurs when the pure metals are melted together. On the other hand, that portion of the freezing-point curve which lies between the end-points of the mixture gap (24% Cu at 1450° and about 85% Cu at 1375° C.) is definitely shown not to be horizontal; the observed discrepancy cannot be attributed to under-cooling. On solidification, therefore, the system Fe-Cu shows the behaviour of a system of three or more substances. The absorption of impurities during the process of melting, in amount sufficient to explain the phenomena, could not be established.

Zinc dust precipitation [of gold, silver, and copper from cyanide solutions]; Efficiency of—. W. J. Sharwood. Amer. Inst. Min. Eng. Met. and Chem. Eng., 1917, 17, 437.

THEORETICALLY, 1 unit weight of zinc should precipitate 6.03 units of gold, 3.30 units of silver, or 1.93 of copper; but laboratory tests with commercial zinc dust usually show an efficiency of 30 to 60%. Extremely fine and pure zinc dusts prepared by redistillation of spelter have shown efficiencies of 75% and higher, especially in presence of 1 or 2% of lead; coarse or granular zinc gives low results. The working efficiency on a large scale may be a mere fraction of 1% in the case of low-grade gold solutions, much zinc being

wasted in side reactions; a 50% efficiency may be approached with rich silver solutions. A practical example of mixed precipitation showed an efficiency of 0.39% for gold, 4.75% for silver, and 3.93% for copper, the figures being obtained by dividing the weight in lb. by the electro-chemical equivalent, dividing the quotient by the number of equivalents of zinc used, and multiplying by 100; the zinc dust was assumed to contain 90% of the metal.—T. H. B.

Copper; Electrolytic recovery of—and of sulphuric acid from copper mill pickling solutions. J. L. Jones. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 8 pages.

THE solution obtained in the removal of scale from copper by treatment with heated dilute sulphuric acid, which becomes saturated with copper sulphate, is treated electrolytically in order to recover both the copper and the acid, the latter being then available for further pickling. The cathodes consist of steel plates which are given a preliminary coating of copper by means of a cyanide bath, and the anodes of sheet lead. The recovery tanks are made of wood with a lead lining and arranged in cascade in a cement pit provided with a sump for the accumulation of leakage. The series system of electrical connections is used, with parallel circulation of the electrolyte across the face of the electrodes. The solution is regenerated until the acid content is about 20% and the copper 1%, a current efficiency of 72% being obtained. Good results are also obtained by a continuous circulation of the solution through the pickling and recovery vats, whereby the acid content is maintained at about 14%, and the copper at 3.5%.—J. N. P.

Brass; Metallography of—Development and reabsorption of the β -constituent in alloys which are normally of the α -type. C. H. Mathewson and P. Davidson. J. Amer. Inst. of Metals, 1917, 11, 12–63.

TO determine the effect of the metastable β -constituent on the strength and ductility of α -brass in the worked and annealed conditions, α -brasses containing 70, 67, and 65% Cu, respectively, prepared from pure copper and zinc, were over-heated to produce a prominent network of the β -constituent and then cooled or annealed to effect re-absorption of this network to a different extent in each specimen. In the 70% alloy, no β -constituent was developed by annealing at 900° C. for 15 mins. and quenching in water, but the ductility of the alloy was considerably reduced. By annealing at 920° C. before quenching, partial fusion occurred and irregular results were obtained. The ductility was considerably increased by rapid air-cooling after annealing at 920° C., owing to the re-development of the α -phase throughout the mass. With the 67% alloy, little change in strength or ductility was effected by quenching from 880° C., owing to the non-retention of the β -phase in the quenched specimens. By air-cooling from 880° C., the tensile strength was decreased by 3000 lb. per sq. in. and the elongation (on 2 in.) increased by 3 percentage units, this being in accord with the structural evidence showing that the β -network had become more or less obliterated. A further decrease in tensile strength, due to the disappearance of the β -constituent, was obtained by cooling the alloy from 880° C. to 450° C. at the rate of 50° per min. The 65% alloy, in the "dead soft" condition, had a tensile strength between 41,000 and 42,000 lb. per sq. in. and an elongation of 80% on 2 in. By annealing and quenching at 790° C. the strength was increased by 5000 lb. per sq. in. and the elongation decreased by 16 percentage units; these effects were accompanied by the development of a distinct network

of the β -constituent, the proportion of which increased with the quenching temperature until, by quenching from 850° C., the tensile strength was further augmented by 3000 lb. per sq. in. and the elongation diminished by 1 percentage unit. These changes in strength and ductility were found to depend on the presence of the β -constituent in the form of a well-developed network around the α -grains, rather than on the mere presence of a moderate proportion of this constituent in the alloy. Since partial destruction of this network had a greater effect in raising the elongation than in lowering the tensile strength, an attempt was made to effect a combination of high strength and high elongation by quenching at a high temperature, to develop the β -network, and then annealing at a low temperature to effect granulation of the latter; a tensile strength of 46,000 lb. per sq. in. and an elongation of 70% were obtained by quenching at 820° C. and annealing for 1 hr. at 450° C. In further considering the possibility of increasing, by this means, the strength of α -brass for purposes where extreme ductility is unnecessary and cold-working undesirable, the tensile properties of 65/35 brass in which the β -constituent had been developed intentionally were determined after cold rolling and after cold working followed by light annealing. In the latter case, the tensile strength of the quenched (β -containing) alloy, which was originally 10,000 lb. per sq. in. higher than that of the slowly cooled (α) material, still remained 9000 lb. per sq. in. higher than the latter after very light annealing at 300° C., and the β -containing alloy was then considerably stronger and only slightly less ductile than the plain α -alloy. As a preliminary to the above work, the equilibrium curves of that part of the copper-zinc system covering the range of commercially important alloys were investigated and developed sufficiently to permit a useful calculation of the proximate composition of any pure brass in a state of equilibrium within the temperature range 500°–900° C.—W. E. F. P.

Brasses of the Muntz metal type: Corrosion of — H. S. Rawdon. Amer. Inst. Metals, Sept., 1917. Met. and Chem. Eng., 1917, 17, 382.

BRASS of the type Cu 60, Zn 40%, often becomes very weak and brittle when exposed to electrolytic action, particularly in sea water. Examination of the microstructure shows that the zinc-rich constituent is leached out leaving a powdery skeleton of copper. Later, the second constituent may be attacked. Conditions which affect the rate of corrosion are the microstructural composition of the alloy, contact with strongly electro-negative metals, adhering deposits of basic zinc chloride resulting from corrosion, thoroughness of annealing, temperature of the electrolyte, and stresses to which the alloy is subjected.—T. H. B.

Lead: Use of salt in the metallurgy of — O. C. Ralston, C. E. Williams, M. J. Udy, and G. J. Holt. Bull. Amer. Inst. Min. Eng., Aug., 1917. Met. and Chem. Eng., 1917, 17, 437.

Two methods are available for oxidised ores of lead; in one the lead is leached out with a saturated solution of salt acidified with sulphuric acid, followed by either electrolytic or lime precipitation; in the other, the ore is mixed with salt, and treated in a blast roaster or reverberatory furnace at 800° C. or higher. Lead chloride fumes are formed and caught in a Cottrell electrical precipitator, and the lead chloride finally reduced with lime and carbon; the calcium chloride slag which is formed can be used instead of sodium chloride in the process, and in this way from 50 to 75% of the chlorine is recovered. For oxidised lead

ores containing precious metals or copper, the leaching process can be used after a chloridising roast at slightly over 600° C. The volatilisation method is applicable to sulphide ores, but precious metals and copper cannot be extracted; these may be leached out after a chloridising roast, which is, however, more difficult to effect than with oxide ores. The volatilisation process also promises to be a suitable treatment for oxidised silicious lead ores, though neither of the salt processes seems to offer a solution of the "complex sulphide" problem.—T. H. B.

Antimony: Electrolytic production of — direct from stibnite ore. D. J. Demorest. J. Amer. Inst. of Metals, 1917, 11, 83–87.

IN a process by which antimony was produced at the rate of 800 lb. per day, stibnite (Sb_2S_3) was dissolved in an 8% solution of sodium hydroxide or sulphide and the solution electrolysed while circulating between iron electrodes, the cathodes being perforated to facilitate attachment of the deposit. A current density of 7 amp. per sq. ft. at 2.7 volts was employed, and a current efficiency of 76% obtained. The deposited antimony was free from "sprouting," firmly adherent, but easily stripped, and of great purity (S 0.02 and As 0.01%, with traces Fe but no Pb). Regeneration or renewal of the electrolyte was necessary as soon as the weights of antimony deposited and sodium hydroxide used became equal, since the solution then contained 4% of sodium thio-sulphate and 2% of sodium sulphide and commenced to attack the anodes by converting them into iron sulphide. Successful regeneration was effected on a small scale by evaporating the solution to dryness, roasting the residue to form sodium sulphate, and heating the latter with coal to produce sodium sulphide for use in treating fresh ore.—W. E. F. P.

Alloys: The hardness of — P. Ludwik. Z. Ver. Deut. Ing., 1917, 547–554. Engineering, 1917, 104, 444–445.

VARYING quantities of different metals were added to copper, tin, lead, zinc, and aluminium, and the hardness of the resulting alloys was ascertained by the Brinell test. In the case of copper addition of 1% of tin increases the hardness by 10%; 10% increases the hardness to twice, 15% to three times its value; annealing of the bronzes does not affect these figures much. The further addition of zinc to Cu-Sn further increases the hardness of the bronze, but much less than tin would do. Zinc alone added to copper augments its hardness slightly, but with 35% of Zn the hardness curve of the alloy rises suddenly (malleable brass). The hardness of brass is increased more by the addition of Sn, and also of Al (durana metal), than that of copper is; such bronzes are more brittle, however, and become soft on annealing. The addition of up to 8% of Al exercises little effect on the hardness of copper; higher percentages are more effective than Sn. Ni hardens copper less than Sn and Al do, Mn ranks between Ni and Sn in this respect, 15% of Mn being equivalent to 5% of Sn. Both Pb and Bi decrease the hardness of copper. Mg proved by far the most effective hardener of all the metals investigated. The hardness of tin is increased to twice its value by the addition of up to 15% of Pb; more lead makes the tin softer (soft solder). Cu has a stronger hardening effect on tin than lead in all proportions; Sb behaves like Cu, and 15% of Cu or of Sb imparts to tin three times its original hardness. Both Cu and Sb together (bearing metal) have a still greater hardening effect; Sb and much Pb added together give a softer bearing metal. Mg and Al have very strong effects; 0.5% of Mg makes the tin twice as hard. The addition of

1—8% of Sn increases the hardness of lead threefold, 15%—30% of Sb fivefold. Tin also hardens the lead, but much less; in ternary alloys of Pb-Sb-Sn the effect of Sb shows only at high percentages. Bi ranks below tin as hardener of lead. Cd has a much stronger action, surpassing even Sb, and Mg again the strongest; 0.5% of Mg increases the hardness of lead threefold. The presence of a little lead or tin renders zinc only a little harder; higher percentages of Sn make zinc (and also aluminium) softer. Ternary alloys of Zn-Sn with Cu or Al, and quaternary alloys with Cu and Sb, show this softening in a more pronounced way, whilst addition of Sb and especially of Cu to Zn renders the zinc harder; Zn with 4% of Cu has twice the hardness of Zn. Annealing effects little in these cases. An addition of 0.25% of Mg hardens the Zn as much as 4% of Cu. Cd stands next to Mg as a hardening agent of Zn; but the hardening effect of Cd reaches its maximum with only 4%, and the Al curve resembles that of Cd in alloys with Zn. Al is little affected in its hardness by the addition of Sn, above 4% of which rather softens it. Cu hardens Al, but Al-Cu is little influenced by tin. Zn has likewise a hardening effect on Al, weaker than that of Cu, however. Mg proves also the most efficient hardening agent of Al (magnalium); its effect in ternary alloys is less pronounced than in the case of other metals. The alloys of Al with Cu and Mg and, further, with Mn (duraluminium) are very hard, and annealing further increases the hardness of these alloys, as also of Al-Zn and Al-Cu alloys. There is a gradual increase in the hardness of Al-Cu alloys, amounting, e.g., to 17% when they are kept for three weeks at ordinary temperature.

Non-ferrous light metal scrap; Briquetting of —. A. L. Stillman. Amer. Inst. Metals, Sept., 1917. Met. and Chem. Eng., 1917, 17, 381.

MOST white metals and brasses can be welded together into "heavy scrap" having a sp. gr. from 65 to 85% that of the corresponding ingot metal. This is effected by multi-stage compression, moderate in its first stages, to interlock the fragments and expel entrapped air, and increasing to a final pressure of 33,000 lb. per sq. in. Fluxes or binders should not be used, unless the highest available pressure is insufficient to cause cohesion.

—T. H. B.

Rhodium; Action of oxygen on —. A. Gutbier, A. Hüttlinger, and O. Maisch. Z. anorg. Chem., 1916, 95, 225—246. J. Chem. Soc., 1917, 112, ii., 483.

WHEN rhodium is heated in air or oxygen at temperatures from 600° to 1000° C., the product is always the oxide, Rh_2O_3 , the rate of oxidation increasing rapidly with the temperature. Above 1150° C., the oxide is completely decomposed, the metal being obtained. The oxide, Rh_2O_3 , is greyish-black. The previously recorded formation of lower oxides is due to incomplete oxidation.

Metals; Search for two unknown —. M. Gerber. Monit. Scient., 1917, 61, 73—81, 121—127, 169—177, 219—226.

In the periodic classification of Mendeléeff there are vacancies for two elements with atomic weights about 99 and 187, which the author supposed might accompany, unsuspected, molybdenum (96) and tungsten (184) in minerals. Slight differences in chemical behaviour were found in specimens of tungstic acid prepared from different sources, and a complexity of the element tungsten was inferred. The abnormal specimens showed spectra identical with normal tungsten compounds. Similar results were found with molybdenum com-

pounds, so that the spectroscopic evidence negated the idea of complexity of tungsten and molybdenum. The author suggests the existence of isotopic forms of these elements, after the analogy of lead.—H. J. H.

The sub-station problem of electro-chemical plant. Yardley. See XI.

PATENTS.

Iron ore process; Direct —. P. H. Ledeboer. London. Eng. Pat. 109,952, May 23, 1917. (Appl. No. 7396 of 1917.)

IRON ore is finely crushed and washed in a current of water to remove argillaceous material, including most of the phosphorus which the ore may contain. The ore is then converted into magnetic oxide by roasting it with a small quantity of carbon, carbonaceous material, or reducing gas. If sulphur is present it must previously be removed by electromagnetic separation or by raising the temperature sufficiently to expel it. Traces of phosphorus, arsenic, etc., may be removed by further magnetic separation. The pure magnetite thus obtained is mixed with coke, coal, anthracite, charcoal, sawdust, molasses, or the like, and heated to dull redness in a reducing furnace. The partly reduced material is transferred to a second reducing furnace at a higher temperature, through which a current of water-gas or the like is passed. The pure reduced iron is then transferred to a furnace heated by producer gas or water-gas, the reducing flame of which plays on the metal and passes downward to the underside of the hearth. The heated iron is pressed into blocks which may then be used for the production of iron or steel of any desired quality.—W. F. F.

Iron or steel; Process and solution for the treatment of —. A. Hayes. New York, Assignor to Carnot Development Corporation. U.S. Pats. (A) 1,241,112 and (B) 1,241,113, Sept. 25, 1917. Date of appl., Mar. 31, 1916.

(A) Iron or steel is heated and quenched in a hot solution of sal ammoniac, common salt, a substance capable of yielding fluorine, and "a reagent."
(B) The quenching solution consists of hydrochloric acid, free chlorine, and a substance capable of yielding fluorine, with or without sal ammoniac and sodium chloride.—W. F. F.

Lead; Extraction of — from its ores or lead-containing materials. H. L. Sulman and H. F. K. Picard. London. Eng. Pat. 109,817, June 30, 1916. (Appl. No. 9228 of 1916.)

ORES or other materials containing lead in the form of sulphate, or other form which may easily be converted into sulphate, e.g., by roasting, are treated with hot saturated brine to dissolve the lead sulphate. The formation of sodium sulphate, which would render the brine unfit for further use, is avoided by adding an equivalent amount of calcium chloride, insoluble calcium sulphate being thereby produced. The calcium sulphate and residues are removed by filtration, and the lead precipitated from the solution as carbonate by the addition of dry powdered sodium carbonate. The lead carbonate is then removed by filtration, and the solution may be used over again. Alternatively, the lead sulphate may be dissolved by brine, the lead precipitated by sodium carbonate or sodium sulphide and removed by filtration, and the liquor subsequently treated with calcium chloride to precipitate calcium sulphate which is removed by filtration and the solution used over again. If the ore contains zinc sulphate, this is dissolved by the brine, but may be retained in solution by adding sodium carbonate in quantity

sufficient to precipitate the lead carbonate only. Zinc carbonate may be precipitated by a further addition of sodium carbonate after the lead carbonate has been removed by filtration. If silver is also present the zinc sulphate is first removed by leaching, the residue treated as above for the recovery of lead, and the final residue treated with cyanide for the recovery of silver.—W. F. F.

Separator; Electromagnetic —. A. F. Hallimond and W. G. Fletcher, London, Eng. Pat. 109,857. (Appl. Nos. 14,629, Oct. 14, 1916, and 5054, Apr. 10, 1917.)

THE material to be separated is fed from a hopper on to a rotating disc having gaps at intervals, the feed being stopped automatically, when the gaps are passing the hopper, by a cam-operated sliding valve. A series of fixed magnet poles are provided above the disc, and a commutator cuts off the supply of current to the magnets as the gaps pass under them, so that the attracted material is discharged through the gaps to suitable receptacles beneath. In an alternative form the disc is replaced by a horizontal drum on to which the material is fed on its rising side. The magnetic field is cut off when a pocket in the periphery of the drum passes below the magnet so that the separated material is discharged into the pocket. This material is discharged from the pocket when it reaches the lowest point in its rotation. In another form the material is fed on to a horizontal endless conveyor passing below the magnet, the return portion of the conveyor being parallel and just below. Two gaps are provided in the conveyor, and are arranged to register when just below the magnet, so that when the field is cut off, the magnetic material is discharged through both gaps into the receiver below.—W. F. F.

Metalliferous ores; Process of concentration of —. S. I. Clawson, Salt Lake City, Utah. U.S. Pat. 1,240,824, Sep. 25, 1917. Date of appl., Jan. 2, 1914.

THE pulverised ore is mixed with a saline solution, and gas and oil are injected. The mixture is discharged into a closed separating chamber under pressure and the concentrate is withdrawn at the opposite side of the chamber. The surplus gas under pressure is also withdrawn from this side of the chamber and conveyed back to the point of injection to be used again.—W. F. F.

Welding-electrode and process of welding. Process for electric welding. P. A. E. Armstrong, Assignor to W. L. Clark and A. H. Adams (The Quasi-Arc Co.), New York. U.S. Pats. (A) 1,241,893, and (B) 1,241,900, Oct. 2, 1917. Dates of appl., Mar. 10 and Mar. 23, 1915.

(A) AN electrode for depositing metal consists of a metal tube with inner and outer coatings of insulating, slag-forming material. The outer coating melts at a higher temperature than the inner coating and acts as a protecting shield for the molten metal. The inner coating may contain an alloy, such as ferromanganese, which it is desired to add to the metal of the electrode. (B) Manganese-steel is deposited on work consisting of manganese-steel by an electrode of that material coated with insulating material which acts as a slag when fused. The electrode is maintained in contact with the molten metal but not with the work, and the deposited metal is cooled by a stream of water.—W. F. F.

Case-hardening material and process of making same. A. O. Blaich, Assignor to A. O. Blaich Co., Chicago, Ill. U.S. Pat. 1,241,909, Oct. 2, 1917. Date of appl., Jan. 29, 1917.

CARBON granules are impregnated with a solution

of soda ash and dried at a temperature at which the soda ash is unaffected. The granules are then sprayed with oil to coat their surfaces, and mixed with pulverised calcium or barium carbonate.—W. F. F.

Zinc-extraction process. H. R. Hanley, Winthrop, Cal., Assignor to Bully Hill Copper Mining and Smelting Co. U.S. Pat. 1,241,966, Oct. 2, 1917. Date of appl., June 5, 1916.

ZIN-bearing materials are mixed with concentrated sulphuric acid so as to form a thick mud, which is dried and roasted at from 200° to 650° C., to eliminate arsenic, selenium, and other volatile elements, and convert the zinc compounds to sulphate, which is then extracted with water. After removing metals more electro-negative than zinc, the solution is electrolysed, thus depositing zinc and liberating sulphuric acid, until from 70% to 90% of the zinc sulphate is decomposed. The remaining electrolyte is evaporated until the dissolved salts are precipitated, and the sulphuric acid is separated and used for the treatment of fresh quantities of zinc ores.—J. N. P.

Melting-pot or crucible [for melting brass]. J. C. Henderson, Washington, D.C., Assignor to Driver Harris Co., Harrison, N.J. U.S. Pat. 1,241,971, Oct. 2, 1917. Date of appl., July 8, 1916.

A THIN-WALLED melting pot is cast from a highly refractory alloy containing chromium or a metal having similar properties, and nickel or other metal associated with iron in the periodic table having substantially the same atomic weight, these combined metals amounting to not less than 60% of the alloy. The walls increase in thickness towards the bottom and a refractory non-flaking coating not acted upon by molten brass is provided on the inner surface.—W. F. F.

Lead sulphide ores; Treatment of — [to produce basic lead sulphate]. P. C. H. West, London. Eng. Pat. 102,377, Nov. 16, 1916. (Appl. No. 16,414 of 1916.) Under Int. Conv., Nov. 24, 1915.

SEE U.S. Pat. 1,225,296 of 1917; this J., 1917, 655.

Furnace for annealing metals. R. Masters, Dudley. U.S. Pat. 1,241,750, Oct. 2, 1917. Date of appl., Aug. 11, 1914.

SEE Eng. Pat. 2866 of 1914; this J., 1915, 364.

Leaching apparatus. U.S. Pat. 1,240,904. See I.

XI.—ELECTRO-CHEMISTRY.

Electro-chemical plant; The sub-station problem of —. J. L. McK. Yardley, Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 20 pages.

ELECTRICAL apparatus has now been largely developed in the direction of low-voltage, large-capacity designs such as is demanded by electro-chemical processes. Variations in the applied voltage which are of considerable magnitude in electrolytic processes, on account of variations in resistance during the progress of electrolysis, or through changes in the number of cells connected in the circuit, can be provided for by means of "boosters." With rotary converter units of 300 kilowatts, giving a voltage of 200 to 300, direct-connected alternating-current "boosters" have been developed so as to make it possible to vary the direct current voltage delivered by the rotary converter by 30 or 40 volts on either side of the

mean value obtained when operating upon a particular transformer tap. Small variations, such as those brought about by fluctuations in power supply, have been provided for by employing rotary converters with direct connected, synchronous, alternating-current "boosters," though, more usually, the voltage has been equalised by introducing more than the normal amount of reactance in the step-down transformers or more copper in the field coils of the rotary converters. Line variations in the rotary converter are also met by varying the strength of the field current, a typical range for such an installation as that mentioned above being 237½ to 262½ volts. In the aluminium industry, a direct current voltage of approximately 250 volts was formerly used, enabling about 40 cells each taking 6 volts to be connected in series, and making it possible to cut out individual cells without involving any appreciable voltage variation on the leads. An improved efficiency in aluminium electrolysis has now, however, been gained by employing a direct current voltage of 500 to 550. The maximum efficiency of the rotary converter is practically reached at 600 volts, above which the cost of apparatus and operation troubles increase largely. In the electro-deposition and refining of metals, such as copper and zinc, a voltage range of 2:1 is frequently, and 3:1 sometimes, encountered through withdrawals of large sections of the tank for the removal of the metal and treatment of the electrolyte. This large voltage range can usually be supplied more satisfactorily by an installation of "booster" rotary converters arranged by providing one or two taps on the primary or secondary of the transformer and by providing the necessary switching for quickly transferring the "booster" rotary converter from one tap to another. By this means an extreme variation of 2.5:1 can be arranged. An alternative is to employ motor generator sets with separate exciters, whereby a continuous change of voltage is possible.—J. N. P.

Mica; Electrical conductivity of—E. Branly. Comptes rend., 1917, 165, 450—455.

A SHEET of unpierced mica, 0.003 mm. in thickness, was interposed between two metallic discs with plane polished surfaces, and contact between the sheets was ensured by means of a gas compression pump acting on one of the discs, the other disc being supplied with weights. The pressure was measured by a mercury and an ethylene dibromide manometer in parallel. A source of continuous current, such as a thermo-electric pile with Bi-Ag elements, or a Daniell's cell, and a galvanometer, were also placed in the circuit. With a sheet about 0.003 mm. thick, the mica allowed the current to pass from a single thermo-electric element at an E.M.F. of 0.004 volt. The conductivity was often immediately complete, manifesting itself as soon as a slight pressure was put on the sheets. An insignificant shock, or a feeble oscillating discharge at a distance, brought about the passage of the current when the pressure was removed. When the thickness exceeded 0.004 mm. the conductivity did not show itself with an initial E.M.F. as feeble as that of a single thermo-electric element and an E.M.F. of at least 1 volt was required, the conductivity rising by jerks and being only slowly established. The actions of shock, and of electric discharge at a distance, were again like those on ordinary detectors as used in wireless telegraphy.—B. N.

Silver peroxide and the valence of silver. Weber. See VII.

Electrolytic pickling process and its effect on the physical properties of iron and steel. Coulson. See X.

Electro-analysis apparatus. Jones, See XXIII.

PATENTS.

Selenium and like sensitive cells. M. Martinez. London, Eng. Pat. 109,486, Sept. 16, 1916. (Appl. No. 13,181 of 1916.)

A THIN sheet or granular layer of prepared and annealed selenium, or like material, is placed between opposite sources of light and heat, one of which is kept constant at a required intensity while the other is made variable so as to render the general resistance of the cell capable of adjustment. The granular layer is held between metallic electric conductors formed of netting, wire, or perforated metal. The selenium sheet is made by first granulating the material, and then forming it into a sheet between discs which are caused to move one on the other under pressure, and annealing the sheet at a temperature between 120° and 200° C. whilst between the discs.—B. N.

Furnaces; Electric—J. O. Boving, London. Eng. Pat. 109,465. (Appl. Nos. 12,687, Sept. 7, 1916, and 2807, Feb. 26, 1917.)

THE current is maintained constant in an electric furnace, by means of a hydraulic organ for modifying the position of the electrode conveying the current. The supply of fluid under pressure to the hydraulic organ is regulated by a valve actuated directly by the fluid pressure, and a balanced escape valve for the fluid is provided, its position being automatically adjusted by electro-magnets. The electro-magnetic arrangement is energised directly by a current shunted from the electrode leads, or by a transformer current, derived from the primary current through the main electric lead and electrode, or a shunt therefrom. This secondary current is used to energise an electro-magnetic device, comprising a construction such as is employed in a single-phase repulsion motor. A rheostat is also provided whereby a hand adjustment may be used in addition to the automatic adjustment of the current.—B. N.

Furnaces; Method of producing and controlling high temperatures in electric—J. J. Denton. London, Eng. Pat. 109,639, Aug. 21, 1916. (Appl. No. 11,844 of 1916.)

HIGH temperatures in an electric furnace are produced by forming an ionising path for the current by chemical agency, employing compounds which in a state of fusion or when blended with others set up free ions, and the temperature is afterwards controlled by additions to the furnace to an extent to suit the temperature required. Thus, caustic alkali mixed with sand may be sprinkled in a gully made in the resistor material, or may be used in the form of a cartridge placed on the resistor material between the electrodes, and moistened with water. Ions are thus produced for starting the conduction of the current. The temperature may be localised by adding to desired parts of the resistor, to suit the temperature required, further material, such as lime, which is adapted to produce an increased ionising path at a higher temperature, and therefore produces an increased flow of current.—B. N.

Furnace; Electric—D. R. Knapp, Assignor to The Eastern Steel Co., Pottsville, Pa. U.S. Pat. 1,240,460, Sept. 18, 1917. Date of appl. Feb. 19, 1916.

AN induction furnace is provided with a fixed base, and a supporting casting mounted on the base so that it may be revolved. A circular element is supported by a trunnion on the casting, and a crucible or trough is mounted on it. The

furnace is provided with means for heating the metal in the trough by induction, and it may be locked against rotation. An oscillating movement of the circumference may be given to the trough in its locked position, by varying the plane of the circular element, and when the furnace has been released it may be revolved to discharge the metal in any radial direction. A maximum cross-sectional area of metal at one part of the trough, and a minimum cross-sectional area at another part, may thus be produced, and the position of the maximum and minimum areas may be varied simultaneously.—B. N.

Electric furnace; Polyphase—J. L. Dixon, Detroit, Mich. U.S. Pat. 1,241,499, Oct. 2, 1917. Date of appl., June 26, 1917.

In a three-phase electrode furnace, the current flowing through one of the electrodes passes through a solenoid and is counterbalanced to a larger or smaller degree by an opposing smaller solenoid. By means of movable magnetic cores connected to a pivoted beam, the opposing magnetic flux is adjusted by the resultant of the currents flowing through the other electrodes, and at the same time the movable beam actuates the circuit controller of a motor which raises or lowers the first-mentioned electrode.—J. N. P.

Electric furnaces; Regulating apparatus for (automatic adjustment of electrodes in)—W. Sykes, Pittsburgh, Pa., Assignor to Westinghouse Electric and Manufacturing Co. U.S. Pat. 1,241,574, Oct. 2, 1917. Date of appl., Apr. 12, 1912.

THE electrode is suspended by a cord passing over a pulley and round a conical drum connected to a motor. The electrode is counterbalanced by a weight attached to a cord wound, in the opposite direction, round a cylindrical portion of the drum and the variations in the weight of the electrode as it is consumed are compensated by the movement of the cord on the conical drum. The motor is operated by a current induced from the main circuit, and thus adjusts the height of the electrode above the furnace to maintain a definite constant strength of current in the arc.—J. N. P.

Electric-arc furnace [for nitrogen fixation], O. J. S. Platou, Assignor to Norsk Hydro-Elektrisk Kvaestofaktieselskab, Christiania, Norway. U.S. Pat. 1,241,655, Oct. 2, 1917. Date of appl., June 2, 1916.

In an arc furnace with a magnetically spread flame, the circular reaction vessel has the shape of a tall narrow rectangle in cross-section and is surrounded by a casing of approximately spherical shape. The windings of the magnet coils are arranged in the air space between the reaction chamber and the outer casing, and the magnet poles, which project a short distance into recesses in the walls of the inner chamber, are in metallic connection with the outer casing. By maintaining a slight negative pressure, air for the reaction is drawn into the inner air space through holes in the walls of the inner chamber from the air space between the casings.—J. N. P.

Insulation of condensers for telephone circuits, C. Cordes, Magdeburg, Germany. U.S. Pat. 1,241,926, Oct. 2, 1917. Date of appl., Dec. 17, 1910. Renewed Jan. 18, 1917.

A MATERIAL for impregnating telephone condensers which is solid, easily fusible, and of higher insulating capacity than paraffin, is prepared from castor oil by treatment with hydrogen in the presence of finely-divided catalytic metal at a raised temperature.—J. N. P.

Electrolytic apparatus, H. R. Hanley, Wintthrop, Cal., Assignor to Bully Hill Copper Mining and Smelting Co. U.S. Pat. 1,241,967, Oct. 2, 1917. Date of appl., June 5, 1916.

In an electrolytic cell with the anodes and cathodes in close proximity, use is made of a hollow anode having a number of openings in the lower part, through which air is delivered so as to brush away gas bubbles adhering to the cathode.—J. N. P.

[*Electrical contacts; Compositions of matter [for —] and processes of making same*. A. J. Liebmann, New York. Eng. Pat. 109,870, Nov. 2, 1916. (Appl. No. 15,692 of 1916.)

SEE U.S. Pat. 1,177,119 of 1916; this J., 1916, 608. Molybdenum, titanium, or the like may be used in place of tungsten, and the components are preferably mixed with a binder which can be subsequently volatilised. Mercury, introduced in the form of copper amalgam, may be used as binder.

Electrolysing apparatus, R. J. J. Mueller, and Universal Oxygen Co., Sheboygan, Wis., U.S.A. Eng. Pat. 110,036, Oct. 16, 1916. (Appl. No. 14,690 of 1916.)

SEE U.S. Pat. 1,221,206 of 1917; this J., 1917, 602.

XII.—FATS; OILS; WAXES.

Palm kernel oil; Methyl nonyl ketone from—A. H. Salway. Chem. Soc. Trans., 1917, 111, 407—410.

THE author has succeeded in isolating methyl nonyl ketone from the volatile matter removed from palm kernel oil by steam distillation in the deodorisation process. The crude material used, which had been obtained on a large scale, consisted of a semi-solid fatty mass holding water in a state of emulsion, and containing 30% of free fatty acids, 26% of neutral fat, 1.2% of neutral volatile oil, and 28.7% of water. The odour and taste of the original palm kernel oil are essentially caused by the volatile neutral oil and to a minor extent by the volatile fatty acids. The crude material was again distilled in a current of steam, the volatile oil dissolved in ether and shaken with sodium hydroxide solution to remove fatty acids, and methyl nonyl ketone isolated from the neutral volatile oil by means of its sodium bisulphite compound. In an experiment starting with palm-kernel oil, 1200 grms. of the oil yielded 1.4 grms. (0.12%) of neutral volatile oil containing 90% of methyl nonyl ketone. Coconut oil treated in the same way yielded 0.03% of neutral oil, of which only 30% could be converted into a semicarbazone (compare Haller and Lassieur, this J., 1910, 704, 1330).

Turkey-red oil products; Technical analysis of—A. Goldberg and E. Zipper. Chem.-Zeit., 1917, 41, 401—402.

THE composition of commercial products consisting of mixtures of Turkey-red oil with various fat-solvents (petroleum spirit, oil of turpentine, chlorinated hydrocarbons, etc.) may be ascertained with sufficient accuracy in most cases by distillation with steam, followed by fractional distillation of the volatile portion and determinations of specific gravity, chlorine content, etc., of the fractions. Turkey-red oil itself yields no volatile oily products on distillation with steam.

Theory of contact catalysis. Poisoning of catalytic agents, Bancroft. See I.

Investigation of the seeds of Pangium edule and Hydnocarpus alcala, Brill. See XX.

PATENTS.

Hydrogenation of oils. E. B. Maxted and J. R. Ridsdale, Walsall. Eng. Pat. 109,993, Sep. 29, 1916. (Appl. No. 13,837 of 1916.)

A LARGE reacting surface of unsaturated oil and hydrogen is obtained by projecting the mixture through a vertical column provided with fixed horizontal propeller-like baffle-plates so shaped and placed in opposition to each other that the moving liquid-gas mixture is rotated alternately clockwise and anti-clockwise.—A. DE W.

Oil-stock clarifier, seeder, and breaker. G. L. Noble, Chicago, Ill. U.S. Pat. 1,249,869, Sep. 25, 1917. Date of appl., Nov. 15, 1916.

THE apparatus consists of a cylindrical tank fitted with an internal co-axial rotary shaft carrying scrapers adjacent to the tank walls, and a pipe coil. The coil is connected to the hollow shaft, which can be supplied with hot or with cold water. The tank has an upper inlet for charging, and the lower part is constricted to form a trough which contains a screw conveyor and an outlet for discharging.—A. DE W.

Detergent compounds; Washing — and modes of using the same. H. C. Wilson, Kendal. Eng. Pat. 109,846, Sep. 28, 1916. (Appl. No. 13,777 of 1916.)

AN improved detergent liquor for fabrics, etc., is obtained by adding oleic or other fatty acid dissolved in a liquid hydrocarbon or chloro-derivative of the same to ordinary soapy or washing liquor. The solution may also be applied to the fabric before treating with washing liquor.—A. DE W.

Soap. M. Spazier, Los Angeles, Cal. U.S. Pat. 1,241,943, Sep. 25, 1917. Date of appl., Jan. 27, 1917.

A SOAP compound is composed of soap, 50.72; moisture, 11.90; sodium carbonate, 32.39; ammonium acetate, 1.79; and sodium acetate, 3.20%.—A. DE W.

Washing crystal. M. Spazier, Los Angeles, Cal. U.S. Pat. 1,241,044, Sep. 25, 1917. Date of appl., Jan. 27, 1917.

A WASHING crystal consisting of water, 57.28; sodium carbonate, 40.02; ammonium acetate, 2.22; and sodium acetate, 0.48%.—A. DE W.

Insulation of condensers for telephone circuits. U.S. Pat. 1,241,926. See XI.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

PATENTS.

Cement paint. K. S. Laurie, Allahabad, India. Eng. Pat. 109,951, May 22, 1917. (Appl. No. 7343 of 1917.)

A PAINT is obtained by adding "a liquid hydrocarbon of the petroleum series" to a mixture of Portland cement and linseed oil, no further grinding being required.—A. DE W.

Paint and process of making same. W. A. West, Elkhorn, Wis. U.S. Pat. 1,241,067, Sep. 25, 1917. Date of appl., Aug. 18, 1916.

A PERMANENT emulsion paint is made by mixing a paint oil with an immiscible diluent of different specific gravity, e.g., skim milk, the mixture being homogenised by forcing it under a pressure exceeding 500 lb. per sq. in. through a medium impermeable under lower pressure, then mixing with a "body material," pigment, and an additional diluent liquid.—A. DE W.

Phenol-aldehyde condensation products. A. W. C. van Voorhout, The Hague. Eng. Pat. 110,041, Oct. 30, 1916. (Appl. No. 15,465 of 1916.)

TRANSPARENT phenol-formaldehyde condensation products are produced by heating together equal weights of pure phenol or cresol and formaldehyde together with a small amount of a basic catalyst, e.g., potassium hydroxide, until all the solvent water and about one-half of the water set free by condensation are distilled off and strong foaming occurs, when heating is discontinued; 20% by volume of a neutral liquid other than water, such as strong methyl or ethyl alcohol, is then added to prevent development of excessive heat and to facilitate expulsion of remaining water. When one-half of the alcohol is distilled off, the mass is run out into moulds. The final stages of the reaction are carried out slowly in a current of air at temperatures gradually increasing from 60° C. to 120° C. or higher, at normal pressure, over a period of about 30 hours. For opaque condensation products, impure phenol or cresol may be used, and alcohol replaced by 1 to 4% of turpentine and 2 to 3% of glycerin, whilst the addition of vaseline facilitates removal of the product from the mould.—A. DE W.

Phenols and formaldehyde; Manufacture of insoluble condensation products from —. W. Reeser, Amsterdam, Holland. Eng. Pat. 10,055, July 9, 1915. Under Int. Conv., July 29, 1914.

SEE Fr. Pat. 479,319 of 1915; this J., 1916, 1164.

Plastic composition [from polymerised vinyl esters] and process of producing it. F. Klatte and A. Rollett, Schwanheim, Assignors to Chem. Fabr. Griesheim-Elektron, Frankfurt, Germany. U.S. Pat. 1,241,738, Oct. 2, 1917. Date of appl., July 2, 1914.

SEE Ger. Pat. 281,687 of 1913; this J., 1915, 623.

Apparatus for treating the ocotillo plant for extracting the gum therefrom. U.S. Pat. 1,240,894. See XVII.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

PATENTS.

Vulcanising; Apparatus for —. Soc. pour la Production et la Vente des Articles en Caoutchouc "Bogaty", and J. A. Talalay, Moscow. Eng. Pat. 109,906, Dec. 30, 1916. (Appl. No. 18,673 of 1916.)

UNIFORMITY of temperature is maintained by a steady injection of air or other gas from a number of nozzles along the length of the lower part of the vulcanising apparatus; the gas first streams upwards over a series of vertical steam coils and is then directed downwards by a series of baffles; part of the gas then passes into the outer atmosphere and part enters on a new cycle around the previous path. The articles under treatment therefore receive part of the necessary heat direct from adjacent steam coils and part from the circulating gas which has been heated in the manner described.—D. F. T.

Vulcanisation of rubber and similar materials. Dunlop Rubber Co., Ltd., London, and D. F. Twiss, Sutton Coldfield. Eng. Pat. 110,059, Dec. 9, 1916. (Appl. No. 17,756 of 1916.)

THE process of vulcanisation is accelerated by the introduction into the rubber mixing of a caustic alkali, such as sodium hydroxide or potassium hydroxide, either mixed with a finely-divided mineral compound or dissolved in an organic compound such as glycerol.—D. F. T.

[Chewing] gum and process of making same. W. B. Pratt, Wellesley, Mass. U.S. Pat. 1,240,875, Sep. 25, 1917. Date of appl., Nov. 1, 1913. Renewed Feb. 28, 1917.

THE solid, coagulated gummy residuum of the latex of the "cow tree," in which the original starch has been converted into sugar, is suitable for use as chewing gum. It is plastic and non-adhesive in the presence of water at 98° F. (37° C.), and brittle at about 50° F. (10° C.).—A. DE W.

Apparatus for treating the ocotillo-plant for extracting the gum therefrom. U.S. Pat. 1,240,894. See XVII.

XV.—LEATHER; BONE; HORN; GLUE.

Tanning process in jellies: Ultramicroscopic investigation of the — W. Moeller. *Kolloid Zeits.*, 1917, 20, 257—270. *J. Chem. Soc.*, 1917, 112, ii., 454.

THE formation of an insoluble salt by the interaction of an electrolyte in aqueous solution and a second electrolyte in the jelly is not an essential condition in the production of laminated structures. An aqueous solution of silver nitrate when left in contact with a gelatin jelly containing no added electrolyte, gives rise to the formation of alternating layers. This cannot be attributed to the presence of small quantities of chlorides and phosphates in the jelly, for the same result is obtained when pure gelatin is used. The laminated structure would indeed seem to be produced when any ionisable salt diffuses into a jelly. The same heterogeneous structure results when gelatin jellies are subjected to the action of tanning solutions. The author's view (see this J., 1917, 465) that gelatin consists of a fibrillated substance (α -gelatin), the spaces between the fibrils being filled by a structureless substance (β -gelatin), is made the basis of an explanation of the rhythmic effects which are the result of the diffusion processes which occur when jellies are brought into contact with solutions of salts.

PATENTS.

Tanning substances soluble with difficulty contained in crude quebracho liquors; Process for treating — H. Franke, Wilsdorf, Austria. Assignor to A. Redlich, Vienna. U.S. Pat. 1,241,950. Oct. 2, 1917. Date of appl., June 26, 1914.

SEE Eng. Pat. 17,273 of 1914: this J., 1915, 971.

Method of drying casein. U.S. Pat. 1,240,816. See XIXA.

XVI.—SOILS; FERTILISERS.

"Black alkali" (sodium carbonate) in calcareous soils; Formation of — J. F. Breazeale. *J. Agric. Res.*, 1917, 10, 541—590.

THE term "alkali" applied to soils is commonly employed in the United States to designate an accumulation of soluble salts in soil, which, in the case of sodium carbonate, causes the soil solution to be dark coloured. The case investigated by the author is the presence of sodium salts in a calcareous soil. A series of solutions of a sodium salt, in distilled water free from carbon dioxide, of graduated concentrations was prepared and put into bottles with calcium carbonate, and the bottles were tightly stoppered and shaken for several days. The solutions obtained were titrated for sodium carbonate, using phenol-

phthalein as indicator. A series of tests was made also in presence of carbon dioxide, and the solutions were titrated for sodium bicarbonate using methyl orange as indicator. The effect of the presence of soluble calcium salts in these reactions was studied. It was found that small amounts of calcium nitrate and chloride greatly impeded the formation of sodium carbonate from sodium nitrate, chloride, and sulphate and calcium carbonate, and that on increasing the amounts the reaction could be stopped. The presence of calcium sulphate impeded but did not stop the reaction. Similar results were obtained in presence of carbon dioxide, except that calcium sulphate had no inhibitory action when sodium sulphate was the sodium salt used. The experiments were repeated in the presence of soil, and it was found that sodium salts increased the solubility of calcium carbonate in the soil, and that the formation of sodium carbonate took place as before. The sodium carbonate formed decomposed the organic matter of the soil, and in this respect was more active than sodium bicarbonate. The organic matter was partly protected from this action by the presence of sodium chloride and sulphate. The author's conclusion is that the crusts and barren spots found in alkali soils are due to the formation of sodium carbonate by the action of sodium salts on calcium carbonate.—J. H. J.

Gypsum as a fertiliser. O. Nolte. *J. Landw.*, 1917, 65, 67—73. *J. Chem. Soc.*, 1917, 112, i., 624.

OWING to its ability to undergo hydrolytic decomposition into acid and base, gypsum influences the reaction of the soil especially by virtue of the constituent with the predominating reaction, that is, the sulphuric acid. Consequently, as far as possible, gypsum should not be used with acid and physiologically acid fertilisers, and in particular should never be applied to acid soils. On the other hand, it acts favourably in conjunction with physiologically basic salts, as it removes or weakens the basic reaction resulting from plant growth, and so assists in the retention of a loose texture by the soil. Gypsum may be employed with advantage when there is a shortage of such physiologically active fertilisers as potassium sulphate and chloride, superphosphate, and ammonium sulphate.

Boron: Effect of three annual applications of — on wheat. F. C. Cook and J. B. Wilson. *J. Agric. Res.*, 1917, 10, 591—597. (See also this J., 1915, 675; 1916, 319.)

HORSE manure containing sufficient borax to act as a fly larvicide was used to fertilise an experimental plot of land on which wheat was grown for three successive years. On another plot, colemanite was used as the source of boron, and there were also control plots of manured and unmanured land. The borax was applied at the rate of 154 lb. of boric acid per acre in the first year and at the rate of 38.5 lb. (i.e., an amount sufficient to destroy larvæ) in the following years. The colemanite, which is less effective than borax as a larvicide, was applied at the rate of 50.75 lb. of boric acid per acre. It was noticed that there was a yellowing of the young wheat after the heavy dose of borax in the first year, and that there was a reduced yield of grain of about 10% in the first two years, while colemanite had little effect. In the last year all yields were low. Only minute amounts of boron were absorbed by the wheat and were divided about equally between the straw and the grain. Soluble boron compounds could be detected in the soil nine months after the first heavy dose, but not after the other doses. The boron appears to be gradually converted into insoluble compounds, and there is no evidence of a cumulative action.—J. H. J.

Coal gas ; Action of — on plants. III. Action of coal gas, whilst passing through soil or water, on roots and leafy branches. C. Wehmer. Ber. Deuts. Botan. Ges., 1917, 35, 403—410. J. Chem. Soc., 1917, 112, i., 618—619. (See also this J., 1917, 1021, 1106.)

ANNUAL plants such as cress, grasses, and beans, were grown in culture solutions through which coal gas was slowly bubbled, or in pots so arranged that coal gas could be led into the soil from above or below ; and leafy shoots of the lime, elder, privet, illex, *Philadelphus*, and various conifers were kept under observation in culture solutions treated with the gas. Undiluted coal gas was found to be highly toxic for the roots of plants, but the constituents of the gas which dissolve in water are not so acutely dangerous. The effect on young cress, for example, is much more striking if the gas is led upwards through the soil than if it is just led into the top layers. The experiments on leafy shoots showed that the ill-effects of coal gas on the upper parts of a plant are not always conditioned by damage to the roots. The effects of the ascent of water charged with the gas into the shoots vary remarkably from part to part of the shoot and from plant to plant. With the exception of the yew, most conifers are highly resistant, but the usual effect is an early shedding of the leaves, the rind and buds remaining practically unhurt. An atmosphere containing 1% of hydrogen sulphide is fatal to the seed or seedlings of cress, but in the concentration 0.03%, that is, more than is commonly found in coal gas, this "poison" is distinctly beneficial to the germination of cress.

Sulphuric acid ; Effect of addition of — to the soil on the growth of the beet. K. Andrlík. Z. Zuckerind. Böhm., 1917, 41, 685—688. J. Chem. Soc., 1917, 112, i., 620.

INSTEAD of adding soluble nutrients to the soil, the author has tried the effect of applying cheap chemicals, like the mineral acids, to render more of the natural constituents of the soil available to the plant. He has compared the growth of the sugar beet on field plots sprinkled before seed-time with dilute sulphuric acid (2—4 kilos. per acre) and on untreated plots, and finds indications that the weights of root and leaves are less, but the quantity and quality of the sugar slightly greater on the treated soil.

Plants ; Action of — on organic substances. G. Ciamician and C. Ravenna. Gazz. Chim. Ital., 1917, 47, II., 109—129.

IN order to determine whether the facts previously recorded (this J., 1917, 559) could be attributed to enzymic action of the plants, a series of experiments was made in which spinach leaves, preserved from putrefaction by toluene, were kept in contact with various organic substances for a month, in a current of oxygen. The carbon dioxide evolved was measured by absorption in baryta water. Catechol and saligenin were decomposed to a considerable extent, whilst salicylic and benzoic acids were practically unchanged, but partially inhibited the enzymic action of the leaves. Pyridine and piperidine were unaltered, but nicotine showed some autoxidation after exposure to light. Substances showing the greatest decomposition were also most readily affected by potassium permanganate. The enzymes were not present in the expressed juices of the leaves, but were insoluble and adhered to the material. No definite relationship could be traced between the amounts of carbon dioxide liberated and the decomposition of particular substances. The experiments indicate that it is not possible to state definitely that the diminution in substances inoculated into plants is due to autoxidation.—C.A.M.

Plants ; Nutrition of green — by means of organic substances. C. Ravenna. Gazz. Chim. Ital., 1917, 47, II., 131—139.

MAIZE plants were cultivated in sterile solutions of nutrient salts containing from 1 to 10% of dextrose. The leaves of plants which had been exposed to light during the cultivation contained starch, even when no carbon dioxide had been present. The region of the solar spectrum which had the greatest influence on the formation of starch was that which had also the greatest influence on the chlorophyll function. Plants cultivated in the solutions in an atmosphere free from carbon dioxide and oxygen did not show any formation of starch, even in the light. The general conclusion drawn from the experiments is that dextrose absorbed by the roots is oxidised in the plant system to carbon dioxide, which the chlorophyll of the leaves converts into starch.

—C. A. M.

Phosphates of calcium. Part IV. The basic phosphates. Bassett. See VII.

XVII.—SUGARS ; STARCHES ; GUMS.

Sugar refinery products ; Origin of the nitrogenous colouring matters in —. V. Staněk. Z. Zuckerind. Böhm., 1917, 41, 607—614. J. Chem. Soc., 1917, 112, i., 544. (Compare this J., 1917, 935, and Stoltzenberg, 1916, 1169.)

IT has been suggested that the nitrogenous colouring matters (including "fucosezinc acid") in molasses and desaccharification residues may owe their formation to the condensation of amino-acids with sugars during the refinery processes. Maillard (this J., 1912, 144 ; compare A. R. Ling, this J., 1908, 1033) has already shown that many free amino-acids react with the common sugars to form such products, and the author has now tested whether such a condensation can take place in more or less alkaline solutions. It is found that when solutions of invert-sugar or sucrose are heated in an autoclave at 105°—130°C. with sodium glutamate or aspartate or with asparagine, carbon dioxide is liberated, the solutions become acidic, and dark colouring matters are formed which are almost completely precipitated by lead acetate. The same colouring matters are obtained if precipitated chalk is added to overcome the acidity. Without the amino-acid, the colour of the solution is not so deep, and the colouring matter is completely soluble in alcohol. With the amino-acid, nitrogenous substances which do not dissolve in alcohol are produced as well. A fraction, which somewhat resembles fucosezinc acid in being a very dark brown powder, soluble only in alkalis, has been isolated. Asparagine and aspartic acid give rise to much more of this product than glutamic acid.

Molasses ; The nitrogenous colouring matters of —. (1) H. Friedrich. (2) V. Staněk. Z. Zuckerind. Böhm., 1917, 41, 614—618. J. Chem. Soc., 1917, 112, i., 544—515.

FRIEDRICH states that about 72% of the sucrose present can be precipitated in a pure white condition by mixing molasses with an equal quantity of cold glacial acetic acid. Most of this acid may be recovered in a concentration of 71% by distillation, when a dark brown, asphalt-like mass is left containing about 18% of ash (23.75% K). This residue may be worked up for betaine by trituration with about six times its bulk of methyl alcohol. The insoluble portion (27%) is a nitrogenous colouring matter containing about 3.4% of nitrogen, and yielding yellow derivatives on nitration. Friedrich agrees with Staněk (see

preceding abstract) as to the nature of the nitrogenous colouring matter, except that he regards the condensation of the amino-acids as taking place with caramel substances rather than with the sugars themselves. He therefore proposes the term "caramelazine substances."

Slaněk points out that the colouring matters which he has obtained by heating solutions of sugars and salts of amino-acids were formed at temperatures below that at which caramel is produced. He also suggests that Friedrich was dealing not only with the original colouring matters of molasses, but also with new ones produced during the distillation by the condensation of the invert-sugar and amino-acids under the influence of the acetic acid.

Effect of addition of sulphuric acid to the soil on the growth of the beet. Andrlík. See XVI.

Influence of glycerol on the activity of invertase. Bourquelot. See XVIII.

Determination of starch in preserved meats, etc. Challet. See XIXa.

Determination of starch in clover. Von Fellenberg. See XIXa.

PATENTS.

Sugar syrup; Manufacture of inverted—N. W. Taussig, New York. Eng. Pat. 103,989, Jan. 25, 1917. (Appl. No. 1293 of 1917.) Under Int. Conv., Feb. 7, 1916.

SEE U.S. Pat. 1,181,086 of 1916; this J., 1916, 648. A small quantity of an edible gum may be added to the sugar solution.

Ocotillo plant; Apparatus for treating—for extracting the gum therefrom. E. W. Snyder, Los Angeles, and J. D. Crawford, San Francisco, Cal. U.S. Pat. 1,240,891, Sep. 25, 1917. Date of appl., Dec. 16, 1916.

THE apparatus consists of a digester fitted internally with a container for the plant. The container is open at the top, and the sides and bottom are perforated, and means are provided for heating between the lower part of the digester and the bottom of the container. The gum solvent is introduced in the form of a spray at the top of the digester and is directed into the container by vertical baffle-plates fitted to the top of the digester. The baffles also ensure the return to the container of condensed liquid from a cooler arranged in the top of the digester between the baffles. The digester is fitted with an outlet for discharging the extract at the bottom.—A. DE W.

XVIII.—FERMENTATION INDUSTRIES.

Malting and brewing in Germany during the war. W. Windisch. Woch. Brau., 1917, 34, 1—2, 9—10, 17—20, 25—29, 33—35, 41—44, 49—52, 57—60, 65—68, 73—78, 81—83, 93—96, 101—105, 113—117, 121—125, 129—134.

WITHIN the first year of the war the brewing of thin beers became necessary owing to reduced malt supplies. These "war beers" surpassed expectation in respect of head-retention, fullness of flavour, and stability, and they will probably remain popular after the war. In the second year the brewing of thin beers was further complicated by the exceptionally poor malting quality of the 1915 barleys, these containing a large proportion, e.g., 20—40%, of corns which germ-

inated only to the "chitting" stage under malting conditions. Good results were attained with these malts nevertheless, by fine grinding, cold pre-mashing, and proteolytic digestion; high yields of extract were thus obtained and the beers were rich in soluble nitrogenous matters which enhanced their fullness of flavour and still more their head-retaining power. The special measures referred to have been advocated for some time by the author (this J., 1916, 1170; also Emslander, 1917, 156, and Lehmann, 1917, 515) as enabling imperfectly modified or short-grown malts to be satisfactorily employed in brewing, and he considers that the experience gained with the malts from 1915 barleys will lead to a preference for short-grown malts, which of course entail a much smaller malting loss than those germinated for the usual period. When the shortage of malt became serious the German Government permitted the use of sugars in brewing for top-fermentation beers, but there is now no sugar available for this purpose. Discussing the flavour of "war beers" the author emphasises the importance of "condition," which not only contributes to the stability of the beers but also masks slight defects of flavour. Alcohol is another very important factor in conferring fullness of flavour, and for this reason it is undesirable to restrict attenuation in order to retain extract in the finished beer, or to produce worts rich in dextrins at the expense of fermentable sugar, for dextrins do not contribute much to palate-fulness. The paper contains a long description of the advantages of the mash-filter in brewing, and in a final theoretical section the author sets out his views on the interaction of the salts of brewing waters with those derived from the malt, and also on the changes undergone by the salts and sulphur present in barley, during germination (see this J., 1917, 608).—J. H. L.

Beers; Preparation of thin—and substitutes during the war. K. Windisch. Woch. Brau., 1917, 34, 213—215, 224—227.

A CIRCULAR issued by the German Brauerbund, relating to the production of light beers, recommends thin mashing, with cold pre-mashing if necessary, plentiful hopping, unrestricted fermentation at not too low temperatures, with frequent and vigorous rousing, and fairly long storage under a moderate pressure with a view to complete attenuation and good condition. The author discusses these and other points, more particularly in relation to the brewing of very thin beers, e.g., of 3% original gravity. By mashing-in with a large amount of water, so as to produce a first wort, say of 8° Balling, the dissolution of extract is facilitated and sufficient water is left over for sparging. Cold pre-mashing and proteolytic digestion are strongly recommended (cp. W. Windisch, preceding abstract; also this J., 1916, 1170). Mashies should be held for some time, e.g., half an hour, at the lower conversion temperatures, 62°—67° C., to ensure the maximum production of fermentable sugars, the formation of large amounts of dextrins being inadvisable (cp. preceding abstract). Plentiful hopping is essential for stability, flavour, and retention of head, and the amount used should be limited only by what the beer will stand. The primary fermentation must be arrested whilst sufficient sugar remains to bring the beer into condition during storage. The great importance of a high content of gas for thin beers renders it desirable to prolong storage for at least 3 or 4 weeks, under a pressure, say, of 0.4 atm., and at a temperature of about 3°—4° C., not low enough to cripple the yeast present. The necessity for shortening the primary fermentation makes it difficult to produce enough yeast for pitching.

The author describes methods of meeting this difficulty, which consist in producing two worts of different gravities, using the denser one for the production of the pitching yeast and afterwards adding the weaker one as krausen or priming, or if a single 3% wort is produced the yeast may first be grown for a short time in a small quantity of strong wort before pitching (cp. Schönfeld and Goslich, following abstract). In conclusion the author makes some remarks on non-alcoholic beverages.—J. H. L.

Yeast; Growth and fermentation of — in thin worts. F. Schönfeld and C. Goslich. *Woch. Brau.*, 1917, 34, 205—206.

THE authors discuss their experience of the fermentation of thin worts at the brewery of the Versuchs- und Lehranstalt Berlin. In bottom-fermentations 0.5 litre (0.26 kilo.) of pressed yeast was used per hectolitre for 7% as for 11% worts. For 6% worts the amount was finally reduced to 0.33 litre to prevent too rapid fermentation; very satisfactory results were thus obtained with worts treated with 2 lb. of hops per cwt. of malt. The same quantity of yeast was used for 3% worts, smaller amounts being undesirable owing to danger of infection. In top-fermentations 0.33 litre of yeast was used for 6% worts, and if beer of 3% original gravity was required the 6% wort was diluted with hopped water after fermentation. With a ruling temperature of 5°–6° C. in the fermentation cellar, the pitching temperatures found most suitable were 10° C. for bottom-, and 15° C. for top-fermentations. In spite of a slight rise in temperature in the 6% worts, there occurred ultimately a fall of 3°–4° C. To promote yeast growth it was found desirable to rouse the worts and also to stimulate the yeast before pitching by mixing it with a small quantity of 10–12% wort for some hours, to enable it to absorb nutriment and commence budding. By these measures sufficient yeast for pitching was obtained even from the 3% worts, the reproduction being 1½ or 2-fold in these cases, and 3 or 4-fold in the 6% worts. The yeast from the 3% worts, however, required rather frequent renewal.—J. H. L.

Yeast; Extraction of different preparations of dried —. E. Buchner and S. Skraup. *Biochem. Zeits.*, 1917, 82, 107—133. *J. Chem. Soc.*, 1917, 112, i., 613.

FROM yeast treated with acetone, the zymase, pepsin, and endotryptase can only be extracted by water after grinding. This is not the case, however, with air-dried yeast prepared by Lebedev's process. From such preparations, the zymase, etc., are readily extracted by water, and previous grinding does not improve the extracts. The authors discuss in some detail the structure of the yeast and the theories put forward to explain the relationships between the enzymes and the protoplasm.

Fermentation processes; Action of toluene on —. E. Buchner and S. Skraup. *Biochem. Zeits.*, 1917, 82, 134—140. *J. Chem. Soc.*, 1917, 112, i., 613.

TOLUENE has practically no influence on the rate of fermentation by acetone preparations of yeast. This is not in accordance with the results of Euler and Kullberg (this J., 1911, 973). On repeating their experiments (at 31° C.) with Lebedev preparations or maceration juice made therefrom, it was found that toluene did inhibit fermentation, as these authors observed. The inhibition took place however, only in the earlier stages of the fermentation; in later stages this could not be

observed: in fact, after the first inhibition, the rate increased somewhat in the presence of toluene.

Invertase; Influence of glycerol on the activity of —. E. Bourquelot. *Comptes rend.*, 1917, 165, 567—569.

ATTEMPTS to effect a synthesis of sucrose by the action of invertase on dextrose and levulose dissolved in glycerol, gave negative results. Further experiments showed that glycerol affects the enzyme. For example, in 10% aqueous solutions it appreciably impairs, and in 50% solutions almost completely destroys the hydrolytic activity of the invertase.—J. H. L.

Bacillus paralacticus. F. Ducháček. *Biochem. Zeits.*, 1917, 82, 31—47. *J. Chem. Soc.*, 1917, 112, i., 612—613.

B. paralacticus was isolated from lactobacilline. It produces in milk 0.6—0.7% lactic acid, whereas *B. bulgaricus* produces under the same conditions 2.3—2.5%. If the bacillus acts in the presence of the neutralised medium (in the presence of calcium carbonate), 50% of the sugar can be fermented in four months. Under the same conditions, *B. bulgaricus* can cause fermentation of the whole of the sugar within ten to fourteen days. The reason of this difference is that the coagulum produced in the fermentation is sufficiently acid to inhibit the action of the former species of bacillus. The best medium for the growth of *B. paralacticus* is peptonised malt extract containing a suitable sugar. A further distinction between *B. bulgaricus* and *B. paralacticus* is that the latter produces *r*-lactic acid, whereas the former produces an inactive acid. About 4.6% of the acid produced is in both cases acetic acid.

Various modes of combination of methyl alcohol in plants; Determination of pectin- and lignin-methyl alcohol in roots. Von Fellenberg. See XIXA.

PATENTS.

Digesters [for boiling amylaceous materials under pressure]. H. Boulard, Paris. Eng. Pat. 110,015, Oct. 4, 1916. (Appl. No. 14,102 of 1916.)

DIGESTERS used for boiling amylaceous materials under pressure are connected together in pairs by means of a pipe fitted with a valve which, when opened, allows steam to pass from one digester to the other. The connecting pipe is fitted near the top of the digesters so that steam can pass from one to the other without carrying over any considerable amount of material with it. When the boiling is completed in one digester, the valve is opened and steam allowed to pass into the second digester containing a new charge of material. The valve is closed when the pressure of the steam in the first digester is just sufficient to expel the digested material.—J. H. P.

Acetone, alcohol, and yeast; Process for the preparation of —. Farbenfabr. vorm. F. Bayer und Co. Ger. Pat. 291,683, Mar. 10, 1914.

THE wort is subjected to fermentation first with *Bac. macerans* and then with yeast. In this way not only are alcohol and acetone obtained but also a good crop of yeast.

Apparatus for impregnating liquids with carbonic acid or other gases. Eng. Pat. 109,958. See I.

XIXa.—FOODS.

Starch in preserved meats, etc.; Determination of —. Challet. Bull. Soc. Pharm. Bordeaux, 1917, No. 1. Ann. Chim. Analyt., 1917, 22, 206—209.

THE quantity of starch present is found from the cupric-reducing power of the material before and after hydrolysis. The hydrolysis is carried out by boiling 5 grms. of the sample for 1 hour under a reflux condenser with 50 c.c. of a solution consisting of hydrochloric acid (sp. gr. 1.25), 110 c.c., sodium chloride, 100 grms., and water, 400 c.c. Clarification is effected by means of basic lead acetate, phosphotungstic acid, or sodium metaphosphate; the cupric-reducing power is expressed in terms of dextrose, and the difference between the amounts of dextrose found before and after hydrolysis is multiplied by 0.9 to obtain the quantity of starch. If the preserved meat contains liver, the quantity of starch present can only be determined approximately; to allow for unchanged glycogen, the amount of reducing substances found before hydrolysis is multiplied by 2 before it is subtracted from the total reducing substances. Allowance must be made for lactose, if this sugar is present.

—W. P. S.

Starch; Determination of — in clover. T. von Fellenberg. Mitt. Lebensmittelunters. Hyg., 1917, 8, 55—56. J. Chem. Soc., 1917, 112, ii., 515—516.

THE author has recently described a direct method for the estimation of starch (this J., 1917, 935). In certain cases, particularly with ground clover, difficulties are experienced in the precipitation of the starch, due to the action of protective colloids; in such cases, the following modification of the process is advocated. The substance (1 gm.) is dissolved in 20 or 25 c.c. of calcium chloride solution (1:1); the solution is diluted to 100 c.c. and immediately filtered, since otherwise a larger amount of the disturbing substance is dissolved. Seventy-five c.c. of the filtrate is treated with a slight excess of N/50-iodine solution and agitated for five minutes. The residue is extracted with dilute calcium chloride solution (1 in 10; 30—40 c.c.). N/50-thiosulphate solution is added until it is decolorised, and the starch is again precipitated and centrifuged; the residue is treated with a few c.c. of dilute calcium chloride solution containing a few drops of iodine solution, collected in a Gooch crucible, and washed with calcium chloride solution containing iodine. The process is completed as described previously.

Chlorine; Volumetric determination of — in foods, etc., by the wet method without formation of ash. A. Weitzel. Arb. K. Gesundh. Amt., 1917, 50, 397—404. J. Chem. Soc., 1917, 112, ii., 501.

SMALL quantities of chlorine are readily lost in the customary estimation of this substance in the ash of organic substances. Two processes are therefore described which are available for foods, etc., and do not necessitate the preparation of an ash. According to the material, decomposition is effected with nitric acid or sodium hydroxide. The examination of meat or dog biscuit is effected as follows. Air-dried meat (2 grms.) or biscuit (5 grms.) is heated with nitric acid (sp. gr. 1.15, 20 c.c. or 50 c.c.) under a reflux condenser on a boiling-water-bath, with occasional shaking, for thirty minutes. Water (50 c.c. or 20 c.c.) is now added, and the mixture is heated over a gauze to gentle boiling for fifteen minutes. The cooled liquid is treated with 10 c.c. of silver nitrate solution (1 c.c. = 0.005 gm. NaCl), warmed for 15 mins. on the steam-bath, cooled, diluted with water to 100 c.c., and filtered. The excess of silver nitrate

is estimated in 50 c.c. of the filtrate by titration with ammonium thiocyanate in the presence of iron alum. In the examination of ling and salted fish roe, 2 to 5 grms. of the powdered, sieved, air-dried substance (according to the chlorine content) is heated on the steam-bath with occasional shaking during thirty minutes with potassium hydroxide solution (10%, 20—50 c.c.); after being cooled, the solution is diluted to 250 c.c. Twenty-five c.c. of this solution is mixed with nitric acid (sp. gr. 1.15, 20 c.c.) and standard silver nitrate (20 c.c.), and the mixture is heated under a reflux condenser to gentle ebullition until the colour becomes pale. The cold liquid is diluted to 100 c.c., filtered, and the chlorine estimated in 50 c.c. of the filtrate. The process yields accurate results, which are slightly higher than those obtained by the usual method, because, in the latter case, small amounts of alkali chlorides are lost by volatilisation.

Cocoa; Determination of the alkalinity of — and detection of added alkali. X. Rocques. Ann. Chim. Analyt., 1917, 22, 201—204.

THE total ash is determined on a quantity of the cocoa corresponding with 5 grms. of the dry, fat-free substance, and the soluble and insoluble portions of this ash are determined in the usual way by thorough extraction with boiling water; the alkalinity of the soluble ash is found by titration, using methyl orange as indicator and boiling the solution, the result being expressed in terms of K_2CO_3 on the dry, fat-free cocoa. The neutralised solution is then used for the determination of the P_2O_5 . According to French law, the alkalinity of the soluble ash must not exceed 2.75%, expressed as K_2CO_3 on the dry, fat-free substance; if this limit is exceeded, the article must be sold as "solubilised cocoa." With pure cocoa, the quantity of soluble ash is about one-half of the amount of insoluble ash; when 1.5% of added alkali (as K_2CO_3) is present the two quantities are equal, and with larger proportions of alkali the soluble ash exceeds the insoluble ash; the insoluble ash decreases slightly in quantity with increasing quantities of added alkali, due to a portion of the phosphates being rendered soluble. The soluble phosphoric acid shows a corresponding increase. The presence of added alkali, of course, increases the alkalinity of the soluble ash and also to a very slight extent that of the insoluble ash.—W. P. S.

Methyl alcohol in plants; Various modes of combination of —. Determination of pectin- and lignin-methyl alcohol in roots. T. von Fellenberg. Mitt. Lebensmittelunters. Hyg., 1917, 8, 1—29. J. Chem. Soc., 1917, 112, i., 616—617.

IN addition to pectin, the majority of plants contain other methoxy-compounds in which the methoxy-group is more firmly combined and is not eliminated by sodium hydroxide. In such cases, methyl ethers are obviously present. Since Zeisel's process is somewhat cumbersome and does not allow a distinction between the methyl groups present in ester or ether groups, the author has modified his previous process (this J., 1915, 574; 1916, 860). This also presents the advantage of only indicating methyl groups, whilst, by Zeisel's methods, other alkyl groups are also eliminated. The lignocelluloses, and also suberin, contain firmly-bound methyl alcohol. In accord with König and Rump, the author includes under the term "lignin" those non-volatile methoxy-compounds of plants which are insoluble in alcohol and ether and do not yield methyl alcohol when treated with sodium hydroxide, but do so with concentrated sulphuric acid. Since the methoxy-content of these substances is variable and

generally unknown, and the compounds can only be recognised by their methoxy-content, the author prefers to consider them as "lignin-methyl alcohol," and not as "lignin." The assumption of König and Rump (this J., 1915, 1203), that cellulose and lignin are only intimately associated and not chemically united in the crude fibres, is not justified by the evidence they adduce. In connection with the form of occurrence of methyl alcohol in plants, the author has examined pine wood, cork, normal and brown hay, roots and their adulterants, cacao and cacao shells. It is found that the pectin of wood is not identical with that of fruit, since it is insoluble in water and not dissolved when heated under pressure with organic acids. Cork contains several methoxylated acids and a certain proportion of lignin, the methyl alcohol of which constitutes about 25% of the total methyl alcohol. In the fermentation of brown hay, methyl alcohol is eliminated from the pectin and partly oxidised to formic acid; simultaneously, an increase occurs in the lignin-methyl alcohol.

For the estimation of total methyl alcohol, the finely ground sample, freed from fat if necessary (0.2–0.5 grm.), is heated to gentle ebullition for ten minutes with sulphuric acid (72%, 15 c.c.). After cooling water (25 c.c.) is added, and the mixture is distilled until 25 c.c. has been collected. The distillate is made alkaline with sodium hydroxide, and again distilled until 16.2 c.c. has passed over. With substances of low methoxyl content, two further distillations are performed, in which 10 c.c. and 6 c.c. respectively are collected. The final distillate is weighed and colorimetrically investigated, as previously described. The lignin-methyl alcohol is deduced from the differences between the values for the total and pectin-methyl alcohol. When very small quantities of lignin are present, it is advisable to estimate both forms in the same sample; the distillation residue obtained after estimation of the pectin is collected, washed with hot water, alcohol, and ether, dried, and distilled with sulphuric acid.

Bacillus paralacticus. Ducháček. See XVIII.

PATENTS.

Bread: Manufacture of a concentrated — C. A. Heudebert, Nanterre, France. Eng. Pat. 107,192, Sept. 18, 1916. (Appl. No. 13,230, 1916.) Under Int. Conv., June 15, 1916.

FIVE hundred grms. of "grain" yeast is mixed with 32 litres of warm water, 30 kilos. of flour is incorporated with the liquid and, after 1 hour, the mixture is poured into a kneading machine together with 70 kilos. of flour; 1 kilo. of salt dissolved in 3 litres of water is also added. The dough is milled, rolled into strips, and cut into square cakes which are kept in the dark in a slightly moist atmosphere at 30° to 40° C. for about 1 hour. The cakes are then baked at about 210° C. for 40 mins., and allowed to cool slowly in covered boxes for 24 hours. The product is friable and has a regular, porous texture.—W. P. S.

Organic phosphorus compound contained in vegetable foodstuffs: Manufacture of the assimilable — O. Imray, London. From Society of Chemical Industry in Basle, Switzerland. Eng. Pat. 109,519, Oct. 24, 1916. (Appl. No. 15,146 of 1916.)

FOUR hundred and fifty kilos. of paste containing 30% of the tetrabasic calcium salt of the organic phospho-compound obtained as described in Eng. Pat. 23,692 of 1903 (this J., 1904, 126) is dissolved in 60 kilos. of pure concentrated (30%)

hydrochloric acid, 0.5 kilo. of animal charcoal is added, and the mixture stirred for 1 hour; it is then filtered and the calcium which is not combined with the phospho-compound is precipitated by adding to the filtrate 15 to 18 kilos. of oxalic acid dissolved in water. The calcium oxalate is separated by filtration and the filtrate is mixed with 1200 litres of 95% alcohol; the dibasic salt of the organic phospho-compound thus precipitated is collected, washed, and dried. It forms a white, tasteless powder.—W. P. S.

Milk sterilising apparatus. F. H. Rogers, London, and W. T. Fremlin, Maidstone. Eng. Pat. 109,638, Aug. 18, 1916. (Appl. No. 11,750 of 1916.)

IN apparatus of the type in which a central steam-chest is surrounded by a series of external annular steam-chests forming passages for the flow of the milk, the cover for the various sections is so constructed that clamping it in position completes the connections between the milk sections and also between the steam sections. The walls of each of the steam sections are secured at top and bottom to annular rings which engage concentric grooves in the cover and base, rubber rings being used to ensure tight joints. Nipples project upwards from each steam section into ports within the cover so as to place the sections in communication with one another when the cover is in position. The rings closing the lower ends of the intermediate steam sections have feet or lugs which rest on the base and provide passages for the circulation of the milk.—W. P. S.

Casein: Method of drying — W. M. Brownell, Brooklyn, N.Y., Assignor to A. N. Hood and J. T. Nightingale, Boston. U.S. Pat. 1,240,816, Sep. 25, 1917. Date of appl., May 5, 1916. Renewed Feb. 20, 1917.

CASEIN is heated until it forms a plastic adhesive mass, and is then passed under pressure through a heated chamber and out into the open air.

—F. Sp.

Means for desiccating liquors containing matter in solution or suspension [e.g., milk and the like]. Eng. Pat. 109,471. See 1.

XIXB.—WATER PURIFICATION; SANITATION.

Chloride of lime; Interaction of — with the normal constituents of natural waters and sewage. G. W. Heise. Philippine J. Sci., 1917, 12, A, 17–34.

THE author has studied the rate of decomposition of chloride of lime in water, sewage, and solutions of organic substances. Available chlorine was estimated by taking samples, as required, and titrating with standard sodium thiosulphate solution in the presence of phosphoric acid, potassium iodide, and starch solution. It was found that in the dark, at ordinary temperatures, the reactions proceed with almost constant velocity for periods of 30 mins. to 1 hour, after which they proceed very slowly. In the light the rate of decomposition is greatly accelerated. The amount of chlorine consumed is usually proportional to the concentration in which it is added: on the other hand, the chlorine consumption is not necessarily proportional to the concentration of organic matter. In the control of the disinfection of water or sewage by hypochlorite, bacteriological tests should supplement determinations of chlorine consumption. These latter should be carried out as nearly as possible under the conditions of temperature, illumination, and concentration that obtain in practice.—L. A. C.

PATENT.

Manufacture of alkaline peroxide. Eng. Pat. 101,709. See VII.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Alkaloids of ipecacuanha. Part II. F. L. Pyman. Chem. Soc. Trans., 1917, 111, 419—446. (See this J., 1914, 764.)

THE non-phenolic ether-soluble alkaloids of ipecacuanha were converted into the hydrobromides and crystallised from water. After separation of the emetine hydrobromide, the mother liquor was mixed with sodium hydroxide solution and extracted with chloroform. The base recovered from the chloroform solution was dissolved in alcohol and mixed with half its weight of hydrated oxalic acid dissolved in hot alcohol, when a deposit of a crystalline hydrogen oxalate was obtained. This salt was obtained from all the commercial varieties of ipecacuanha examined, namely Matto Grosso, Minas, Cartagena, and Johore, the yields ranging from 0.03 to 0.06% of the weight of the bark. The crude salt consists chiefly of the hydrogen oxalate of a new base which was found to be the O-methyl ether of psychotrine, together with a smaller quantity of the hydrogen oxalate of another new base, which has been named emetamine. The two alkaloids were separated by fractional extraction with dilute acid from chloroform solution, when the more basic methylpsychotrine was removed first. It was purified by crystallisation of the sulphate, which forms large colourless prisms containing 7H₂O, melting, with effervescence, at 247° C. (corr.) after becoming yellow at about 220° C. Methylpsychotrine is much more readily soluble in dry ether than in wet ether, probably combining with water to form a hydrate as does psychotrine. It is dextro-rotatory both as free base ($[\alpha]_D = +43.9^\circ$ in commercial absolute alcohol) and in the form of salts. Methylpsychotrine is formed in small quantity, together with a substance similar in properties to rubremetine (Carr and Pyman, this J., 1914, 764), by the oxidation of emetine with two atomic proportions of iodine. Karrer's dehydroemetine iodide, obtained by the oxidation of emetine with a larger proportion of iodine (this J., 1916, 1177) is shown to be identical with rubremetine hydroiodide. When reduced with sodium and alcohol, methylpsychotrine yields a mixture containing emetine and an isomeride of emetine (isolated as benzoylisometine, C₂₅H₃₅O₄N₂.CO.C₆H₅, m.pt. 207°—208° corr.), together with phenolic bases and a new crystalline (diacidic) base, C₂₅H₃₅O₃N₂ or C₂₅H₃₃O₃N₂, m.pt. 128° C., which is non-phenolic and contains three methoxyl groups. When heated with benzoic anhydride, methylpsychotrine yields a colourless, monobasic N-benzoyl derivative; hence it and consequently psychotrine also, contains an imino-group, and the opinion previously expressed that psychotrine is a tertiary base is incorrect. The formation of cephaeline and isocephaeline by reduction of psychotrine, and of emetine and isometine by reduction of methylpsychotrine is thus due to the reduction of a C:C and not of a C:N linking.

Emetamine was purified by crystallisation of its hydrobromide, and was obtained in colourless needles, m.pt. 155°—156° C. It has the formula, C₂₅H₃₅O₄N₂ or C₂₅H₃₃O₄N₂, contains four methoxyl groups but no N-methyl group, is non-phenolic, and a diacidic base. It does not yield a benzoyl derivative when heated with benzoic anhydride. It is dextro-rotatory ($[\alpha]_D = +12.3^\circ$

in absolute alcohol), but its salts are laevo-rotatory. No other alkaloids besides methylpsychotrine and emetamine appear to be present in the original crude hydrogen oxalate, and it has been calculated from the rotatory powers of the crude salt and of the hydrogen oxalates of the pure alkaloids that the different commercial varieties of ipecacuanha contain from 0.015 to 0.033% of methylpsychotrine and 0.002 to 0.006% of emetamine. The hydrobromides of both alkaloids are precipitated by sodium bromide, and they are probably constituents of Hesse's hydroipecamine hydrobromide (this J., 1914, 601). Further experiments on N-methylemetine and its salts and the methine derived from its methiodide are also described.

Emetine has proved of value and has been largely employed for the treatment of amoebic dysentery in the Expeditionary Forces operating in hot climates. The other alkaloids of ipecacuanha and their derivatives and also derivatives of emetine have been investigated with a view to obtain, if possible, a substance in which the relative toxicity to amoeba and man is greater than in the case of emetine, but none of the compounds examined appear to have important advantages over emetine therapeutically (see also following abstract).

Ipecacuanha alkaloids and some synthetic derivatives of cephaeline; Pharmacological studies of the toxicity of —. A. L. Walters and E. W. Koch. J. Pharm. Expt. Ther., 1917, 10, 73—81. J. Chem. Soc., 1917, 112, i., 612. (Compare Karrer, this J., 1916, 1177.)

THE authors have measured the relative toxicity of the methyl, ethyl, propyl, isopropyl, butyl, isobutyl, *tert*-butyl, amyl, isoamyl, and allyl ethers of cephaeline. The substitution of the methyl group in emetine (cephaeline methyl ether) by radicals of the higher homologous alcohols markedly decreases the toxicity for rats, guinea-pigs, and rabbits. The isoamyl ether is the least toxic of the series, having about one-fifth the toxicity of emetine when given subcutaneously. Emetine is not a very toxic alkaloid when given in a single dose, but is dangerous when given repeatedly in small doses over a considerable period of time.

Sparteine; Microchemical reactions of —. O. Tunnmann. Apoth.-Zeit., 1917, 32, 100—103. J. Chem. Soc., 1917, 112, ii., 518—519.

A 1—2% SOLUTION of sparteine when treated with a drop of dilute chromic acid gives immediately a pale yellow precipitate consisting of small droplets; after a short time these change into a mass of colourless needles which speedily become straw-yellow; single well-defined prisms are also formed. 0.1 mgrm. of the alkaloid yields after some time crystals united to form lattices, which slowly become transformed into prisms. The limit of sensitiveness is 50 µgrm. With concentrated zinc chloride solution (1:1), a white precipitate is formed consisting of aggregates of short rods. In presence of a trace of hydrochloric acid, the white turbidity does not appear, but, after fifteen minutes, individual prismatic crystals are formed which show marked polarisation colours and extinction parallel to the long axis; limit of sensitiveness, 0.4—0.3 µgrm. When the alkaloid is warmed with copper chloride solution (4%) and hydrochloric acid, long, lemon-yellow prisms are gradually formed. The excess of copper chloride (which is usually only deposited when the solution is completely evaporated) appears as colourless or pale green needles or prisms. The reaction is not very sensitive. With mercuric chloride and hydrochloric acid, a white precipitate is formed, which is converted

into rhombic prisms. With small amounts of alkaloid, the precipitate does not appear, but after twenty to thirty minutes, individual prisms are formed. These are insoluble in alcohol and glycerol; the limit of sensitiveness is 30–40 μ gm. The reaction with zinc chloriodide solution has been described previously (this J., 1917, 941). Hydriodic acid gives a dark brown to black precipitate; under the microscope, long, blackish-brown prisms or brown or red aggregates appear after some hours. The crystals are readily soluble in alcohol and attacked by glycerol. Limit of sensitiveness, 5–3 μ gm. Potassium iodide gives a brown precipitate, which is soon converted into brownish-black nodules, from which paler, prismatic needles are formed; limit of sensitiveness, about 5 μ gm. Potassium cadmium bromide [cadmium bromide (1 gm.), potassium bromide (2 grms.), water (7 grms.)] yields colourless, flat prisms, which are converted into dendritic aggregates. In addition, rhombic platelets and brown globules are formed. The crystal forms are very diverse. The crystals are insoluble in glycerol. Limit of sensitiveness, 8–5 μ gm.

Geneserine: Constitution of —. Transformation of eserine into geneserine. Alkaloids of the Calabar bean. VI. M. Polonovski. Bull. Soc. Chim., 1917, 21, 191–200. (See also this J., 1915, 920, 1070; 1916, 273).

GENESERINE is regarded as the amine-oxide derivative of eserine produced by the attachment of an oxygen atom at the amino-group of the latter substance; the behaviour of geneserine with sulphur dioxide, and its oxidising action towards hydriodic acid and methyl iodide, are in accord with the properties of the amine-oxides, and the liberation of silver from neutral silver nitrate may be regarded as a process of "mutual reduction" analogous to the reaction of hydrogen peroxide with permanganic acid. This view of the constitution of geneserine was confirmed by oxidation experiments, potassium permanganate or dilute nitric acid giving rise to methylamine as the only isolated product from eseroline, whereas in aqueous-alcoholic solution hydrogen peroxide actually effected the conversion of eserine into geneserine. Similarly eserethol in acetone solution was oxidised by hydrogen peroxide with formation of geneserethol, but the conversion of eseroline into geneseroline could not be effected. The difference between the constitution of eserine and geneserine is therefore to be represented by the two formulæ $\text{CH}_5\text{N}:\text{C}_{12}\text{H}_{14}\text{N}\cdot\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CH}_3$ and $\text{O}:\text{N}(\text{CH}_3):\text{C}_{12}\text{H}_{14}\text{N}\cdot\text{O}\cdot\text{CO}\cdot\text{NH}\cdot\text{CH}_3$.—D. F. T.

Yohimbine and quebrachine. E. Filippi. Arch. Pharmacol. Experim., 1917, 23, 107–128, 129–140. J. Chem. Soc., 1917, 112, i., 582.

FROM purely chemical evidence, Fournneau and Page (this J., 1914, 373) have come to the conclusion that yohimbine and quebrachine are identical (compare Spiegel, this J., 1916, 327). The author has carried out a careful pharmacological comparison of the two alkaloids, from which he concludes that although they are similar in many respects, yet in others they show such marked differences that they cannot be considered as identical, although belonging to the same pharmacological group. The chemical similarity of the two alkaloids with each other and with strychnine is further shown by the occurrence of Vitali's reaction.

Digitalis plants: Development of the typical glucosides of the leaf in germinating and growing —. W. Straub. Biochem. Zeits., 1917, 82, 48–59. J. Chem. Soc., 1917, 112, i., 615–616.

THE amount of the glucosides in different stages

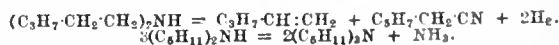
of the growth of the plant was estimated by a pharmacological method (by ascertaining the number of lethal doses for a frog in different fractions). The glucosides in question are *digitalinum verum* and digitalein, which are soluble in water, and both of which are found in the seeds, and digitoxin, which is insoluble in water, but soluble in chloroform, and "gltalin," which is soluble in chloroform and cold water, which are found in the leaves (see also this J., 1917, 731). Digitalein also occurs in the leaves. As a result of pharmacological tests of the fractions obtained from plants in various stages of the growth, a very approximate quantitative estimation of these alkaloids could be made. It was found that the glucosides of the seeds are not reserve material, but disappear during germination, and are stored in the leaves, in which organs they do not increase further in quantity. The glucosides proper of the leaves make their first appearance in the earliest foliage leaves and continue to increase in quantity until they form 1% of the dried matter.

Pangium edule and Hydnocarpus alcala; Investigation of the seeds of —. H. C. Brill. Philippine J. Sci., 1917, 12, A, 37–46.

FROM the seeds of the *Pangium edule* the authors obtained the glucoside, gynocardin, and an oil, and from the leaves, the enzyme gynocardase. Gynocardin was obtained as golden yellow crystals, melting at 160° C., by recrystallising from hot water the alcoholic or hot water extract of the dried seeds. Repeated washing of the extract with ether or acetone was necessary in order to remove all traces of oil, otherwise the substance would not crystallise. This glucoside is characterised by its marked stability in the presence of hydrolysing agents as compared with other members of the same class, e.g., amygdalin. The oil contains palmitic and oleic acids and a small quantity of an optically active acid. From the expressed juice of the leaves the enzyme, gynocardase, was precipitated by the addition of alcohol. It was found to belong to the class of β -enzymes typified by emulsin. No cyanogenetic glucoside was discovered in the seeds of the *Hydnocarpus alcala*. Over 90% of chaulmoogric acid was present in the free acids of the oil expressed from these seeds.—L. A. C.

Amines: Transformation of secondary and tertiary — into nitriles. A. Mailhe and F. de Godon. Comptes rend., 1917, 165, 557–559.

VAPOURS of di-isoamylamine, b.pt. 187° C., passed over finely-divided nickel at 320°–330° C., yielded some permanent gas consisting of 78–80% of hydrogen and 20–22% of olefines, and a liquid product which on fractional distillation gave first some isoamylene at 35°–40° C., then a 60% fraction between 120° and 140° C., and afterwards unaltered di-isoamylamine, leaving a residue, b.pt. 200°–245° C., containing tri-isoamylamine. From the fraction distilling between 120° and 140° C., isoamyl nitrile (isobutyl cyanide), b.pt. 127°–129° C., was obtained. The reactions may be represented thus:—



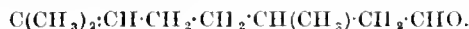
Part of the isoamylene was decomposed into carbon and hydrogen by contact with the nickel. There was no evidence of the intermediate formation of primary amine. Vapours of tri-isoamylamine, b.pt. 235° C., passed over nickel at 360°–370° C., gave some permanent gas and a liquid containing isoamyl nitrile and unaltered tri-isoamylamine.—J. H. L.

Pine oil; "Oyster Bay" ——. P. Singh. *Perfum. and Essent. Oil Rec.*, 1917, 8, 304.

THE "Oyster Bay pine," *Frenela rhomboidea*, was introduced from Australia between 1885 and 1891, into the Nilgiri region (India) where it now covers about 130 acres. In experiments at the Forest Research Institute, Dehra Dun, it was found that about a ton of the green leaves, containing 43% of moisture, yielded (in November) 13.5 oz. of oil on distillation with steam at 40–60 lb. pressure. This oil gave satisfactory results as a soap perfume, in a Bombay factory. Its composition appears to be similar to that of the oil from the Australian *Frenela*, which is said to contain *l*-pinene, limonene, and dipentene, with geranyl acetate as chief ester constituent. The characters of the Nilgiri oil were:—Sp.gr. at 16° C., 0.871; $[\alpha]_D^{20} = -27.6$; n_D^{20} 1.4695 at 18°; ester value, 51; saponif. value before acetylation, 52.3, after acetylation, 59.8; free alcohols (as geraniol), 2.1%; total alcohols, 17.3%; esters (as geranyl acetate), 17.8%; solubility, in 90% alcohol, 0.75 part; 1 part dissolves in 21.5 parts of 80% alcohol.—J. H. L.

Citronellals; Two isomeric ——. H. J. Prins. *Chem. Weekblad*, 1917, 14, 692–695. *J. Chem. Soc.*, 1917, 112, i, 538.

By repeated fractionation, two isomerides have been isolated from citronellal. The first has b.pt. 203°–204° C., sp.gr. at 14° C. 0.8880, and forms a semicarbazone, m.pt. 85°–86° C. The second has b.pt. 198°–200° C., sp. gr. at 14° C. 0.8745, and gives a semicarbazone, m.pt. 82.5°–83° C. It is suggested that the first has the formula $\text{CH}_2\text{C}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CHO}$, and the second the formula



Zinc phenolsulphonate; Volumetric determination of ——. G. Adanti. *Boll. Chim. Farm.*, 1917, 56, 317–318. *J. Chem. Soc.*, 1917, 112, ii, 517.

IN the presence of bromine and an acid, zinc phenolsulphonate reacts in accordance with the following equations: $(\text{OH}\cdot\text{C}_6\text{H}_4\cdot\text{SO}_3)_2\text{Zn}\cdot 7\text{H}_2\text{O} + 11\cdot\text{SO}_4 = \text{ZnSO}_4\cdot 7\text{H}_2\text{O} + 2\text{OH}\cdot\text{C}_6\text{H}_4\cdot\text{SO}_3\text{H}$ and $2\text{OH}\cdot\text{C}_6\text{H}_4\cdot\text{SO}_3\text{H} + 12\text{Br} \rightarrow 2\text{C}_6\text{H}_4\cdot\text{Br}_2\cdot\text{OH} + 6\text{HBr}$. Exactly 0.5 gram. of the crystallised zinc phenolsulphonate is dissolved in water and the solution made up to 500 c.c. In a flask holding about 300 c.c. and fitted with a ground stopper, 50 c.c. of this solution is mixed with 50 c.c. of 0.6% potassium bromide solution and 50 c.c. of 0.1671% potassium bromate solution, 5 c.c. of concentrated sulphuric acid being then added, and the flask again shaken and left closed in a dark place at about 25° C. for three hours. Ten c.c. of 10% potassium iodide solution, recently prepared, is next added, and, after the lapse of an hour, the iodine liberated is determined by titration with *N*/10 sodium thiosulphate. The number of c.c. of the thiosulphate used is subtracted from that required in a blank test with the 50 c.c. of bromide and 50 c.c. of bromate alone; the remainder, multiplied by 0.00447, gives the weight in grams of crystallised zinc phenolsulphonate in the 50 c.c. of solution taken.

Mercuric oxycyanide; Volumetric determination of ——. A. Tagliavini. *Boll. Chim. Farm.*, 1917, 56, 297–299. *J. Chem. Soc.*, 1917, 112, ii, 510.

MERCURIC oxycyanide, used as a disinfectant, particularly for the hands, may be analysed as follows:—A weighed quantity of 0.3–0.4 gm. of the salt is dissolved in 50 c.c. of cold water, and

the liquid, after treatment with 1 gm. of sodium chloride and a drop of 0.2% methyl orange solution, is titrated with *N*/10-hydrochloric acid until it turns red. After the volume of acid required is read, 2 grms. of potassium iodide is added to the solution, and the yellow liquid thus obtained is again titrated with *N*/10-hydrochloric acid as before. From the two volumes of acid required, the percentages of oxycyanide and cyanide in the salt may be calculated, the reactions proceeding according to the equations: (1) $\text{HgO}\cdot\text{Hg}(\text{CN})_2 + 2\text{HCl} = \text{HgCl}_2 + \text{Hg}(\text{CN})_2 + \text{H}_2\text{O}$, and (2) $\text{Hg}(\text{CN})_2 + 4\text{KI} + 2\text{HCl} = \text{HgK}_2\text{I}_4 + 2\text{KCl} + 2\text{HCN}$.

Mercury; Determination of — in galenical preparations. H. Wastenson. *Pharm. Post.*, 1917, 50, 125–126. *J. Chem. Soc.*, 1917, 112, ii, 509.

THE method of destroying organic matter previously employed in analysing protein preparations containing silver (this *J.*, 1916, 1271) is applied to the determination of mercury in galenical preparations. The substance (0.3–0.5 gm.) is heated with concentrated sulphuric acid (10 c.c.) and nitric acid (sp.gr. 1.4, 3 c.c.) until reddish-yellow vapours are not further evolved, the liquid has become clear and colourless, and the flask filled with sulphuric acid fumes. If the vapours still smell of sulphur dioxide, treatment with nitric acid (3 c.c.) is repeated. After being cooled, water (25 c.c.) is added, which is removed by evaporation. The cold solution is treated with water (15 c.c.) and potassium permanganate solution until a permanent pink coloration is produced: the latter is discharged with ferrous sulphate, the solution diluted with water (75 c.c.), and titrated with *N*/10-ammonium thiocyanate solution in the presence of ferric alum. The method is suitable for organic and inorganic preparations of the oxides of mercury, but not for such as contain the haloids. It can also be used for estimating mercury in plasters and pills, and in ointments provided that they are tolerably free from paraffin.

Methyl nonyl ketone from palm-kernel oil. Salway. See XII.

Action of plants on organic substances. Ciamicran and Ravenna. See XVI.

PATENTS.

[Acetaldehyde, etc.] *Products of condensation and oxidation from acetylene*; Manufacture of —. Chem. Fabr. Rhénania, B. K. Stuer, Aachen, and W. Grob, Stolberg, Germany. Eng. Pat. 109,983, July 17, 1916. (Appl. No. 10,042 of 1916.)

ACETYLENE alone or mixed with neutral gases, ammonia, hydrogen sulphide, or steam, is passed over contact substances, e.g., metallic oxides, at a high temperature. The presence of an oxidising agent or of compounds of alkalis, alkaline earths, or of magnesium is advantageous. Suitable temperatures are between 300° and 400° C., or, in presence of large amounts of steam, 400° to 500° C., at the ordinary or increased pressure. Acetaldehyde is the main product on passing a mixture of 1 part of acetylene and 4 parts of steam over bog iron ore at 400°–420° C. A 50% yield of acetonitrile mixed with bases containing nitrogen results on passing acetylene and ammonia in equal proportions over bauxite at 350°–380° C. Almost pure thiophen is prepared by passing a mixture of 2 parts of acetylene to 1 part of hydrogen sulphide over specially treated bauxite at 320° C.—F. W. A.

Urea ; Process of producing — J. E. Bucher, Coventry, Assignor to Nitrogen Products Co., Providence, R.I. U.S. Pats. (A) 1,211,919 and (B) 1,211,920, Oct. 2, 1917. Dates of appl. (A) July 3, 1914, (B) Oct. 21, 1915.

(A) AN alkali cyanate is treated with an ammonium salt of carbonic acid, to form ammonium cyanate and alkali bicarbonate. The ammonium cyanate is converted into urea, which is concentrated by adding solid alkali cyanate, and then separated by varying the temperature so as to utilise the differing rates of change of solubility of the urea and of the by-products of the reaction. Urea may also be separated from the alkali bicarbonate by adding alkali to form the normal carbonate, crystallising the urea, and then introducing carbon dioxide to remove a considerable part of the remaining alkali as bicarbonate. (B) The process described in (A) is modified by passing carbon dioxide into an ammoniacal solution of a metallic cyanate, so as to produce ammonium cyanate and a precipitate of metallic bicarbonate. Part of the ammonia required is derived from the decomposition of the cyanate in solution. After the ammonium cyanate has been converted into urea, the latter may be separated from the by-products by distilling off the water while passing in carbon dioxide to prevent conversion of the bicarbonate into carbonate.—F. Sp.

Manufacture of the assimilable organic phosphorus compound contained in vegetable foodstuffs. Eng. Pat. 109,519. See XIXA.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

PATENT.

Colour photographs ; Taking and exhibiting of — A. H. Walker, London. From Hess-Ives Corporation, Philadelphia, U.S.A. Eng. Pat. 110,059, Feb. 8, 1917. (Appl. No. 1936 of 1917.)

IN colour photography, either in a camera or in a projection apparatus, in which a transparent reflector is used to separate the incident light into colour components or to combine coloured lights, a larger total amount of available light is obtained by coating the front surface of the mirror with a dichroic substance. A surface of Eosine, for instance, reflects about 59% of the incident green light and transmits about 50% of the incident red light, whereas a half-silvered glass, having no dichroic qualities, reflects 50% of the green light but transmits only 50% of the red light. A thin deposit of gold is more durable than Eosine but not so effective; it transmits more than 50% of the green and reflects more than 50% of the red. —B. V. S.

XXII.—EXPLOSIVES ; MATCHES.

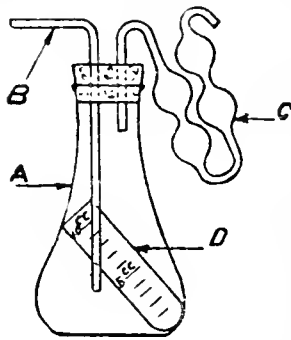
Ammunition ; Investigation of defective small-arms — at Washington. Met. and Chem. Eng., 1917, 17, 375.

DEFECTS in small-arms cartridges from the Frankford Arsenal, Philadelphia, have been found to be due to the use of inferior mixtures in the composition of the primers, to the method of testing the various batches of cartridges at the Arsenal, according to which the results obtained varied from day to day with the same batch of ammunition, and to the exposure of the cartridges during active service to dampness and more vigorous climatic conditions than were covered by the specifications under which the ammunition was manufactured. Free sulphur when used in a primer composition has been found to give a deleterious compound with potassium bromate, which is present in the inferior grades of potas-

sium chlorate now being used; the defect thus caused would not appear in newly-finished ammunition. The use of mercury fulminate in place of sulphur has been recommended but not yet adopted. The inferior quality of the antimony sulphide and copper used has also contributed to failures.—J. N. P.

Nitrogen in explosives ; Determination of — B. Oddo. Gazz. Chim. Ital., 1917, 47, 11., 145—158.

A WEIGHED quantity of the substance is placed in the flask A, with a little sulphuric acid as solvent, and the tube, D, containing mercury in excess of the weight of sulphuric acid used, is introduced. The flask is then closed by the cork, through which passes the tube, B, and the bulb tube, C, in the base of which is a little sulphuric acid, and dry carbon dioxide is aspirated through the apparatus until all air is expelled (40 to 45 mins.). The openings of the tubes, B and C, are then closed and the apparatus weighed, the tube, C, opened,



and the mercury in the tube, D, made to fall into the acid in the flask. The apparatus is shaken with a circular motion and gently heated until the bubbles of nitric oxide pass regularly through the acid in C. When all gas has been evolved a current of dry carbon dioxide is again passed through the apparatus, which is then closed and weighed again. The loss in weight gives the amount of nitric oxide, which is calculated into nitrogen. Several of these flasks may be connected with the carbon dioxide apparatus for simultaneous determinations.—C. A. M.

XXIII.—ANALYSIS.

Electro-analysis apparatus. J. L. Jones. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 6 pages.

THE electrodes are stationary and consist of pieces of platinum gauze of 40 meshes per linear inch; the larger one, ordinarily arranged as cathode, weighs about 30 grms. and the smaller one 16 grms. Stirring of the electrolyte is provided by means of a straight tungsten rod 2.4 mm. in diameter and 20 cm. long, with a glass screw fused on, and arranged to rotate at from 300 to 1000 revolutions per minute. In alkaline solutions, a coating of glass is spun over the exposed surface of the tungsten in order to protect the metal. To prevent loss of liquid by spraying, a hard rubber disc with a convex lower surface carries the terminal screws for the electrodes and fits closely over the beaker of 200 to 400 c.c. capacity containing the electrolyte. A small disc electric heater is placed under the beaker. A number of these cells are connected in parallel in the electrical circuit, which provides current at 15 volts. A separate rheostat with each unit enables the current to be separately adjusted with each cell.—J. N. P.

Mercury ; Detection of — in chemico-legal cases. C. L. Spica. Gazz. Chim. Ital., 1917, 47, 11., 139—144.

SEPARATE portions of fresh visceral material were immersed in 95% alcohol and treated with 1 c.c. of 4% mercuric chloride solution and with 0.5 gm. of pure calomel. After 2 years' exposure to

diffused light the flasks were opened, the contents filtered, the insoluble matter washed with water and then treated successively with 10% hydrochloric acid, 10% nitric acid, and hydrochloric acid and potassium chlorate. It was found that the mercuric chloride had been largely converted into a compound (probably albuminate) not extracted by dilute hydrochloric acid, though only a small amount was not extracted by the successive treatments with the acids and potassium chlorate. Doubtful reactions for mercury were obtained with the alcoholic filtrate from the material in contact with calomel, but a considerable quantity of the calomel had been transformed into a compound (probably albuminate) which was soluble in dilute hydrochloric acid, and most of which could be isolated as metallic mercury by electrolysis of the solution. Some of the calomel also remained in an unaltered condition, or at least in a form in which it was not soluble in hydrochloric or nitric acid.—C. A. M.

Germanium; Qualitative detection of — and its separation from arsenic. P. E. Browning and S. E. Scott. *Amer. J. Sci.*, 1917, 44, 313—315.

THE authors have modified Buchanan's method of separating germanium from germaniferous zinc oxide containing lead, cadmium, arsenic, and traces of selenium. A mixture of the oxide with a little potassium permanganate, manganese dioxide, or potassium chlorate and 10—15 c.c. of concentrated hydrochloric acid is distilled, and germanium sulphide precipitated from the distillate with hydrogen sulphide. 0.1 gm. of zinc oxide containing 0.21% of germanium, gave a distillate from which a distinct precipitate of germanium sulphide was obtained with hydrogen sulphide. The method was successfully applied to show the presence of germanium in argyrodite previously decomposed with nitric acid and evaporated to dryness. 0.0001 gm. of germanium is easily detected in the presence of 0.2 gm. of zinc oxide, and 0.00006 gm. gives a satisfactory test in the presence of 0.025 gm. of zinc oxide. The following modification of Winkler's method of separating germanium and arsenic is recommended:—A solution of the sulphur salts formed by fusing the mineral with sodium carbonate and sulphur is treated with ammonium acetate, acidified with acetic acid, and treated with hydrogen sulphide. The arsenic is completely precipitated, and the germanium remains in solution.—F. Sp.

Fractional combustion. Bancroft. See IIA.

Volumetric determination of pyrophosphoric acid. Balareff. See VII.

Reaction of manganese salts. Macri. See VII.

Absorption of sulphuric acid by ferric hydroxide, and formation of colloidal sulphur from sulphides. Dittler. See VII.

Hydrogen oxalates of the alkaline-earth metals. Bruhns. See VII.

Sensitive reaction of hydrogen peroxide depending on the formation of dihydroxytartaric acid. Deniges. See VII.

Technical analysis of Turkey-red oil products. Goldberg and Zipper. See XII.

Determination of starch in preserved meats, etc. Challet. See XIXA.

Volumetric determination of chlorine in foods, etc., by the red method without formation of ash. Weitzel. See XIXA.

Determination of starch in clover. Von Fellenberg. See XIXA.

Determination of the alkalinity of cocoa and detection of added alkali. Rocques. See XIXA.

Various modes of combination of methyl alcohol in plants. Determination of pectin- and lignin-methyl alcohol in roots. Von Fellenberg. See XIXA.

Microchemical reactions of sparleine. Tunmann. See XX.

Volumetric determination of zinc phenolsulphonate. Adanti. See XX.

Volumetric determination of mercuric oxycyanide. Tagliavini. See XX.

Volumetric determination of mercury in galvanic preparations. Wastenson. See XX.

Determination of nitrogen in explosives. Oddo. See XXII.

Official Notice.

THE NITROGEN PROBLEM AND THE WORK OF THE NITROGEN PRODUCTS COMMITTEE.

A Memorandum having the above title has just been issued by the Munitions Inventions Department. The substance of the Memorandum is given below.

The nitrogen problem.

The manufacture of the vast quantities of explosives that have been called for by the present conditions of warfare has led to an unprecedented demand for various nitrogen compounds. The world's consumption of nitrogenous fertilisers appears practically to double every ten years, and in 1913 had attained the large figure of 2,500,000 tons of Chile nitrate and about 1,400,000 tons of ammonium sulphate.

With the outbreak of war, the demand for explosives became of paramount importance and the requirements of agriculture for the time being took a secondary position. The prospect of world shortage of food, however, has served to bring the agricultural aspect of the problem again into the forefront. The researches of Sir William Crookes and the experimental work of Lord Rayleigh upon the fixation of atmospheric nitrogen by means of the electric arc, pointed the way to a method of utilising the unlimited supply of nitrogen in the air, and thus providing against the time when other natural sources of nitrogen compounds should have become exhausted.

The establishment on a very large scale during the past 20 years of processes for nitrogen fixation is one of the most striking electrochemical developments of modern times. Special reference may be made to the arc process as used in Norway, the Haber or synthetic ammonia process developed in Germany, and to the cyanamide process for the manufacture of nitrolim from calcium carbide, as carried on in Norway, Sweden, France, Italy, Germany and the United States.

In spite of the fact that the incentive to the commercial establishment of nitrogen fixation may be said to have originated in this country, no steps were taken in the United Kingdom to obtain nitrogen compounds other than cyanides synthetically. The ammonia recovered at gas-works and coke-ovens has constituted practically the only form of combined nitrogen produced in this country. During the war the command of the seas has hitherto enabled Great Britain to rely entirely upon importation for the whole of our supplies of nitrate of soda, the most important raw material of our explosives industry. The Central Powers, on the contrary, having been cut off from external supplies, were compelled to fall

back upon their internal resources, with the result that nitrogen fixation processes, some of which were established commercially before the war, have been developed upon an enormous scale.

Formation of the Nitrogen Products Committee.

Soon after the formation of the Munitions Inventions Department in August, 1915, proposals for the fixation of nitrogen began to be received from inventors. These schemes were referred to the Chemical Inventions Committee of the Advisory Panel, but as they were isolated applications of the general problem and were of limited scope, they did not immediately lead to any definite line of policy being taken upon the question. The importance of the problem was recognised, however, and the attention of the Minister was directed to it from time to time in the monthly departmental reports.

The inauguration of the submarine campaign in February, 1916, and the grave menace of overseas supplies of nitrates emphasised the importance of taking action on the matter. At this opportune moment a memorandum on the nitrogen problem was submitted to the Department by the Faraday Society. Several conferences were held to discuss the steps that should be taken, and as a result, the Nitrogen Products Committee was constituted in the following June. Members of the Advisory Panel, representatives of other Departments of the Ministry of Munitions and of the Government, and delegates of the leading scientific societies were invited to serve. The constitution of the Committee is as follows:—The Comptroller: Col. H. E. F. Gould-Adams, C.B., C.M.G., R.A. (Chairman), G. S. Albright (Chairman of the Processes Sub-Committee), W. R. Cooper, representing the Physical Society (Chairman of the Gas-Firing Sub-Committee), Sir James Dobbie, F.R.S., representing the Board of Agriculture and Fisheries (Chairman of the Economics Sub-Committee), Prof. A. K. Huntington, representing the Faraday Society (Chairman of the Experiments Sub-Committee), Sir John F. C. Snell, representing the Institution of Electrical Engineers (Chairman of the Power Sub-Committee), W. R. Bousfield, K.C., F.R.S., Dr. Charles C. Carpenter, Kenneth M. Chance, Prof. J. Norman Collie, F.R.S., Lieut.-Col. A. W. Crossley, F.R.S., representing the Chemical Society, Prof. F. G. Donnan, F.R.S., Sir Arthur Duckham, K.C.B., Dr. R. C. Farmer, representing the Explosives Department, F. Gossling, representing the Board of Trade, Dr. J. A. Harker, F.R.S. (Director of Nitrogen Research Section), F. H. Jones, Right Hon. Lord Moulton of Bank, K.C.B., F.R.S. (Director General of Explosives Supply), C. H. Merz, J. H. Rider, Dr. E. J. Russell, F.R.S., Prof. the Hon. R. J. Strutt, F.R.S., Sir R. Threlfall, K.B.E., F.R.S., A. J. Walter, K.C. (Ministry Representative on the Board of Trade Committee on Electrical Power Supply), Secretary to the Committee: R. T. G. French. Secretary to the Advisory Panel: H. W. Dickinson.

The terms of reference were:—

(1) To consider the relative advantages for this country and for the Empire of the various methods for the fixation of atmospheric nitrogen from the point of view both of War and Peace purposes: to ascertain their relative costs, and to advise on proposals relevant thereto which may be submitted to the Department.

(2) To examine into the supply of the raw materials required, *e.g.*, pure nitrogen and hydrogen, and into the utilisation of the by-products obtained.

(3) Since some of the processes employed depend for their success on the provision of large supplies of cheap power, to ascertain where and how this can best be obtained.

(4) To consider what steps can with advantage be taken to conserve and increase the national

resources in nitrogen-bearing compounds and to limit their wastage.

(5) To carry out the experimental work necessary to arrive at definite conclusions as to the practicability and efficiency of such processes as may appear to the Committee to be of value.

(6) As a result of the foregoing steps, to advise as to starting operations on an industrial scale.

An important advance was made when the then Minister of Munitions, the Right Hon. E. S. Montagu, M.P., met the Members of the Committee on October 10th, 1916. He assured them that the Government appreciated the importance of the nitrogen problem, and that he would do everything in his power to see that the recommendations ultimately made received the fullest consideration. At this meeting Sir William Crookes was present. At the same meeting the organisation of the Committee was completed and the following Sub-Committees were set up: Processes, Economics, Experiments, Power, and General Purposes.

At a later date another Sub-Committee was found necessary to deal with the question of coal distillation processes and the production and utilisation of power-gas. The Gas-Firing Sub-Committee was accordingly constituted. In all, the Committee and its Sub-Committees have held upwards of eighty meetings.

Nitrogen fixation research.

The necessity for research was evident from the outset and the Department at once took steps for the organisation of a suitable research staff and the acquisition of a laboratory. Fortunately, the co-operation of the authorities of University College was secured and a part of the new Ramsay Laboratory, at that time scarcely completed, was placed at the disposal of the Department.

The item placed first on the research programme was a complete investigation into the production of synthetic ammonia by the Haber process. This decision was influenced by the claims made for the process and by the commanding position it occupies in Germany, where the economic conditions as regards coal supplies and the comparative absence of water power are similar to those in Great Britain. Moreover, the almost complete lack of precise information concerning the commercial details of this process made it apparent that the research would present many unknown factors and was therefore likely to occupy a considerable time.

Towards the end of the year, the Committee came to the conclusion that the ammonia oxidation process was well adapted as an emergency measure for securing quickly a considerable output of nitric acid or nitrates. Although already working with more or less success upon the Continent, the process had not at that time been operated in this country. A systematic investigation of the most recent developments of the process was therefore undertaken.

Many important problems have arisen in connection with the two main researches indicated above. Reference may be made to such questions as the most efficient and commercially practicable catalysts for the synthesis of ammonia and for ammonia oxidation, and the commercial preparation in bulk and at a sufficiently low cost of hydrogen of the high degree of purity required for the synthesis of ammonia.

On account of the formidable technical difficulties presented by the different problems, it was obvious that a research staff of considerable experience in all the recent developments of physical chemistry was needed for carrying quickly to a successful issue the work of the research programme. In the selection of the personnel, therefore, endeavour was made to obtain men possessed of special qualifications.

The Department has been fortunate in securing a number of such men, with the result that the progress made has been more rapid than might have been expected under the present difficult circumstances. It may be mentioned that the chemist responsible for the research on the synthesis of ammonia had the advantage of having previously worked for some time on the problem at Professor Haber's laboratory at Karlsruhe.

In December, 1916, when the research work was in its early stages, a demonstration and lecture took place at the Research Laboratory and was attended by representatives of the Explosives Supply Department and of the War Office, and by delegates and members of other Government Departments and of scientific societies. The Minister of Munitions was unable to be present, but early in 1917 he asked for practical recommendations to be submitted to him at an early date.

Interim report of the committee.

In view of the magnitude and complexity of the problem, the Committee was unable immediately to present a complete report. Certain definite conclusions had been arrived at, however, and these together with recommendations thereon, were embodied in a unanimous Interim Report which was submitted to the Minister of Munitions in February, 1917. The substance of the recommendations is given below.

(a) *By-product ammonia.*—The importance of increasing the output of by-product ammonia for munitions and for agriculture was pointed out. Steps were indicated whereby an increase could be obtained from existing gas-works and coke-oven plants. It was also recommended that action should be taken to avoid the loss of ammonia known to be occurring in certain districts.

(b) *Ammonia oxidation process.*—The erection at the earliest possible moment of plant capable of producing in the aggregate at least 10,000 tons of nitric acid per annum from gas-works or coke-oven ammonia was recommended.

(c) *Cyanamide process.*—The erection of a factory having an annual output of the order of 50,000 tons of cyanamide was recommended; the cyanamide to be utilised as such for agriculture or for the production of ammonia.

(d) *Synthetic ammonia process.*—The erection of a full-sized trial unit plant for synthetic ammonia process was recommended.

The Minister of Munitions invited members of the Committee to meet him, and the recommendations of the Interim Report were discussed in detail. At the conclusion of this meeting the Minister appointed a small Executive Committee to supervise the action involved in giving effect to his decisions, and to report to him from time to time upon the progress made.

The Minister's decisions and the action taken thereon.

The Minister's decisions were as follows :—

(a) *By-product ammonia.*—The Committee was requested to deal with the problem of conserving ammonia and of augmenting the output on the lines of the recommendations.

(b) *Ammonia oxidation process.*—The Ministry of Munitions would undertake the installation of one Government plant on the lines suggested, or, if the Committee so advised, the Ministry would agree to the erection of plants by suitable private firms. The information resulting from the research work was to be placed freely at the disposal of *bona fide* manufacturers, but was not to become the exclusive property of any firm or group of firms.

(c) *Cyanamide process.*—The Committee was requested to investigate the relative merits of a Government scheme and of other schemes that had been put forward involving private enterprise, and to submit a report embodying definite proposals.

(d) *Synthetic ammonia process.*—The erection of the full-sized trial unit was authorised.

In carrying out these decisions, the Executive Committee dealt first with the problem of conserving and increasing the output of by-product ammonia. The co-operation of the Controller of Coal Mines, of the Gas Companies, and of the domestic and industrial users of coke was enlisted, and the matter was then placed under the direction of the Explosives Department in March, 1917, in view of its existing organisation for dealing with the supply of ammonia.

The next step taken was to summon a conference of manufacturers likely to be interested in the ammonia oxidation process as a good deal of useful information had been collected regarding it and the research work had already reached a semi-commercial stage. Conferences took place at the Munitions Inventions Department in March, 1917, and were attended by representatives of a number of the more important interests. Several manufacturers at once agreed to take up the further study of the process with a view to its commercial development, and have since actively co-operated with the Department. Some of them have already erected experimental plant on a considerable scale.

Encouraging progress continued to be made with the research, and arrangements and plans were made for the erection in London of a trial plant consisting of a single commercial unit designed to give an output of one ton of strong nitric acid per day. At this stage the work of establishing the process on a commercial scale for the manufacture of nitric acid and ammonium nitrate was handed over to the Explosives Department at their request in August, 1917. The work of investigation, however, has been continued at the Research Laboratory as several important aspects of the process still remain to be explored.

With regard to the manufacture of cyanamide, the Executive Committee came to the conclusion that the schemes involving private enterprise did not adequately fulfil the ends in view and recommended the erection of a factory by the Government. The Committee proceeded to collect further information on cyanamide processes in actual operation, and representatives proceeded overseas for this purpose. Complete details of a scheme involving a large-scale factory with electric power station are now in course of preparation for submission to the Minister of Munitions.

Meanwhile a considerable amount of work had been carried out in connection with the synthesis of ammonia, including a detailed investigation of the whole of the conditions governing the process, and of the efficiency and life of numerous catalysts. These studies led to the devising of a method of working whereby the output of ammonia per unit of catalyst space has been increased to a figure, which, as far as is known, exceeds anything hitherto attained. The design and erection of a semi-technical unit apparatus embodying a number of novel features, with the necessary pumps, circulators, gas holders, etc., was then undertaken. It is expected that the operation of this unit, which is now at work, will enable the remaining problems as to the chemical engineering details involved in the design of the full-sized trial unit authorised by the Minister to be definitely settled.

Research upon the preparation of pure hydrogen in bulk has been carried on conjointly with the above investigations, and arrangements have already been made for the trial on a semi-commercial scale of a process that has given very promising results in the laboratory.

Nitrogen in sulphuric acid manufacture.

An important practical outcome of the conferences with manufacturers has been the intro-

duction of ammonia oxidation plant to take the place of the nitre-pots used in the manufacture of sulphuric acid by the leaden chamber process. In pre-war times, the annual consumption of Chile nitrate for this purpose amounted to 18,000 tons. With the present increased output of sulphuric acid the consumption is greater, so that the possible saving of overseas freight is appreciable.

One of the small converters designed in and made for the Departmental Research Laboratory has been installed at the sulphuric acid works of Messrs. Brunner, Mond and Co., and has been working satisfactorily for some months. The firm is now arranging to adapt similar converters to the whole of their leaden chambers. The United Alkali Co., the South Metropolitan Gas Co., and others are making arrangements to adopt the process, and are utilising two types of converter to the Laboratory designs. Drawings have also been placed at the disposal of the Explosives Department for the benefit of other controlled establishments.

The apparatus is compact; the expense involved in its installation, apart from ammonia purification plant, is comparatively small, and its operation is simple. Arrangements have therefore been made for the rapid manufacture of the converters likely to be required, since it is believed that these designs may become standard types for the purpose in question. An explanatory pamphlet, compiled by the Research Staff and embodying detailed information concerning the construction and operation of the converters, will be available shortly for the use of firms who have already taken up the process or are desirous of doing so.

Further research.

Up to the present date the research has practically been confined to the two processes mentioned above and to problems arising therefrom. The investigations of the Committee have shown, however, that many important and promising fields still remain to be explored.

Under present circumstances, all activities have been concentrated upon processes which have a possible value as war measures and no attempt has been made to extend the programme of research beyond such limits. In view, however, of the national importance of the nitrogen problem both now and in the future, it is hoped that definite arrangements will be made to preserve the continuity of the research after the war.

The importance of cheap electric power.

It was realised from the outset that the generation of electric power at a cost decidedly lower than has hitherto been attained in this country was a vital factor if an attempt was to be made to establish certain of the nitrogen fixation industries in Great Britain on a sound economic basis from the point of view of post-war competition. A thorough enquiry has therefore been made as to the possibility of cheapening the production of electric power from coal, not only by its generation in bulk with the most modern plant, but also by the use of methods involving carbonisation and gasification, with recovery of the ammonia, fuel oils, and other by-products hitherto wasted when raw coal has been directly used. The Sub-Committees concerned have had the advantage of obtaining the personal views of a number of experts who attended to give evidence on different aspects of the problem. This enquiry has been distinctly fruitful, and much detailed information has been collected.

Schemes for the utilisation of various undeveloped water powers in the British Islands for nitrogen fixation have also been submitted and have been carefully examined. At least one of these schemes for hydro-electric development on a considerable scale presents *prima facie* prospects

of becoming a valuable national asset. The Power Sub-Committee recommended that a survey should be made of the drainage area in question with a view to confirming the details of the scheme as submitted. The survey has recently been completed and is expected to result in the formulation of a definite development scheme for the utilisation of this water power. It is estimated that the engineering work involved will take about two years to complete, and the scheme is therefore to be regarded as a post-war measure.

Costs of operating nitrogen fixation processes.

Since many of the nitrogen fixation processes have not only a value for munitions but also a post-war importance, endeavours have been made to investigate the probable requirements of this country for nitrogen products. A detailed examination has been made of the production, consumption, imports and exports of such products, and special consideration has been given to the question as to the relative order of the costs involved in operating the synthetic and non-synthetic processes.

Most of the information relating to synthetic processes has had to be obtained from foreign sources, and the Committee has been able to secure many figures of an authoritative character. The information thus collected has been subjected to critical examination in the light of manufacturing experience in allied industries and conclusions have been arrived at as to the costs likely to be incurred under British conditions.

The magnitude of this part of the enquiry may be measured when it is stated that the Committee is in possession of comprehensive data concerning the cost of manufacture of:

- (a) Nitric acid and nitrates by the older methods, and by the arc and ammonia oxidation processes;
- (b) Calcium carbide and cyanamide;
- (c) Ammonia and ammonium sulphate by the Haber and cyanamide processes;
- (d) Hydrogen and nitrogen;

as well as concerning the costs involved in operating the Chili nitrate and the by-product ammonia industries.

Co-operation with other Government departments.

Realising that many of the branches of the Committee's activities related to problems which were also occupying the attention of other Government Departments, an attempt has been made to secure as far as possible co-operation and interchange of information. Thus, on the question of the carbonisation of coal, an exchange of views has taken place with the Fuel Research Board. On the question of the production of hydrogen on a large scale at the lowest possible cost, a problem of great importance in connection with aeronautics, collaboration in experimental work with the Admiralty has been arranged. It will be noted that the constitution of the Committee has provided for liaison with the Explosives Department, the Board of Agriculture, the Board of Trade, and a number of scientific societies.

Nitrogen fixation in the British Empire.

In accordance with the terms of reference the final report of the Nitrogen Products Committee will include a review of the nitrogen problem as it affects the British Empire. This branch of the work has not yet been fully dealt with, but representations have been made to the Dominions, to Dependencies (through the Colonial Office), to Egypt, and to India informing the Governments concerned of the activities of the Committee, and offering to place at their disposal all the information in the possession of the Department.

As a result of the negotiations thus instituted, the Department is already in direct touch with official representatives of the Governments of Australia, Canada, New Zealand, South Africa,

Egypt and Mysore, and also with important developments in other parts of India.

Nitrogen fixation in allied countries.

An interesting event was the visit to this country in February, 1917, of a delegation from the recently constituted Commission de l'Azote acting under the French Ministry of Munitions. It was soon evident that the delegation was most immediately interested in the various processes already established in this country for the manufacture of ammonium nitrate, and a visit of inspection to many of the controlled establishments was accordingly arranged through the Explosives Department.

Several conferences with the delegates were held at the M.I.D. during their stay in this country and an interchange of ideas and information took place upon the most recent developments in nitrogen fixation in France and Switzerland. The entente thus established has been maintained by the periodical exchange of information and documents between the French Ministry of Inventions and the Munitions Inventions Department.

The Allied Governments of Italy and Russia have also nominated representatives to act in liaison with the Department upon the nitrogen problem. The developments already accomplished in the countries in question have enabled these liaison officers to afford immediate and valuable assistance.

The action taken by the United States Government on the nitrogen question is also worthy of notice. Under the National Defence Act of 1916, a sum of £4,000,000 was set aside for the establishment in the United States of nitrogen fixation on a large scale. Committees of the Academy of Sciences, and afterwards of the Ordnance Department were set up. Their advisers visited England, and the more important nitrogen fixation installations on the Continent outside Germany. Upon the recommendation of their experts, the U.S.A. War Department has decided to erect forthwith works for the manufacture of synthetic ammonia by a modified Haber process. A statement concerning the activities of these Committees and setting forth the decisions arrived at was recently published.

Final report of the Nitrogen Products Committee.

The various Sub-Committees set up by the Nitrogen Products Committee have already completed or are now engaged upon their final reports. There will then remain the report of the Main Committee, which will of necessity be a somewhat detailed document owing to the scope of the enquiry that has been undertaken. Endeavours are being made to expedite the last stages of the work so that the final report may be available at the earliest possible date.

Trade Report.

SOUTH AFRICAN INDUSTRIES.

The first issue of a new journal has just made its appearance, under the title, "The South African Journal of Industries." The journal is issued under the authority of the Minister of Mines and Industries, and forms a means of conveying to the public the results of the work of the Department. The need for such a journal has been accentuated since the appointment of the Scientific and Technical Committee, which, in addition to dealing with questions of industrial research, is

engaged in the preliminary work of preparing an economic survey of the natural resources of South Africa; to this end reports are being prepared by authorities on the various subjects, and these will be published in the journal.

The journal is to be issued on or about the 15th of each month, price 5s. per annum, post free within the Union. Subscriptions should be sent to the Government Printer, Pretoria.

There are a number of interesting articles and papers in the issue now under notice. H. Warrington Smyth, Secretary for Mines and Industries, contributes a paper on "The beginning of organisation for industrial expansion," in which he enumerates the facts which led up to the formation of the Industries Advisory Board and the Scientific and Technical Committee, and indicates briefly the work to be carried out by these bodies. Extended reference is made to the Report of the Dominions Royal Commission, appointed in 1912. The Acting Director of Census (C. W. Cousins) contributes some notes on the 1917 Census of Manufacturing Industries, which is now in progress of taking.

The mineral production of the Union is dealt with, based on figures extracted from the Annual Report of the Government Mining Engineer for 1916. This Report shows that the total value of the mineral production was £43,531,009 in 1915, and £50,593,359 in 1916. Increases in the values of nearly all the products are reported; diamonds account for an increase of over £5,300,000, and notable increases are also seen in the output of asbestos, antimony, lead, and corundum.

The subject of industrial alcohol and the manufacture of motor fuel in the Union is discussed. Legislation has now been made whereby Union spirits, suitably denatured, may be used as motor fuel without payment of excise duty. Either for use in making motor fuel may also now be made from Union spirits without excise duty being paid thereon. Motor spirit must be coloured blue, green, or violet by means of a suitable dye-stuff. The conditions to be observed in the manufacture of motor fuel are enumerated.

J. Burt-Davy, in "Notes on the use of ground limestone as a fertiliser," refers to the increases in crop yield obtainable on all soils save "alkaline" soils by the application of finely-ground limestone.

"Industrial possibilities of the Zuurpruim" are discussed. The kernels of the fruits (*Ximenia Americana*), examined at the Imperial Institute, contained 3.4% of moisture and yielded 65.6% of oil to light petroleum and 65.8% to acetone. The oil is non-drying and could probably be used for lubricants, soap-making, etc., but it is very viscous. The residual meal contained 38.8% of crude proteins, 5.3% of fat, and 38.1% of starch, and is intermediate in "food units" between linseed meal and decorticated cottonseed meal. Feeding trials in Germany are stated to have shown, however, that the meal is not well suited for use as a feeding stuff and further experiments on this point are being conducted.

"South African buchu" is dealt with by Dr. E. P. Phillips, who describes the cultivation, preparation and adulteration of the substance, and gives details of exports from South Africa and the prices obtained.

Articles on "South Africa's great opportunity," by C. D. Leslie, "Encouragement of South African industries," by A. Aiken, "The economics of agricultural production in South Africa," by R. A. Lehfeldt, and "Increase of food production," are also included.

The journal concludes with two book reviews, some interesting short notes, and a "black list" showing articles imported into the Union during the first seven months of 1917, which it is considered are capable of being produced in the Union.

Journal of the Society of Chemical Industry.

No. 23, Vol. XXXVI.

DECEMBER 15, 1917.

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Official Notices.

CROSS AND BEVAN ESSAY PRIZE OF £20 AND LATHAM RESEARCH GRANT OF £300.

The Council desires to remind intending competitors for the Cross and Bevan prize that Essays must be received at the offices of the Society before the close of the present year.

The Essay prize is open to all members of the Society who are British subjects. The Research Grant is limited to competitors under 25 years of age at the time of sending in the essay.

Full particulars were published in the issues of the Journal for 15th January and 15th and 28th February, 1917.

PROHIBITED EXPORTS.

By an Order-of-Council, dated 27th November, 1917, the following headings are deleted from the list of prohibited exports* :—(B) Asbestos and articles manufactured wholly or partly of asbestos; (C) Cascara sagrada; (B) Cinchona bark; (C) Formic acid; (C) Iridium compounds; (C) Osmium compounds; (C) Palladium compounds; (B) Quinine and its salts; (A) Radium compounds; (C) Rhodium compounds; (C) Ruthenium compounds; (B) Fats, all animal and vegetable, and articles and mixtures containing such fats, not otherwise prohibited; (B) Fatty acids and articles and mixtures containing fatty acids; (C) Iridium and its alloys and manufactures containing iridium; (A) Lubricants, mineral, and articles and mixtures containing mineral lubricants; (B) Lubricants, not otherwise specifically prohibited, and articles and mixtures containing such lubricants; (A) Mica block and mica splittings; (B) Mica sheets, mica waste, mica powder, micanite, and articles made from and insulating materials containing mica in any form; (B) Oils, animal, not otherwise specifically prohibited, and articles and mixtures containing such oils; Oils, vegetable, the following, and articles and mixtures containing such oils :—(A) Castor; (A) Coconut; (A) Colza or rapeseed; (A) Cotton seed; (A) Ground nut; (A) Linseed; (A) Palm kernel; (B) All other vegetable oils not otherwise prohibited; (A) Oleaginous kernels, nuts, seeds, and products not otherwise specifically prohibited; (C) Osmium and its alloys and manufactures containing osmium; (C) Palladium and its alloys and manufactures containing palladium; (C) Rhodium and its alloys and manufactures containing rhodium; (C) Ruthenium and its alloys and manufactures containing ruthenium; (A) Turpentine substitute, and articles containing turpentine substitute.

The following headings are added :—(A) Asbestos and articles manufactured wholly or partly of asbestos; (C) Araroba or Goa powder; (C) Areca or betel nuts; (C) Arecoline; (C) Buchu leaves; (C) Calabar beans; (C) Cascara sagrada and its preparations; (C) Chrysarobin; (A) Cinchona bark, its alkaloids and their salts; (C) Coca

leaves; (C) Colocynth; (C) Cubebs; (C) Cuprea bark; (A) Formic acid; (B) Indian hemp (*Cannabis indica*); (B) Iridium compounds; (B) Osmium compounds; (B) Palladium compounds; (A) Radium and its compounds; (C) Rhatany root; (B) Rhodium compounds; (B) Ruthenium compounds; (C) St. Ignatius beans; (C) Soda, nitrite of; (C) Squills; (A) Fats, all animal and vegetable, and articles and mixtures containing such fats, not otherwise specifically prohibited; (A) Fatty acids and articles and mixtures containing fatty acids, not otherwise specifically prohibited; (B) Iridium and its alloys and manufactures containing iridium; (A) Lubricants, not otherwise specifically prohibited, and articles and mixtures containing such lubricants; (A) Mica block, mica sheets, and mica splittings; (B) Mica waste, mica powder, micanite, and articles made from and insulating materials containing mica in any form; (A) Oils, fixed, all animal and vegetable, and articles and mixtures containing such oils, not otherwise specifically prohibited; (A) Oleaginous kernels, nuts, seeds, and products of all kinds; (B) Osmium and its alloys and manufactures containing osmium; (B) Palladium and its alloys and manufactures containing palladium; (C) Parchment; (B) Rhodium and its alloys and manufactures containing rhodium; (B) Ruthenium and its alloys and manufactures containing ruthenium; (C) Saponaceous berries (soap nuts and saparita), barks and roots; (B) Terebene, and articles containing terebene; (A) Turpentine substitute, not otherwise specifically prohibited, and articles containing such substitute; (C) Vellum.

On and after the 7th day of December, 1917, the heading "(B) Coal, except coal allowed by the Commissioners of Customs and Excise to be shipped as bunker coal" will be deleted and replaced by the heading "(A) Coal, except coal allowed by the Commissioners of Customs and Excise to be shipped as bunker coal."

FINANCIAL FACILITIES FOR TRADE AFTER THE WAR ESPECIALLY IN RELATION TO RAW MATERIALS AND CONVERSION OF WORKS.

The Lords Commissioners of H.M. Treasury and the Minister of Reconstruction have appointed a Committee with the following terms of reference :

To consider and report whether the normal arrangements for the provision of financial facilities for trade by means of existing banking and other financial institutions will be adequate to meet the needs of British industry during the period immediately following the termination of the war, and, if not, by what emergency arrangement they should be supplemented, regard being had in particular to the special assistance which may be necessary—

(A) To facilitate the conversion of works and factories now engaged upon war work to normal production.

(B) To meet the exceptional demands for raw materials arising from the depletion of stocks.

The Committee will consist of the following :—

Sir Richard V. Vassar-Smith (Chairman of Lloyds Bank and President of the Institute of Bankers), Chairman of the Committee; Sir John Bradbury (Joint Permanent Secretary to H.M. Treasury); Mr. A. E. L. Chorlton (Director of Ruston, Proctor & Co. Ltd., Agricultural Machinery Manufacturers); Mr. E. Brocklehurst Fielden (Deputy Chairman of the Lanes, and Works.

* The prohibition of exports is as follows :—

Goods marked (L), to all destinations;

Goods marked (B), to all ports and destinations abroad other than ports and destinations in British Possessions and Protectorates;

Goods marked (C), to all destinations in foreign countries in Europe and on the Mediterranean and Black Seas, other than France and French Possessions, Russia, Italy and Italian Possessions, Spain and Portugal, and to all ports in any such foreign countries, and to all Russian Baltic ports.

Railway, and a former Member of Parliament for the Middleton Division of Lancashire); Sir Algonon Firth (Chairman of the Associated Chambers of Commerce of the United Kingdom); Mr. Robert Fleming (Chairman of several well-known Investment Trust Companies); Mr. A. C. D. Gairdner (Managing Director of Union Bank of Scotland, Glasgow); Mr. Frederick C. Goodenough (Chairman, Barclay & Co., Ltd., Bankers); Sir Alex. McDowell, K.B.E. (Member of the firm of Carson and McDowell, Solicitors, and well-known in the linen trade); Sir Alexander Roger (Ministry of Reconstruction; formerly Director-General of Trench Warfare Supply Department at the Ministry of Munitions); Mr. John Sampson (Representative of the Controlled Establishments Association); and Mr. A. W. Tait (Member of the firm of G. A. Touche & Co., Chartered Accountants, and Director of a number of large commercial undertakings).

EXPORTS OF COAL.

The Coal Exports Committee directs the attention of coal exporters and others to the fact that the Order-of-Council issued on 27th November prohibits on and after 7th December the export of coal to all *British* destinations abroad except under licence. Firms wishing to ship coal to such destinations after 6th December should therefore apply on the proper forms (which can be obtained from the Collectors of Customs at the coal ports, or from the War Trade Department (Coal Division), 3, Central Buildings, Westminster, S.W.1) for the necessary licences, in the same way as in the case of shipments to Allied and neutral countries.

DEALINGS IN POTASSIUM COMPOUNDS.

Under the Order, dated 17th October, restricting dealings in potassium compounds (this J., 1917, 1969), no person may offer to purchase, purchase, or take delivery of certain potassium compounds except under and in accordance with the terms of a licence issued on behalf of the Minister of Munitions by the Controller of Potash Production, and no person may offer to sell, sell, supply or deliver any such compounds to any person other than the holder of a licence and in accordance with the terms thereof. The Controller of Potash Production now announces that until further notice he licenses the purchase by any person of potassium compounds coming within the terms of the Order, notwithstanding that such purchases may exceed an aggregate of 3 lb. per month, *provided that the compounds so purchased are used solely in B.P. form or in B.P. preparations for purely medicinal purposes.* By this general licence, retail druggists, hospitals and similar institutions, medical men and others are relieved of the onus of applying for individual licences to purchase compounds coming within the conditions indicated in italics above, and wholesale druggists and others may supply such compounds for use as above set out without the necessity of verifying that the purchaser holds an individual licence to purchase or take delivery. It will, however, be necessary for the wholesaler, in making his returns to the Controller, to state the aggregate amount and value of his sales of compounds for purely medicinal purposes during the period covered by each return. Special forms of return will be provided for this purpose. All sales of compounds other than those exceeding 3 lb. aggregate per month per person, and the sales for medicinal purposes hereby licensed, must be conducted strictly under purchasers' licences as prescribed by the Order, and, together with an aggregate statement of sales under 3 lb., and for medicinal purposes, must be brought out on the returns as at present.

METALLURGICAL COKE.

The Minister of Munitions has made an Order dated 27th November, ordering that the war material to which Regulation 30A of the Defence of the Realm Regulations applies shall on and after 17th September, 1917, include metallurgical coke of the following classes and descriptions:—Scottish, Nottinghamshire, Lincolnshire, Cumberland.

SUGAR (BREWERS' RESTRICTION) ORDER, 1917.

An Order, issued by the Ministry of Food, dated 19th November, prohibits the use by brewers of any saccharine substance other than solid glucose or the invert or other produce of low-grade cane sugar polarising not over 8.9, and from which not less than 40% of its weight has already been extracted in the form of grocery crystal sugar, honey sugar, or syrup. Brewers are, however, permitted to use their existing stocks or any sugar which was already, at the date of the Order, in transit to them from the manufacturers. The quantity of such saccharine substances that brewers are permitted to use is not more than 40% of the quantity used by them in the year 1915.

SUBSTITUTION OF GAS FOR PETROL AND PETROLEUM.

It is officially announced that the following appointments have been made to the Gas TrACTION Committee which the Government recently decided to establish:—Chairman—Sir Boverton Redwood, Bart. (Director of Technical Investigations, H.M. Petroleum Executive); Major Aston McNeil Cooper-Key, C.B. (H.M. Chief Inspector of Explosives, Home Office); Sir Evan D. Jones, Bart. (Petrol Controller, Board of Trade); Mr. H. H. Law, C.B., M.Inst.C.E. (Chief Engineering Inspector, Local Government Board); Sir Arthur Churchman, Bart. (Controller of Mineral Oil Production, Ministry of Munitions); Mr. W. Doig Gibb (Technical Adviser on Gas Works Products, Ministry of Munitions of War); Dr. Chas. C. Carpenter, M.Inst.C.E. (Ministry of Reconstruction); Mr. Edward S. Shrapnell-Smith (Chairman of Joint Committee of Mechanical Road Transport Associations, Economy Officer H.M. Petroleum Executive); Mr. James Ollis (Chief Officer, London County Council Public Control Department); Lieut-Colonel R. K. Bagnall-Wild, R.E. (Member of Technical Committee of the Motor Industries and President of the Institution of Automobile Engineers); Mr. F. W. Goodenough (Chairman of Executive Committee of British Commercial Gas Association, and member of National Gas Council); Alderman William Kay (Chairman of Manchester Corporation Gas Committee and member of National Gas Council); Mr. George W. Watson, M.Inst.Mech.E. (Inspecting Engineer to the Commercial Motor Users' Association, Incorporated); and Mr. W. Worby Beaumont, M.Inst.C.E. (Technical Adviser to the Commissioner of Police of the Metropolis).

The terms of reference are: To consider and report upon—

1. The employment of gas in substitution for petrol and petroleum products as a source of power, especially in motor vehicles, and the manner in which such gas may be supplied, stored, carried, and used, with due regard to the safety of the public.

2. The action, if any, which should be taken by the Government to encourage and safeguard the use of gas for this purpose.

Mr. Shrapnell-Smith has consented to act as Secretary for the time being, and until further notice all communications should be addressed to him at 8, Northumberland Avenue, London, W.C.2.

STANDARDISATION OF PETROL GAUZE.

The Controller, Department of Aeronautical Supplies, Air Board Office, announces that considerable trouble and delay has been experienced in obtaining a regular supply of petrol gauze, primarily due to the fact that aircraft contractors depended upon importation for the finer mesh required for this very important accessory of aeronautical engines, and it was found that a wide variety of mesh was called for by different manufacturers, although they required the mesh for similar purposes, and in some cases it was very difficult to justify distinction. For instance, the difference in the width of the aperture between 200-mesh gauze and 180-mesh gauze is only 1-10,000th of an inch. There has been a tendency to call for meshes much finer than are justified by the conditions. This has resulted in the use of gauze which is much more fragile than is necessary or desirable. To overcome this difficulty, the Air Board took the leading manufacturers of wire cloth into consultation, and the Royal Aircraft Factory experts made certain experiments, which has resulted in a standardised gauze being agreed upon. This will greatly facilitate manufacture, and will enable the material to be produced in Great Britain in adequate quantities to meet the demands from aircraft factories. The gauze will be known as "Air Board Standard Petrol Gauze," and all orders and enquiries should be sent to the Air Board Office, S. (M.A.) 5, Room 609, Strand, London, W.C.2.

USE OF OLIVE OIL IN PRODUCTION OF WOOLLEN AND WORSTED GOODS.

The Army Council have made the following Order, under date 4th December:—

1. No person, the business carried on by whom consists wholly or partly in the production or manufacture of woollen or worsted goods, shall, after 15th December, 1917, without a permit issued by or on behalf of the Director of Raw Materials, apply, or cause to be applied, any olive oil for the production of tops or yarn.

2. No person hereinbefore defined shall, without a permit issued by or on behalf of the Director of Raw Materials, apply, or cause to be applied, any olive oil for the production of tops in quantities exceeding two-thirds of the standard recognised by the Bradford Conditioning House.

CEYLON MONAZITE SANDS AND OTHER THORIA MINERALS.

The Principal Collector of Customs at Colombo reports, under date 15th October, that an official statement has been made to the Ceylon press respecting the mineral survey which has been conducted in Ceylon in co-operation with the Imperial Institute. The survey, it is stated, has led to the discovery of beach deposits of monazite sand which will usefully supplement the commercial supplies of thoria required for the manufacture of incandescent gas mantles. Samples of the sand have been investigated by the Imperial Institute, and the results have been so promising that the Ceylon Government has arranged to work the deposits. Details of the arrangements are

not yet available, but suitable British concentrating machinery has been selected by the Institute for the purpose, after experimental trials, and will shortly be shipped to Ceylon. At one time the monazite deposits in Brazil were the only commercial source of supply of thoria, and these were controlled by the German Thorium Syndicate. The monopoly enjoyed by this Syndicate was subsequently threatened by the discovery of extensive deposits of monazite in the native State of Travancore in India, which are so rich that samples examined by the Imperial Institute were found to contain nearly twice as much thoria as the Brazilian monazite. The German Syndicate, however, obtained control of the company formed to work the Indian deposits, and they continued to exercise a dominating influence over the industry until the outbreak of the war. Since then the company has been reconstructed and given a British character, and it is understood that another portion of the deposits in Travancore has been taken up and will be worked by a second British company. The work of the mineral survey has shown that Ceylon can furnish several other thoria minerals besides monazite. Among these is thorianite, the richest known source of thoria. This new mineral when it was put on the market was sold in Ceylon at as high a rate as £1600 per ton, but the deposits have proved to be limited.

Canadian Section.

THE STANDARDISATION OF DECINORMAL SULPHURIC ACID.

BY FRID. W. BABINGTON, B.A., AND ALFRED TINGLE, D.Sc.

(Abstract.)

The usual method of standardising sulphuric acid solutions by means of barium chloride is open to serious objection on account of the occlusion of soluble salts by barium sulphate and also because the method measures total sulphates in solution. The first source of error can be obviated partially or entirely by particular methods of operation involving much attention to minute details, but the second objection is fundamental.

The authors have therefore sought a rapid and accurate method, for which the necessary reagents can easily be obtained in a state of purity. The best procedure is considered to be to select a suitable acid and compare its solution volumetrically with the acid to be standardised.

Oxalic acid is not very suitable for the purpose as it is seldom free from ash and is liable to contain variable amounts of water.

H. Kastle (Amer. Chem. J., 1910, 44, 817) has recommended the use of *p*-nitrotoluene-*o*-sulphonic acid or *p*-amino-*o*-sulphobenzoic acid, but these acids are not readily available to most analysts.

Succinic acid has also been recommended, but Phelps and Hubbard (this J., 1907, 554) state that it requires long and careful purification.

The authors consider that either tartaric acid or salicylic acid is suitable for the purpose, both being cheap and readily obtained in a state of purity, whilst further purification can be easily effected if necessary. Further, both of the acids are anhydrous and have fairly high mol. wts., and neither is liable to change on storage when dry. A disadvantage attaches to each, however. Salicylic acid can only be used in alcoholic solution, whilst tartaric acid is subject to change if its solutions are kept for too long.

A number of experiments were made in which approximately decinormal sulphuric acid was titrated against approximately decinormal caustic soda solution which had been practically freed from carbonate by addition of barium chloride. Decinormal solutions of tartaric and salicylic acids were also titrated against the caustic soda solution. The results for these acids agreed exactly.

The sulphuric acid was then standardised by addition of barium chloride in slight excess, using the ordinary precautions and, in another series of tests, taking every care to ensure thorough washing and freedom from barium sulphide. The results of these tests agreed well among themselves but were somewhat higher than those obtained in the tests with tartaric and salicylic acids. Results, more concordant with the latter, were, however, obtained by adding excess of barium hydroxide solution to the sulphuric acid, acidifying with hydrochloric acid and weighing the barium sulphate. Extremely low results were obtained when the sulphuric acid was exactly neutralised by means of standard barium hydroxide solution, using phenolphthalein as indicator, and the resulting barium sulphate weighed.

The barium hydroxide solution was examined by two methods. In one, excess of sulphuric acid was added to the solution and the whole evaporated to dryness and ignited in a platinum dish, and in the other sulphuric acid was added in excess and the precipitate washed, dried, and weighed. The results of the first method were higher.

In further experiments on the exact neutralisation of sulphuric acid with barium hydroxide a variety of indicators was used, and the amounts of barium hydroxide solution used and barium sulphate obtained were noted. The following results were obtained, 25 c.c. of sulphuric acid being used in each case:—

TABLE I.

Indicator.	Vol. of barium hydroxide used.	Weight of BaSO ₄ obtained.
	c.c.	gm.
Phenolphthalein	12.05	0.2735
Lucmold	12.05	0.2765
Cochineal	12.05	0.2797
Rosolic acid	12.20	0.2775
Methyl orange	12.00	0.2780

Thus the weight of barium sulphate obtained is not constant, nor is it proportional to the volume of barium hydroxide solution from which it is derived.

The results of all the experiments are summarised in the following table, in which the strength of the sulphuric acid solution is expressed in terms of the barium sulphate obtained from 25 c.c. as determined by various methods.

TABLE II.

Method.	BaSO ₄ obtained.
	gm.
1. Titration in comparison with tartaric acid	0.2924
2. Titration in comparison with salicylic acid	0.2921
3. Direct precipitation with barium chloride	0.2949 (mean)
4. Direct precipitation with excess of barium hydroxide	0.2915 (mean)
5. Exact neutralisation with barium hydroxide (using phenolphthalein)	0.2735
6. Evaporation of Ba(OH) ₂ with excess of acid and calculation from titration	0.2868
7. Addition of excess sulphuric acid to Ba(OH) ₂ and titration, with calculation from titration	0.2837

Methods (1) and (2) agree perfectly, and method (4) agrees fairly well with them, so they are probably correct. The divergence of method (3) from (1) and (2) cannot be due to the presence of sulphates in the sulphuric acid, since this would cause a high result in method (4), hence it is probably due to occlusion of barium chloride, which would not occur to any great extent in method (4). It should be noted that any method of standardisation of decinormal or weaker solutions of sulphuric acid involving weighing of barium sulphate is liable to larger experimental error than titration, since 0.1 c.c. of N/10 acid is only equivalent to 1.17 mgrm. BaSO₄.

Method (4) is not recommended, owing to the trouble experienced in preventing the barium sulphate from passing through the filter. The low result obtained with method (5) is due to incomplete precipitation, since the other possible source of error (presence of alkaline impurities in the barium hydroxide solution) is unimportant as shown by comparison with methods (6) and (7). The discrepancy between (4), (6), and (7) seems best accounted for by supposing the presence of an alkaline silicate. The results of methods (6) and (7) seems to reflect considerably on Richardson's method (this J., 1907, 78).

Further experiments were made in connection with the variations of the neutral point as shown in Table I. The same solutions were used as before, the barium hydroxide being clear and free from carbonate except that present in solution. The subjoined table shows the results obtained, using 10 c.c. of sulphuric acid in each case (the figures of the first two columns have been calculated from those for 25 c.c.). In the first four sets of tests the alkali was added to the acid and in the fifth the acid to alkali:—

TABLE III.

Indicator.	Alkali solution used.				
	Barium hydroxide.	N/10 sodium hydroxide.	N/20 sodium hydroxide.	N/20 NaOH - excess NH ₄ Cl.	N/20 sodium hydroxide neutralised by acid.
	c.c.	c.c.			
Phenolphthalein	8.30	9.48	18.60	—	19.20
Lucmold	8.30	9.59	18.90	18.30	18.90
Cochineal	8.30	9.46	18.80	18.80	18.90
Rosolic acid	8.32	9.52	19.10	—	19.10
Methyl orange	8.24	9.12	18.60	18.60	18.60

The solutions used were not standardised, so that the figures in the various columns are not in all cases comparable. It is suggested that the abnormality in the titration of sulphuric acid against sodium hydroxide may be due to the absorption of carbon dioxide during titration. The authors do not agree with Smith's suggestion (this J., 1917, 415) that the irregular results are due to the presence of carbonates, since it is unlikely that the solubility of barium carbonate in the solution used is so great as to cause errors of such magnitude. Also the neutrality as shown by lucmold agrees with that shown by phenolphthalein and not with that shown by methyl orange. If carbonates been present, lucmold indications should differ from those with phenolphthalein and agree with those of methyl orange. For similar reasons it is believed that ammonia was not an important factor.

Liverpool Section.

Meeting held at Liverpool University on Friday,
November 16th, 1917.

MR. A. T. SMITH IN THE CHAIR.

MODERN MARGARINE TECHNOLOGY.

BY W. CLAYTON, M.S.C.

The introduction of new and extensively used foodstuffs has often synchronised with periods of great wars. Thus condensed milk was first used in large quantities by the Northern Armies in the American Civil War, in 1856, and soya-beans and bean oil were developed as a result of the Russo-Japanese War, when the Japanese soldiers found soya-bean products a staple war-food. Margarine is pre-eminently a war product, having its inception during the Franco-Prussian War, and finding its place as a universal article of diet during the present great struggle.

Margarine manufacture is really a present-day success, with a seemingly prosperous future ahead. It is cheap, made from quite pure materials, having excellent food values, and simulates butter very closely. The former prejudice against its use is rapidly breaking down, and to-day the industry is very promising indeed, and many new works are being established, pointing to keen competition after the war.

When, in 1869, the French Government offered a prize for a cheap butter-substitute, to conform as closely as possible in physical and chemical characteristics with butter, and of good keeping qualities, a French chemist, Mège-Mouriès, began a research into the formation of fat in milk. He reasoned that in the animal metabolism, the carbohydrates are converted into fat, which in turn changes into butter-fat by the process of pepsin-digestion. This led him to try to effect artificially a similar change in animal fats. Fresh beef fat, usually from the kidney or intestines, free from tissue, was digested for two hours at 45° C. in an aqueous solution of sodium carbonate, in presence of pigs' or sheep's stomachs. As a result of pepsin action, the fat was completely separated from the remaining tissue; it was then skimmed off, and warmed with a 2% solution of common salt to prevent early rancidity. On standing, a yellow fat separated which was cooled to about 22° C. The semi-solid mass possessed a butter odour, and when pressed between warmed plates, the more fluid constituent was obtained, averaging about 50 to 60% of the fat. This fat, when cooled, had a butter-like consistency, and was termed "Oleo-margarine," being sold as such in Paris.

Mège-Mouriès improved on this product by churning it with 10% of cow's milk, and water containing macerated cow's udder (0.4%), until a satisfactory emulsion was obtained. This was solidified, washed, salted, coloured, and sold as a butter-substitute, having a moisture-content of about 12.5%, and a m. pt. of 17°—20° C.

Factories were erected and developed in Austria, and later, in 1873, an English patent was taken out by Hippolyte Mège. The Parisian Council of Hygiene, in 1873, sanctioned the sale of these butter substitutes, at the same time prohibiting their claim to the title "butter."

The name "Margarine," derived from the Greek word for "pearl," was introduced by Chevreul, who applied it to the compound formed by the union of margaric acid and glycerin, as found in human fat and in olive oil. It is not certain whether "margarine," as thus understood, is a definite chemical compound, for whilst some chemists regard $C_{17}H_{31}O_2$ as margaric acid, a

definite member of the stearic series of fatty acids, others claim it to be merely an eutectic mixture of stearic and palmitic acids.

Adopting Chevreul's nomenclature, the oleo-margarine described above was thus considered to be a mixture of oleine and margarine, the stearine matter having been removed.

In 1887, the Margarine Act was passed, and all butter substitutes thenceforth had to bear the title "Margarine." To comply with the requirements of the Food and Drugs Act, it is now necessary to attach a margarine label, printed in 1½ in. letters, to any package exposed for sale. If the packages are exposed for sale in a box, it will suffice for the word "Margarine" to be printed on the lid, and in that case, the packages must be handed to the buyer enclosed in a wrapper bearing only the one word, "Margarine," in ½ in. block letters.

Since the time of Mège-Mouriès, the manufacture of margarine has steadily progressed, numerous oils have been introduced, and up-to-date methods and machinery brought into vogue. The fat is no longer digested artificially, the flavour of butter being simulated in other ways. Also margarines from vegetable oils and fats have steadily displaced the former purely animal products.

The chief animal fats employed in margarine manufacture are lard, oleo, "premier jus," and stearine. "Premier jus," obtained from the best beef fat, can be fractionated to yield oleo and stearine, e.g., by hydraulic pressure at 38° C., using filter-cloths, or by fractional crystallisation for some days at 28° C. By the former method, the more fluid oleo oil is expressed; in the latter, the harder stearine crystallises out.

Stearine is not used in large proportions in a margarine mixing because of its high melting point (54° C.), but is useful when vegetable oils preponderate, as it corrects the consistency of the final product. The corresponding mutton oleo, jus, and stearine are not in such demand, and their physical properties are somewhat different from their beef analogues, thus leading to changes in the composition of the margarine. A great variety of vegetable oils is employed. The solids or fats include coconut and palm-kernel oils, and in the United States palm oil is also used. The oils include cottonseed, arachis, soya bean, and sesame oils, and more recently kapok, maize, and wheat oils. Last, but by no means least, must be included hardened or hydrogenated oil, which will be discussed in some detail later.

The refining of oils for edible purposes has become a fine art, and almost any of the vegetable oils just mentioned can be obtained quite tasteless and odourless, and of a high analytical degree of purity.

Upon the relative proportions of these various oils and fats, both animal and vegetable, depend the quality and texture of a margarine. It may be taken for granted that where much animal fat is used, a dearer brand of margarine results, and that the cheapest brands are almost entirely vegetable in origin. The formulæ or compositions employed depend upon the quality required, the market condition prevailing, and the weather. In warmer weather, more of the solid constituents will be used.

The introduction of hydrogenated products in margarine manufacture marks a great technical advance, and one which is likely to develop very rapidly in the future. The fundamental principle underlying the hydrogenation of oils and fats, is to make valuable hard fats from relatively cheap raw material, by the addition of hydrogen. By the addition of about 1% of hydrogen to cottonseed oil, for instance, a fatty product of at least the consistency of lard may be obtained. Since hydrogenation can be stopped at any time, it is obvious that with a given oil, an end product of any desired melting point up

to that of the fully saturated product is possible. Hydrogenated oils have excellent keeping qualities and are said to help margarine in this respect. Knapp found no rancidity in samples of such oils even after 18 months, and the free acid content (0.7% as oleic acid) remained practically constant. An objection has been raised by Brauner that hardened oils raise the moisture content of a margarine, owing to their property of retaining water, much in excess of what other oils do. He claims to have proved this on a large scale on many occasions. As far as I am aware such a difficulty has not been met with in our factories, and in any case, the problem admits of very easy solution.

The use of hardened oils really hinges upon their edibility or otherwise, and on this point much controversy has raged. Little doubt exists as to their being thoroughly suitable for human consumption, since they are assimilated during human metabolism just the same as any other fats, but whether the traces of metal catalyst almost invariably present affect the health, was for a long time a dubious matter.

Nickel is the most widely-used catalyst and traces of it are to be found in most samples of hardened oils. The amount of this metal likely to be present depends on the amount of free acid in the oil, and on the time of actual contact of oil and catalyst. Bömer found in a sample of hydrogenated sesame oil containing 2.5% fatty acid, an ash content of 0.01% with 0.006% of NiO. Again, a whale oil with 0.3% fatty acid, had an ash of 0.006% with 0.0045% NiO. Thus if a daily quantity of 100 grms. of hardened oil were eaten, the maximum amount of nickel absorbed would be 0.6 mgrm. Physiological tests show this quantity to be quite harmless: in fact it has been proved that small daily doses of nickel powder have no ill effect, 99.8% of the metal being rapidly excreted.

Another objection that has been raised against the use of these oils in margarine manufacture, is that good products may be prepared from bad raw material. As a particular instance, whale oil can be hydrogenated to yield a tasteless, odourless, and germ-free fat, physiologically harmless. Suspicion was aroused that margarine manufacturers might use cheap and unwholesome fish or other oils, hardened to form good clean products. Much controversy has centred round this point. So long as the raw material was unsound, the public would not sanction the final margarine. Maybe there will be a legal fixing of the raw material in the future. At any rate, such a course has been frequently advocated, especially in the United States.

Milk is used in margarine manufacture for two primary reasons, viz.: as a basis for flavouring development and as an emulsifying agent. Only milk of a high hygienic standard should be employed, either fresh-skimmed or separated. It is an ideal medium for micro-organisms, containing, as it does, the essentials of life in a readily assimilable form. The micro-organisms present in milk are lactic and butyric bacilli, various yeasts and moulds, and pathogenic organisms. For the destruction of the undesirable bacteria, especially of the pathogenic type, the milk is pasteurised by heating to 82° C. for a few minutes. The chemical and physical properties of the milk were not considered to be seriously affected, until quite recently when Renshare and Ware showed that there is a rapid decrease in the amount of sugar, and an increase in acidity, on pasteurising milk. The lactose is decomposed by certain lactic organisms which act very rapidly at 80°–85° C., producing lactic acid, part of which is probably transformed into other substances, since the acid

found never exceeds one-third of the amount of lactose decomposed.

By heating to 82° C. the milk is deprived of some useful souring bacteria, but also has its content of undesirable and pathogenic organisms reduced. A Government Report of 1914 by Delépine states that the bacterial content of 1 gm. of milk was reduced from 14,120,000 to 1900 in one case and from 5,770,000 to 100 in another. Much discussion has taken place as to whether the tubercle bacillus in milk is killed during pasteurisation. Richmond, in his work on "Dairy Chemistry," p. 282, says, "As the tubercle bacillus is comparatively easily destroyed by heat, pasteurisation of milk may be resorted to to destroy the organisms: keeping the milk for 15 minutes at 70° C. will practically remove the source of infection." Delépine states that he is convinced "that cream infected with human tubercle bacilli was not invariably sterilised when exposed to a temperature of 85° C. even when the exposure lasted 15 minutes." He continues: "I subsequently obtained similar results with milk containing tubercle bacilli of bovine origin."

Unfortunately the complete sterilisation of milk by boiling is prohibited, inasmuch as the characteristics of the milk would be too much changed, and a burnt flavour would result. It is very probable, however, that in the near future pasteurisation will be replaced by complete electrical sterilisation, a method which would leave the physical and chemical and flavouring characteristics of the milk unaltered and would be ideal from the margarine manufacturers' standpoint. Milk can be sterilised by means of a high tension alternating current, and such a method has been patented. It should also be possible to have a large scale ultra-violet ray apparatus to sterilise milk at ordinary room temperature, just as Dornae and Daire sterilised water using quartz electric lamps. Butter and fats have also been rendered germ-free, by being carried on an endless band or a revolving drum in a thin layer, past a series of ultra-violet ray lamps. In any case, the future holds much in store for changing this part of a margarine process involving the incipient reduction of all the bacteria in the milk.

In the present system of pasteurisation, the milk is well agitated, and delivered, after being pasteurised, about 8 feet above the inlet level, thereby enabling a vertical cooler to chill the milk as it descends to the souring tanks. By cooling to about 10° C. bacterial activity is inhibited and the action of germs which have resisted heating, or have gained accidental access, is minimised. It now becomes necessary to inoculate the milk with those germs necessary to develop a butter-like flavour. A pure culture, or "starter," is added, consisting of lactic acid bacilli. The temperature is raised to a point known to be favourable to the bacterial development, and lactic fermentation proceeds until a degree of acidity is reached which causes rapid precipitation of curd. The milk is again cooled to a safe inhibiting temperature, at which it is maintained until required in churning.

Lactic fermentation gives the milk a pleasant acid taste and aroma, due to the production of lactic acid, among other products, but the true flavour of butter is lacking. Much research has yet to be done before margarine can be made having a distinct and recognisable odour and taste like butter. Some manufacturers add flavours of various kinds when blending the final margarine, but this is only a temporary expedient. The true flavour will be obtained when the requisite bacterial action on either milk or fat is discovered. Personally I foresee a time when milk as a flavouring basis will not be required. Research should be

directed somewhat along the lines of Mège-Mouriés' ideas, towards a pre-digestion of the fats to butter-fat, or else to a selective bacterial action on both animal and vegetable fats. Water and an emulsifying agent could then replace milk. My own experience leads me to a quite optimistic view of probable progress in this direction.

The milk having been prepared for churning, it is now necessary to emulsify the oils with it. According to the quality of margarine desired, a mixture of animal and vegetable oils and fats is melted in large vessels, in which the temperature can be adjusted by means of steam or cold water. The melted mixture passes through strainers to a temper-room, where a constant suitable temperature can be maintained for each given mixture. This, however, is not really a necessary procedure; all temperature adjustments can be made just as well in the melting room, and then the oils are run straight to the churns.

Two types of churn are in general use. The older is a double-jacketed vessel which may be heated by steam, or cooled by water, as necessary, and is provided with stirrers, *e.g.*, two sets of revolving baffle-plates. The oil or milk is added, the other constituent is then run in. Sometimes both oils and milk flow in together. Efficient stirring at a suitable temperature is maintained, until emulsification is satisfactory. The emulsion is then released through a valve at the bottom of the churn, and flows on to a slanting shoot, where it is immediately met by a spray of ice-cold water, striking upon it with such force as not only to cause instant solidification, but also to break up the mass into yellow granules. These so-called "crystals" float down the shoot in the excess water, and collect in a wooden trough beneath, which permits complete drainage of the absorbed water.

The newer type of churn is electrically controlled, and is of the "continuous" type, *i.e.*, milk and oils are led by separate pipes to a thermo-regulated chamber, where on intermingling, numerous blades, rapidly revolved by means of a motor, effect complete emulsification, the emulsion being discharged as soon as formed, on to a shoot as already described. Alterable pumps allow regulation of the flow of milk and oils, so that various mixtures may be employed, according as one quality or another is desired. This electric or continuous churn is coming into great favour, and is far in advance of the older type.

In some factories the ice-water spray is not employed. Instead, the emulsion is solidified on a well-cooled revolving drum, and the solid margarine stripped off automatically.

The process of emulsification is of first importance. The object of churning is to imitate the emulsion found in cream and milk, where the fat globules have diameters ranging from 0.01 mm. to 0.0016 mm., and remain as discrete particles. The general theory of emulsification indicates that with two immiscible or only partially miscible liquids, two types of emulsions are possible, each constituent being in turn the disperse and then the continuous phase. For concentrated emulsions a third agent is required. Where oil is to be the internal of disperse phase, the emulsifying agent should be capable of lowering the surface tension of the external or continuous medium, and should be viscous, as is glycerin, or an emulsoid, like gelatin. If oil be dispersed in water, a stable emulsion can be made, the stability depending on the minuteness of the oil drops, this in turn being a result of the efficiency of the emulsifying apparatus. If, however, water be dispersed in oil, a very unstable system is produced, separation into two layers taking place as soon as beating-up ceases. Now milk, by virtue of its colloidal

content, is an excellent emulsifying agent, when oil is the disperse phase. Consequently if milk be in a churn in bulk, and oil is slowly fed in, with continuous agitation, an excellent emulsion of great oil concentration can be produced, and will set to a homogeneous mass afterwards. But if, as in some factories, oil be in the churns in bulk, and milk is fed in, a very unstable system results, which easily separates into layers on stopping the agitation for a while. This has been proved many times, and the explanation seems clear. To get a suitable emulsion of water in oil, one would require an emulsifying agent which should form an oil-soluble colloidal solution, but in milk the colloids are water-soluble. Both theory and practice condemn any form of churning which would lead to emulsions with oil as the continuous medium. Such emulsions when cooled by ice water, or on drums, solidify with clot formation, and the resultant margarines are "spotted" in texture. It is interesting to note that the electric continuous churn gives a stable emulsion of oil in milk, as would be expected from theoretical principles.

The temperature of churning is very important, and, other things being equal, about 25° to 35° C. should be the rule. Higher temperatures lead to milk curdling, and consequent spotting of the finished margarine by casein clots. Also one must remember the very delicate relationship between flavour and temperature.

Though some technologists still maintain that fats of high-melting point like stearine lead to imperfect emulsification, and consequent poor texture in the final margarine, it is possible to work under such conditions as to obtain eminently satisfactory emulsions. Conditions are known which allow even fairly large quantities of stearine to be mixed with low-melting vegetable oils, and yet give homogeneous and permanent emulsions.

Investigations have been made to increase artificially the efficiency of emulsification by the addition of various colloids to the milk. Starch, gelatin, glycerin, egg-yolk, lecithin compositions, and numerous patent mixtures have been tried. These substances have been regarded as forming a membrane or film around the oil globules and so preventing their coalescence, thus leading to increased stability of the emulsion system. At the same time, it must not be forgotten that the electric charge on the particles may also play a large part in preventing coalescence. Still, whatever the ultimate explanation, it is a fact amply proved by experience, that the addition of so small a quantity as 0.1% of, say, glycerin or gelatin to the milk before churning, leads to much better emulsification. Where the ice-water spray system is used, the starch, gelatin, or other reagent is washed out, and cannot be detected in the final margarine. This is a decided advantage from the manufacturer's point of view. The rapid cooling and crystallisation of the emulsion inhibits separation, and also serves to absorb the minute casein particles associated with the fat globules.

The yellow "crystals" are removed to a maturing-room, where, under constant thermal conditions, the bacteria introduced by the milk can develop. This occupies many hours, depending upon the quality of the margarine being made. The best animal margarines are permitted the longest maturing time. Maturing accomplished, it is now necessary to knead the "crystals" together to form a coherent, butter-like mass, and at the same time to expel the excess of water, since the legal limit of moisture in margarine is 16%. Consequently the matured "crystals" are rolled in drums, or passed between a set of rollers. The following are typical analyses of two different churnings of "Alpha" brand, an animal margarine, where 100 gallons of soured milk was emulsified

with 1 ton of oils. The crystals were passed through a roller apparatus.

	Fat, %.		Water, %.	
	(1)	(2)	(1)	(2)
Crystals	67.30	67.30	27.46	27.47
Rolled product	78.38	80.23	16.03	12.47

The average amount of water in the crystals is 33 %, and in the rolled product, 14.5 %.

The buttery mass is now passed on to the blending department, where it is prepared for delivery to the consumer. The blenders hold various amounts of margarine and are fitted with curved blades, which by rapid revolution ensure thorough mixing of the margarine with salt, colouring matter, preservative, etc., in about 35 seconds. The amount of salt and colour to be added is determined by the consumer. The quantity of butter added, as a means of ensuring nicer flavour and better texture, must not exceed the legal limit of 10 %. Preservative, usually boric acid, is added in amount not exceeding 0.5 %. This provides against undue bacterial action, whereby acidity would develop, and cause rancidity.

The following analyses are instructive, and show that the acidity of a margarine is closely related to its milk content. The figures show the number of c.c. of N/10 caustic soda required to neutralise 10 grms. margarine melted in water, using phenolphthalein as indicator :—

	Before rolling		After rolling.	
	N 10NaOH	H ₂ O	N 10NaOH	H ₂ O
Brand A (a) ..	0.62	35.9%	0.33	18.3%
" (b) ..	0.58	34.2	0.26	10.9
" Δ ..	0.48	33.1	0.25	12.2
Irish butter ..	—	—	0.22	15.1

To illustrate how the acidity of a margarine would develop were no preservative added, the following figures may be cited. In this case the margarine was melted in alcohol and titrated against N/10 NaOH.

	Initial. 24 hrs. 48 hrs. 72 hrs.			
Brand D	2.17	2.50		2.66
" E	1.90	2.52		6.80
" F	2.63	2.86	3.71	4.80
" G	2.96	3.02		3.00*
	2.96	3.05		5.48†

* Kept in the cold store.

† Kept in the maturing room.

The acidity, as measured by the water-soluble acids, is practically a constant in each case.

When the margarine has been blended, it is packed, labelled, and passed into the cold-storage until required for shipment.

In order to improve the texture of a margarine, the addition of 0.5 to 5 % of a wax such as ceresin wax has been suggested. Glycerin has been used in this connection to impart a glossy appearance to the margarine. Glucose has been used, but Zoffmann has showed it to be injurious, owing to yeast fermentation leading to formation of carbon dioxide and bursting of the packages. Personally

I see no need for the addition of anything in the blending of a margarine in order to improve texture. If the process of emulsification is controlled properly, and the right conditions observed for even those cases where stearine and other high-melting fats are used, the texture will take care of itself.

Analytically, the difference between butter and a margarine is soon found by a determination of the soluble and insoluble volatile fatty acids, the so-called Reichert-Meisssl and Polenske numbers. But it has been urged that for a rapid and easy differentiation, some chemical reagent be added to a margarine. Thus Soxhlet suggested the use of phenolphthalein. In some countries, it is fixed by law that sesame oil to the extent of 10 % be a constituent of margarine, this oil permitting of a rapid and distinct colour test.

Frothing and browning being characteristics of butter on heating, and margarine simply spluttering and separating into water and oil on similar treatment, it is usual when blending, to introduce some substance which will bring about frothing and browning, when even low quality or pastry margarines are heated. Amongst the many things proposed and in use are butter, milk powder, casein, lecithin, yeast, malt-extract, cholesterol, egg-yolk, lactic acid, and many patent emulsions of lecithin and sesame oil.

The advent of artificial milk is a distinct advance in margarine technology, and one likely to have far-reaching consequences. It is fairly easy to imitate milk in so far as it is an emulsion of oil in water; it is just as easy to go a step further and add lactose and mineral matter to the emulsion, to strengthen the similarity. But to imitate milk successfully, the casein constituent must be introduced, and this proved the stumbling block for many years, in all attempts to produce a synthetic milk. However, casein-bodies have been extracted from nuts and nut-meals by means of alkaline media such as phosphates and carbonates, and artificial milks have been made from which cream, margarine, and cheese have been successfully produced. Here then is a new field, comparable with the introduction of hardened oils.

For the margarine manufacturer, having the oils, and possibly the oil-cakes too, at his command, may produce milk artificially, pasteurise it, and then flavour it by means of a culture, and so be quite independent of the dairy-farms.

The margarine industry is new, but in its short life many advances have been made. There is no doubt at all but that the industry will prosper, and as its scientific principles become more and more exploited, and its technology more developed, the place of margarine as a permanent and staple article of food will be more and more recognised.

DISCUSSION.

The CHAIRMAN, in opening the discussion, pointed out the stimulation of chemical industries by the French Government, who had offered prizes for margarine research on the one hand and had also commemorated the name of Leblanc in a similar manner. It was further interesting to note the interdependence of sciences like chemistry and biology in margarine manufacture.

Mr. COLLINGWOOD WILLIAMS was of the opinion that at the present time no butter was being added to margarine, although the law allowed up to 10 %. "Synthetic milk" could not be made successfully until the necessary enzymes were produced in the laboratory, which was at present an impossible achievement. A test to distinguish between butter and margarine was to examine a thin layer of the fat under the microscope, using polarised light, when margarine showed a crystalline appearance.

Dr. E. F. ARMSTRONG said that the controversy centred round the occurrence of traces of nickel catalyst in margarine was of Continental origin, and traces of metal were found in Continental brands of margarine owing to the technical inexperience of the firms using the "hardening" process: British hydrogenated oils contained practically no nickel. Concerning the production of good edible fats from cheap raw material like low-grade whale-oil, he did not think it was successful, and, in fact, it was not commercially used. The difference between margarine and butter depended on the content of mixed glycerides; these were difficult to identify and determine, and research in this field would help to advance margarine manufacture.

Mr. W. MANSERIDGE thought that an artificial milk industry would benefit margarine manufacture, since the natural product was comparatively costly on account of transport, etc., although in countries like Holland the much cheaper water carriage enabled milk to be carried from farm to factory at low cost.

Mr. CLAYTON, in reply, mentioned that the polarised light test failed in the case of "renovated" or "process" butter. A German chemist had published the results of some work on the hydrogenation of bad oils, using aluminium compounds as catalysts, and producing a fairly pure fat; this had roused public suspicion, and much controversy had ensued. No hardened fish-oils were used in the British margarine industry.

London Section.

Meeting held on Tuesday, December 4th, 1917.

DR. CHARLES A. KEANE IN THE CHAIR.

THE ECONOMICS OF COAL PRODUCTION.

BY PROF. HENRY LOUIS, M.A., D.Sc.

When the Chairman of the London Section asked me to open the present session with a paper, I was naturally faced with the difficulty of selecting a suitable subject, since it happens that the only branch of chemical industry upon which I can claim to speak with any of the authority of experience is one in which relatively very few of the members of this Section are at all interested. I therefore propose to submit a short review of a subject which will in my opinion appeal not only to every manufacturer, whether engaged in a chemical industry or otherwise, but further, to every citizen of the United Kingdom, whilst it is also peculiarly appropriate to the "Canny Town," which I have the honour of representing in this Society.

It is too often overlooked that Britain's greatness is built essentially upon the foundation of an abundant and cheaply gotten coal supply, and it is impossible to doubt that when this supply shall fail us, the hour of Britain's decadence will have struck. Coal is not merely one of the chief articles of British export, but it is practically the sole material product that we have for exportation. Not only do we export coal directly

as cargo or in bunkers, but also indirectly: when American cotton is converted in this country into piece-goods or Spanish iron-ore into machinery for exportation abroad, we are really re-exporting the raw material that we imported, plus the coal that has been consumed in its manufacture. Whether we export the coal as such, or export the products of the energy developed by the combustion of that coal, makes no real difference to the economic position as far as the coal is concerned. The real reason why we have become successively the world's chief manufacturer and the world's chief common carrier, is because we had available an immense supply of coal that could be extracted more easily and more cheaply here than in foreign countries. Every manufacturer knows how important an item in costs is the expenditure on energy and on fuel, and is aware that if this should increase seriously, competition with foreign nations would become hopeless. Our future depends essentially upon our ability to maintain this supply of cheap coal. Having regard to the enormous importance of the question, I think it well worthy of adequate discussion, and it appears to me that the first step towards any discussion of the problem is the presentation in clear form of the various items that enter into the cost of coal as supplied to the consumer; it is only when their significance is fully grasped, that it will be at all possible to forecast how these are likely to be affected in the future and how they in their turn will affect the problem as a whole.

The cost of coal at the pit's mouth may be taken as being made up of the following items:—

- (1) The value of the coal in its unsevered condition.
- (2) The cost of wages paid to the men engaged in its extraction.
- (3) The cost of the various materials and supplies.
- (4) Administrative and incidental expenses.
- (5) The profit of the colliery proprietor, including interest upon the capital employed.

I have attempted to calculate the proportions in which these various items contribute to the cost of coal at the pit's mouth, and have selected for this purpose the year 1913; the figures I propose to give are a rough average applicable to the United Kingdom as a whole; they will differ considerably in each coalfield, and individual collieries will show even wider variations; all that can be attempted is a general average applicable to the kingdom as a whole, and this is what I have endeavoured to compute. I make the ratios of the various items to be as follows:—

	%	s. d.
Royalty	5.35	0 6.5
Wages	62.55	6 4
Materials	16.45	1 8
Administration	7.00	0 8.5
Interest and profit	8.65	0 10.5
	100.00	10 1.5

According to the official figures the cost of coal at the pit's mouth averaged 10s. 1.5d. in 1913, and the costs given are calculated as percentages upon this total. It should furthermore be noted that the price of sea-borne coal delivered into barges in the Thames is given by the same authority as 21s. per ton.

To the cost of coal at the pit's mouth must be added further the cost of transport to the consumer, and in the case of the small consumer, who does not buy direct from the colliery, the merchant's profit.

I propose next to examine each of the items in some little detail.

The value of the coal in its unsevered condition, as it lies in its natural bed, is usually expressed in the form of a royalty; there are a few cases where collieries have purchased outright the seams that they are working, but in such a case the purchase price will have been computed as the present value of the royalties derivable from the coal, so that in either case it is the royalty that forms the basis of calculations. Practically all the coal in this country belongs to private mineral landlords, the leading exceptions being the coal in the Forest of Dean and under-sea coal, which belong to the Crown; in practice, however, the Crown deals with its mineral property just as any other mineral landlord would do, and there is therefore no need to consider the Crown ownership of coal apart from the general proposition. The story of how the ownership in this country came to be vested in mineral landlords is a long one, and one which I have dealt with elsewhere; here I need only say that it has in the vast majority of cases been acquired by strictly legal means and in return for services rendered to the community. I need only refer to the analogous case of the United States, where coal which originally belonged to the State has been handed over practically for nothing to citizens of the States, because it was held that only in this way could the national mineral resources of the country be rapidly and successfully developed, and that the indirect gain to the State by thus fostering national industries far outweighs any direct revenue that might have been obtained by retaining in the hands of the State the ownership of the coal resources of the nation. The startling rapidity with which America has taken the lead among the world's coal producers fully demonstrates the soundness of this policy.

I do, however, hold that in cases where deep-laying coal, of the existence of which neither the owner of the surface nor his predecessors in title could have had any inkling, has been discovered solely through the labours of a national institution, the Geological Survey of Great Britain, as has happened for example in Kent, the owner of the surface has no equitable right in the coal thus discovered. He has contributed no more to the discovery than has any other tax-payer, and I cannot see what equitable claim he has to the coal thus discovered for him. I hold that State mineral discoveries ought to be the property of the State; this principle has actually been admitted to some extent in the recently suggested legislation respecting discoveries of mineral oil, and in my opinion it should be extended to all minerals. Apart, however, from this very special case, I wish to make it clear that I look upon the ownership of coal by the mineral landlord as not only equitable but also as an advantage to the coal mining industry as well as to the entire community.

Upon the whole, the royalties charged are not exorbitant, and although occasional cases of extortionate charges or even of unwillingness to allow mineral to be worked at all may be quoted, there would be no difficulty in dealing with these, and generally speaking, the system works well and to the advantage of the country.

With regard to the amount of royalty, that is to say the price of the unsevered coal, there is little information since the 1889 Commission on Royalties made its report; that report showed that the royalties throughout the country amounted to about 5d. per ton; it is, however, probable that this figure would be a little low to-day,

and I consider that the figure that I have given of 6d. per ton is not very far from the mark. No doubt it will rise in the future under the effects of the mineral duties imposed by the 1909-10 Finance Act, an ill-considered piece of legislation which not only tends to increase the cost of the unsevered mineral, but also, by the way in which Increment Value Duties are imposed, directly discourages the development of our national mineral resources.

Wages form, it will be seen, the principal item in the cost of coal production. They are best considered under three customary heads: The labour at a colliery is usually divided into underground and surface, and the underground men are again sub-divided into hewers, who actually get the coal, and the other underground men, or offhand men as they are usually called. It need hardly be said that the proportions of these different classes vary within very wide limits from colliery to colliery according to circumstances; an average of wages taken over the whole country would probably give about the following proportions of wages for the total number of workers employed:—

Hewers	19
Offhand workers	32
Surface workers	19

The item of wages is obviously one of the greatest importance, forming as it does about 63% of the total cost at the pit's mouth; bearing in mind that the cost of materials represents very largely the value of the labour employed in their production, it is clear that wages represent more than two-thirds of the value of the coal at the pit's mouth, and that anything that can be done towards reducing the cost of the other items is of small significance compared to that of keeping labour costs within reasonable limits.

The cost of hewing must in some respects be considered apart from the other labour costs; hewers are always paid tonnage rates, whereas many of the others receive a datal wage, though some of them, e.g., putters who transport the coal underground, are generally paid by the ton. The hewing cost now forms no less than one-third of the cost of coal at the pit's mouth. This item has been continuously increasing for many years, and the increase has been enormously greater during the war than at any time previously. It is not to be expected, and most employers who have considered the question seriously do not even consider it desirable, that wages should ever come down to their previous level; most of us hold that the collier ought to have a standard of living higher than he has been accustomed to in the past; the only hesitation that attends increase in the rate of wages is that, as a rule, such increases in the past have not improved the status of the coal miner; he has only taken advantage of them to do less work. This feature is probably the most disquieting element in considering the future of British coal mining.

In the decade 1883-92, the average production was 320 tons of coal per worker employed.

In the decade 1893-02, the output was 295 tons.

In the decade 1903-12, the output was 380 tons.

No doubt to some little extent such decrease in production may be accounted for by the fact that the thicker and more easily worked seams are gradually becoming exhausted, and the production from the thinner seams is gradually forming an increasing proportion of the total, but the diminution in efficiency due to this cause should be far more than counterbalanced by the

increased use of underground machinery, especially of coal cutters and face conveyors, which greatly multiply the working capacity of the hewer. It cannot be too often or too emphatically stated that high wages can only be paid by an industry when they are really earned by the men engaged therein. In other words, the only solution that I can see for the difficulties of the position is to be found in an increased output per man. Hitherto the influence of the powerful Coal Miners' Unions has, to say the least of it, not been exerted in the direction of urging men to increase their production, and in this respect a reversal of policy on their part is an imperative necessity if Britain is to retain its position amongst the nations.

Offhand labour represents about 22% of the cost of coal at the pit's mouth; here it ought to be possible to effect decided savings, without, of course, decreasing the rate of wages; the adoption of mechanical means of underground transport on a more extensive scale, and reorganisation of some of the underground methods in use, appear to be quite possible. In the same way some saving might also be effected in surface labour; seeing, however, that this item represents under 12% of the total cost, the margin within which economies might be effected is comparatively small. The item of materials includes a large number of miscellaneous substances; the most important probably is timber used underground; it also includes the coal consumed in providing the necessary energy for working the pit, explosives, lubricants, and materials like rails, ropes, pipes, canvas, bricks, cement, etc., and the various items required for repairs and renewals. All these were, comparatively speaking, reasonable in price in 1913, and it is highly improbable that except as regards timber, economies in the quantities consumed can be effected in the future. On the contrary, the more extended use of machinery in the place of hand-labour is likely to involve greater costs under this head.

Administration includes a number of items, such as fees of directors, salaries of managers and secretaries, the cost of clerical work, of surveys, legal expenses, compensation for surface damage, rates and taxes (which form at present a very heavy item), wayleaves, etc. No great exception can be taken to any of these items except perhaps to that of wayleaves; the 1889 Royalties Commission determined the cost of wayleaves at about 3d. per ton on all coal raised in the kingdom, but it is probable that it amounts to about 3d. per ton at the present time. The effect of wayleaves is often overlooked, because most collieries group wayleaves and royalties under the same heading; the two are, however, really quite distinct. A royalty is, as I have shown, the purchase price of the unsevered coal, whereas a wayleave is rental paid for accommodation, namely, for permission to carry coal under, through or over someone's property. The price asked for it is usually the measure of what the colliery company can be compelled to pay, not of the damage suffered by the landowner. I cannot but think that this system of exacting wayleaves is inequitable, and that in this as in many other countries the right of an owner of minerals to transport these to some public means of communication should be held to be a servitude imposed in the public interest on the ownership of all land, and that the price to be paid for such passage should be assessed by an independent tribunal upon the basis of payment in full to the landowner of compensation for any injury that he may suffer by the transit of the mineral, but nothing more.

The amount of the colliery owner's profit, including in this term interest upon and redemption of the capital invested, is a subject that has been frequently discussed. At the present moment

the amount of capital invested in coal mines throughout the country is probably just about of the order of 10s. per ton of coal raised annually, and this figure is one that tends to increase.

Dr. J. B. Simpson, in his little work on "Capital and Labour in Coal Mining," written in 1900, considered that with an annual output of 200,000,000 tons, the capital invested was from 80 to 100 millions, and that the average return on this capital did not exceed 5%.

Dr. Simpson, in the above-quoted work, tabulates figures for the periods 1700 to 1759, and for 1866 to 1896, and Lord Joicey and others have based calculations upon the Board of Trade Report for 1901; putting these figures in the same form as those adopted above by myself for 1913, they may be tabulated as follows:—

	1700 to 1759.	1866 to 1896.	1901.
Wages	37.5	66.0	67.37
Materials and administration	25.0	17.0	16.54
Royalty	12.5	8.5	7.96
Profit	25.0	8.5	8.13
	100.0	100.0	100.00

The year 1913, which I have selected for illustration, happens to have been a particularly good year for the coal trade as prices were high and profits were above the average. In that year the selling price was approximately 10s. per ton at the pit's mouth, so that the profit would have been also 8.65% on the capital invested. It must, however, be borne in mind that this figure is the average that I have obtained from a number of collieries in successful operation, and that it therefore excludes all consideration of capital completely lost or sunk in unsuccessful ventures, i.e., not yielding a fair return: I am of opinion that Dr. Simpson's estimate of a return of 5% upon the whole of the capital expended in coal mining in the country, including successful and unsuccessful ventures, must be very near the mark, whilst as above said 8.65% is the average I have obtained from ordinarily successful concerns. It must be borne in mind that this return represents not merely interest on capital invested in a speculative business, but must also provide money to form a sinking fund to replace the amount of capital invested. Taking the average life of a colliery at about 39 years, and allowing for a sinking fund to accumulate at the rate of 3% (a reasonable rate for 1913), this would amount to a charge of about 23d. per ton of coal raised, or practically 2% off the profit above given, so that the real interest on capital paid by these successful collieries, allowing for redemption, is about 6½%.

Dr. Simpson considers that the average for the country, allowing for redemption, is about 3½%, a view in which most authorities concur, and which I also consider to be very near the truth.

It is necessary next to examine the cost of transport to the consumer, and it is self-evident that this must vary within the widest possible limits, according to whether the consumer lives next door to the colliery or a couple of hundred miles from it.

The cost of coal in the London market is an instructive example, and one which will probably be the most interesting to the present audience. In 1913, when the price of coal at the pit's mouth was given officially as 10s. 13d., the price of sea-borne coal in barges in the Thames was given also officially at 21s.

It is difficult to see how this latter cost is arrived at: the average freight from the Tyne to London during 1913 was 3s. 6-5d. per ton. Transport from the collieries to the steamer in the county of Durham may be averaged at between 1s. 3d. and 1s. 9d. per ton, including the cost of putting on board and trimming; discharging is included in freight. Tyne river dues are 1½d. Port of London dues 1½d., weighing 1d., so that the balance above cost, or say 5s. 3d., represents profits of the various merchants through whose hands it passes, and loss and waste in carriage. Coal carried by rail pays somewhat higher rates; probably it is a fair estimate that the average distance travelled by coal that comes into London by rail would be somewhere about 130 miles. Railway transport in this country is unquestionably expensive, a fact due to the conditions under which the English railway system has grown up; including the cost of waggons, which in most cases are the property of the colliery owners, terminal charges, etc., the average price per ton mile for the above distance should be approximately 0-9d. for household coals, and 0-75d. for manufacturing coals, so that I estimate the average cost of bringing coal by rail into London at somewhere about 9s. per ton.

Wastage in transit is a very serious item, and may range from 5 to 15%. Merchants' profits are quite considerable; I do not suggest that any dealer in coal in any stage makes unfair or exorbitant profits, but it would certainly appear that coal passes through an unnecessarily large number of hands between the pit and the consumer in many cases.

Reviewing now the various items that go to make up the cost of coal to the consumer, the obvious problem for the future is to determine whether reductions are possible, and where they are to be sought for. I think it is fairly evident that of the items above enumerated, neither the colliery proprietors' profit nor the coal-owners' royalty leaves much margin for reduction. Wages are obviously the largest item, and have been growing very rapidly, even before the war. Dr. Simpson, in his work already alluded to, states that in 1700 the hewer received for his wages one-twelfth of the selling price of coal, in 1800 one-eighth, in 1896 one-fifth, and in 1913, as shown above by myself, one-third.

If the rate of wages per day is not to go down to its previous level (and it is not in the least likely to), the only chance of reduction in this item would be by increased output; this might be obtained to some extent if it were possible to get the coal-miner to see that the only salvation for the industry in the future lies in increased production, or it may be brought about by the more extensive and better application of mechanical methods. In this country we have been relatively slow to adopt coal-cutting machines, but they have now gained a fair footing in the industry, and their use is extending yearly. The employment of coal-cutting machinery is a problem that cannot be treated in general terms, because the conditions of different coal seams vary within very wide limits, but there is little reason to doubt that in the future machines will be devised capable of being adapted to even the most widely varying conditions. In the same way mechanical means will no doubt be used to decrease the amount of off-hand and surface labour, these two items amounting together to nearly as much as the hewing cost by itself. There is but little hope that the cost of materials will come down very much; in fact, it is more likely to increase than to decrease in the future, not only because materials in themselves are likely to cost more, but because an increased use of machinery necessarily implies an increase in the employment of materials.

In an interesting paper by Dr. G. O. Smith and Mr. C. E. Lusher, on "The Cost of Coal (in America)," read before the American Mining Congress in November 14th, 1916, the authors write:—

"Anyone who is at all cognisant of the trend in the price of labour and material can see little hope of relief in lower costs for these items."

It may be of interest to point out that this conclusion, which quite agrees with my own, indicates how closely the American position resembles ours. Furthermore, it may be noted in passing that the distribution of items is not unlike our own; in the above paper certain figures are given, from which it can be calculated that the percentage of various items going to make up the net cost of bituminous coal in the United States averages as follows:—

	%
Labour	69
Materials	17
Administration	10
Royalty	4

The head of administration includes many items such as rates and taxes, which are beyond the control of the colliery company. In others, however, the possibility of certain economies is not excluded, and this is even more likely to be true of the charges incurred after the coal has left the pit's mouth. It may be suggested that one of the most promising methods of dealing with the situation would be by a close federation among colliery companies. If for instance all the collieries in a coalfield were federated and administered as one large unit, the costs of administration would be reduced, selling charges would be greatly decreased, because the elimination of competition would avoid the necessity for the numerous agents and merchants who are now maintained by the coal trade. Supplies could probably be purchased to better advantage and more cheaply by so large an organisation, and it could maintain a staff for the special purpose of conducting researches with a view to cheapening production on a scale that is impossible for the existing smaller companies. Above all, if the coal production of the country were concentrated in the hands of a very small number of large organisations of this kind, it would probably be possible to mark out definite areas within which other coalfields would refrain from competing, and thus reduce the amount of transport of coal to a minimum. Here again I am of very much the same opinion as the American paper that I have just quoted, which says:—

"In the item of transportation perhaps the most promising relief is that of reducing the length of haul." I have already pointed out that the cost of railway transport in this country is very high; if our railway conditions were like those of India, where coal is carried at 0-1d. per ton-mile, matters would be on a very different footing. We must, however, face the fact that any great reduction in the cost of railway carriage in this country is out of the question. One of the most promising modes of lowering the cost of coal to the distant consumer would be by reviving and improving the inland navigation of the United Kingdom. Unfortunately our canals have been neglected, and have mostly been allowed to fall into the hands of the railway companies, whose interest it has been rather to stop than to foster canal transport. Much interesting matter may be found in the Report of the Royal Commission on Canals and Inland Navigation of the United Kingdom, 1906; it appears that the charge per ton-mile by canal averages about 0-5d., whilst in the evidence of

Mr. W. H. Bartholomew before that Commission it is stated that the working cost of horse haulage is only 1-13th penny per ton mile; there would appear therefore to be a large field here in which improvements may be effected.

As I have pointed out previously, the item of waste is a serious one; here again economies might be effected by the operation of large units. If at all large coal receiving depots the fines and dust were collected and made into briquettes, these could be sold at the price of the best round coals, whilst the cost of their manufacture is not a serious item. This system of briquetting coal dust at receiving depots has been in vogue in Germany for a considerable time, and ought in my opinion to be adopted without delay in this country.

I do not, however, pretend to be able to do more than throw out a few suggestions indicating the possibilities of the future. That we cannot continue as we are for an indefinite period is to my mind quite certain. Whatever else may occur, I think it undoubted that we shall have to look forward to a period of most strenuous industrial competition when peace is restored, and that we shall be entering upon that competition under conditions less favourable than those which we have hitherto enjoyed, because our great accumulation of capital, which formed one of the main elements of national strength, will have been sadly diminished, and unless we are able to produce at least as cheaply as other nations, I see but little hope of retaining our former industrial ascendancy. This ability lies entirely within the power of labour to maintain or to destroy. The only solution that I can see for the problem lies not in low wages but in high production, which could probably be best stimulated by making wages dependent, not, as hitherto, upon prices, which labour cannot control, but upon output, which is wholly within control of the worker.

DISCUSSION.

Dr. CHARLES CARPENTER said that the fact that labour was the key of the whole question could not have been better emphasised than by the figures the President had given of the constant decrease in the output per man. The restriction of output by the workman was one of the most serious problems that had to be faced. Unfortunately most of the antagonism was based upon the idea that the future prosperity of the working man depended upon his output of work. This was observable not only in the unskilled trades, where one might expect to find it owing to lack of training and a somewhat lower standard of knowledge, but also in the highly skilled trades. Workers were imbued with the idea that the less they did the more work there would be for them. To what extent this feeling originated with the fear of unemployment it was difficult to say, but an allowance must be made for that fear when one considered the conditions under which labour mostly earned its living. One would have thought that the conditions through which the country was now passing would have opened the eyes of labour generally to the seriousness of that attitude, yet they knew it was not the case, and this showed how deeply rooted was the practice. With regard to the coal industry, it was the fact that a large amount of the coal brought to the surface was very badly cleaned, and the amount of dross and dirt in it now was much greater than in normal times. The reason was that, as in all other industries, there was a shortage of men and the ordinary labour for cleaning was not available. The war had shown that an enormous amount of work, even of the most strenuous kind, could be performed by woman labour; but the labour

of the picking belts was not of that arduous character. The coal travelled along a canvas band and there were pickers on either side who picked off the lumps of stone or dross. There was now not enough male labour to do this work, and the result was that dross was sent with and at the same transport cost as the coal. Cleaning was, however, work which women could easily do, but the unions were so short-sighted that they would not allow them to be employed on the belts. It was hardly conceivable that we were in the fourth year of the war and that a union so responsible, and which had produced such splendid men—he need only mention one, the Rt. Hon. Thos. Burt—should take up such an attitude. If the working man in industry took that short-sighted view he was afraid there was no hope. It did not matter whether we won the war or not—we should lose our future unless we could change this view of labour. How was it to be done? Had sufficient trouble been taken to teach labour its responsibilities in this matter? Had we begun as we ought to have done at the schools? Had we seen that the system of training and teaching was the right and proper one to bring up the young as good citizens? He was afraid we had done nothing of the kind. In a large majority of cases our education had been conducted on the cheapest and most narrow-minded lines, though it was vital to the progress of the nation as a whole. So that however we might blame labour we must bear a great deal of the blame ourselves. That was one respect in which employers, as well as the employed, must alter their practice. They must take more interest in their workers and get them to take more interest in the prosperity of their particular industry than they had done in the past. One point which he knew was controversial, but which should be mentioned, was the export of coal. He thought the authorities were now alive to the fact that the coal industry was a national one, using the word national in a bigger sense than it had been used in the past. There were responsible people concerned with problems of reconstruction who realised that fuel was one of the most vital of these problems, and that what was true of coal was also realised in regard to all minerals in the kingdom and the Empire. If the programme which he believed would be carried out was carried out, we should see as one of the fruits of reconstruction a broad-minded view in which all these possibilities were taken into account. Much had been left to private enterprise in the past. He believed it was true that there was no obligation to deposit records of borings which had been made in different parts of the country. Borings had taken place for minerals of one kind and another of which the State had no knowledge whatever. That, of course, was clearly wrong. The State ought to be in touch with every development of this kind which was going on. He thought in all probability there would be some method by which the search for or production of minerals, including coal, would be associated with some central authority. We should then not again do what we did at Travancore, where we turned the mineral rights over to the Germans because it was reported that the mineral there was not monazite but something else. Referring again to coal mining, the slow progress of mechanical coal cutting in Great Britain had not been altogether due to the mine-owners. There was the prejudice with regard to its use by the men and the general view of labour towards the carrying on of work by machinery. It thus became very difficult for the capitalist to put down machinery because the expressed policy of labour was that while the employers could put down the machinery, labour would regulate its effectiveness. He believed the attitude in the United States was different, and it would be interesting to know why the workmen there were

so very much more enlightened in that respect than they were over here.

Mr. ARNOLD LUTTON said with regard to royalties that hitherto the royalty which the landowner got was very moderate; 6½d. a ton was not high, and in England up to now royalties had been lower than in any other country in the world on the average. But the position was likely to be different. Years ago it had been possible to pick out quite a number of sites where coal could be found but now this was not the case. Landowners would get to know the value of their land and where there were different capitalists competing for land the royalty was likely to increase. The effect would be to raise the price of capital for coal mining and more harm would be done by the disturbance of confidence than was gained. Speaking with 30 years' experience, he suggested that the nation should buy up the coal-owners at a fair price. He did not think very much of the improvement of canals in this country because of the short distances concerned. There was no economy in sending coal by barge, and that was the reason why the canals were not very much used. It was different in Europe and America where the canals might be hundreds of miles long. With regard to boreholes, the Geological Survey officials were very diligent in finding out all the boreholes that were sunk and it was very difficult to put down a borehole without some official trying to find out what had been done and what had been discovered. But if anyone had spent £10,000 or £20,000 on ascertaining certain facts for their own private use he did not see why he should make everybody a present of that information.

Prof. J. S. S. BRAME said that the paper had removed certain misconceptions which had existed as to questions relating to economies in coal production, more particularly royalties and profits. Dr. Carpenter had mentioned the export of coal and he could not but think that this was a matter which was very intimately connected with the whole question and one which was certain sooner or later to become a very important question for consideration in this country. At the present time we exported one-third of our production, and in the five years prior to the war we exported the equivalent of two years' production. From 1873 to 1914 we exported about two thousand million tons. It seemed to him that this exportation must bring us appreciably nearer to the day when we should not have cheap coal. With regard to the decline in output per head, Prof. Louis looked to an increase in the production per head as the salvation of the situation. If there was increased production of coal as the result of more strenuous labour, and probably the introduction of better machinery, would not that react in producing a fall in prices? If that were the case he could not see how high wages were to be maintained. Could Prof. Louis give any data as to the corresponding output per head of those engaged in the coal industry in other countries? Prof. Louis also had referred to combines which would bring about considerable economies in administration. There were one or two directions other than those instanced by Prof. Louis in which combines would have advantages. If there were efficient combination and efficient management of pits over a considerable area it would be possible by means of electric distribution of power from central generating stations working on coal which had probably a very low market value, to operate the pits at a very greatly reduced cost and in that way economise on the 7% used at the collieries. It would favour the introduction of coal-cutting machinery which in many cases was electrically driven. In this way there would be the advantage of utilising this waste coal and obtaining a con-

siderable amount of by-products of very great value. Briquetting was one method of disposing of the low-class small fuel at depots, but such bituminous coal mixed with pitch would probably give a briquette which would not appeal to the ordinary consumer. In South Wales, where nearly all the briquetting was done in this country, 96% of the total amount of coal briquetted was steam coal, and was low in volatile matter. What was wanted was a really good briquetting agent other than pitch which was suitable to highly bituminous coals.

Mr. W. H. QUARRELL suggested that the figure for royalty given in the paper was rather on the high side. As regards materials we must not look for any reduction in the cost in the future, at any rate for several years. He would like particularly to mention the cost of waggons, which was an extremely serious thing. While the waggon trade was bound to have a period of great prosperity after the war, the waggons belonging to the private owner and to collieries were rapidly deteriorating. Moreover, we had yet to solve the problem of whether we were going to have 8, 10, 15, or 20-ton waggons. Then again tubs were a serious question. A great many were inclined to complain of the officials, but they must admit that the officials had been fairly lenient on this question of tubs and dust. The Clifton prosecution, which ended about 10 days previously, had enlightened them and was a caution. The difficulties, however, under present circumstances of getting tubs into the pits, and bringing them to the level in accordance with the statute, had not received quite sufficient justice. Prof. Louis had put down interest and profit at 8.65% and he had stated that this figure was for mines which had been successful. His own calculations related to certain concerns which had passed through many difficulties and which he could not say had been so successful, but taking into account a proper sinking fund the profit was under 5%. If it had not been for carrying on a trade upon which the country so much depended, the people with money in many colliery concerns would have been better off if they could have invested in War Loan. With regard to prices, it was not without interest to notice that whereas in the metropolis at the present time a good class coal could be obtained for 39s. 6d. and a good kitchen coal for 35s. 6d., the price of coal in Frankfurt was 53s. 4d. He had taken out from general statistics of the United Kingdom the comparative figures of production for 1897 and 1912 per annum per person employed at the pits. In the former year it was 298 tons and in 1912 it had fallen to 244 tons. That was a very serious drop. He admitted that in 1912 there was a coal strike and so probably the 244 tons would have to be taken as a little higher, but between those two years there were two very marked epochs. One was the Workmen's Compensation Acts and the other the Eight Hours Act. In the United States in the corresponding years the production per annum per person employed was 494 and 660 tons respectively, and to him these were most remarkable figures. As to co-operative working, anyone who had had anything to do with the working of collieries must be impressed with the difficulty of regularly procuring sufficient spares or of borrowing an article from your neighbour. Therefore it would be of enormous advantage to have central buying agencies for various districts in order to influence standardisation of the apparatus employed. A further feature for the successful future working of collieries was the working of the thin seam. That was a problem that had come forward with great seriousness. At a meeting on November 10th in Lancashire, a very experienced colliery manager, Mr. J. Jackson, said that in 1910, which was a

perfectly peaceful and normal year, he had put some of his best men on to a 2-ft. seam and the greatest output he could get was one ton per man per day. Mr. Jackson had said that it was his considered judgment that under present conditions, including the minimum wage, he would not venture to expect more than $\frac{1}{2}$ ton per man per day from such a seam. Another very important point was that the collieries of this country had very largely grown up by rule of thumb and by rough and ready methods of management and that they had not called in early enough the man of science.

Major G. E. MORGANS, R.E., suggested that one method of increasing output was to guarantee to the workmen that the rate which they had been promised should be maintained notwithstanding the greater output. The concurrent advantage to the colliery proprietor of the increased total output and resultant lowering of total cost per ton of coal landed was manifest. He thought that the realisation of this guarantee was one of the reasons why in America the output per man per shift was as high as it was, although the greater thickness of the seams was the main factor in the big output they got there. Our seams were relatively so very thin that it had not been possible to introduce the same simple coal-cutting machinery which was in vogue in America. It was not suitable to our older collieries.

With regard to the output from thin seams, Major Morgans stated that he had cut coal from thinner seams than 2 ft., and he could say that there were plenty of collieries working on thin seams which were getting very much larger outputs per man than had been mentioned by Mr. Quarrell.

Mr. WALTER F. REID, referring to the question of the thickness of seams, said that in the case of the St. Louis Exhibition there was a very thick seam, into which the railway wagons were lowered and loaded by the hewers underground. The coal was not touched afterwards, but crushed and burned under the boilers, and in the same way the ashes were removed mechanically. Long rows of these trucks were ready for this work and, moreover, they had a capacity more than double that of our trucks. The works which they served produced about half a million horse-power. It was a case in which the consumer and the miner worked together. The distance was certainly not very great, but it was not less than the distances found in our industrial areas in the north of England and the Midlands. Altogether, he thought there was a possibility of a better arrangement being made between the miner and the user. One method which had not been referred to was to gasify the coal in the lower part of the mine, in a producer, without bringing the coal to the surface for the purpose. He had suggested that before and knew that Prof. Louis would raise objections to it and say it was dangerous and that the Government would not allow it, but at the same time it was quite possible, from the scientific and practical point of view, to produce power at the bottom of the mine and send it along a wire instead of transporting a very great dead weight of coal in trucks and bringing the trucks back. That was enormously wasteful and the possibilities of what could be done in this direction were to be seen in the manner in which some of the London railways had been electrified, the power being transmitted from one large power house. As to briquettes, he thought it would be found that where lump coal could be had they would not prove remunerative, as they would have to be sold at a lower rate than the expense of briquetting would bear. He also mentioned the use of dust in central establishments not for briquetting but for obtaining by-products and power on the spot. Dust should be

utilised in a central position; it was simply nibbling at a very big thing if a lot of small installations were put up over the country for utilising small quantities of coal dust fuel. Indeed, he thought the whole problem of power would have to be solved somewhat on the lines he had mentioned at St. Louis, viz., pulverising the coal at the pits and using it mechanically under the boilers. This prevented waste during combustion and was a better way of utilising coal than having lump coal of different sizes and all sorts of differences in working conditions which the consumer was always grumbling at but could not control.

Mr. J. W. GORDON said that in the comparison which had been instituted between American and English costs there were certain discrepancies which he hoped it would be quite easy to put right. There was first the question of profit which appeared in the English statement but did not appear in the American statement, and then there was also the question of materials and administration. Prof. Louis had said that in this matter there was not so much difference between the English and American account, but looking at the figures there would seem to be a very considerable difference. In the English statement materials and administration appeared together as 16½%, whereas in the American statement materials alone came out to 17% and administration on top of that amounted to 10%, a total of 27% as against 16½% in the English statement. He did not know whether he had misapprehended the figures but it appeared to him a point that was worth clearing up. Prof. Louis had also stated that it was difficult to see how the cost of sea-borne coal was arrived at and that there was a difference of 5s. 3d. representing the profits of the various merchants through whose hands the coal passed, as well as waste and loss in carriage. The answer to this question appeared to be furnished by the estimate of the cost of bringing coal by rail into London at 9s. per ton. He took it that the cost of bringing it by rail must regulate the cost to the London purchaser for the reason that a very large proportion of our coal must be brought by rail. Thus the price of rail-borne coal must regulate the price of that coal which was brought by sea. In other words, the sea-borne coal must bear the price of rail-borne coal.

Mr. J. B. COWBURN said it seemed that a reduction in the price of coal must take place either by increasing the rate of output per man or by diminishing wages. He did not, however, recognise why it was necessary to disturb the whole of the labour market when the object could be achieved by legislation which would reduce the railway rate for carrying the coal to London. The conditions of mining underground were certainly not such as to induce the miner to want to work longer than necessary. He noticed that whereas wayleaves were 3d., royalties were 6d. The man who was paid the higher figure had the surface of his land left practically intact to do what he pleased with but the man over whose land wayleaves were obtained was deprived of the use of a certain amount of his land entirely. As to the suggestion that there should be combination among colliery owners, he quite realised that this might lead to administrative economies, but combines were generally looked upon as likely rather to force up prices than to decrease them.

Mr. NORMAN SWINDON said that what had happened in America with regard to increased output per man had been the development of a new system of management on scientific lines. This was the outcome of a number of very able researches on the part of Mr. Taylor, who had investigated the number of operations involved

and reduced them considerably and at the same time increased the output from 8 to 40 times according to conditions. He himself was engaged at the present time in working out bonuses and had found that it was possible to show a substantial decrease in costs, at the same time almost doubling the men's wages. The point to be borne in mind was that they must have the confidence of the men and that there would be no attempt to cut the rate merely because the men were earning high wages, otherwise the bonus system would be doomed to failure. It was purely a matter of careful analysis for the men to double their wages and the cost to be reduced by one-third. That was one of the reasons why the output in America was greater than it was in this country.

Prof. LOUIS, replying to the discussion, said that he hoped it would not be thought that he suggested that the workman alone was to blame. He considered the employer was at least as much to blame as the workman for the position in which we found ourselves to-day. At present, however, the workman had the upper hand, and it was better to commence the attack on that side, but it certainly was not his aim to suggest that the fault lies entirely with him. Mr. Cowburn had asked why royalties amounted to 6d. and wayleaves to 4d. That question implied a misconception of the difference between the two things: a royalty was a purchase of the coal, whereas a wayleave was merely an occupation rental, either above or below ground. An owner could only sell his coal once, whereas he could lease his land underground or above ground for an infinite period. The same speaker also suggested legislation to reduce the railway rate, but legislation could not reduce the cost of railway transport. It was impossible to cheapen things by legislation. Suppose as an extreme case that the country took over the railways and carried the coal for nothing, that would not reduce the cost of carriage. The country would pay for it, and the cost would come out of the nation's pocket. Such suggestions were based entirely on an economic fallacy. Prof. Brame and Mr. Gordon both wanted to know why the American colliery owner made no profit. He must confess that the table he had exhibited did rather suggest that, but the fact was that he had simply quoted figures which the American authorities had supplied; they did not suggest that the Americans made no profit, but simply that the profit was not disclosed. The percentages were simply the percentages of the cost of coal without taking profit into account and that was why they were somewhat higher relatively than the English figures. In reply to Mr. Gordon, he himself could see no discrepancy between the respective figures although the American ones were a little higher than the English for the reason he had given. Mr. Gordon also suggested that the reason why sea-borne coal apparently made a larger profit was because the price was based on the price of coal brought by rail. That was, on the surface, a quite obvious suggestion, but he himself had hesitated to put it forward because it seemed to him that if it were the case nobody would buy ex ship. People would buy f.o.b. and pay their own sea rates to the Thames if they used sufficiently large quantities. He had suggested there were other reasons which he did not know to account for the fact that the man who carried the coal by sea appeared to make 3s. more profit. There were, however, probably more wastage and losses by sea than by rail. In reply to Mr. Lupton and Mr. Quarrell, he should explain that he had been rather careful to confine the paper to the economics of coal production and to avoid technicalities because he did not think that was the right place for such considerations. As to Prof. Brame's

remarks upon briquetting, the bulk of the coal briquetted on the Continent was bituminous coal. It was perfectly suited for this purpose and made an excellent briquette for household and other uses. It was quite true that 90% of the coal briquetted in South Wales was steam coal, but the reason was not that bituminous coal was not suitable but that steam coal dust had practically no market value, whilst bituminous coal had, and that was why the former was briquetted. In the same way he did not agree with Mr. Reid that the profits on the sale of briquettes would be so small that the business would not be remunerative because the dust that was to be briquetted had so small a market value. There were accumulations of dust which were left simply because it could not be used as such, but he held that it would pay handsomely to briquette it. The suggestion that coal dust and fine coal might be used for power production had often been made, but it was one which bristled with difficulties. As far as he knew there had not yet been a producer made that would satisfactorily deal with dust. The problem was nowhere near satisfactory solution at the present moment. Mr. Reid had also suggested that it would be more satisfactory to generate electricity at the pit either underground or at the pit's mouth and transport electricity rather than coal. That was by no means an easy problem to deal with straight off. In fact, it could not be answered without knowing the conditions in each case. Electricity could not be transported for nothing: for every mile that the current was transmitted, the resistance dissipated a certain amount of current, so that a certain amount of the coal used in generating electricity at the pit's mouth was used in transporting the electricity to its destination, and it became a question of calculation whether it was cheaper to burn the coal there or to burn it in the locomotive for transporting the coal. Generally speaking, from one or two special cases which he had investigated, he much doubted whether it was cheaper to transmit electricity by wire for very long distances. For short distances it was cheaper, but somewhere between the two extremes there came a margin which was a matter of rather complicated calculation. He was exceedingly glad that Dr. Carpenter had struck what he thought was a high note and the proper note, viz., that it was every man's duty to do a fair day's work, and if that could only be impressed on the nation a very valuable piece of work would have been accomplished. How it was to be done otherwise than by education he did not see. One of the faults of the past century or more was that wages had been based on prices. The working man then said to himself that the less work he did the higher the price and the better his wages would be without his doing any more work. Surely the proper attitude was to base wages not upon prices but upon output. He admitted the question was a difficult one. Nobody had yet solved it and found the proper system and he admitted he did not see any solution as yet. At the same time he did not think the solution of the problem was beyond the wit of man. It should be possible to devise a system in which all the workmen in any industry would be interested in the results of that industry from the point of view of output, and the moment they found their interests were bound up with big outputs then the problem would be solved. Until that time, he confessed he did not see how we were going to get out of the difficulty which must be got out of if the best results were to be obtained from our coal-fields by producing coal at least as cheap as that of other nations. He was firmly convinced that it was the duty of everyone connected with the coal trade to use their utmost energies to attain that end.

Nottingham Section.

Meeting held at Nottingham on Wednesday,
November 14th, 1917.

DR. R. M. CAVEN IN THE CHAIR.

The CHAIRMAN gave an introductory address in which he briefly reviewed the history of the Society and referred to the large increase in its membership since the outbreak of war. The increase in membership of the Nottingham Section he attributed largely to the recent growth of chemical industry in the district.

DISCUSSION ON NITRE CAKE.

Mr. J. T. WOOD said that the method he had used to dissolve nitre cake was to place it on a perforated shelf in a rectangular slate tank having a capacity of about 16 cub. ft. The cake dissolved rapidly and the solution soon became saturated. He had used the solution for pickling skins and also for refining grease. For the former purpose it did not appear to have the same action as an equivalent quantity of sulphuric acid. He mentioned that the amounts of sulphuric acid found by titration in three different samples of nitre cake were 26.95, 30.4, and 27.34% respectively (the figure 31.56% had been mentioned in this J., 1917, 811). A saturated solution of the strongest of the three samples, made in the cold, had sp. gr. 1.4721 and showed sulphuric acid (by titration) 252.3 grms. per litre, total sulphates (as SO_4) 569.7 grms. The saturated solution appeared to extract further quantities of acid from nitre cake; thus, the relative acidities of the saturated solution when prepared and after three and sixteen hours' further contact with the cake were 10.4, 11.2, and 13.4 respectively.

Mr. WOOD concluded by referring to the principal papers on the subject which had appeared recently in the *Journal* (1915, 857, 1121; 1916, 77, 109, 155, 418, 486, 838, 1059, 1152; 1917, 336, 385, 575, 591, 810).

Mr. W. G. TIMMANS said that nitre cake when fresh was dry and easily handled, but it readily took up moisture from the atmosphere. Railway companies refused to supply wagons for conveyance; owners must supply wagons. The liquid dripping from a wagon of nitre cake, after transit in wet weather, was tested and found to contain 28% of free H_2SO_4 . A system of motor haulage had been organised in Nottingham for delivery to consumers. Workmen handling nitre cake should be provided with wooden clogs and have their clothing protected by sacking. Indiarubber gloves should be used for protection of the hands. Special dry storage should be provided in an isolated building, otherwise serious damage would occur. The free acid content of fresh dry nitre cake might vary from 19 to 28% in the same batch. Wood, stone, or slate tanks were being used; lead was not prohibited. Siphons should be used for decantation; taps or valves were useless. His firm made a solution containing 14–15% free H_2SO_4 which was sold under the name of sulphate acid. Much difficulty was experienced in storage and delivery to consumers owing to crystallisation of the sodium sulphate. The solubility of the crystals varied with the atmospheric temperature, and once formed they did not dissolve in the solution. Nitre cake was being used in the Nottingham district for lacc bleaching, grease extraction from wool, pickling of metals, and mineral water manufacture. Some

trouble had been caused in lace bleaching by discoloration of the goods, this had been overcome by increasing the free acid content of the bleach bath.

Mr. G. C. GRISLEY said that probably the most successful method so far employed for utilising nitre cake was in the production of saltcake and hydrochloric acid by furnacing with salt in an ordinary saltcake pot and furnace. The products so obtained were never up to the standard of those made from salt and acid direct; the salt cake generally showed a tendency to cake, and it was very difficult to get successive charges down to the minimum of free acid and salt owing to the differences in acid strength of even the same batch of nitre cake. The hydrochloric acid obtained occasionally contained nitrous gases due to the incomplete decomposition of nitre. These were very troublesome in the handling of the acid, many serious accidents having been recorded both in filling and emptying carboys. Nitre cake had been used in the manufacture of crude ferric sulphate for sewage precipitation, by furnacing with burnt ore from pyrites burners, grinding, and leaching with water. It had also been used as a carrier for sulphuric acid for export, by making a cake containing up to 60% sulphuric acid and running it into drums of sheet steel, so obviating the expense of following Board of Trade regulations. It could also be used as a diluent for sulphuric acid in the manufacture of superphosphate, and an acid works attached to such an industry could easily dispose of the whole production of nitre cake obtained in the manufacture of the acid. Acid containing 24 to 3% of Na_2SO_4 could be easily handled and without deleterious effect on the superphosphate product.

Mr. JOHN WHITE said that unless adequate precautions were taken it might happen that carbon dioxide produced with the use of nitre cake for use in aerating mineral waters, might cause the mineral water to be contaminated with arsenic or with nitrous compounds. Some efficient process for washing the gas before use would be necessary.

Mr. TIMMANS replied that some trouble had been experienced in mineral water manufacture, but it had been overcome by washing the carbon dioxide with sodium bicarbonate solution.

Dr. TERLINCK said he had many years ago used nitre cake as a substitute for sulphuric acid for the recovery of fats in the wash waters of wool in a factory, where it did not pay to recover subsequently the potassium salts. He used the nitre cake in big lumps, placing them on a pitch pine lattice at the top of a vat. The crystals of sodium sulphate eventually formed gave no trouble if the usual cork were replaced by a wooden plug, some 6 inches in diameter and as high as the vat itself. The plug could be removed by pulling from the top by means of a chain. The running off of the solution and eventually the centrifuging of the sulphate crystals was quite simple. He thought, however, that the applications of nitre cake hitherto suggested were not sufficient to cover the production, and he therefore proposed to use this troublesome by-product for the purification of ammonium salts. He foresaw that in the rather near future synthetic ammonia would become a dangerous competitor to coal-ammonia if steps were not taken to remove the organic bases contained in the latter. Already before the war, specially purified ammonium sulphate (e.g., the brand *Gas de Paris*) was at a premium on the Continental fertiliser market. Only purified ammonia could, as he had heard from different sources, be used for catalytic oxidation to nitric acid, etc. He had himself devised, years ago, a method for the preparation on a small scale of pure ammonia and its derivatives, his purpose having been to overcome the usual difficulties in the ignition

of magnesium ammonium phosphate in the course of phosphate estimations. After having ascertained that the treatment with nitric acid, as suggested by Stas, was not very efficient (probably because the acid distilled over before it had done its work), he had obtained very good results by heating commercial ammonium sulphate with sulphuric acid and eventually with nitre cake, in the presence of mercuric sulphate. The method was a development of the Kjeldahl process and required exactly the same precautions; in recent years, copper sulphate had replaced the expensive mercuric catalyst, and he thought the method could be applied industrially. The ammonia could be received directly in a solution of nitre cake and the product heated as above described. Out of the mixture of sodium, ammonium, and copper sulphates obtained the copper could be easily recovered by means of sodium sulphide. Instead of lime, ignited magnesite could be used to expel the ammonia and the solution of sodium and magnesium sulphates thus obtained could easily be freed from iron by means of hypochlorite, and subsequent addition of sodium carbonate should precipitate magnesium carbonate, sodium sulphate being left in solution. According to the proportions, temperature, concentration, etc., it was possible to produce the different varieties of magnesium carbonate, from crystallised $MgCO_3$ to basic $MgCO_3 \cdot (MgO + xH_2O)$. As a consequence, the different qualities of magnesium oxide could also be obtained, covering the demand for medical purposes, for basic magnesia cements, marmorites, lithoxylates, etc., and also for some specialities for the steel industry. He thought it worth while to examine if even ignited dolomite in one or another of its stages of de-carbonation could not be used instead of magnesite. Concur, in an unpublished investigation of the behaviour of ignited dolomite towards hot ammonium chloride solutions, had ascertained that no lime was dissolved so long as any magnesia was present; he thought it would not be impossible to work out a similar process in the case of sodium and ammonium sulphates, though evidently the presence of the Na and SO_4 ions complicated matters somewhat. He pointed out that if investigations in this line proved successful, the demands of English industries for magnesium compounds could be covered by home production, thus removing its dependency upon the Greek and Stassfurt deposits. In conclusion he alluded to the fact that Great Britain years ago had led the production of magnesium compounds and quoted some expressions and uses still existing on the Continent as a result of this bygone state of affairs.

Dr. E. NAEF said that the suggestions for the use of nitre cake which had been advanced all dealt with the utilisation of the so-called free acid in the nitre cake. Important as that problem was, especially at the present juncture when sulphuric acid was difficult to obtain, it did not solve the problem of nitre cake, which was produced in millions of tons, the bulk consisting of sodium sulphate which had to be worked up and converted into marketable articles at a profit. From a great many experiments which he had carried out, it appeared that one way of dealing with it was to convert the nitre cake or sodium sulphate into sodium sulphide. On grinding nitre cake or sodium sulphate with finely ground anthracite, charcoal, or boiler coal and heating to a comparatively low temperature, say 500° — 600° C. or more, in an iron vessel or furnace, sodium sulphide was obtained with a yield of 95—98%. When nitre cake was used sulphur dioxide was evolved at the same time. This could be avoided if the free acid was neutralised in the grinding mill with soda ash. The sulphurous acid evolved could be used as such

or in the production of sulphites or bisulphites, or for neutralising ammonia liquors, such as gas liquors, making ammonium sulphite, and also in a limited degree for making acetic anhydride. Liquid sulphur dioxide had also been used of late in the extraction of hydrocarbons and bituminous coal. As the process must be arranged so as to work on a large scale, success depended on constructing a plant which dealt more or less automatically with the charge and discharge of materials. Sodium sulphide thus obtained could be refined by crystallising and commanded a very fair market price. It was used for chemical and metallurgical purposes. The production of sulphur dyes had also assumed great proportions and about 50,000 tons of sodium sulphide crystals per year was required for this alone. It was also possible that by treating sodium sulphide at higher temperatures with a limited amount of air it could be re-oxidised to sodium sulphite directly. Sodium sulphite could now be converted into sodium carbonate by treating it with carbon dioxide or flue gases and water vapour at temperatures ranging from 300° to 500° C. in iron vessels, possibly in the same vessel where the reduction has taken place. The mass was kept well stirred so as to ensure the intimate contact of gas and solid. The vessel should be so arranged as to have automatic feed and discharge of material and counter-current gas system. Hydrogen sulphide evolved could be used for sulphur recovery by the Chance process. In treating sodium sulphide with hydrogen at temperatures from 360° — 600° C. a large amount of hydrogen sulphide was given off, but he had not succeeded at that low temperature in converting it into sodium or sodium hydride. The product obtained dissolved in water and gave a strong caustic soda liquor which still contained some sodium sulphide. Treatment with milk of lime and decantation gave stronger caustic soda liquor. In place of hydrogen, producer- or water-gas could be used, but the carbon dioxide content of these gases converted the sodium sulphide into sodium carbonate. As regards the utilisation of acid in nitre cake, he had found that by treating nitre cake heated to 300° — 350° C. with superheated steam of 300° C., dilute sulphuric acid distilled off. The strength of this acid was about 10—15% according to the quantity of steam used. The beginning of the distillation gave more concentrated acid than the end as the charge became exhausted. This acid was too weak to be concentrated. A small amount of sodium sulphate, 1—2%, was also carried over with the water vapour. The amount of sulphuric acid driven off was 90% of the acid contained in nitre cake, so-called free acid, when operating with nitre cake containing 27—30%. The utilisation of nitre cake seemed to him to be bound up with the alkali industry, as the sodium salts produced as stated above could be refined in works of that nature most profitably.

Dr. E. B. R. PRIDEAUX said that in view of the well-known solubility relations of $Na_2SO_4 \cdot 10H_2O$, which seemed to retain its general form in the presence of moderate amounts of sulphuric acid, the best separation of the sodium sulphate from sulphuric acid would appear to be effected by the cold water percolation as described by Mr. Wood, the temperature being kept as low as possible. On the other hand if some method of steaming with subsequent separation of hot liquid were used, the temperature should be as high as possible, since the solubility of the anhydrous salt diminished with rise of temperature from 32° to 100° C. The first-named temperature would be the worst from this point of view, as the solubility was then at a maximum. With regard to distillation with superheated steam, it was to be noted that the solubility in water fell to zero at a temperature above 360° C.

Communication.

NEW RESEARCHES ON THE VARIABILITY OF PLANTATION PARA RUBBER.

BY B. J. EATON, F.I.C., GOVERNMENT AGRICULTURAL CHEMIST, FEDERATED MALAY STATES.

The present communication summarises the principal and most important new results obtained by the author since the publication of the previous papers by himself together with J. Grantham and F. W. F. Day (*vide* this Journal, October 15, 1915; July 15, 1916; October 31, 1916, and January 15, 1917). Although these new results neither add to nor subtract from the theories enunciated in the previous papers as to the cause of variability, they deal with interesting and important side issues and contributory factors which influence the rate of cure or speed of vulcanisation of plantation Para rubber, and thus add confirmation, if any were needed, to the results given in the previous papers and the theories deduced from these results. No special sequence has been adopted in describing these experiments.

One reason why comparatively slow progress has been made in these investigations in the author's laboratory is that, in order to prove any one particular fact, nearly every experiment has been repeated on ten different dates, in order to eliminate any errors or the influence of secondary factors.

The work has, however, now reached such a stage that this is no longer necessary, since methods of preparation, with the advance in knowledge gained from the hundreds of samples already examined, can now be sufficiently rigidly controlled, so that identical results are obtained from any one method of preparation, provided sufficient care is taken to eliminate any secondary factor. The only cases in which it may be necessary to repeat an experiment on a special method of treatment or preparation of the raw rubber, is where such method has only a slight influence in either accelerating or retarding the rate of vulcanisation. In such cases, the differences obtained are naturally of academic or scientific rather than of practical importance, although the results obtained may lead to other important results in practice.

It is proposed here merely to give brief details of each experiment with the results obtained in respect to rate of cure, together with the cause responsible for increase or decrease in rate of cure, in the light of the theories already advanced.

The figures showing tensile properties are omitted, since they do not give any differences of particular interest. The complete figures will, however, be published in a special bulletin which is being compiled, giving full details of all the experimental research which has been carried out during the last three years in the Experimental Vulcanising Factory and Rubber Testing Laboratory of the Department of Agriculture, Federated Malay States.

Rolling up of wet sheet.

A note on this experiment, which had at the time just been carried out, was added at the end of a previous communication (this J., July 15, 1916). The following is the result of one comparative test which was confirmed by other experiments. Unsmoked sheets of average thickness (plain, *i.e.*, not marked by grooved rollers) were prepared, each from 1 gallon of latex diluted to contain 1.5 lb. of dry rubber per gallon, coagulated by the addition of 3 oz. of a 5% solution of acetic acid. The control sheet was hung to dry in the ordinary manner and the other sheet,

immediately it was taken from the sheeting machine, was rolled by hand into a cylinder. Both the control and the cylindrically rolled sheet were creped when the former was dry. (N.B.—A period of six to seven days after coagulation, before machining to thin crepe, is actually sufficient for all types of rubber.)

The results shown in Table I were obtained, "A" being the rolled up sheet and "B" the control sheet hung to dry in the ordinary way.

TABLE I.

Ref. No.	Optimum time of cure from standard curve.	Optimum time of cure from maximum product.
	Hours.	Hours.
208 S.2 A.	1½	1½
208 S.2 B.	2½	2½

The experiment was repeated on ten different dates with similar results.

The above results show that by rolling up wet sheet, the cure becomes nearly as rapid as in the case of "slab" rubber, *i.e.*, unpressed or lightly pressed coagulum, containing practically all the serum, except that which drains out during the preliminary contraction.

This shows that the principal factor affecting the rate of cure of "slab" rubber is the amount of water left in the coagulum and that sufficient nitrogenous matter is left in sheet of average thickness to produce a rapid rate of cure, provided the moisture is retained for a period of six days or longer, so that the nitrogenous matter can become decomposed and produce the degradation product responsible for acceleration in rate of cure.

Influence of different thicknesses of sheet when rolled up wet.

More recent experiments on "slab," rolled-up thin wet slab, rolled-up thick wet sheet, and rolled-up thin wet sheet, together with controls, show that the thickness makes a slight difference but that the primary factor is moisture content. The following are the results from one experiment which was confirmed by all subsequent experiments:—

TABLE 2.

Ref. No.	Type of rubber.	Optimum time of cure from standard curve.	Optimum time of cure from maximum product.
		Hours.	Hours.
297 S.1 A.	Slab.	1½	1½
297 S.1 B.	Rolled thin slab.	1½	1½
297 S.1 C.	Thin slab.	1½	1½
297 S.1 D.	Rolled thick sheet.	1½	1½
297 S.1 E.	Thick sheet.	1½	1½
297 S.1 F.	Rolled thin sheet.	1½	1½
297 S.1 G.	Thin sheet.	2½	2½

The reason why the rolled-up thick and thin sheet does not cure quite as fast as the slab is undoubtedly due to the removal of the second accelerator, *i.e.*, the accelerator present in the serum and latex, which is removed by the rolling or pressing on the sheeting machines.

Thin v. thick layers of coagulum.

A further experiment, which shows that the rate of cure is influenced by the amount of moisture retained, was as follows:—A gallon of latex of sp. gr. 0.9910, corresponding to 1.5 lb. of dry rubber per gallon of latex, was coagulated by the

addition of 3 oz. of a 5% solution of acetic acid in the ordinary narrow enamelled pans, 18 in. long by 6 in. broad by 3½ in. deep. A similar quantity, coagulated in a similar manner, was distributed, before coagulation took place, *i.e.*, immediately after the acid was added, between ten broad pans, so that each pan contained only a thin layer of latex. On the following day, the coagulum was rolled by means of a hand wooden rolling-pin and approximately the same amount of serum removed from each, *i.e.*, (a) from the thick coagulum, and (b) from the ten thin layers of latex combined. The serum in the pans, produced by the contraction of the coagulum, and the serum which drained out of the coagulum for several hours after rolling was also included and thus the total serum removed from the coagulum by drainage and rolling was obtained. The rubber was crêped after a period of about 12–14 days, the ten layers of thin coagulum being combined and crêped together.

The results of one experiment are given in Table 3:—

TABLE 3.

Ref. No.	Type of rubber.	Serum removed by drainage and rolling.	Optimum time of cure from standard curve.	Optimum time of cure from maximum product.
			Hours.	Hours.
189 S.7 A.	Thick coagulum.	92 oz.	1½	1½
189 S.7 B.	Thin layers.	81 oz.	2½	2½

It will be seen that although the quantity of serum removed in each case is very similar, the "slab" rubber or thick coagulum cures much more rapidly than the thin layers. In the light of previous experiments, the acceleration is obviously due to the decomposition of the nitrogenous substances in the thick coagulum owing to the moisture present, while the thin layers are practically dry in two days and thus degradation of the nitrogenous matter and formation of the accelerating agent is inhibited. It will be observed, however, that these thin layers cure more rapidly than ordinary thicker sheet rubber made from thick coagulum, and this is due almost certainly to the second factor which the author has found to exist in latex and to be responsible for acceleration in rate of cure, *i.e.*, the substance (the composition of which is at present unknown) which exists already formed in the latex and serum. These thin layers retain a much larger proportion of the serum than ordinary sheet rolled out from thick coagulum. This experiment is of considerable interest from the point of view of estate practice, since in the preparation of sheet rubber of any definite thickness, the original thickness of the coagulum, up to a certain point, will have an influence on the rate of cure.

The rate of drying (*vide* later experiments) and hence the rate of cure is also affected by the toughness or hardness of the sheet, which is influenced by the amount of rolling, and this factor therefore enters into the problem in connection with the original thickness of the coagulum and the final thickness of the sheet.

Influence of rate of drying on rate of cure.

Although the above experiments show that the rate of drying has a marked influence on the rate of vulcanisation, it was considered advisable to carry out further experiments in which the rate of drying of different types of rubber was determined daily, till the samples were as dry as they would become under ordinary air-drying conditions.

The results obtained are given in Table 4 below:—

TABLE 4.

Ref. No.	Type of rubber.	Optimum time of cure from standard curve.	Optimum time of cure from maximum product.
		Hours.	Hours.
251 A. . .	Unpressed slab.	1½—1½	1½
251 B. . .	Pressed slab.	1½—1½	1½
251 C. . .	Thick plain sheet.	2½	2½
251 D. . .	Thin plain sheet.	2½	2½
251 E. . .	Thick crêpe.	2½	2½
251 F. . .	Thin crêpe.	3	3½

Table 5 shows the percentages of moisture in the above samples for a period of 15 days.

TABLE 5.

	A.	B.	C.	D.	E.	F.
Immediately after machining	64.5	61.0	23.9	22.7	22.5	17.4
3 p.m. same day (<i>i.e.</i> 5 hours later)	—	—	14.3	14.1	12.4	6.2
1 day after	56.1	55.9	9.9	9.3	9.1	2.2
2 days after	52.6	53.3	8.7	8.0	6.9	0.0
3 days after	47.1	48.1	7.9	7.3	5.7	0.2
4 days after	44.9	45.2	7.4	6.8	5.0	0.4
5 days after	42.6	43.2	6.9	6.3	4.5	0.3
6 days after	36.4	37.5	6.3	5.8	3.5	0.1
7 days after	29.2	31.0	6.0	5.4	2.7	0.2
8 days after	22.6	24.1	5.5	4.9	2.2	—
9 days after	21.7	22.2	5.4	4.6	1.7	—
10 days after	21.4	21.7	5.1	4.3	1.4	—
11 days after	21.4	21.8	4.9	3.9	1.1	—
12 days after	21.4	21.7	4.9	3.9	1.1	—
13 days after	21.2	21.6	4.6	3.6	0.7	—
14 days after	21.1	21.5	4.4	3.5	0.4	—
15 days after	21.1	21.5	4.3	3.3	0.6	—

It will be seen from the above results that the rate of curing is influenced by the rate of drying and, under ordinary circumstances, the amount of moisture during the first six days of drying alone influences the rate of cure. Later experiments will show that under the normal conditions of shade temperature (about 85° F.) in this country, any type of raw rubber can be converted into thin crêpe about six or seven days after coagulation and rolling.

A further and more complete experiment, the results of which are given in Table 6, confirms the above results:—

TABLE 6.

Ref. No.	Type of rubber.	Optimum time of cure from standard curve.	Optimum time of cure from maximum product.
		Hours.	Hours.
272 A. . .	Unpressed slab.	1	1
272 B. . .	Pressed slab.	1	1
272 C. . .	Thick sheet.	1½—2	1½
272 D. . .	Thin sheet.	2	2
272 E. . .	Thin sheet rolled.	1½	1½
272 F. . .	Original thick crêpe.	2½—2½	2½
272 G. . .	Thin crêpe.	3	3
272 H. . .	Thin crêpe blank-eted wet.	2½	2½
272 J. . .	Thin crêpe rolled up.	3	3

Table 7 shows the percentages of moisture retained during a period of ten days after coagulation and machining or rolling.

TABLE 7.

	A.	B.	C.	D.	E.	F.	G.	H.	J.
Immediately after machining	69.7	66.5	23.4	19.7	22.3	21.6	15.0	16.5	19.9
1 day after	58.9	57.4	7.8	7.2	16.8	7.9	2.9	13.5	17.7
2 days after	54.8	53.7	6.7	6.2	14.8	5.7	0.9	12.6	17.1
3 days after	50.4	43.0	6.1	5.5	13.7	4.7	0.2	11.8	17.1
4 days after	42.9	42.9	5.5	4.7	13.1	3.5	0.0	11.0	15.9
5 days after	35.2	35.2	5.2	4.3	12.9	3.1	0.0	10.5	15.5
6 days after	26.3	26.3	4.8	3.8	12.7	2.3	0.1	9.9	15.9
7 days after	22.7	22.3	4.7	3.5	12.6	1.8	0.1	9.4	14.7
8 days after	22.0	21.7	4.5	3.2	12.5	1.5	0.1	9.0	14.4
9 days after	21.7	21.4	4.4	3.1	12.4	1.4	0.1	8.7	14.0
10 days after	21.7	21.2	4.1	2.8	12.3	0.9	0.0	8.3	13.8

The above results confirm the previous experiment (Ref. No. 251) and contain results of further interest which need discussion. It will be seen, in both cases, that unpressed slab, *i.e.*, coagulum removed from the coagulating pans and placed directly on the drying racks, does not cure faster than pressed slab, from which a certain amount of serum has been removed by rolling with a wooden hand-rolling pin. The reason for this is obvious when the figures for rate of drying are considered. It will be seen that, during a period of 10 days in each case, the pressed slab does not lose its moisture more rapidly than the unpressed slab although it has less moisture immediately after rolling, and this is due to the fact that the compression of the slab by hand rolling toughens the rubber somewhat and prevents it from drying rapidly. In both cases there is sufficient moisture to produce the maximum amount of accelerating substance under the conditions employed.

This experiment, with pressed and unpressed slab, was repeated in a separate experiment on ten different dates with similar results. It is unnecessary, however, to give the results in this paper.

The acceleration of cure of the rolled thin sheet compared with the thin sheet (as in Ref. No. 208, given previously), due to the retention of moisture, is apparent. The slight acceleration of cure of the thick sheet compared with the thinner sheet is also seen. It would appear, in this case, that the greater rate of cure is almost entirely due to the retention of a larger amount of the serum accelerating substance in the thicker sheet, since the rates of drying are very similar. This is also borne out by the slower rate of cure of the thick crêpe sample (F), which, although it starts with a higher moisture content than the thin sheet (D), has a slower rate of cure, due to losing its moisture more rapidly.

In manufacturing even thick crêpe, the washing water used is able to remove more of the serum, due to the tearing up and stretching of the rubber, than in the rolling of sheet between smooth even-speed rollers. The higher original moisture content of the thick crêpe (F) compared with the thin sheet (D) is due partly to the water which remains on the corrugated surface of the former.

It will be seen, by comparing samples G and H, that the blanketing of thin wet crêpe also accelerates the rate of cure slightly, whereas the rolling up of the thin crêpe into a cylinder (J) has no effect. (*Vide* Ref. No. 346, quoted later.)

Further detailed experiments on this latter point have been carried out, with similar effects, in the case of the blanketed thin wet crêpe, but the results need not be included here. In the case of the rolled-up wet thin crêpe, slight acceleration is sometimes produced and at other times the effect is nil. It is necessary, however, to seek a reason for the acceleration in rate of cure of the blanketed thin wet crêpe and the small or nil effect in the case of rolling up thin wet crêpe (although the rolling up of thin wet sheet into a cylinder has been shown to have a marked effect in accelerating the rate

of cure). In the light of previous experiments and from the results which accrue when thin wet crêpe is rolled up in this manner, several reasons may be deduced to explain this apparent anomaly although it will be difficult to ascertain which is really the correct cause (*vide* Ref. Nos. 340 and 346 quoted later.)

In the first place, when wet crêpe is rolled up in this manner, a great development of the growth of spores of micro-organisms, present in the rubber, takes place, with the formation of numerous pigments. When thin wet crêpe is blanketed, this only takes place to a comparatively small extent. When wet sheet is rolled up in this way, no formation of pigments takes place. When wet sheet is rolled, the cylinder formed is solid and no air is occluded, except such as is absorbed in the water present. This also applies to "slab" rubber or unpressed coagulum. When thin wet crêpe, which has a corrugated surface—even when finished on smooth rollers—is rolled up, the cylinder formed is full of air spaces, and the development of the micro-organism spores and the formation of pigment would therefore appear to take place only in the presence of air or oxygen. It is probable that these organisms either carry the degradation of the organic nitrogenous matter too far or else utilise the degradation products for their growth and the formation of pigment, and consequently no acceleration in rate of cure is produced when thin wet crêpe is rolled up in this manner. Another explanation may be that the conditions existing in the thin wet crêpe, rolled up in this manner, are aerobic, whereas in slab, rolled-up sheet, and blanketed crêpe, the conditions are anaërobic and the changes produced in the organic nitrogenous substances, resulting in the formation of a vulcanisation accelerator, are produced under anaërobic conditions. Which of these two explanations is correct remains to be proved. The correct explanation of this anomaly will be seen from the results in some more recent experiments quoted later (*vide* Ref. Nos. 346 and 340.)

The author is carrying out further researches on this point, in connection with the development of chromogenic organisms in dry raw rubber allowed to become damp or wet (*vide* Agricultural Bulletin, F.M.S., Vol. IV., Nos. 6 and 7, February and March, 1917).

Another interesting fact in connection with rate of drying and rate of cure is also presented in the above experiment (Ref. No. 272) and has been confirmed by subsequent experiments. It will be observed that although the sample of original thick crêpe (F) contains more moisture at the start than the blanketed thin wet crêpe (H), the percentage has dropped to 7.59 in the former case, one day after machining, while in the latter it is 15.57 and subsequent days show similar relationships. The reason for this is again obvious to those acquainted with the nature of the raw wet coagulum. The original thick crêpe is spongy and porous and loses its moisture comparatively rapidly, whereas a thin crêpe which has been subjected to the maximum of rolling with tight

rollers and is subsequently converted to blanket crêpe by rolling several thin layers together, is very tough and impervious and loses moisture very slowly. The rate of drying depends very largely on the amount of rolling, other factors, such as thickness, being constant. In spite of this slower rate of drying of the blanketed thin wet crêpe, however, it cures more slowly than the original thick crêpe or than the thick or thin sheets, which also dry more rapidly. This apparent anomaly is again explained by the practically complete removal of all the serum from the thin crêpe during washing and machining.

Effect of concentration of latex.

As would be expected in the light of the theories advanced by the author and his collaborators, the concentration of the latex has an influence on the rate of cure, the more concentrated the latex, *cæteris paribus*, the more rapid the rate of cure. This factor is responsible on estates for some of the variability in rate of cure, which occurs in the case of marketed rubber and is especially noticeable during the last year or so, in the case of "first latex" crêpe rubber. Formerly it was customary, in the case of the preparation of both sheet and crêpe, to dilute the latex, whereas more recently "first latex" crêpe rubber is manufactured by the coagulation of the concentrated latex, which may contain from 2.5 to 3.5 or even 4 lb. of dry rubber per gallon. In the case of sheet rubber, the pure latex from the field is diluted usually to contain from 1 to 1½ lb. of dry rubber per gallon, in order to obtain a sheet of good appearance. If concentrated latex is used in sheet manufacture, the coagulum is tough and difficult to roll and mark on the marking machines, and frequently contains bubbles due to fermentation, or bubbles formed when the coagulant is stirred and mixed with the latex, which are unable to escape owing to the thick nature of the latex. Needless to say, such bubbles have no deteriorating effect on the real quality of the rubber, and, from the point of view of real quality, sheet from concentrated latex is, *cæteris paribus*, of superior quality to sheet from diluted latex, and has a more rapid rate of cure, which is preferable from the manufacturers' standpoint. It is essential, however, in order to obtain uniformity in this respect, to adopt some standard dilution, but, if raw plantation rubber were sold on its real merits, the concentration of latex used should be as high as possible, to suit all estates, certainly higher than 1½ lb. of dry rubber per gallon.

Table 8 gives the results of experiments on two series of samples.

TABLE 8.

Ref. No.	Type of rubber.	Concentration of latex per gallon.	Optimum time of cure from standard curve.	Optimum time of cure from maximum product.
		lb. oz.	Hours.	Hours.
212 S.1 A.	Slab.	1 14	11	11
212 S.1 B.	Slab.	1 4	11—11	11
212 S.1 C.	Sheet.	1 14	21—21	21
212 S.1 D.	Sheet.	1 4	21	31
212 S.1 E.	Crêpe.	1 14	3	31
212 S.1 F.	Crêpe.	1 4	31	31
212 S.6 A.	Slab.	2 5	1—11	11
212 S.6 B.	Slab.	1 5	11	11
212 S.6 C.	Sheet.	2 5	21	21
212 S.6 D.	Sheet.	1 5	21	21
212 S.6 E.	Crêpe.	2 5	21—3	3
212 S.6 F.	Crêpe.	1 5	31	31

Samples from highly concentrated latex from several estates have given greater differences than are shown in the table above. Later experiments, in which the author was able to obtain a much

more concentrated latex (about 3.5 lb. of dry rubber per gallon) have given even more marked results.

Progressive increase in rate of cure of sheet crêped daily.

Our experiments, described in previous papers, have demonstrated that a progressive change takes place in slab rubber or unpressed or lightly pressed coagulum during the first six days of drying or maturation, after which little or no further change takes place.

Similar experiments, in which comparative samples of sheet were crêped daily, up to the tenth day after coagulation, have given similar results.

The following are the samples prepared:—Ref. No. 254 A. Coagulum machined to thin crêpe same day. B. Converted to sheet and crêped 1 day after. C. 2 days after. D. 3. E. 4. F. 5. G. 6. H. 7. J. 8. K. 9. L. 10 days after. Table 9 gives the vulcanisation results.

TABLE 9.

Ref. No.	Optimum time of cure from standard curve.	Optimum time of cure from maximum product.
	Hours.	Hours.
254 A. ..	31	31
254 B. ..	3	3
254 C. ..	21	3
254 D. ..	21—21	3
254 E. ..	21	21
254 F. ..	21	21
254 G. ..	21	21
254 H. ..	21	21
254 J. ..	21—21	21
254 K. ..	21—21	21
254 L. ..	21—21	21

This experiment (together with previous experiments on slab) shows that any type of rubber can be converted to thin crêpe, after about the sixth day, without affecting its quality or rate of vulcanisation.

The effect of smoking rubber.

In previous papers, the author has demonstrated that the smoking of wet rubber, as normally practiced on estates, in the preparation of smoked sheet for the market, retards the rate of cure, and that the retardation is due probably entirely to antiseptic constituents of the smoke employed. It has also been found that, while smoking invariably retards the rate of cure of "slab" rubber, in the case of sheet, comparative samples of smoked sheet sometimes cures faster than unsmoked sheet. A reason for this had to be sought and the effect was found to be due to a cause which the author had anticipated from previous researches, viz., the effect of heat. In the smoking process, two factors are involved, viz., the effect of the smoke products and the effect of the higher temperature. It has been found that the effect of the higher temperature of the smoke-house is to accelerate the rate of cure, by accelerating the biological changes which take place in the wet rubber during the first few days of drying. This explains why smoked sheet sometimes cures faster than unsmoked sheet, but is usually slower, owing to the retarding effect produced by the smoke products.

(Note.—In connection with vulcanisation researches carried out by the Imperial Institute on behalf of Ceylon, it is stated that smoking retards the rate of cure to a marked extent. This is possibly due to the type of fuel used in smoke-houses in Ceylon, or to some other factor. The author has reason to believe that the type of fuel is of some importance and that coconut husks, for instance, which give a dense smoke rich in creosotic products, probably produce a slower curing rubber.)

Sheet dried in hot air.

The following samples were prepared in order to ascertain the effect of the temperature of drying on the rate of vulcanisation, in the case of sheet rubbers :—

Ref. No. 330 A. Sheet, air-dried at ordinary temperature.
Ref. No. 330 B. Sheet, dried in hot air chamber at about 150°F.
Ref. No. 330 C. Sheet, smoked.

Table 10 gives the vulcanisation results for one series of this experiment.

TABLE 10.

Ref. No.	Optimum time of cure from standard curve.	Optimum time of cure from maximum product.
	Hours.	Hours.
330 S.1 A.	2½	2½
330 S.1 B.	2	2
330 S.1 C.	2	2

It will be seen that the sheet dried in hot air vulcanises faster than the sheet dried at ordinary temperature. In this experiment, throughout the ten series, the smoked sheet also cured faster than the unsmoked sheet, which showed that the temperature effect in the smoke-house was greater than any retarding effect due to the smoking. The sheet dried in hot air was dried in a special wooden-walled chamber with steam coils at the bottom, over which the air was drawn by means of an exhaust fan. The waste steam from the boiler used for the vulcanisation machinery was employed, and, except for the steam left in the boiler, after work ceased at 2—3 p.m. daily, the chamber was only heated from about 9 a.m. to 3 p.m., although the temperature was maintained above the ordinary atmospheric temperature for a considerable part of the night, by the waste steam.

Slabs dried in hot air.

Similar experiments were carried out by drying slab rubber in hot air. The following samples were prepared :—

Ref. No. 319 A. Slab control, air-dried for 12 days.
Ref. No. 319 B. Slab smoked for 12 days.
Ref. No. 319 C. Slab smoked after air-drying for 7 days.
Ref. No. 319 D. Slab smoked after air-drying for 12 days.
Ref. No. 319 E. Slab dried in hot air chamber for 12 days.
Ref. No. 319 F. Slab dried in hot air chamber after ordinary air-drying for 7 days.
Ref. No. 319 G. Slab dried in hot air chamber, after ordinary air-drying for 12 days.

Samples C and F were left in the smoke house and hot air-drier for a further 6 days respectively and samples D and G for 12 days, after the original period of drying at ordinary temperature.

Table 11 gives the results of one series of the above experiment, which was repeated on ten different dates with similar results.

TABLE 11.

Ref. No.	Optimum time of cure from standard curve.	Optimum time of cure from maximum product.
	Hours.	Hours.
319 S.4 A.	1 — 1½	1
319 S.4 B.	1½ — 1¾	1½
319 S.4 C.	1 — 1½	1½
319 S.4 D.	1	1
319 S.4 E.	¾	1
319 S.4 F.	¾ — 1	1
319 S.4 G.	1	1½

The most marked feature of the above results is the retardation in rate of cure of the smoked slab (B) and the acceleration in rate of cure of the slabs dried in hot air (E).

Another feature, which is observed, is that, after drying at ordinary temperatures for 7 and 12 days and then smoking (samples C and D), the rate

of cure is no longer retarded, in fact it is slightly accelerated, due almost certainly to the fact that the smoke has no longer any effect in retarding the cure, since it is not absorbed to any extent, while the heat of the smoke-house accelerates the cure. Similarly drying in hot air for a further period, after ordinary air-drying (samples F and G), accelerates the rate of cure.

Another interesting feature is the moisture content of the slabs after the different treatments, all samples being weighed on the same date. Table 12 gives the moisture content of the samples referred to in the table above.

TABLE 12.

Ref. No.	Moisture (%).
319 S.4 A.	28.1
319 S.4 B.	7.7
319 S.4 C.	24.3
319 S.4 D.	28.1
319 S.4 E.	15.3
319 S.4 F.	25.0
319 S.4 G.	28.3

It will be seen how remarkably rapidly the smoked slab (B) dries compared with the others; the next rapid, in this respect, is the sample dried in hot air (E). The samples which are smoked and dried in hot air, respectively (C and F), after maturing for 7 days at ordinary temperature, only lose a further small percentage of moisture, while those treated similarly after 12 days' ordinary air-drying (D and G) do not appear to lose further moisture. This is due to the formation of an impervious outer layer on the slab. Whether the greater rapidity of drying of the smoked slab (B) compared with the slab dried in hot air (E) is connected with the smoke products, it is not possible yet to say, as the conditions in respect of temperature, apart from smoking, were not strictly comparative.

Another interesting feature of the smoked slabs (B) was the fact that, on removal from the smoke-house, they sweated considerably and absorbed a small percentage of moisture. This may be due to the concentration of serum salts on the surface, the residual serum-products, obtained by the evaporation of latex serum, being very hygroscopic.

The fact that the smoking of sheet rubber sometimes accelerates and sometimes retards the rate of cure of the rubber, while, in the case of slab, the smoking process always causes retardation, is probably to be explained on the ground that slab contains much moisture and is very porous and soft, and thus the antiseptic smoke products are absorbed and affect the curing capacity of the rubber, before the heat has had time to accelerate the biological changes resulting in acceleration in rate of cure. In the case of sheet, which is much tougher and harder, and contains less moisture, due to rolling out of the coagulum, sometimes the heat and sometimes the smoke products affect the rubber first and determine its rate of cure.

Accelerated maturation of slab by drying in hot air.

In the above experiments (Ref. No. 319), it is seen that by drying or maturing slab or sheet rubber in a hot air chamber, the rate of cure is accelerated. It has also been shown in previous publications from this laboratory that the ordinary period of maturation of slab (and sheet) at shade temperatures (85°F.) is about six days. From the above experiments with slab dried in hot air, it was thought that the same acceleration in rate of cure, as is obtained normally in six days, might be obtained in a shorter period, by drying and maturing slab at a higher temperature; this

proved to be the case, as is shown in Table 13 below for samples prepared as follows:—

Ref. No. 332 A1. Slab dried in hot air 1 day, then crêped.
 Ref. No. 332 B. Slab air-dried 2 days, then crêped.
 Ref. No. 332 B1. Slab hot-air dried 2 days, then crêped.
 Ref. No. 332 C. Slab air-dried 3 days, then crêped.
 Ref. No. 332 C1. Slab hot-air dried 3 days, then crêped.
 Ref. No. 332 D. Slab air-dried 4 days, then crêped.
 Ref. No. 332 D1. Slab hot-air dried 4 days, then crêped.
 Ref. No. 332 E. Slab air-dried 5 days, then crêped.
 Ref. No. 332 E1. Slab hot-air dried 5 days, then crêped.
 Ref. No. 332 F. Slab air-dried 6 days, then crêped.
 Ref. No. 332 F1. Slab hot-air dried 6 days, then crêped.

Table 13 gives the rates of cure of the samples for one series, the experiment being repeated with similar results.

TABLE 13.

Ref. No.	Optimum time of cure from standard curve.	Optimum time of cure from maximum product.
	Hours.	Hours.
332 S.1 A1.	2½	2½
332 S.1 B.	2½—2½	2½
332 S.1 B1.	1½	1½
332 S.1 C.	1½	1½
332 S.1 C1.	1	1½
332 S.1 D.	1½	1½
332 S.1 D1.	1	1
332 S.1 E.	1½	1½
332 S.1 E1.	1	1
332 S.1 F.	1½	1½
332 S.1 F1.	½—1	1

It will be seen from the above table that the same rate of cure is obtained by maturing and drying the slabs in a hot air chamber for three days (C1), as is normally attained at ordinary temperature in six days (F). Secondly, drying in hot air beyond the three-day period still further accelerates the rate of cure.

The results of this experiment confirm the marked effect, during the early stages of drying, of a temperature above the normal atmospheric, in accelerating the rate of vulcanisation.

An interesting feature of the above samples is the moisture content, before crêping, i.e., after the respective drying periods, to which each sample was subjected. The moisture contents are given in Table 14.

TABLE 14.

Ref. No.	A1.	B.	B1.	C.	C1.	D.	D1.	E.	E1.	F.	F1.
Moisture %	56.2	58.3	52.7	55.6	43.0	54.5	27.2	49.9	21.2	47.3	20.1

The importance of the above results, in connection with the preparation of rubber of this type for the market, is obvious and the method does not demand any drastic alterations in respect to special drying rooms. The ordinary smoke-houses can be utilised, but, instead of allowing the hot smoke products to act directly on the rubber in the rooms, only the heat from the furnaces is utilised and the smoke products are allowed to escape, by means of a flue attached to the furnace; the latter must be of such a type that smoke does not escape into the room.

The effect of fungus "spot" disease development on rubber.

It has been shown above, in connection with ordinary samples of slow curing crêpe, that, if this type of rubber is rolled into a cylinder while wet, in order to retain the moisture present, and thus endeavour to accelerate the rate of cure by inducing the necessary biological changes, no such change is produced, and that, in crêpe rubber rolled up in this manner, there is a very great

formation of pigment in the rubber due to the development and growth of various fungus spores.

It has since been found, however, that if similar thin wet crêpe is pressed into blocks by hydraulic pressure (the blocks prepared measured about 1 foot square by 6 to 9 inches thick), so that all the air between the thin layers of rubber was pressed out and the block was made solid, no pigmentation developed, except when the block was insufficiently pressed and air was occluded. This confirms the statement made above as to the necessity of air or oxygen in the development of the pigment in "spot" disease of prepared rubber. Secondly, while there was little or no acceleration in rate of cure in the thin wet crêpe rolled by hand into cylinders, which in each case was covered with "spot" disease, there was a marked acceleration in rate of cure in the blocked wet crêpe.

Table 15 gives the results for two series of the experiment, which was repeated on ten different dates with similar results.

TABLE 15.

Ref. No.	Type of rubber.	Optimum time of cure from standard curve.	Optimum time of cure from maximum product.
		Hours.	Hours.
346 S.2 A.	Control crêpe.	3	3
346 S.2 B.	Block crêpe.	2½	2½
346 S.2 C.	Block crêpe.	2½	3
346 S.3 A.	Control crêpe.	2½—3	3
346 S.3 B.	Block crêpe.	2—2½	2½
346 S.3 C.	Block crêpe.	2½—3	3

The acceleration in rate of cure of the blocked wet crêpe (B) is seen clearly.

The following results, however, are of the greatest interest in this connection, and throw considerable light on the problem. Samples of slab were matured in the ordinary manner and converted to crêpe after the usual maturation period of six days or more. Two samples of this crêpe were then hung to dry in the ordinary way, and the third was taken direct from the crêping

machine and rolled into a cylinder. As in the case of ordinary slow-curing crêpe, a great development of "spot" disease took place. One of the remaining two samples, hung to dry, was, after being thoroughly dried, dipped into water for about 30 seconds, then removed and shaken in order to remove superfluous moisture and, in some cases, mopped with a cloth to remove more water, and then rolled into a cylinder and left for several weeks. These latter samples also developed "spot" disease, but not so extensively as in the case of the matured slab rolled into a cylinder immediately after crêping (i.e., before drying as thin crêpe).

(Note.—For development of "spot" disease in dry rubber allowed to become damp subsequently, vide *Agricultural Bulletin*, F.M.S., Vol. V., Nos. 5—6, February-March, 1917, "Note on the development of chromogenic organisms in dry rubber allowed to become damp," by the author.)

In the case of these fast-curing rubbers, the development of the "spot" disease has caused an extraordinary retardation in rate of cure, the most marked result being obtained, as would be expected, in the case of the crêpe rolled into a

cylinder direct from the crêping machine, in which the "spot" disease was most marked.

In most of the series of this experiment, the rate of cure was retarded by about 1 hour, while in two series the retardation was over 1½ hours under the conditions of vulcanisation employed.

The following are the samples prepared:—

- Ref. No. 340 A. Slab crêped and hung to dry.
 Ref. No. 340 B. Slab crêped and rolled into cylinder by hand, direct from the crêping machine.
 Ref. No. 340 C. Slab crêped and hung to dry, and dipped in water after having been dried and then rolled into a cylinder by hand.

Table 16 below gives the vulcanisation results for two series of the experiment:—

TABLE 16.

Ref. No.	Optimum time of cure from standard curve.	Optimum time of cure from maximum product.
	Hours.	Hours.
340 S.1 A.	1½	1½
340 S.1 B.	2	2
340 S.1 C.	1½	1½
340 S.7 A.	1	1
340 S.7 B.	2½	2½
340 S.7 C.	1½	1½

It remains now to seek a reason for the non-effect of "spot" disease in an ordinary slow-curing crêpe and the marked retardation in rate of cure produced by "spot" disease in a fast-curing rubber. The cause, in the light of our previous researches, is almost certainly due to the fact that, while the nitrogenous substances (protein chiefly) present in slow-curing crêpe have very little effect on its vulcanising capacity, the utilisation of any such protein by the fungi spores during development would not affect the rate of cure in this type of rubber. In a fast-curing rubber, however, the fungi utilise the simpler nitrogenous substances formed by the degradation of the protein, which act as vulcanisation accelerators, i.e., the fungi in their development destroy the accelerating substance or alter its composition, so that it no longer behaves as an accelerator, and the rate of cure of the fast-curing rubber affected with "spot" disease is retarded.

The experiment also illustrates the necessity in research of this description, of not basing general opinions on a particular type of rubber, and shows the value also of carrying out much of this research on the spot, where it is much simpler to follow up any particular clue.

In several series of the above experiment, the rolled-up rubber was not re-washed, after the development of the "spot" disease, but the rolls were unwound and the thin crêpe re-hung to dry in the ordinary way. The accelerator was not, therefore, removed by treatment with water, but must have been partly destroyed or converted into some derivative, which does not act as an accelerator of vulcanisation.

Another exceedingly interesting feature of the above experiment, but one on which the author desires to carry out further experiments, is that in the rubber in which the "spot" disease develops to the greatest extent (sample B), there has been a loss of some constituent or constituents in the gaseous form, apparently amounting to about 4—5% of the weight of the rubber. This is the first occasion, as far as the author is aware, on which it has been proved definitely that the development of fungoid growth on prepared rubber has a detrimental effect.

Tank v. pan sheet.

On many large estates during the last 2—3 years, large tanks have been substituted for the small enamelled iron coagulating pans formerly

in use. The average coagulating pan, or a type especially favoured, measures 18 in. long by 6 in. wide by 3½ in. deep, and holds approximately 1 gallon, when filled to the top. Large tanks holding 50—100 gallons, or even more, are constructed with division plates, so that the distance between these plates represent what in the coagulating pan was represented by the depth of latex employed, i.e., in the large tanks, sheet is coagulated sideways or edge on. This is done in order to economise floor space, and also it prevents surface oxidation of the coagulum, since the surface exposed now represents the edge of the sheet after the coagulum is rolled to sheet form. It is not proposed here to deal with the various types of such tanks nor with their economics, except to state that they have many advantages and were advocated by the author and others as long ago as 1912. One of the best, which the author has seen, was made by a manager of an estate and, generally speaking, these tanks represent a normal evolution of the plantation rubber industry, necessitated by increase of crops and area. The problem, to be discussed here, is their effect on the vulcanising capacity of the rubber and the results illustrate what a comparatively small variation in estate practice may cause variability in the product. This effect is due really to the type of tank adopted, or more especially to the method of division. Most tanks have the division plates about 1½ inches apart and this therefore represents the thickness of the unpressed coagulum, which is eventually rolled to sheet. As stated above, the ordinary coagulating pan is about 3½ inches deep and is usually filled with latex, for coagulation purposes. In the pans, therefore, we have coagulum 3½ inches thick. As might be expected, when coagulum 1½ inches thick from tanks, and coagulum 3½ inches thick from pans, is rolled between rollers at a fixed distance apart, the resultant sheet will be softer and will roll out thinner, by stretching laterally and longitudinally, from the 1½ inch coagulum, than from the 3½ inch coagulum, which will be harder and thicker after it leaves the rolls. The thinner and softer tank sheet will dry more rapidly and will vulcanise therefore more slowly, owing to the partial inhibition of the biological changes producing the vulcanisation accelerator. On the other hand, assuming that the tank sheet from 1½-inch coagulum is rolled only to such an extent that the final dry sheet is of the same thickness as that from 3½-inch coagulum, it will cure faster, since more of the serum is retained, owing to the smaller amount of rolling given to the 1½-inch coagulum to bring it to the same final thickness as the sheet from 3½-inch coagulum. Secondly the tank sheet from 1½-inch coagulum, prepared by the smaller amount of rolling, although of the same thickness as the pan sheet, will dry more rapidly owing to its more spongy and porous nature. The advantages in respect to vulcanisation capacity thus lie in favour of tank sheet, since to obtain a rubber which dries equally or even more quickly and also vulcanises faster, it is not necessary to roll the tank coagulum as tightly as the pan coagulum.

It can be seen from the above statement that the amount of latex placed in a pan of any particular size will also influence the vulcanisation of the resultant rubber (as sheet), if other factors are constant. The author has found this in several instances to be a cause of variability in estate practice.

The effect in the case of crêpe would be nil and, as will be seen also from slab samples, which are included in the tables, the effect of the difference in the thickness of the original coagulum is almost negligible. It can be stated, however, that 1½ inches is about the minimum thinness of coagulum in the preparation of slab rubber. Thinner

coagulum will dry too rapidly, thus inhibiting the essential biological changes.

Table 17 gives the vulcanisation results for samples of slab from tanks and pans, and also samples of sheet (unsmoked) from tank and pans, in which the same tightness of rollers was employed in the preparation of the sheets from tank and pan.

TABLE 17.

Ref. No.	Type of rubber.	Optimum time of cure from standard curve.	
		Hours.	Hours.
335 S.1 A.	Unpressed slab from pan (3½ in.).	1	1½
335 S.1 B.	Unpressed slab from tank (1½ in.).	1 — 1½	1½
335 S.1 C.	Sheet from pan.	2 — 2½	2½
335 S.1 D.	Sheet from tank.	2½ — 2½	3
335 S.2 A.	Unpressed slab from pan.	1 — 1½	1½
335 S.2 B.	Unpressed slab from tank.	1 — 1½	1½
335 S.2 C.	Sheet from pan.	2½ — 2½	2½
335 S.2 D.	Sheet from tank.	2½	2½

The retardation in cure of the tank sheet is seen from the table.

The following table gives the results obtained from sheet samples prepared from pans and tanks, but in this case two sheets from tank coagulation were made, one (B) being rolled to approximately the same final thickness as the pan sheet (A) and the other tank sheet (C) being passed between smooth rollers a similar number of times to A, the final tightness of the rollers for A and C being the same, whereas to obtain the same thickness for the tank sheet (B) as the pan sheet (A) it is not necessary to bring the rollers so close together.

The following, therefore, were the samples prepared:—

- Ref. No. 341 A. Unsmoked sheet from pan, from coagulum 3½ inches thick.
 Ref. No. 341 B. Ditto from tank, from coagulum 1½ in. thick, rolled to same final thickness as A.
 Ref. No. 341 C. Ditto from tank, from coagulum 1½ in. thick, rolled to the same extent as A.

Table 18 below gives the vulcanisation results in the case of two series of the experiment and also shows the thickness of the sheets.

TABLE 18.

Ref. No.	Thickness of sheet.	Optimum time of cure from standard curve.	
		Hours.	Hours.
341 S.8 A.	3.0	2½	2½
341 S.8 B.	3.4	2½	2½
341 S.8 C.	2.2	2½ — 2½	2½
341 S.9 A.	3.6	2½	2½
341 S.9 B.	3.4	2½	2½
341 S.9 C.	2.2	2½ — 2½	2½
341 S.10 A.	3.6	2½	2½
341 S.10 B.	3.0	2½	2½
341 S.10 C.	2.4	2½	2½

In this case it will be seen that the rate of cure of the pan sheet (A) and the tank sheet (B) of similar thickness, is approximately the same, while the tank sheet (C), the final thickness of which is much less, when rolled to the same extent and with the same tightness of rollers employed for rolling the pan sheet (A), cures more slowly.

It is interesting to compare the above results with the rate of drying, which was determined for the three series above. Table 19 gives the percentages of moisture in the samples, weighed at the same time, during the first six days of drying and the moisture on the 11th or 12th day, on which the samples were converted to crêpe.

TABLE 19.

Days after machining.	S.8. Moisture %.			S.9. Moisture %.			S.10. Moisture %.		
	A.	B.	C.	A.	B.	C.	A.	B.	C.
0	19.0	36.5	18.7	21.1	32.1	23.2	19.2	30.6	20.9
1	4.9	13.4	3.6	6.0	10.4	3.9	5.4	5.6	3.8
2	3.0	5.0	2.5	4.6	4.4	2.5	4.2	3.3	2.4
3	3.1	3.7	1.7	3.8	3.4	1.9	3.5	2.6	1.7
4	2.3	3.2	1.3	3.3	2.8	1.2	2.9	2.0	1.2
5	1.9	2.8	0.8	2.7	2.3	0.8	2.4	1.7	1.0
6	1.1	2.1	0.3	2.2	2.1	0.7	2.0	1.5	0.7
11	—	—	—	1.0	1.3	0.1	—	—	—
12	0.2	0.1	0.1	—	—	—	0.9	0.7	0.3

Rate of vulcanisation of tree scrap.

From our previous work, it might be concluded that tree scrap, being naturally dried latex, and therefore, as one would think, containing all the constituents of a concentrated latex, should cure rapidly, owing to the influence of the residual serum constituents, which are normally removed in washing and creping fresh coagulum. It has been found, however, that tree scrap has its optimum cure, under the conditions of vulcanisation employed in our laboratory, at about 2½—2¾ hours, which may be described as an intermediate rate of cure. A reason for this had therefore to be sought.

Experiments were carried out in which thin layers of latex were allowed to dry overnight on (A) glazed plates, (B) porous plates, and it was found that the former cured rapidly and the latter at about 2½—2¾ hours, that is more slowly. The reason for this, in the light of our previous researches, is obvious. The rubber from latex which has been dried in thin layers on glazed plates or vessels, does contain all the constituents of the rubber, while in the case of the latex placed on porous plates, a large proportion of the serum is absorbed by the plates; hence, the vulcanisation is retarded, as we are not dealing actually with a rubber which contains all the serum constituents. The freshly-cut channel on the tree acts as porous plate, and the tree scrap therefore does not contain all the serum constituents, since some portion is absorbed by the soft porous wood of the freshly-cut channel; and tree scrap, therefore, cures in a similar manner to rubber prepared by placing thin layers of latex on porous plates.

The natural accelerator of Para rubber.

Stevens has recently published a paper under this title (*vide* this J., April 16, 1917), which entirely confirms our researches, while going slightly further into certain details in connection with the vulcanisation accelerator or accelerators which the present author has found to be produced in plantation Para rubber by the degradation of the proteins, and also preformed in the latex and retained by the raw rubber under certain conditions of preparation. Whether these two accelerators are the same or different substances remains to be investigated. The author has shown that a greater amount of the serum residue (obtained by evaporation) is necessary to produce the same acceleration in rate of cure, as in the case of the degraded protein. It must be remembered, however, that we are not yet dealing with pure substances, and it may be that the serum residue contains a smaller proportion of the same substance which is produced in larger proportions by the biological degradation of the nearly pure proteins separated from the serum. If these accelerators are the same, it means that there is in latex itself simpler nitrogenous substances, as well as the complex proteins, and it is possible that the proteins are built up in the latex from these

simpler compounds, and can be degraded again by biological methods to produce the same compounds.

The author has not obtained the maximum acceleration which is obtained in slab, by adding these accelerators to a slow-curing rubber separately. No experiments, however, have been carried out by the author yet, by combining the two accelerators and noting their additive effect. If they are two distinct substances, it is possible that their additive effect may be greater than when used separately. In slab rubber, we undoubtedly have the effect of both, since, after the coagulum has been left to mature for six days, not only is a change undergone by the proteins, but the serum constituents are more difficult to remove from the partially dried rubber, and are therefore probably retained to a greater extent, in rubber of this type.

Referring again to Stevens' paper, the author would like to point out that Stevens has either not fully understood our previous papers or has obscured the real issue. He alludes to our previous work as follows:—"Eaton arrived at the conclusion that this insoluble matter has no effect on the rate of vulcanisation. His mistake arose from taking rubber already containing its full complement of nitrogenous matter, instead of working with a rubber from which the latter had been removed."

The author maintains, however, that no such mistake has been made. In our researches we were endeavouring to show why plantation Para rubber prepared in different ways varied in cure, and especially why ordinary crêpe rubber cures slowly and slab rubber (the latter being our own discovery) cures rapidly, and we were not dealing with the vulcanisation capacity of a synthetic caoutchouc or a rubber freed from such compounds, but with normal plantation samples. It soon became obvious to us from our own researches that ordinary crêpe rubber did not cure slowly on account of lack of proteins, but on account of a lack of a particular substance (not protein), which acts as an accelerator. Stevens in his previous researches had missed this, probably for reasons pointed out by the author and J. Grantham (this J., October 31, 1916). It is of interest to note also that after severely criticising the vulcanising mixture used by the author and by Schidrowitz, Stevens has, in the paper now referred to, adopted similar mixings.

If any mistake has been made, it was made originally by Stevens in connection with his earlier work, in which he appeared to think that the vulcanisation capacity of ordinary plantation rubber, which contains a full complement of protein, was connected with the protein matter *per se*, whereas our researches have shown this to be incorrect, although the author is not prepared to deny that proteins may have an effect on the vulcanising capacity of synthetic caoutchouc.

The author would also like to take this opportunity of replying to certain criticisms or replies of Stevens (this J., November 30, 1916) in reference to the paper on "The variability of plantation Para rubber with different technical mixings." Stevens, in his reply, alludes to the fact that probably 50% of manufactured rubber goods contain lead oxide, which, as our researches have shown, obscures the effect of the natural accelerator in Para rubber. The author is not in a position to dispute this fact, but fails to see that it is, in any respect, an argument against the effect of the natural accelerator, or its importance in connection with the variability in cure of plantation rubber for the remaining 50% of manufactured goods. Results of estate samples, which will be published shortly, show that, apart from our special slab rubber, the variability in rate of cure of estate samples has not been exaggerated, even at the present time, when uniformity

in preparation on estates is much greater than 4—5 years ago.

Stevens also refers to the fact that our explanation of the action of lead oxide, if correct, would also apply to magnesium oxide. The author fails to see why this should be so, since it is well known that different mineral accelerators produce different effects, and lead oxide, as far as the author is aware, is a much more powerful accelerator than magnesium oxide. While agreeing with Stevens as to the large number and amounts of different ingredients used for various purposes in modern rubber manufacture, in the author's opinion it would be a mistake to carry out research of this nature with such mixings—the simpler the mixing for such purposes the more likely is one to effect the isolation of variables responsible for the different vulcanising capacity of various raw rubbers. Ample confirmation of the results of our researches in connection with variability in rate of cure, has been received from various well known rubber manufacturing firms, who should be in a position to realise the effects, without perhaps being aware of the causes, and it is difficult therefore to understand Stevens' attitude in attempting to minimise these variations.

Finally, with regard to the relationships between the curves, while not strictly in arithmetical progression, they are very close, as can be seen by comparing the different curves. The explanation lies in the curves themselves, if these, as we believe, can be taken to represent the state of cure of the rubber. There certainly does not appear to be any more reason for adopting a geometrical than an arithmetical progression in the relationships.

It may be stated here, a point which was omitted in our previous paper under discussion, that the experiments described were not carried out as a reply to Stevens' criticisms, but were actually done in 1915 and would not have been published at the time had Stevens not raised the question of the type of mixing, since the experiments with these "mineral" mixings were admittedly incomplete.

Summary.

1. The experimental results on variability in rate of vulcanisation of plantation Para rubber, described here, confirm previous work by the author and his collaborators and theories deduced from these researches and give results of additional interest.

2. Various types of experiments, in connection with the rate of drying of freshly machined coagulum, show that the moisture content of the coagulum is the most important factor determining rate of vulcanisation and also confirm previous work by the author on the presence of a second accelerating substance, preformed in Hevea latex.

3. Acceleration in rate of cure can be induced even in thin crêpe by blocking the thin wet crêpe under pressure, so as to exclude air.

4. For the formation of pigment, known as "spot" disease, which is evidence of the development and growth of the spores of certain chromogenic micro-organisms, not only moisture but air or oxygen is essential.

5. The development of these micro-organisms on a slow-curing crêpe rubber has little or no effect on its vulcanising capacity, in respect to rate of cure, since thin crêpe contains none of the vulcanisation accelerator present in "slab" crêpe.

6. Similar development of micro-organisms in "slab" crêpe causes a marked retardation in rate of cure, due undoubtedly to these organisms utilising the accelerator, or altering its composition.

7. In the development of "spot" disease in rubber, there appears to be a considerable loss of some constituent, which is removed in the gaseous form. Further researches on this point are necessary.

8. The progressive change which takes place in slab during the first 6—7 days of drying or maturing, also takes place in sheet up to this period. From these results, any type of rubber can be converted into thin crepe, after six days' drying, without affecting its rate of cure.

9. In the smoking of rubber, two variables are concerned: (a) antiseptic effect of the smoke products; (b) temperature of drying. The former retards the rate of cure of the rubber, and the latter, within the limits used in practice, accelerates the rate of cure. Hence, smoked sheet may cure faster or slower than similar unsmoked sheet, depending on the balance of these two factors during the early stages of smoking.

10. Drying by hot air not only accelerates the

rate of cure, but reduces the ordinary maturation period of slab from six to three days.

11. The concentration of the latex affects the rate of cure of the coagulated rubber, owing to the different amounts of accelerator retained in the rubber, under similar conditions as to machining.

12. Tree scrap has a comparatively moderate rate of cure, instead of a rapid rate of cure, as might have been expected, owing to the fact that it does not contain all the serum constituents, which are absorbed partly by the freshly cut porous channel on the tree.

Note.—Further work on various aspects of the problem is contained in various numbers of the *Agricultural Bulletin*, F.M.S., published monthly.

The special bulletin, which contains the results of all the researches to date, except the experiments which are in progress, will be published very shortly and may be obtained on application to the author or the Director of Agriculture, F.M.S.

Journal and Patent Literature.

PATENT SPECIFICATIONS may be obtained by post by remitting as follows:—

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French.—1 fr. 05 c. each, as follows: Patents dated 1902 to 1907 inclusive, *Bells et Cie.*, 56, Rue Ferou 8. Paris (3e.).

Patents from 1908 to date, *L'Imprimerie Nationale*, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

Liquids: Handling and transportation of.—

M. H. Eisenhart. *J. Ind. Eng. Chem.*, 1917, 9, 980—982.

WHEN purity is not an essential factor, tank cars are used for transporting nitric and sulphuric acids between plants, but for hydrochloric and acetic acids small containers are generally used, the latter acid being frequently shipped in wooden barrels. To ascertain the most suitable metal for the pipes, valves, etc., in any particular case it is advisable to suspend strips of apparently suitable metals in the liquid, and to note the effect both of the liquid and the fumes. Steel is almost exclusively employed for the sulphuric acid and mixed acids used in the manufacture of nitro-cellulose, although it is unsuitable for nitric acid alone. For the latter and for the lower strengths of sulphuric acid the alloys of iron and silicon ("duriron," "tantiron," etc.) are suitable, and have replaced stoneware in many places. Silica ware is now in considerable use for pure chemicals, for, although as fragile as glass, it can resist changes of temperature without breaking. For the handling of weak acid solutions wood is well adapted. Aluminium is not suitable for alkalis, but may be used with glacial acetic acid and with very weak solutions of nitric and sulphuric acids. Enamelled iron is being used in many directions for kettles, piping, and special apparatus, and is particularly suitable for brewery plant and for the handling of many food products. Satisfactory results have also been obtained by the use of pipes lined with tin, copper, lead, etc. For moving liquids in general and particularly nitric and sulphuric acids, air pressure is the most simple and least troublesome method. For valves alloys of iron and silicon have proved satisfactory when subjected to acid fumes, and have lasted for three to four years, where previously the ordinary valves required renewal every three or four weeks.—C. A. M.

Liquids: Storage and transportation of.— F. R. Baxter. *J. Ind. Eng. Chem.*, 1917, 9, 978—979.

AN outline is given of the methods of transporting oil by tank steamers and pipe lines. The lines from the Kansas fields to New York contain, when full, 760,159 barrels of crude oil, the value of which, according to the quotations of May, 1917, was \$1,444,302. The pipes are made of wrought iron and are tested up to a pressure of 1200 lb. The crude oil at the wells is usually stored in wooden tanks of a capacity of 250 barrels and upwards. It is estimated that by 1927 the U.S. Navy will annually require 10,000,000 barrels. To meet this demand two oil areas have been reserved in California and one in Wyoming, and will not be drilled until the oil is required.—C. A. M.

Liquids: Transportation and storage of— in small packages.— L. R. Adkins. *J. Ind. Eng. Chem.*, 1917, 9, 979—980.

THE wooden barrel used in the petroleum industry in the Eastern United States is made of red and white oak, and is coated inside first with an adhesive substance such as vegetable gum, by-products of the sugar industry, or water glass, and then with a good hide glue. In recent years iron barrels have been replacing the wooden barrels. They are made by rolling sheet iron on heavy presses, and are welded by means of gas or electricity. The cylindrical form is preferable to the ordinary barrel shape as it stands more wear and tear. The chief disadvantage in the use of the iron barrel is that the iron oxide is liable to flake off the interior and contaminate the liquid. Tin cans for the petroleum trade are made from tin or terne plate of 26 to 28 gauge, and enormous quantities of kerosene are exported to all parts of the world in the standard 5-gall. cans.—C. A. M.

PATENTS.

Evaporator and boiler feed-water heating apparatus for power plant; Combined —. The Griscom-Russell Co., New York. Assignees of R. C. Jones, Garden City, N.Y., U.S.A. Eng. Pat. 103,644, Dec. 21, 1916. (Appl. No. 18,336 of 1916.) Under Int. Conv., Jan. 26, 1916.

THE vaporisation temperature of the evaporator is regulated by a reducing valve to accommodate the system to varying loads on the boiler. The distillate from the evaporator passes first through a boiler feed-water heater and then through a primary heater for the water to be evaporated. The liquid to be evaporated is also passed through a secondary heater, through which the unevaporated liquid from the evaporator is passed in a contrary direction.—W. H. C.

Valves for use in evaporating apparatus. Kestner Evaporator and Engineering Co., Ltd., J. A. Reavell, and W. G. Mann, London. Eng. Pat. 110,180, Oct. 6, 1916. (Appl. No. 14,221 of 1916.)

THE valve casing is provided with a removable sleeve or liner having an inclined valve seating at the lower end against which the valves abuts. By providing a full, straight passage for the liquid instead of the usual sinuous path, deposition of salts from concentrated liquors is prevented to a large extent.—W. H. C.

Power presses for extracting liquids from vegetable matter or other material. J. C. Fiddiment, Baltimore, Md., U.S.A. Eng. Pat. 110,035, Oct. 16, 1916. (Appl. No. 14,683 of 1916.)

A PRESS for extracting liquid comprises an outer shell having slightly tapering inner walls, and a concentric inner rotating compressing member for conveying the material through the press and expressing the liquid. The compressing member comprises a number of flanged discs, threaded on a shaft, each disc having a groove in which a pair of loose rings are mounted and are adjustable to vary the width of the annular space on each side of them between the flanges. The discs are bored longitudinally for the insertion of a conveyor screw rotated by gearing from the main shaft and passing through all the annular spaces in the discs. The material is fed in at one end and is transferred from one groove to the next by fixed inclined abutments in the grooves. The material is prevented from being carried round by the compressing member by a parallel rotating member below it at the inlet end, having flanges which enter the annular channels. The expressed liquid escapes by the conveyor channel and also by circumferential openings in the shell.—W. F. F.

Expressing liquid from materials containing the same; Processes for —. J. W. Hinchley, London, and G. Gorton, Bexhill-on-Sea. Eng. Pat. 110,379, Oct. 13, 1916. (Appl. No. 14,601 of 1916.)

IN apparatus of the type described in Eng. Pats. 101,782, 108,503, 110,381, and 110,384 (this J., 1916, 1254; 1917, 998 and following), sewage sludge, fish refuse, oilseeds and nuts such as palm kernels and copra, crushed beetroot, and sugar cane, may be treated at a preliminary pressure up to 0.5 ton per sq. in., the steam admitted up to a pressure of 200 lb. per sq. in., and temperature up to 380° F. (193° C.), and the final pressure may be up to 2 tons per sq. in.—W. F. F.

Expressing liquid from materials containing the same; Apparatus for —. J. W. Hinchley, London, and G. Gorton, Bexhill-on-Sea. Eng. Pats. (A) 110,381 (Addition to Eng. Pat. 101,782) and (B) 110,384, Oct. 13, 1916. (Appl. Nos. 14,603 and 14,606 of 1916.)

(A) IN apparatus of the type described in the

principal patent (this J., 1916, 1254), the orifices for the admission of fluid to the material in the cylinder are separate from those for the discharge of expressed liquid and are provided with non-return valves. (B) IN apparatus of the type described in Eng. Pats. 101,782, 108,503, 110,379, 110,381, and 110,383 (this J., 1916, 1254; 1917, 998, p. 1230, and preceding), the strainer or filtering surface is protected by a steel perforated liner or plate against which the piston slides.—W. F. F.

Expressing liquid from materials containing the same; Processes and apparatus for —. J. W. Hinchley, London, and G. Gorton, Bexhill-on-Sea. Eng. Pat. 110,382, Oct. 13, 1916. (Appl. No. 14,604 of 1916.)

IN processes and apparatus of the type described in Eng. Pats. 3998 of 1915, 101,782, 108,503, 110,379, 110,381, and 110,384 (this J., 1916, 1254; 1917, 998, and above), the treating fluid is cold air or water. Two or more hot or cold gases or liquids may be admitted successively to the press and the mechanical pressure may be constant or variable.—W. F. F.

Concentration of vitriol and other liquids; Apparatus for use in the —. F. Brown, and The United Alkali Co., Ltd., Liverpool. Eng. Pat. 110,183, Oct. 9, 1916. (Appl. No. 14,321 of 1916.)

A CASCADE concentrator is fitted with basins each of which has two spouts. The inlet spout of each basin rests on the edge of the support of the basin next above and the outlet spout rests in the inlet spout of the basin next below.—W. H. C.

Filtering; Process of —. M. B. Lamb, Santiago, Chili. Assignor to Allis-Chalmers Manufacturing Co., Milwaukee, Wis. U.S. Pat. 1,242,355, Oct. 9, 1917. Date of appl., June 22, 1914.

A FILTER cake containing a "desirable substance," e.g., sodium nitrate, and an "undesirable substance," e.g., sodium chloride, is washed with a solution of the latter; in the case mentioned the sodium nitrate is removed and the chloride left in the cake, preventing its collapse.—W. H. C.

Drying apparatus. B. Panara, Rome, N.Y. U.S. Pat. 1,242,368, Oct. 9, 1917. Date of appl., Apr. 23, 1917.

A NUMBER of superimposed tiers of separate drying rooms, provided with doors at the sides, have a ventilating chamber on the top, from which a fan blows air through the top tier of drying rooms. Means are provided for connecting any of the drying rooms with, or shutting them off from, the air current and from communication with the other drying rooms.—W. H. C.

Drying-machine. W. M. Brownell, Brooklyn, N.Y., Assignor to A. N. Hood, Newton, Mass., and J. T. Nightingale, Boston, Mass. U.S. Pat. 1,242,518, Oct. 9, 1917. Date of appl., May 1, 1916.

THE material to be dried is sliced by a knife and then forced under pressure through a number of drying tubes surrounded by a heating chamber. The tubes have constrictions at each end, and the discharge ends of the upper tubes project beyond those below.—W. H. C.

Separator or clarifier; Centrifugal, self-balancing —. H. A. Riggs, Indianapolis, Ind. U.S. Pat. 1,242,863, Oct. 9, 1917. Date of appl., Jan. 7, 1916.

A SEPARATING drum provided with conical discs, and having a hollow centre, is mounted pivotally on a rigid vertical shaft which passes into, and is of smaller diameter than, the hollow centre. Bow-shaped springs are interposed between the shaft and the lower part of the hollow centre.—W. H. C.

Centrifugal machines [hydro-extractors]. T. Broadbent and Sons, Ltd., and H. Broadbent, Huddersfield. Eng. Pat. 110,215, Oct. 27, 1916. (Appl. No. 15,301 of 1916.)

IN a centrifugal nitrating machine, an inner detachable conical lining is provided between the basket and the central support; this serves to protect the working parts of the machine from acid, and it can be removed and replaced without disturbing the working parts. The lining is attached either to the outer casing of the machine or to the central support. The change from low to high speed of rotation is effected by means of a hand lever and cam.—W. H. C.

Separating liquids from gases, particularly applicable for separating oil from steam; Apparatus for —. The British Thomson-Houston Co., Ltd., London. F. S. Carter, Port Talbot, and F. Samuelson, Rugby. Eng. Pat. 110,219, Nov. 1, 1916. (Appl. No. 15,610 of 1916.)

THE gas is passed through a chamber in which a number of perforated discs mounted on a horizontal shaft are rotated between a number of perforated discs fixed to the chamber walls. The separated liquid is discharged from the bottom of the chamber. A fan may be fixed on the shaft so that the discs are rotated by the action of the current of gas on the fan.—W. H. C.

Furnace gases; Removal of dust from —. H. P. Bingham, London. Eng. Pat. 110,235, (Appl. Nos. 16,795, Nov. 23, 1916, and 7390, May 22, 1917.)

IS a dust filter of the type in which the dust-laden gases pass horizontally through a bed of broken brick or other filtering material contained in a chamber between two louvered walls, the discharge of the filtering material is controlled by a ram or articulated system of bars or plates, which may be moved so as to grip the filtering material in the upper part of the discharge neck and hold up the material above, while that below falls out when a sliding damper, on the lower end of the discharge neck, is withdrawn. The louvered grids on the inlet side are set in an inclined frame, which extends only half way up the chamber, and those on the outlet side are set in a vertical frame and extend the whole height of the chamber. The louvres are formed with vertical webs to prevent sagging.—W. H. C.

Air and the like cleaning devices. Babcock and Wilcox, Ltd., London, and D. C. Meikler Reid, Lee, Kent. Eng. Pat. 110,275, Feb. 23, 1917. (Appl. No. 2669 of 1917.)

DUST-LADEN air is carried into a depositing chamber by vacuum or pressure and is sprinkled with a refuse-depositing medium (e.g., water) during its passage through the inlet pipe. The depositing chamber is provided with screens, which are sprayed with the depositing medium on the discharge side from a number of spraying devices, so arranged that the areas sprayed overlap.

—W. H. C.

Filling materials for reaction, concentration, or absorption towers and the like. C. J. Goodwin, London. Eng. Pat. 110,260, Jan. 23, 1917. (Appl. No. 1165 of 1917.)

THE filling material has the form of two truncated cones joined together at their smaller ends. The joint is smoothed or rounded off and an external collar may be provided round the joint. The cones may have perforations, corrugations, or serrations to increase their efficiency, and may be constructed of metallic or other suitable wire.

—W. H. C.

Steam boilers and the like; Coal-fired —. G. Wilkinson, Harrogate. Eng. Pat. 110,385, Apr. 2, 1917. (Appl. No. 14,612 of 1916.)

A STEAM boiler is placed by the side of and combined with a vertical retort for distilling coal. Coke is discharged from the retort on to a firegrate and the hot gases pass upwards round the retort to heat it, and also over a group of boiler tubes in flues on each side of the furnace. Baffles may be provided in the flues to distribute the hot gases. The rate of coal distillation may be accelerated by drawing hot gases from the furnace through the retort. Fresh coal is fed into the retort at a rate corresponding to the discharge of coke and therefore to the rate of combustion of coke in the furnace. (See also Eng. Pat. 782 of 1915; this J., 1916, 247.)—W. F. F.

Refrigerating apparatus. E. C. R. Marks, London. From Isko Incorporated, Detroit, Mich., U.S.A. Eng. Pat. 110,533, Oct. 13, 1916. (Appl. No. 11,402 of 1917.)

THE pressure in the expansion coil of a refrigerator is maintained equal to that of the atmosphere by means of an automatic valve which controls the passage of the refrigerant from the condenser to the expansion coil. The valve is operated by a diaphragm, one side of which is exposed to the pressure within the expansion coil and the other side to the pressure of the atmosphere. A by-pass is provided to allow the refrigerant to pass back to the condenser, should the pressure within the expansion coil rise above that of the atmosphere. Expansion coils of special shape are also claimed.

—W. H. C.

Grinding mill. J. W. Cover, Tacoma, Wash. U.S. Pat. 1,242,423, Oct. 9, 1917. Date of appl., Oct. 28, 1916.

A HORIZONTAL rotating drum is provided with a number of axially spaced rings within the drum which support and act as runways for loose longitudinal grinding bars. The material is circulated by flanges projecting inwards from the outer shell, and the pulverised material passes outwards through a perforated peripheral screen forming the cylindrical wall of the drum.—W. F. F.

Liquids; Apparatus for treating — with gases. M. H. Ittner, Jersey City, N.J. U.S. Pat. 1,242,445, Oct. 9, 1917. Date of appl., Jan. 6, 1916.

LIQUID is contained in a closed receptacle into which gas under pressure is admitted at the top. A central vertical tube, perforated at the portion above the liquid level, is supported by the cover, and a rotating vertical shaft passes down through the tube and carries a centrifugal distributor at the bottom having also a central opening for the admission of liquid. Gas passes downwards through the tube, and means are provided in the distributor for intimately mixing the gas and liquid. The mixture is projected outwards into the main body of liquid under a pressure which alternates rapidly and abruptly with respect to the average pressure in the receptacle.—W. F. F.

Tunnel dryer for drying bricks, retorts, and the like. Eng. Pat. 110,531. See VIII.

Separating liquids from solids in fluid suspensions; Apparatus for —. A. L. Blomfield, Denver, Colo., U.S.A. Eng. Pat. 110,188, Oct. 10, 1916. (Appl. No. 14,415 of 1916.)

SEE U.S. Pat. 1,237,745 of 1917; this J., 1917, 1088.

Process of distillation and still for carrying out the same. Eng. Pat. 110,413. See II.

Process and apparatus for oxidising gases. U.S. Pats. 1,242,987 and 1,242,988. See VII.

Solution having a low freezing point. U.S. Pat. 1,243,119. See XX.

IIA.—FUEL; GAS; MINERAL OILS AND WAXES.

Coal; Distillation of — under pressure. J. H. Capps and G. A. Hulet. J. Ind. Eng. Chem., 1917, 9, 927—935.

THE coal was heated by means of an electric furnace in a steel cylinder, into the neck of which was brazed a brass side tube, which conducted the distillation products first into a vertical seamless steel tube surrounded by an external heater, and then, through a cold water jacket, into a second receiver of glass, whilst the uncondensed gases, after passing through bulb tubes containing standard acid to absorb ammonia, were collected over water. The temperature was measured by means of a thermo-couple within the furnace just outside the retort. The pressure was obtained by confining the gases liberated from the coal, until at the desired point the cock was opened, and the gases allowed to escape as fast as they formed. Samples of steam coal, bituminous, sub-bituminous, and soft coals were thus examined. It was found that pressures up to 20 atmos. reduce the amounts of compounds of high b.pt., but increase those of low b.pt. in the condensable vapours evolved from coal below 600° C. They also cause an increase in the proportion of aromatic compounds of low b.pt. in the condensed oils. These results are due to the "cracking" of the vapours of the heavier compounds within the retort. As a rule, the amounts of phenols and acid compounds are also reduced by pressure. The proportion of coke and the amount of fixed carbon in the coke are increased by pressure, owing to the effects of cracking oils in contact with the coal. The calorific value of the coke is also increased, but the proportions of nitrogen, oxygen, sulphur, and volatile substances are reduced, probably through the increased partial pressure of hydrogen in contact with the hot coke. An increase in the volume of gas evolved from coal below 600° C. is produced by pressure. The amount of hydrogen in the gases is increased by pressures up to 20 atmos. at 500° C., but reduced at 550° and 600° C., the increase being attributable to "cracking," and the decrease to the action of the hydrogen on the nitrogen, sulphur, and oxygen in the coke, and upon the unsaturated compounds produced by the cracking. This view is supported by the increase of ethane and methane in the gases.

—C. A. M.

Naphthalene [in gas manufacture]; The production and prevention of —. T. D. Miller. Amer. Gas. Inst. News, Sept., 1917. Gas J., 1917, 140, 27—28, 78—80.

THE author advocates the use of high temperatures and heavy charges carbonised for a sufficient time to extract the gas completely from the coal, and shows that, provided the charges are heavy, i.e., from 475 lb. to 500 lb. in a 16 in. by 20 in. by 9 ft. retort, standpipe and naphthalene troubles do not occur. There appears to be general agreement that any of the hydrocarbons of coal gas or carburetted water-gas is convertible into naphthalene, the latter not being a direct result of high temperature processes but a secondary result of the heating of the gas after its generation. As the breaking up process in superheating gas causes dissociation of the hydrocarbons into carbon and hydrogen (depositing soot), any process which tends to reduce the formation of naphthalene also tends to a reduction of soot, which is the basis of stopped standpipe troubles. Naphthalene in water-gas practice is due to

excessive heats in the superheater, but as this heat is controllable the production may be limited. Experience seems to indicate that the production of naphthalene in vertical retorts is inconsiderable, probably owing to the fact that the passages by which the gas leaves the body of the coal are exceedingly small, and hence the velocity of the gas is increased and the length of exposure to the heated walls of the retort or to the body of incandescent coke is reduced. The cracking effect of various temperatures seems to be in inverse ratio to the time of exposure, i.e., exposure to a low temperature for a certain period will have the same effect as exposure to a higher temperature for a shorter period. Carbonising at low temperatures can be so conducted that there will be a practical absence of naphthalene. If on increasing the temperature the gas could be conveyed from the retorts without subjecting it to the cracking effect of the higher temperatures, the production of naphthalene would remain practically nil. The desirability of carbonising at high temperatures being apparent, it is obvious that in order to prevent undue superheating of the gas, the conveying space should be reduced as the temperature is increased to secure greater velocity. A series of replies to questions addressed to members of the Institute is included. The opinion is commonly expressed that the products of distillation remain too long in contact with the retort walls, but an improvement is noted with full, even, and regular charges. In the case of a vertical retort the gases pass through a cool zone of uncarbonised material and suffer only slight decomposition, whilst with coke ovens the temperature of the top of the oven may be kept low if the design permits. Opinion is unanimous on the absence of naphthalene troubles in vertical retort practice, and on the advantage of heavy charges, thereby increasing the velocity of the gas by reduction of the free space.—J. E. C.

Benzol extraction on gas works. J. H. Clegg. Manchester District Jun. Gas. Assoc., Nov. 3, 1917. Gas J., 1917, 140, 261—263.

THE author describes a Hird continuous plant used for benzol extraction, and gives an account of observations and experiences in working it. The plant consists of a rectangular still heated by coal gas. The oil traverses the bottom of the still around baffle-plates, a depth of one foot being maintained in the still. A dephlegmator is provided, and the hot oil passes through four heat interchangers, the first two being cooled by incoming oil, the others by cold water. The vapours pass through a condenser and the condensed products are separated, benzol and water being collected in separate drums. The benzolised oil flows through the plant by gravity from an elevated store tank. The scrubber washer is of the Holmes rotary brush type in two sections, the second section only being used for benzol washing, with creosote as the washing medium. A little water in suspension in the oil causes no trouble, but free water at the bottom of the still causes frothing. The benzol is sold on a standard of 65% distilling over at 120° C., with a reduction of ¼d. per gallon for every 1% below this standard. The best working temperature of the still is from 265° to 275° F. (120°—135° C.) at the outlet, this giving the greatest quantity of the required quality. If the quality is too good a little steam is admitted near the inlet; the action of the steam is mechanical, facilitating the release of vapours by agitation. In washing the gas the temperature of the wash oil is kept at about 58° to 65° F. (14°—18° C.) and a saturation of 3.3% is obtained, with a yield of 1½ gallons per ton. The reduction in candle power of the gas averages 25%, as also does the reduction in gross calorific value. About half a gallon of benzene and toluene per ton of

coal is retained in the gas. The wash-oil removes hydrogen sulphide from the gas to the extent of about 100 grains per 1000 cub. ft. The heavy distillates from the depilegmator are run off into a settling pan, giving a naphtha containing little naphthalene, and as much as 6% of tar acids, although the original ecreosotes contained none. Naphthalene troubles have been experienced owing to the washed gas having re-absorbed deposits of naphthalene of some years' standing; no naphthalene passed the holders. For working the plant about 70 cub. ft. of gas is required per gallon of benzol produced. The storage tank for benzol is laid about 2 feet in the ground on concrete, with a low brick wall surrounding it to confine the benzol in case of leakage.—J. E. C.

Combustion; Some observations on the effect of the partial pressure of oxygen in— H. C. Dollwig, A. C. Kolls, and A. S. Loevenhart. J. Amer. Chem. Soc., 1917, 39, 2221—2231.

In experiments with a candle and with a lamp burning ethyl alcohol at an asbestos wick in atmospheres containing various proportions of oxygen and nitrogen, it was found that extinction occurred when the partial pressure of the oxygen was reduced to 116 mm. and 112.7 mm. of mercury respectively, the corresponding proportions of oxygen being 15.1% and 16.1%; hydrogen continued to burn in the mixture until the percentage of oxygen was reduced to 6.63. When the partial pressure of the oxygen in air was reduced by gradual exhaustion of the combustion chamber, the flame of a paraffin or tallow candle became extinguished at a partial pressure of oxygen of 19 mm.; the corresponding value for an alcohol lamp was 27 mm. partial pressure, the relative proportion of nitrogen to oxygen being approximately the same as in air. The wide difference between the results under the two sets of conditions is to be attributed to the cooling effect of the excess of nitrogen in the former case, and also possibly, in some degree, to the inert gas interfering with the access of oxygen to the flame.

—D. F. T.

Storage and transportation of liquids. Baxter. See I.

Transportation and storage of liquids in small packages. Adkins. See I.

PATENTS.

Peat; Process for expressing liquid from— Processes and apparatus for expressing liquid from peat. J. W. Hinchley, London, and G. Gorton, Bexhill-on-Sea. Eng. Pats. (A) 110,380 (Addition to Eng. Pat. 3998 of 1915) and (B) 110,383, Oct. 13, 1916. (Appl. Nos. 14,602 and 14,605 of 1916.)

(A) In the process for expressing liquid from peat as described in the principal patent (this J., 1916, 1254), steam at 70—100 lb. per sq. in. is used, the temperature of the peat being about 90° C. (B) In processes and apparatus for expressing liquid from peat as described in Eng. Pats. 3998 of 1915, 101,782, 108,503, 110,381, and 110,384 (this J., 1916, 1254; 1917, 998, p. 1227), the treating fluid is hot liquid, e.g., hot water. Two or more hot or cold gases and hot liquids may be admitted successively to the press and the mechanical pressure may be constant or variable.—W. F. F.

Gas; Production of— from peat, lignite, or wood. C. O. Rasmussen, Copenhagen. Eng. Pat. 101,152, Aug. 7, 1916. (Appl. No. 11,136 of 1916.) Under Int. Conv., Aug. 8, 1915.

Gas produced in the usual way from peat, lignite, or wood, is passed together with steam or hydrocarbons through one or more closed retorts con-

taining substances consisting mainly of carbon (coke or charcoal) and maintained in a state of incandescence.—J. E. C.

Fuel; Hydrocarbon— for use in internal combustion engines. P. H. King and J. A. Stoneham, London. Eng. Pat. 110,520, June 15, 1917. (Appl. No. 8573 of 1917.)

A MIXTURE of acetylene (98%) and water-gas (2%) is mixed with an equal volume of hydrocarbon vapour and the whole condensed to form a liquid containing the acetylene and water-gas in solution. The hydrocarbon vapour may be obtained from petroleum or coal-tar derivatives having a flash point of about 85°—100° F. (29°—38° C.).—J. E. C.

Coal-fired steam boilers and the like. Eng. Pat. 110,385. See I.

Process of distillation [of benzol, etc., from wash oils] and still for carrying out the same. Eng. Pat. 110,113. See III.

Tunnel dryer for drying bricks, retorts, and the like. Eng. Pat. 110,531. See VIII.

Apparatus for detecting firedamp in mines. Eng. Pat. 110,439. See XXIII.

II.B.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

Lignite coal; Distillation of— at low temperatures. H. K. Benson and L. L. Davis. J. Ind. Eng. Chem., 1917, 9, 946—949.

A TYPICAL sample of Tono (Washington) black lignite was used for the distillation. It had the following composition:—Moisture, 20.2; volatile substances, 31.5; fixed carbon, 39.9; ash, 8.4; sulphur, 0.52; and nitrogen, 1.06%. B.Th.U., 9280 cal. At the present time this coal is only used as a steam coal in locomotives of special construction. As the result of a series of distillations at temperatures up to 600° C., it was found that the maximum yield of lignite oils (about 5.5% of the coal) is obtained at 380° C. These crude oils resemble petroleum and shale oils more closely than coal tar, being free from benzene or benzene derivatives. They yield valuable solvent, illuminating, engine, and lubricating oils. For example, at 380° C. the following yields per ton of lignite were obtained:—Crude tar, 108; light oil, 25.8; medium oil, 29.3; paraffin wax, 6.9; and paraffin oil, 38.9 lb. The amounts of gas obtainable (e.g., 4400 cub. ft. at 380°; 9800 cub. ft. at 600° C.) are small, and its calorific value is low. Small amounts of ammonia may be obtained from lignite tar water, but cyanides are only present in traces in the products of distillation at higher temperature. The residual coke is dull black and retains the shape of the original particles. It is of high calorific value (over 12,000 B.Th.U. per lb.), and its heating power increases with the temperature of distillation. The coke obtained at 380° C. (1092 lb. per ton) had the following composition:—Volatile substances, 14.0; ash, 13.0; and nitrogen, 0.5%. B.Th.U., 12,710 cal.

—C. A. M.

PATENT.

Distilling coal, wood, peat, or lignite for obtaining useful liquid and solid products. W. Thomas, Nanaimo, British Columbia. Eng. Pat. 110,217, Oct. 30, 1916. (Appl. No. 15,450 of 1916.)

HOT gas from coal or other material is passed in contact with one side of a double surface condenser and is partially cooled, thereby causing condensation of hydrocarbons. The cooled gas is further purified to remove sulphur, and then

passed in contact with the other side of the condenser and thence through a regenerative system, where it becomes heated to a temperature between 1600° and 1800° F. (870°—980° C.). The hot purified gas is then brought into intimate contact with a body of coal or other material, which may also be heated externally, thus effecting rapid distillation and carrying off sulphur, producing desulphurised fuel.—J. E. C.

III.—TAR AND TAR PRODUCTS.

Aniline; Colorimetric determination of small amounts of—. E. Elvove. J. Ind. Eng. Chem., 1917, 9, 953—955.

AFTER a preliminary test, the solution is diluted so as to fall within the limits of 1 part in 285,000 and 1 part in 2 millions of aniline. 20 c.c. of this solution is mixed with 1 c.c. of calcium hypochlorite solution containing 0.1% of available chlorine, and, after standing for 2 mins., is treated with 1 c.c. of N/1 sodium hydroxide solution, and allowed to stand for 10 mins. (or 5 mins. in the case of the lowest standard, containing 0.01 mgrm. of aniline). The colour of the liquid is then compared with the colour of standards containing from 0 to 0.07 mgrm. of aniline in 20 c.c. of water. The average error in test experiments was 0.003 mgrm.—C. A. M.

Benzol extraction on gas works. Clegg. See 11A.

PATENTS.

Asphalt cauldrons, tar boilers, and the like. W. H. Wood, Birmingham. Eng. Pat. 110,175, Sep. 6, 1916. (Appl. No. 12,602 of 1916.)

THE cauldron or boiler consists of a pan placed over a fire-box, each being surrounded by an outer casing. The conical fire-box is strengthened against distortion by corrugations or grooves, or by curving the wall inwards. The two outer casings are barrel-shaped, and are provided inside with annular flanges, for securing them together and for holding the fire-box and pan in position. The fire bars pass through perforations in vertical flanges at the bottom of the fire-box, and the fire-doors are not flush with the outer casing but inside and protected by it.—F. Sp.

Distillation [of benzol, etc., from wash oils]; Process of— and still for carrying out the same. Simon-Carves, Ltd., and J. H. Brown, Manchester. Eng. Pat. 110,413, Oct. 28, 1916. (Appl. No. 15,390 of 1916.)

TO recover benzol, toluol, naphtha, etc., from the oil with which they have been absorbed in the washing of coal gas, the oil is heated to about 130°—140° C. and passed downwards over a series of horizontal trays at the top of a column still. On leaving the lowest tray the oil, cooled to about 105°—108° C., passes downwards to the bottom of an annular chamber containing a steam coil which reheats it to the initial temperature. The oil overflows the inner rim of the annular chamber and passes downwards over a series of inclined splashing plates to another series of horizontal evaporating trays where the remainder of the absorbed substance is liberated. The oil then passes to the lowest chamber of the still, which contains a coil through which the incoming oil is passed to preheat it.—W. F. P.

Cresole oil substitute and process of making same. G. E. Heyl, London. U.S. Pat. 1,242,188, Oct. 9, 1917. Date of appl., Feb. 21, 1917.

SEE Eng. Pat. 107,911 of 1916; this J., 1917, 958.

Toluol: Manufacture of—. F. Thuman, Westminster. From W. H. Gartley, Philadelphia, U.S.A. Eng. Pat. 110,448, Dec. 20, 1916. (Appl. No. 18,270 of 1916.)

SEE U.S. Pat. 1,225,237 of 1917; this J., 1917, 638.

IV.—COLOURING MATTERS AND DYES.

Modification of the Price method of separating coal tar colours [in foodstuffs] to include Tartrazine. Ingersoll. See XIXA.

PATENTS.

Vat dyes, and process of making same. R. Herz, Frankfort, Germany. U.S. Pats. (A) 1,243,170 and (B) 1,243,171, Oct. 16, 1917. Date of appl., June 16, 1915.

THE products obtained by the action of an excess of disulphur dichloride on aromatic amino-compounds or their derivatives are treated with dilute alkalis, preferably in presence of a suitable reducing agent, or with water; the products are condensed with monochloroacetic acid in alkaline solution, and the condensation products diazotised and converted by means of cuprous cyanide into nitriles, which are then saponified and converted into ring-compounds by the action of alkalis; by heating with dilute acid and subsequent oxidation the final products are converted into orange, red to violet, brown and black vat dyestuffs containing sulphur and giving dyeings of great fastness to washing, scouring, bowking, and chlorine. (A) The fast red vat dyestuff from aniline, and (B) the fast pink vat dyestuffs from *o*- and *m*-toluidine and *p*-xyldine are specially claimed.—F. W. A.

Chromium compounds of azo dyestuffs and process of making same. G. Engi and C. Jagerspacher. Assignors to Society of Chem. Industry in Basle, Switzerland. U.S. Pat. 1,242,536, Oct. 9, 1917. Date of appl., Aug. 3, 1916.

SEE Eng. Pat. 15,156 of 1915; this J., 1916, 1255.

Dye. W. W. Coe, jun., London. U.S. Pat. 1,243,042, Oct. 16, 1917. Date of appl., Aug. 23, 1916.

SEE Eng. Pat. 107,094 of 1916; this J., 1917, 923.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.

Distillation of mixtures of nitric and sulphuric acids. Pascal. See VII.

PATENTS.

Refuse, fibrous or the like material; Treatment of—. W. S. H. Bevin, Liverpool. Eng. Pat. 110,394, Oct. 18, 1916. (Appl. No. 14,791 of 1916.)

THE process relates to the treatment of waste fibrous or textile material with the object of separating seeds, husks, etc., in a condition enabling them to be used as a cattle food, and of recovering the fibres. The material is fed to a pit from which it is lifted by air suction to the top of the apparatus, any stones and heavy matter falling back to the pit. At the top of the apparatus the material is delivered into a centrifuge from which it falls on to a flocking machine consisting of beaters which shake out the seeds and similar matters; the fibrous material passes through a revolving wire mesh cylinder, that portion delivered at the end being caught in a bag, and that portion passing through the mesh being passed through a second wire mesh tube of hexagonal form, thus dividing the fibrous material into first and second grade fibres. The

material passing through the mesh of the hexagonal tube is returned to the commencement of the apparatus for re-treatment. The seeds and other matter separated by the flocking machine pass over a magnetic roller to remove iron wire, and then into a rocking sieve which separates fibre and sand from the seeds, husks, and bran.

—J. H. J.

Cellulose from vegetable fibres, such as wood, cotton, straw, esparto grass, jute, and the like: Process for the extraction of —. B. Cataldi, Turin, Italy. Eng. Pat. 191,175, Sept. 11, 1916. (Appl. No. 12,862 of 1916.) Under Int. Conv., Sept. 11, 1915.

THE material, previously reduced to a suitable state of subdivision, is leached with a slightly alkaline solution; the liquid is run off and the water of "interposition" is removed as completely as possible by hydro-extractors or by treatment under vacuum or a combination of both. The fibres are then subjected to the action of chlorine gas, which is admitted under vacuum, and the slight amount of alkaline salt remaining in them neutralises any excess of hydrochloric acid which may be formed in the treatment. The chlorinated material is finally purified by a second leaching process with an alkaline solution.—J. F. B.

Paper pulp: Beating or grinding of —. E. Partington, Baron Doverdale, Westwood Park, Worcester. Eng. Pat. 110,482, Mar. 21, 1917. (Appl. No. 1276 of 1917.)

PAPER pulp is fed continuously into the first of a series of hollander beating engines, being delivered preferably near the mid-feather of the engine in front of the roll, so that it has to make the circuit of the trough several times before it reaches the outer side. From the outer side it is withdrawn and fed either by pump or by gravity to the next engine of the series, in a similar manner, and is finally discharged continuously from the last engine in a fully beaten condition.—J. F. B.

Celluloid substitute and process of making same. H. Dreyfus, Basle, Switzerland. U.S. Pat. 1,242,783, Oct. 9, 1917. Date of appl., Nov. 12, 1914.

A VISCOUS, concentrated solution of cellulose acetate is made by dissolving it in a mixture of alcohol and trichloroethylene, and the same solvent, with or without other additions, is used to produce a clear transparent substitute for celluloid.—F. Sp.

Parchmentised or vulcanised fibre: Manufacture or treatment of — and new products therefrom. J. Y. Johnson, London. From Diamond State Fibre Co., Bridgeport, Pa., U.S.A. Eng. Pat. 110,318, Dec. 11, 1916. (Appl. No. 7755 of 1917.)

SEE U.S. Pat. 1,236,160 of 1917; this J., 1917, 1092.

Parchmentised or vulcanised fibre: Treatment of — and products obtained thereby. J. Y. Johnson, London. From Diamond State Fibre Co., Bridgeport, Pa., U.S.A. Eng. Pat. 110,650, Dec. 11, 1916. (Appl. No. 17,808 of 1916.)

SEE U.S. Pat. 1,236,959 of 1917; this J., 1917, 1092.

Artificial silk and like threads: Apparatus for treating —. H. de Chardonnet, Paris. U.S. Pat. 1,243,489, Oct. 16, 1917. Date of appl., July 16, 1915.

SEE Eng. Pat. 10,858 of 1915; this J., 1916, 302.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

PATENTS.

Dye content of waste liquors; Commercial process for reclaiming the —. T. Forsyth, Assignor to The Forsyth Dyeing Co., New Haven, Conn. U.S. Pat. 1,242,676, Oct. 9, 1917. Date of appl., Dec. 1, 1916.

THE dye content of waste liquors is reclaimed by adding a neutralising agent with suitable agitation, separating the sludge from the liquor, and then filtering the sludge by gravity whilst it is evaporating by atmospheric action.—F. W. A.

Waterproofing fabrics: Process of —. E. I. Cuthbertson, Vancouver, British Columbia. U.S. Pat. 1,243,327, Oct. 9, 1917. Date of appl., Nov. 22, 1916.

FABRICS are waterproofed by depositing on the fibres a film of a salt of a suitable metal, having water-repellent properties, e.g., aluminium acetate, and impregnating the film with an emulsion of wax, e.g., a mixture of vegetable and mineral wax, or of wax, oil, and resin, which combines with the aluminium acetate to form a "mineralised wax." —F. Sp.

Textile fibres and fabrics and like substances or articles; Fireproofing of —. T. J. I. Craig, and Whipp Bros. and Tod, Ltd., Manchester. Eng. Pat. 110,221, Nov. 9, 1916. (Appl. No. 15,699 of 1916.)

THE process described in Eng. Pat. 16,153 of 1914 (this J., 1915, 868) is modified in such a way that the material previously impregnated with alkali aluminate and preferably dried, is wetted with a solution of alkali bicarbonate and then treated at about 100° C. with steam or steam and carbon dioxide.—J. F. B.

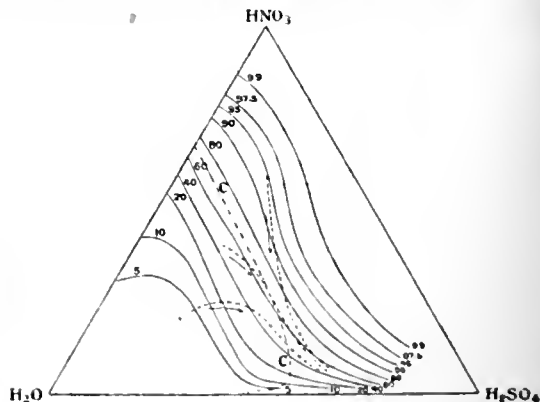
Bleaching fabrics in open form: Plant for —. C. Taylor, Wilmington, Del., U.S.A. Eng. Pat. 103,647, Dec. 29, 1916. (Appl. No. 18,594 of 1916.) Under Int. Conv., Jan. 21, 1916.

SEE U.S. Pat. 1,201,388 of 1916; this J., 1916, 1216.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Sulphuric and nitric acids: Distillation of mixtures of —. P. Pascal. Comptes rend., 1917, 165, 589–591.

THE thermal properties of mixtures of sulphuric and nitric acids are represented in two diagrams, using triangular co-ordinates, in which the independent variables are water, sulphuric acid, and

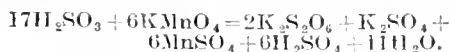


nitric acid. The first diagram shows the boiling points under normal pressure, and the second the concentration of nitric acid in the vapour. Three dotted curves in the second diagram (see fig.) represent the course of distillation of three different mixtures. Over a considerable area of the first diagram, ternary mixtures with a given content of sulphuric acid show a maximum boiling point, and the concentration corresponding to this maximum is displaced towards mixtures low in nitric acid as the content of sulphuric acid increases. The temperature of the maximum boiling point, after falling slightly in the region of mixtures low in sulphuric acid, rises again to about 160° C. for a mixture containing 65% of sulphuric acid, and here the maximum disappears. Diminution of pressure causes a slight increase of nitric acid in the vapours, but does not alter the general character of the phenomena. The addition of sulphuric acid to concentrated nitric acid does not at first modify to any great extent either the boiling point or the concentration of the vapour, and in fact the latter is a function of the water content over almost the entire area of the diagram. There is, however, a rapid variation in boiling point in the neighbourhood of mixtures usually employed to nitrate cotton, and according to Sapozhnikoff this would explain the relative difficulty of preparing nitrocelluloses intermediate between the collodion cottons and nitrocellulose of maximum nitrogen percentage. On the second diagram (see fig.) a curve, C.C. is shown, on the right of which mixtures on distillation will give vapours of continually decreasing concentration, while mixtures to the left of the curve (containing more water than the former) give on distillation vapours in which the concentration of nitric acid passes through a maximum. It can be shown that this maximum does not coincide with a maximum in the liquid under distillation, nor with a maximum in the distillate.—F. Sp.

Sulphur dioxide [in smelter gases, etc.]; Determination of —. O. R. Sweeney, H. E. Outcault, and J. R. Withrow. *J. Ind. Eng. Chem.*, 1917, 9, 949—950.

For the determination of sulphur dioxide in smelter gases, etc., by means of potassium permanganate, it is essential that an excess of permanganate should be present. For colorimetric comparison the best results are obtained by the use of a standard containing 10 c.c. of approximately 0.005N permanganate solution and 490 c.c. of water. After reduction of the permanganate and back titration of the solution the final colour is of a slightly redder tint than before, but by reducing and oxidising the solution several times the colour may be readily matched. About 475 c.c. of water is mixed with 30 c.c. of 2N sulphuric acid in a litre bottle, and 10 c.c. of recently standardised 0.005N permanganate solution added from a burette. After mixing, the solution is divided into two 500 c.c. bottles of uniform clear glass. Sodium sulphite solution or sulphurous acid is added to one of the bottles until the colour is very faint, after which permanganate solution is added to restore the colour, and the two solutions mixed, and again divided. The standard permanganate solution is then added from a burette in sufficient quantity not to be decolorised by the sulphur dioxide in the gas, and the contents of this bottle are introduced into a large sample bottle containing a definite volume of the gas at known temperature and pressure. After shaking this bottle for some time, its contents are run back into the small bottle, and titrated with permanganate solution until the colour matches that of the solution in the other bottle. It is then returned to the gas sample bottle, and again run back into the small bottle, and the colour matched

once more. The total amount of permanganate consumed corresponds to the sulphur dioxide in the gas:—



This method is preferable to the iodine method of titration. It gives good results in the determination of sulphur dioxide in the atmosphere.

—C. A. M.

Selenic acid; Reduction of —. E. B. Bengel. *J. Amer. Chem. Soc.*, 1917, 39, 2171—2179.

CONTRARY to the statement of Mitscherlich (*Ann. Phys.*, 1827, [i], 9, 629), selenic acid of any concentration is reduced by dry hydrogen sulphide at any temperature above -10° C. The rate of reduction increases with the temperature and concentration of the acid. Selenic acid in 10% solution at 45° C. is completely decomposed by hydrogen sulphide in 13½ hours. Sulphur dioxide reduces selenic acid in two stages, selenium dioxide being the intermediate product. When the sulphuric acid produced reaches a certain concentration, the reducing action ceases, but if the solution is diluted, the reaction proceeds to completion. Sulphur reduces anhydrous selenic acid at 65° C., but higher temperatures are necessary for aqueous solutions, e.g., a 94.2% solution is attacked at 68° C., and a 40% solution at 190° C. Selenium reduces selenic acid at ordinary temperatures, and more rapidly at higher temperatures. More concentrated solutions are more readily attacked.

—F. Sp.

Telluric acid; Reduction of —. E. B. Bengel. *J. Amer. Chem. Soc.*, 1917, 39, 2179—2183.

TELLURIC acid in aqueous solution of any concentration is slowly reduced by hydrogen sulphide and by sulphur dioxide; e.g., a 10% solution of telluric acid is completely decomposed by hydrogen sulphide in 21 hours at 115° C., and in 12 days at ordinary temperatures by sulphur dioxide. Tellurium, sulphur, and selenium also reduce solutions of telluric acid. The difficulty of reduction is greater than would be expected from a comparison of the properties of selenic acid and telluric acid, but is in agreement with Thomsen's thermochemical data.—F. Sp.

Carbonates; Studies of the —. III. Lithium, calcium, and magnesium carbonates. C. A. Seyler and P. V. Lloyd. *Chem. Soc. Trans.*, 1917, 111, 994—1001.

IN extension of the earlier investigation of the ionisation and hydrolysis of sodium carbonate and bicarbonate (this J., 1917, 453), it has been found that the ionisation of the lithium carbonates is comparable in degree with that of the corresponding sodium salts; the ionisation proceeds by the stages $\text{Li}_2\text{CO}_3 = \text{Li} + \text{LiCO}_3$ and $\text{LiCO}_3 = \text{Li} + \text{CO}_3$; the calculation of the solubility product $[\text{Li}]^2 \times [\text{CO}_3]$ for saturated solutions of lithium carbonate in water containing a varying quantity of carbonic acid, based on the supposition of the intermediate LiCO_3 ion, gives concordant values and thereby confirms the theory. The solubility product $[\text{Ca}] \times [\text{CO}_3]$ for calcium carbonate has previously been given too high a value, the figure 71.9×10^{-10} now given for 25° C. agreeing with a solubility of 14.6×10^{-5} gm.-mol. per litre, of which about 66% is hydrolysed into hydroxide and bicarbonate. On account of its tendency to decompose into basic carbonates and bicarbonate, crystalline magnesium carbonate has no definite solubility in pure water and even in very dilute solution the undecomposed salt is only very partially ionised;

the reaction approximates to the equation
 $5\text{MgCO}_3 + 2\text{H}_2\text{O} = 3\text{MgCO}_3 \cdot \text{Mg}(\text{OH})_2 + \text{Mg}(\text{HCO}_3)_2$.
 —D. F. T.

Potassium and aluminium salts: Method for the recovery of — from mineral silicates. J. C. W. Frazer, W. W. Holland, and E. Miller. Amer. Inst. Chem. Eng., June, 1917. J. Ind. Eng. Chem., 1917, 9, 935—936.

FURTHER details are given of the method outlined in U.S. Pat. 1,196,734 of 1916 (this J., 1916, 1059). The finely ground felspar is treated with about 0.8 of its weight of potassium hydroxide (or an equivalent quantity of sodium hydroxide) dissolved in a small quantity of water, and the intimate mixture is heated in an open iron vessel until the water has evaporated, and then for about an hour at 275° to 300° C. Under these conditions a reaction takes place, with the formation of a new silicate which has approximately the composition of leucite:—



The alkali may be recovered by treating the solution, from which the "artificial leucite" has been separated, with lime, and filtering off the calcium silicate, and the filtrate when evaporated may be used for the treatment of fresh portions of felspar. The loss in laboratory experiments was about 1%. For the decomposition of the insoluble silicate, as described in the patent, it is necessary to avoid a local excess of acid in the first stage of the process, since this would tend to dissolve also a portion of the aluminium, and the required quantity of dilute hydrochloric acid is therefore added gradually, and with constant stirring. The residual aluminium silicate resembles kaolinite. By treating it with an equivalent amount of sulphuric acid it is converted into aluminium silicate, whilst gelatinous silica separates. The same method of treatment is applicable to sericite and clay. The yield of potassium chloride from felspar is practically theoretical, whilst about 86% of the theoretical amount of aluminium sulphate is obtained. From a ton of felspar containing 10% of K_2O about $\frac{1}{2}$ ton of potassium chloride of 80% purity and about a ton of crystallised aluminium sulphate would be obtained. In normal times the aluminium sulphate would be more valuable than the potassium chloride; hence the importation of cheap German potash would affect the process less than if potassium chloride were the principal product. In fact under ordinary conditions the value of the process will largely depend upon whether it will yield iron-free aluminium sulphate at a lower cost than the method now used for extracting it from bauxite.—C. A. M.

Pyrolusite: Determination of available oxygen in —. O. L. Barnebey. J. Ind. Eng. Chem., 1917, 9, 961—967.

THE oxalic acid method of determining the available oxygen in pyrolusite is inaccurate, owing to the decomposition of the oxalic acid during the heating required to dissolve the ore. The decomposition is accelerated by the presence of manganese salts and by the action of sunlight. A very small amount of carbon monoxide is evolved from dilute (1.5 N) solutions of sulphuric acid containing oxalic acid, but no appreciable amount of oxygen is evolved during the inter-action of manganese dioxide and oxalic acid in dilute sulphuric acid solution. The ferrous sulphate and the direct iodometric methods (see this J., 1917, 571, 884) are free from these errors, and the following method is recommended: The well-mixed sample is ground so as to pass through a 200-mesh sieve, and dried at 105° C.

until constant in weight. 0.5 gm. is heated with 50 c.c. of standard ferrous sulphate solution (90 grms. in 200 c.c. of sulphuric acid of sp. gr. 1.84 and 900 c.c. of water) until dissolved, the solution diluted to about 150 c.c., and the excess of ferrous iron titrated with standard permanganate solution.—C. A. M.

Hydrogen sulphide: Influence of added substances on the iodometric titration of —. A. R. Jayson and R. E. Oesper. J. Ind. Eng. Chem., 1917, 9, 975—977.

THE red coloration which appears during the iodometric titration of hydrogen sulphide in acid solution appears to be due to acid hydrolysis of the starch to erythro-dextrin, which is accelerated by hydrogen sulphide in the presence of iodine. The amount of erythro-dextrin formed, as judged by the depth of the red coloration, depends upon the quantity of acid present, and increases with the concentration of the acid. At the end of the titration erythro-dextrin is no longer formed, but blue starch iodide, and a mixture of the latter with the red erythro-dextrin iodide, would give a purple end coloration. Reduction of the concentration of the acid beyond a certain limit is not practicable in the titration of cadmium sulphide precipitates, owing to the rate of solution being too slow. The end-point is not rendered more definite by the addition of various salts.

C. A. M.

Handling and transportation of liquids. Eisenhart. See I.

PATENTS.

Phosphoric acid and compounds of the same; Apparatus for manufacture of —. W. H. Waggaman, H. Bryan, and C. R. Wagner. Washington, D.C. U.S. Pat. 1,241,791, Oct. 2, 1917. Date of appl., Mar. 16, 1917. (Dedicated to the public.)

A BLAST furnace for producing phosphoric acid comprises an inner chamber for the charge which discharges upon a platform built at the bottom of an outer annular chamber. Tuyères are provided, one set to cause a blast of air to burn and oxidise the charge on the platform, and another set to introduce air into the upper part of the annular space to complete the oxidation of volatile products.—H. J. H.

Nitre cake: Treatment of —. J. Grossmann, Manchester. Eng. Pat. 110,405, Oct. 20, 1916. (Appl. No. 14,922 of 1916.)

NITRE cake is converted into a friable mass, suitable for crushing or grinding, by mixing it in the molten state with about 5% of sodium carbonate, or with sodium carbonate and a "diluent" such as sodium sulphate, and then chilling the mass, e.g., with water, salt solution, glycerin, etc.—F. Sp.

Nitrosic [nitrous] gases: Process of producing —. W. S. Landis, Niagara Falls, N.Y., Assignor to F. S. Washburn, Nashville, Tenn. U.S. Pat. 1,242,953, Oct. 16, 1917. Date of appl., Feb. 20, 1915.

NITROUS gases are produced by passing a mixture of ammonia, oxygen, and air, containing sufficient oxygen to sustain the reaction, e.g., above 30%, but not enough to cause substantial decomposition of the ammonia, through a hot catalyst at constant pressure.—F. Sp.

Oxidising gases: Process of —. Apparatus for oxidising gases. [Preparation of phosphoric acid.] F. C. Schmitz, New York. U.S. Pats. (A) 1,242,987 and (B) 1,242,988, Oct. 16, 1917. Date of appl., (A) Jan. 22, and (B) Oct. 21, 1914.

(A) GASES are oxidised by passing them through

a chamber in a zigzag path, and subjecting them to the action of oxygen passing in the opposite direction. In particular, phosphoric acid is prepared by fusing a mixture of phosphate rock, silica, and carbon, driving off the phosphorus as vapour, oxidising it to phosphorus pentoxide by a counter-current of oxygen, and absorbing the phosphorus pentoxide in a dilute solution of phosphoric acid. (B) A plant for carrying out the process described in (A) consists of an electric furnace, connected by a flue with an oxidising chamber into which oxygen can be introduced in a direction contrary to that of the phosphorus vapour, and an absorption tower.—F. Sp.

Calcium and magnesium; Method of separating—in saline solutions. C. Glaser, Baltimore, Md. U.S. Pat. 1,242,434, Oct. 9, 1917. Date of appl., Oct. 8, 1914.

MAGNESIUM and calcium salts contained in a saline solution are separated from it and from each other by adding a sufficient quantity of sodium carbonate to convert them into carbonates, allowing calcium carbonate to precipitate at a temperature not above 60° C., separating the supernatant liquor, and either precipitating the magnesium as carbonate by heating the liquor to 70°–103° C., or as a slightly basic carbonate by adding a small quantity of caustic soda and heating to 70°–103° C.—F. Sp.

Barium oxide; Process of making——. J. G. Kremers, Milwaukee, Wis. U.S. Pat. 1,243,190, Oct. 16, 1917. Date of appl., Dec. 6, 1915.

BARIUM oxide is produced by heating to a high temperature in a muffle furnace dried briquettes of a mixture of barium carbonate and carbon. The chamber of the furnace may be previously filled with an atmosphere of carbon monoxide, e.g., by introducing carbon alone under suitable conditions.—F. Sp.

Nitrogen compounds; Process for forming——. L. Summers, Chicago, Ill. U.S. Pat. 1,242,264, Oct. 9, 1917. Date of appl., Apr. 22, 1914.

A MIXTURE of manganiferous and carbonaceous material is heated, and gases containing nitrogen are drawn through the mass. Volatile nitrogen compounds are produced and condensed.—F. Sp.

Aluminium nitride; Process for producing——. H. L. Duncan, Mahwah, N.J. U.S. Pat. 1,241,834, Oct. 2, 1917. Date of appl., Oct. 12, 1916.

A CHARGE of carbonaceous and aluminous material is fed into a revolving inclined cylindrical furnace, and is heated by the injection with compressed air in an axial direction of a stream of luminous flame producer gas. At the same time the charge at the lower end of the furnace is maintained under a nitrogenous reducing atmosphere by a jet of hot producer gas which impinges upon it. This leads to nitride formation, and at the same time prevents contact of the heating flame with the walls of the furnace. The combustible gases from the furnace are used to preheat the charge in a second furnace.—H. J. H.

Elements [silicon] from their compounds; Process of securing——. V. M. Weaver, Harrisburg, Pa., Assignor to The Weaver Co. U.S. Pat. 1,241,796, Oct. 2, 1917. Date of appl., Jan. 14, 1915.

THE process consists in feeding a compound of an element, e.g., silicon chloride, into a bath of molten metal, e.g., aluminium, whereby the compound in rising through the melt is decomposed, and the element, i.e., silicon, set free, a metallic chloride being formed.—H. J. H.

Ammonia; Producing——. C. Bosch, Assignor to Badische Anilin und Soda Fabrik, Ludwigshafen, Germany. U.S. Pat. 1,243,382, Oct. 16, 1917. Date of appl., Jan. 12, 1914. SEE Fr. Pat. 466,303 of 1913; this J., 1914, 645.

Apparatus for use in concentration of vitriol or other liquors. Eng. Pat. 110,183. See I.

Process of filtering. U.S. Pat. 1,242,355. See I.

Acid-resisting cement. Eng. Pat. 110,258. See IX.

VIII.—GLASS; CERAMICS.

Iron; Determination of—in glass sand. J. B. Ferguson. J. Ind. Eng. Chem., 1917, 9, 941–943.

FIVE grms. of the sand is moistened with 5 c.c. of dilute (1:1) sulphuric acid in a platinum basin, and evaporated with 40 c.c. of hydrofluoric acid until fumes of sulphur trioxide appear. If, after cooling, any silica can be seen, the process is repeated once or twice, and the temperature then raised until all hydrofluoric acid has been driven off, and copious fumes of sulphur trioxide arise. The vessel is then cooled, and its contents diluted with water and filtered. The residue on the filter, which may contain black carbonaceous particles derived from the ceresin bottle in which the hydrofluoric acid was kept, is dried and ignited in a platinum crucible, and the residue from the ignition fused with iron-free potassium pyrosulphate. The melt is dissolved in dilute sulphuric acid, and the solution added to the filtrate and washings. If a residue of black particles remains, as will be the case if staurolite is present, it is filtered off, ignited, and fused with sodium carbonate. The melt, which should now be free from black particles, is treated with dilute sulphuric acid and the solution filtered from insoluble sulphates, and added to the two previous filtrates. The iron may then be determined in the united filtrates, preferably by reduction with stannous chloride and titration with potassium bichromate.—C. A. M.

Glass; Relation between the physical properties and chemical composition of——. VII. Etch figures. E. W. Tillotson, jun. J. Ind. Eng. Chem., 1917, 9, 937–941.

THE so-called crystalline "etch figures" which are formed when glass is treated with hydrofluoric acid, with or without the addition of soluble fluorides, have been attributed to pre-existing crystals in the glass. The results of experiments here described show that all glasses dissolve uniformly in acid fluoride solutions, and that the formation of matt etches and etch figures is due to the production of insoluble substances which are in contact with the surface and prevent it from dissolving at those points. The solution of the glass and the growth of insoluble crystals take place simultaneously. When the etching solution is acid ammonium fluoride the protective crystals consist of ammonium silicofluoride. In the case of solutions containing potassium salts, characteristic etch figures are produced irrespective of the composition of the glass.—C. A. M.

PATENTS.

Hollow glass ware; Manufacture of—and apparatus therefor. L. N. Bruner, Zürich, Switzerland, and S. D. Olsen, Leeds, Eng. Pat. 110,390, Oct. 17, 1916. (Appl. No. 14,741 of 1916.)

MOLTEN glass flows into a cup inside a rotary

mould and is supplied to the latter by centrifugal action when the cup is rotated rapidly. The cup may be raised automatically above the top of the mould to receive the glass and it may afterwards be lowered gradually so as to coat the mould uniformly. The mould may be fitted with a cap, locked by centrifugally acting balls, which also serves to shape the upper edge of the glass article. On again raising the cup the glass article is discharged from the mould. A series of these moulds may be arranged on a table with a step-by-step action, so that they are used successively. —A. B. S.

[Sheet] glass manufacture. A. A. Ileenhour, Arnold, Pa., Assignor to Pittsburgh Plate Glass Co., and C. R. Sammons, Pittsburgh, Pa., L. K. Guiler, B. H. Thompson, S. A. Gilmore, and A. E. Sixsmith. U.S. Pat. 1,242,441, Oct. 9, 1917. Date of appl., Feb. 19, 1911.

A PORTION of a bath of molten glass is isolated and its temperature reduced by surrounding it by a hollow refractory body, so that it forms the edge of a sheet of glass which is to be drawn from the bath. The temperature of each edge is regulated by adjusting the depth of immersion of either end of the refractory body, and the sheet of glass is then drawn.—W. F. F.

Tunnel dryer for drying bricks, retorts, and the like. J. T. and W. J. Price, Dudley, Eng. Pat. 110,531, Aug. 2, 1917. (Appl. No. 11,124 of 1917.)

IN a tunnel dryer, straight and winding longitudinal flues at each side of the furnace extend partly along each side of the tunnel, opening at one end into the tunnel and at the other to the atmosphere. Similar flues are connected to chequered flues built above the furnace. The lengths of the respective flues are adjusted to the requirements, the object being to distribute hot air uniformly throughout the tunnel.—A. B. S.

IX.—BUILDING MATERIALS.

Tricalcium aluminate: Formation of — [in Portland cement]. E. D. Campbell. J. Ind. Eng. Chem., 1917, 9, 943—946.

LE CHATELIER concluded that the two essential constituents of Portland cement are tricalcium silicate and tricalcium aluminate, but free lime is always present in cements prepared in accordance with his formula, and this is also the case with products made in accordance with the formula of Newberry, who concluded that the essential constituents are dicalcium aluminate and tricalcium silicate. Practically pure tricalcium aluminate was prepared by Shepherd, Rankin, and Wright (this J., 1909, 1124), whilst the author obtained crystals of practically pure tricalcium silicate by slowly cooling a solution of dicalcium silicate and calcium oxide in $5\text{CaO} \cdot 3\text{Al}_2\text{O}_3$ (this J., 1914, 964). Further experiments are now described which support the view that tricalcium aluminate should be regarded as either a saturated solid solution of CaO in $5\text{CaO} \cdot 3\text{Al}_2\text{O}_3$, or as $5\text{CaO} \cdot 3\text{Al}_2\text{O}_3$ with 4 mols. of CaO of crystallisation, rather than as a definite phase stable at all temperatures up to 1535°C .—C. A. M.

Magnesia; Refractory properties of—, H. Le Chatelier and B. Bogitch. Comptes rend., 1917, 165, 488—491.

MEASUREMENTS of the crushing strengths at different temperatures have been made on a

number of commercial magnesia bricks and specimens prepared in the laboratory. Tests were also made on a chrome brick as these form the separating course between the basic hearth and the acidic arch of steel furnaces. The seven specimens were:—I. Styrian brick (made in 1890) fired at 1450°C , normal quality. II. Euboean brick made in 1910. III. Brick of good present-day manufacture. IV. Brick of medium quality; 3% of pyrites cinder added in the making. V. Pure precipitated magnesia fused in electric furnace and thereby contaminated. VI. Raw material of No. IV agglomerated in electric furnace. VII. Chrome brick.

Percentage composition.

	I.	II.	III.	IV.	V.	VI.	VII.
MgO	86.7	93.4	89.4	81.2	93.7	88.5	12.3
CaO	1.0	3.7	4.5	4.8	2.7	4.5	5.8
Fe ₂ O ₃	6.0	0.5	1.1	4.2	0.3	1.4	15.5
Al ₂ O ₃	0.6	0.2	0.8	1.0	1.1	0.6	10.9
SiO ₂	6.7	2.8	4.2	8.8	3.2	6.5	4.7
Cr ₂ O ₃	—	—	—	—	—	—	50.0
MnO	—	—	—	—	—	—	1.5
	101.0	100.6	100.0	100.0	101.0	100.9	100.7

Crushing strength in kilos. per sq. cm.

	15° C.	1000° C.	1300° C.	1500° C.	1600° C.
I.	145	85	66	3.6	1.8
II.	420	—	—	185	8
III.	390	—	—	90	4.8
IV.	230	—	—	16	3.5
V.	—	—	—	90	6.6
VI.	530	—	—	—	3.5
VII.	260	120	6	2	1

The results show that there is a sudden breakdown of crushing strength at 1500°C — 1600°C . for the purer brick II. and at 1300°C — 1400°C . for the less pure Styrian brick, although these temperatures are far below the fusion temperatures of magnesia or of the brick mixtures. Apparently the more fusible binding material melts, leaving the grains of magnesia in a condition analogous to that of wet sand and with only a very small crushing strength. Thus at 1600°C . the best magnesia bricks have a strength in compression distinctly less than silica which is much nearer its melting point. Chrome brick behaves like the magnesia bricks but the temperature of collapse is still lower, viz., about 1100°C .—H. J. H.

Magnesia; Refractory — [for furnace linings]. R. C. Gosrow. Met. and Chem. Eng., 1917, 17, 415—417.

THE author records experience in the manufacture of linings of magnesia from Californian magnesite of composition: MgCO_3 , 98.10%; CaCO_3 , traces; Al_2O_3 and Fe_2O_3 , 0.90%; insoluble, 0.50%. This was calcined in an oil-fired shaft furnace after being broken down to lumps of $1\frac{1}{2}$ —3 in. size. The product had the composition: MgO , 91.7%; CaO , 0.10; Fe_2O_3 and Al_2O_3 , 1.9%; insoluble, 0.85%; loss on ignition, 2.2%. It was reduced to $\frac{1}{4}$ in. size and heated in the crucible of a Stassano electric furnace until it was partly fused. The product on cooling showed a loss on ignition of 0.7%, was hard enough to scratch glass, and did not increase in weight on exposure to moist air for 10 days. Before treatment in the electric furnace the material increased in weight 6% in 172 hours. The dead-burnt product was ground to pass a 6-mesh sieve and mixed with 10% of powdered (80-mesh) ferrie oxide, 5% of basic steel furnace slag, and about 12% of well boiled tar. The mixture was rammed

round a steel plate form so as to make the lining of a Stassano furnace in one piece in position. The author claims to have had considerable success in the use of such linings for furnaces for ferro-alloys, tungsten, molybdenum, and manganese. In making these linings it is desirable to use material containing only small percentages of iron and to use a binder other than tar. Rapid heating of the lining and the use of comparatively thin lining walls also appear necessary to success.

—H. J. H.

Heat-insulating value of roofing materials. W. M. Thornton. Engineering, 1917, 104, 405—406.

EXPERIMENTS at the National Physical Laboratory have shown that the loss of heat by a room is more influenced by the rate of emission of the surface than by the rate of conduction of heat through the material of the walls. This is confirmed by the author's measurements of the heat-insulating properties of roofing materials. The rate of rise of temperature inside a box-shaped chamber with walls of efficient heat-insulating

ciently quickly to be employed for ordinary building purposes and is not too sticky to be worked with a trowel, is made by adding 0.5—5% of plaster of Paris or calcium sulphate to a silicious acid-resisting cement of the customary type. Suggested proportions are: Ground stoneware passing through a No. 30 sieve 8 parts, fine Leighton sand 7 parts, ground blue brick passing through a No. 60 sieve 2 parts, sodium silicate solution at 55°—65° F. (sp. gr. 1.275—1.325) 3 parts, and plaster of Paris 0.12 part, all by weight. The solids are first mixed intimately together and the silicate solution is then incorporated, preferably by treating the material for 5—10 mins. in an edge runner mill. The cement should be used within an hour of its production and the finished work should be heated to 100° C. for several days, or to a higher temperature for a shorter time. These cements are stated not to be affected by mineral acids over a wide range of temperature nor by sulphur dioxide or trioxide, nitrous gases, chlorine, or hydrogen sulphide.

—A. B. S.

Material.	Rise of temperature in testing chamber. °C. per minute.	British thermal units per 100 sq. ft. per hour.	Thickness in inches.	Weight in pounds per square foot.
Bright galvanised iron sheet	0.268	111	0.01	1.6
Galvanised iron, blackened below	0.40	168	0.01	1.6
Galvanised iron, blackened above	0.93	385	0.01	1.6
Galvanised iron, blackened above and below	1.40	581	0.01	1.6
Galvanised corrugated iron after one month's exposure to the weather	0.75	310	0.033	1.28
Do. one year	1.02	422	0.033	1.28
Do. painted black above	1.13	472	0.033	1.28
Roofing glass, serrated	1.10	453	0.22	2.25
Welsh slate	0.81	337	0.17	2.9
Westmoreland slate	0.60	248	0.25	4.8
2-in. T.G. deal covered with asphalted felt	0.30	124	1.0	2.6
Corrugated Fibrocement after one month in use	0.78	325	0.2	1.8
Do. after one year in use	0.80	334	0.2	1.8
Do. painted dead black	0.82	341	0.2	1.8
Do. "aluminium-finished" outside	0.50	207	0.2	1.8
Do. laid on top of thin asphalted felt	0.51	211	0.25	2.0

material was measured, when the top—which could be of any desired material—was exposed to the radiation from an electrically heated surface, of intensity equal to that of bright direct sunlight. The results given in the table show that the emissivity of the surface is the dominant factor and not the conductivity of the material.—H. J. H.

PATENTS.

Sound absorbing material for walls and ceilings. W. C. Sabine, Boston, Mass., and R. Guastavino, Long Island, N.Y., U.S.A. Eng. Pat. 110,194, Oct. 12, 1916. (Appl. No. 14,534 of 1916.)

A POROUS sound-absorbing material is made of particles of sand or like material graded to an approximately uniform size, which will pass through a No. 12 sieve, so that when bonded the interstices between the particles will absorb in excess of 15% of sounds lying between middle C and the third octave above middle C, i.e., the characteristic sounds of articulate speech. The bond suggested is Portland cement. A composite material composed of layers in which the particles are of different sizes may be used to absorb sounds of both low and high pitch; coarse particles are preferable for the former and fine ones for the latter.—A. B. S.

Acid-resisting cement. Chance and Hunt, Ltd., A. E. Holley, and H. W. Webb, Oldbury, Eng. Pat. 110,258, Jan. 20, 1917. (Appl. No. 1024 of 1917.)

A CEMENT which, while resisting acid, sets suffi-

Cement. L. McCulloch, Wilkinsburg, Pa., Assignor to Westinghouse Electric and Manufacturing Co. U.S. Pat. 1,241,531, Oct. 2, 1917. Date of appl., Jan. 7, 1914.

A CEMENT which contracts on setting, is made by mixing magnesium oxychloride with the product of the reaction of sugar and an alkaline substance, e.g., lime.—H. J. H.

Plastic article: Composite—, and process of producing the same. H. W. Charlton, Jones Point, N.Y. U.S. Pats. (A) 1,242,421 and (B) 1,242,422, Oct. 9, 1917. Date of appl., May 22, 1917.

(A) A PLASTIC composition or cement is formed by mixing an insoluble residue obtained from greensand calcined to give it an ochre colour, and an insoluble residue obtained from feldspar. Both residues are obtained as a result of digestion processes. The composition is moulded and treated with steam under pressure. (B) Material containing silicon and aluminium is digested with lime at a temperature and pressure and for a time sufficient to form a compound containing calcium, silicon, and aluminium. Bricks are made by mixing sand with the above as a binding material.

—W. F. F.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Ferro-silicon: Method for the commercial analysis of —. R. E. Lowe, Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 6 pages.

DECOMPOSITION and solution of the finely divided

(100-mesh) sample is effected by heating 1 gm. on a water-bath with 25 c.c. of concentrated nitric acid, in a platinum dish, and adding hydrofluoric acid, a few drops at a time, until no further violent reaction occurs and only a slight insoluble residue remains. Another 5 c.c. of hydrofluoric acid is then added and the solution evaporated to dryness. For the determination of sulphur and phosphorus, the residue is dissolved in 10 c.c. of nitric acid, again evaporated to dryness, and finally dissolved in 50 c.c. of 5% nitric acid. After neutralisation with sodium carbonate, the mixture is diluted, heated, allowed to settle, and filtered. The filtrate now contains the sulphur, with a small amount of sodium fluoride, and the precipitate the phosphorus as iron phosphate. The solution is treated with a slight excess of calcium chloride, the precipitated calcium carbonate and fluoride filtered off, and the filtrate acidified and treated with barium chloride as usual. The sodium carbonate precipitate is dissolved on the filter with nitric acid (1:3) and the solution boiled for 5 mins. with a few drops of strong potassium permanganate solution, after which any manganese dioxide present is dissolved by the addition of a solution of ferrous sulphate in dilute sulphuric acid; the clear liquid is then treated with ammonium molybdate as usual. Manganese, iron, and aluminium are determined in a fresh portion of the sample by the usual methods: solution is effected as above, except that the residue from the first evaporation is dissolved in sulphuric acid (1:5), the solution evaporated nearly to dryness (to expel all hydrofluoric acid), and then boiled with water containing a little hydrochloric acid. Silicon is determined by difference. The method gives results in close agreement with those obtained by fusion with alkali carbonate and nitrate, but is much more rapid and convenient than the latter and less destructive of platinum.—W. E. F. P.

[Steel] fence wire: *Corrosion of* —. O. W. Storey. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 28 pages.

FROM the examination of numerous samples before and after service, it is concluded that the life of fence wire depends both on the quality of the iron or steel base and on the galvanising. Zinc corrodes more slowly under conditions favouring the rapid corrosion of iron, and *vice versa*; and as the galvanising is usually thin, the iron or steel base should be highly resistant. As shown by the greater durability of the older steel fence wire, copper is a strong protective against corrosion, steel fence wire containing copper being as durable as wrought iron; modern wire usually contains no copper and corrodes rapidly. Manganese has no influence on the durability under the conditions of service.—W. E. F. P.

"Stellite" as a substitute for platinum. E. Haynes. J. Ind. Eng. Chem., 1917, 9, 974—975.

"STELLITE" alloys consist, in the main, of cobalt and chromium, the proportion of the latter in the malleable alloys ranging from about 10 to 50%. They are all hard and cannot be worked by machine, although the softer ones can be drilled. They resist nitric acid, even when boiling, but are slowly attacked by hydrochloric, sulphuric, and hydrofluoric acids. They are not attacked by fruit acids, and evaporating dishes made from them are particularly suitable for evaporating solutions of salts or boiling caustic alkali solutions. They are forged with difficulty at temperatures from 750° to 1200° C., and vessels composed of them can be heated to 1200° C., and still retain considerable strength. They are unaffected by hydrogen sulphide or ammonium chloride vapours. When heated to redness they

become coated with a blue-black film, which does not change in weight or appearance after repeated heating. These alloys are also suitable substitutes for platinum in jewellery.—C. A. M.

Lead in copper: *Spectroscopic determination of small amounts of* —. C. W. Hill and G. P. Luckey. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 6 pages.

THE authors describe a method for the determination of small quantities of lead in copper, which is sufficiently reliable for use in the copper refinery. A known weight of the sample is placed in a slight cavity in a positive, graphite electrode, above which a fixed or rotating negative electrode of carbon is used; the spectrum is observed through a grating spectroscope, and the time required for the disappearance (or definite enfeeblement) of the bright lead line in the spectrum is measured with a stop-watch. With a carefully regulated arc, the times vary regularly with the weight of copper used and the lead content of the sample, e.g., from 14 secs. with 0.2 gm. of copper containing 0.001% Pb to 277 secs. with 1 gm. of copper containing 0.038% Pb.—W. E. F. P.

Metals: *Corrosion of* — by acids. O. P. Watts and N. D. Whipple. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 24 pages.

FROM a study of the electrochemical principles involved in the corrosion of representative metals by acid and other solutions, it is concluded that all metals may be classified according as their potentials are greater or less than the discharge potentials of hydrogen on them. Metals of the first class dissolve readily in acids, but those of the second only dissolve readily when oxidising agents are also present; the superiority of nitric acid over other acids as a general solvent for metals is due to its oxidising power. The protective effect of arsenic in the corrosion of iron by sulphuric acid is due to polarisation by hydrogen; amalgamation protects zinc from corrosion by acids because the discharge potential of hydrogen on mercury exceeds the potential of zinc. The corrosion of metals of which solution is hindered by a polarising film of hydrogen is not accelerated by a vacuum, as is frequently stated, but retarded by the removal of atmospheric oxygen, which has a depolarising effect. The above classification is also applicable to the dissolving of any metal in any electrolyte from which hydrogen is displaced during solution, and to the electrodeposition of metals generally.—W. E. F. P.

Determination of sulphur dioxide [in smelter gases, etc.] Sweeney and others. See VII.

Determination of available oxygen in pyrolusite. Barnebey. See VII.

Refractory magnesias [for furnace linings]. Gosrow. See IX.

Calorised iron as an element for thermo-couples. Kowalke. See XXIII.

PATENTS.

Pig-iron: *Making* —. E. Humbert, Welland. Ont., Canada. U.S. Pat. 1,212,142, Oct. 9, 1917. Date of appl. May 17, 1917.

AN electric furnace is fed with a charge containing ferrous scrap which contains less carbon and little more phosphorus than are required in the pig iron, and a carbonaceous material. The charge is heated and air is simultaneously injected into the solid portion of the charge to combine

with the carbon. When the charge is melted the air supply is stopped, and manganese, silicon, or like material is added as desired.—W. F. F.

Furnaces; Electric heating and [steel] melting——
V. Stobie, Dunston-on-Tyne, Durham, Eng. Pat. 110,409, Oct. 26, 1916. (Appl. No. 15,242 of 1916.)

To reduce the consumption of carbon electrodes in steel melting furnaces, a portion of the electrode, outside the furnace chamber, is surrounded by a chamber, which is practically continuous from the electrode hole in the roof to a point along the electrode where the temperature is below the combustion temperature of carbon. The chamber may be of brick or cast iron, and of a definite or variable length, and is closed above by a sealing gland.—B. N.

Castings ingots of metals and alloys; Apparatus for——
P. H. G. Durville, Paris, Eng. Pat. 105,075, Mar. 21, 1917. (Appl. No. 4125 of 1917.) Under Int. Conv., Mar. 21, 1917. Addition to Eng. Pat. 23,719 of 1913 (this J., 1914, 699).

AN ingot mould with a separate upper part lined with refractory material, has also a layer of refractory material on its bottom to retard cooling and solidification. By means of a core secured in the centre of the mould, hollow ingots may be cast, also reinforced ingots by using an internal metallic core. On top of the upper part of the mould is a pocket in which the crucible to contain the molten metal is fixed by wedges; trunnions on each side of the mould support it on a rigid stand, and enable the whole to be inverted.—T. H. B.

Alloy castings; Process of making——
W. McA. Johnson, Assignor to The Continuous Zinc Furnace Co., Hartford, Conn. U.S. Pat. 1,243,416, Oct. 16, 1916. Date of appl., Mar. 3, 1914.

THE constituent metals of the alloy, one of which is a volatile metal, are melted and refined separately and transferred in a molten state, in suitable proportions, into a closed electric furnace, where the mixture is stirred mechanically and further heated to obtain a homogeneous alloy.—T. H. B.

Electric welding; Process of uniting similar or dissimilar metals or alloys by——
H. L. T. Wolfe, Jamalpur, India. Eng. Pat. 110,214, Oct. 26, 1916. (Appl. No. 15,252 of 1916.)

THE piece to be welded is inserted in a slot or recess in the body of metal, and air is excluded from the surfaces by caulking the edges of the slot. The whole is then subjected to a gradually increasing pressure and an electric heating current, the latter being passed through the body of metal. The protruding edges of the inserted piece are thus spread over beyond the caulked edges, and the exclusion of air is further ensured, the current being then increased to bring the surfaces to a welding temperature. The inserted piece may, if necessary, be completely enveloped in a thin sheet of copper or other suitable metallic substance to facilitate the welding.—B. N.

Metals; Apparatus for the electro-deposition of——
F. R. Tubbs, Birmingham. Eng. Pat. 110,248, Dec. 21, 1916. (Appl. No. 18,287 of 1916.)

THE articles to be plated are contained in a perforated barrel having its ends and cylindrical part made of celluloid, or having wood ends covered on the inner, or both inner and outer, sides as well as on the edges, with celluloid. The cylindrical portion of the barrel is cemented to the celluloid, or celluloid-covered ends, so as to obviate crevices in the interior of the barrel, and dispense with the use of metallic screws or the like. The barrel

may be provided with internal ribs of celluloid which may be cemented to the interior or moulded in one piece with the cylindrical portion. The metallic contacts on the inner sides of the ends are accommodated in recesses, and secured in place by non-metallic fastenings. Tubular pivots, to receive the ends of the rotating shafts, are attached to the metallic contacts, and arranged so that their common axis is inclined to that of the barrel. The shafts are made hollow and are provided with copper or other like electrical conducting cores connected to the metallic contacts. Electrical connection is made with brasses, or bushes, in which the shafts rotate, through radial pins in the shafts, and the bushes are connected to suitable leads. The mouth of the barrel is provided with a sliding lid or cover, and with non-metallic fastenings for securing the lid in a closed position.—B. N.

Electroplating apparatus. L. Potthoff, Flushing, N.Y. U.S. Pat. 1,243,098, Oct. 16, 1917. Date of appl., Feb. 11, 1916.

IN an apparatus for electroplating tubular articles, non-conducting plugs are inserted at the ends of the articles and a conductor attached to the article passes through the plug. These conductors support the articles on rails in the plating bath, and an endless conveyor with projecting teeth moves them in succession along the rails.—W. F. F.

Copper tubes; Method and apparatus for electrically making——
E. Emerson, Auburn, R.I. U.S. Pat. 1,243,274, Oct. 16, 1917. Date of appl., Jan. 26, 1917.

COPPER tubes are made by depositing copper electrolytically on a core of lead which has been bent into the form of a circle and its ends secured. The core is subsequently cut and removed by melting. The vat carries a pair of parallel longitudinal conducting bars at the top on each side, the two outer bars being connected by semi-circular strips depending into the vat and the two inner bars by similar concentric strips. The strips support longitudinal bars which act as anodes, and the circular lead core is rotated between and concentrically with the semi-circular strips. The core is supported by three parallel grooved rotating rollers above the vat, and is guided by two guide bars within the vat between the anodes. The electric circuit is completed through the core and one of the supporting rollers.—W. F. F.

Smelting furnaces or cupolas. A. Poulson, Hough Green, and W. C. A. Mate, Garstang. Eng. Pat. 110,283, Mar. 6, 1917. (Appl. No. 3275 of 1917.)

THE blast is led tangentially to an annular chamber surrounding the cupola and from this chamber tangential tuyère holes communicate with the furnace. The blast inlet is surrounded by a heating jacket into which a portion of the hot gases from the cupola is led.—T. H. B.

Metallurgical furnace; Electric——and method of operating the same. W. E. Moore, Pittsburgh, Pa. U.S. Pat. 1,242,464, Oct. 9, 1917. Date of appl., Nov. 27, 1916.

IN the manufacture of steel or other metal in an electric furnace of the arc type, the current is passed through a number of electrodes in series with the metal to melt it, and then through the electrodes in parallel and through a slag and the metal for refining. The current through the metal may be varied by varying the lengths of one or more of the arcs. The current may be supplied by a transformer in which the primaries are connected delta and the secondaries in star for melting the metal, and the primaries connected

in star and the secondaries in delta for refining the metal. Subsections of the primary or secondary or both may be connected in series or multiple to vary the voltage between the melting and refining operations. The melting pot may have a conducting bottom, and three arcing electrodes supplied from a three-phase transformer may be used, means being provided to change the transformer windings from delta to star or *vice versa*.—W. P. F.

Roasting-furnace. A. W. Livingston, Oakland, Cal. U.S. Pat. 1,242,455, Oct. 9, 1917. Date of appl., May 22, 1915.

A FURNACE for continuously roasting ores containing vaporisable constituents has one or more vertical roasting chambers of relatively small diameter and narrower at the top than at the bottom to contain a thin layer of ore, a source of heat on one side and a suction chamber on the other side of each roasting chamber, and connected with them by flues in the walls. Means are provided whereby the ore can be continuously introduced and withdrawn.—T. H. B.

Annealing, case-hardening, fusing and similar processes; Furnace for—. F. J. Grocott, Edgbaston, Eng. Pat. 110,443, Dec. 7, 1916. (Appl. No. 17,551 of 1916.)

A FURNACE of horizontal type is heated by gaseous fuel from a producer which is built as part of the furnace. By the opening or closing of certain passages by dampers the furnace may be used with an oxidising or non-oxidising flame or as a box muffle. The horizontal oven of the furnace is built immediately above a combustion chamber running the full length and breadth of the oven, the chamber being placed immediately over a gas arch, having gas openings in the crown and surrounded by curved air flues. The combustion chamber communicates with the oven by passages extending at the back and both sides of it, and with the top flue to the chimney by passages, some of which extend directly to the top flue over the oven arch; there are also passages leading from the oven into the top flue.

—T. H. B.

Cementing and hardening metal objects; Process for— and oven for carrying out this process. E. Schraner, Zürich, Switzerland. Eng. Pat. 110,465, Feb. 10, 1917. (Appl. No. 2057 of 1917.)

A LAYER of substances such as common salt, potassium nitrate, barium carbonate, compounds of ammonia, lead, etc. which fuse and evolve reducing fumes at the temperature employed, is passed in the hardening chamber on a tray supported above the bottom and formed of adjacent parallel bars. The substance melts and falls into the bottom of the chamber. A layer of the cement material (bones, leather, etc.) is now placed on the tray, the articles to be hardened are embedded in this, and the whole is covered by a top layer containing iron and silicates (e.g., a mixture of iron filings, powdered glass, and sand).

—T. H. B.

Copper and other metals; Apparatus for electrolytic production of—. M. V. Garin, Paris. Eng. Pat. 110,474, Mar. 2, 1917. (Appl. No. 3125 of 1917.)

ELECTROLYTIC apparatus, for the production of copper, nickel, gold, silver, or other metals, is provided with one or more cathode discs mounted on a horizontal shaft, and arranged to rotate opposite one or more circular, semi- or part-circular, insoluble anodes. A sloping or truncated conical surface is presented by each anode to the corresponding cathode, so that the strength

of the current at each point of the cathode or cathodes is proportional to the speed of movement of the cathode surface. A vertical gap is provided in the anode to enable the cathodes and the shaft or shafts to be removed without interfering with the fixed anodes. The cathodes may be of sloping or truncated conical form, in which case the anodes have a plane surface, and diaphragms are placed between the anodes and cathodes. Brushes, rubbers, or wipers of any kind, may be either fixed or receive a special movement for smoothing the surface of the deposit on the rotating cathode discs, thus removing bubbles of hydrogen and producing compact deposits.—B. N.

Distilling apparatus; Electrical—. *Process and apparatus for distilling metallic ores and metal-bearing materials. Electric furnace.* (A) and (D), C. H. Fulton, St. Louis, Mo., Assignor to Metallurgical Laboratories Incorp., Chicago, Ill. (B) and (C), C. H. Fulton and T. M. Bains, jun., St. Louis, Mo., Assignors to Metallurgical Laboratories, Incorp., Chicago, Ill. U.S. Pats. (A) 1,242,337, (B) 1,242,339, (C) 1,242,340, and (D) 1,242,341, Oct. 9, 1917. Dates of appl., Dec. 7, 1916, Jan. 24, Mar. 16, and Feb. 23, 1917.

(A) FINELY divided ore or metal-bearing material is mixed with a suitable reducing agent and moulded into cellular form. The moulded structure is placed between electric conductors in a furnace and forms a continuous resistance without change of form or volume. The distillate passes to a condenser which may be heated to any desired temperature by a heating medium, which may also heat the furnace before distillation commences to reduce the consumption of electrical energy. (B) Metallic ore or metal-bearing material is formed into briquettes which retain their original form and volume when distilled, and the briquettes are fed continuously into the distillation chamber of an electric furnace so that they form a resistance between the electrodes while passing through. (C) The furnace comprises a vertical annular chamber divided into a number of vertical distilling chambers through each of which a column of briquettes containing the metal is fed by feeding devices controlled independently. The briquettes pass through an opening in an electrode, and separate means are provided for making electrical contact between the column and the electrode. (D) In an electric furnace for use as in (A), (B), and (C), the two conducting elements are arranged substantially at right angles. An extension on one element projects into an opening in the other of such size that angular movement may take place without binding. The two elements are connected by a granular conducting material composed of finely divided graphite, 60%, and pitch, 40%.—W. F. F.

Tinning metal plates and other articles; Process of—. C. Dreymann, Baltimore, Md. U.S. Pat. 1,242,532, Oct. 9, 1917. Date of appl., May 15, 1916.

THE plate is passed through a bath of molten tin, and out through a layer consisting essentially of an ester of a saturated fatty acid, e.g., hydrogenated oil.—T. H. B.

Smelting process and apparatus. E. A. Mathers, New York. U.S. Pat. 1,242,833, Oct. 9, 1917. Date of appl., Dec. 20, 1911.

A CONTINUOUS stream of pulverised ore is fed into a closed electric furnace, where it falls successively on a series of heating bodies placed stepwise. Air under pressure is forced into the furnace between the heating bodies in a direction approximately parallel with the stream of ore. The air

and gaseous products of combustion are kept in constant circulation through the furnace and parts communicating with it.—T. H. B.

Amalgams; Process for making—A. I. Halvorsen, Perth Amboy, N.J., Assignor to The Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,243,062, Oct. 16, 1917. Date of appl., Dec. 30, 1915.

A THIN film of mercury, continuously rotating horizontally, is brought into contact with a body of metal which is continuously rotating vertically. A continuous cycle is maintained by removing the amalgam, freeing it from the metal, and returning the mercury to take up more metal.—T. H. B.

Ores; Apparatus for treating—A. J. Garver, Clarkston, Wash. U.S. Pat. 1,243,505, Oct. 16, 1917. Date of appl., Dec. 8, 1914. Renewed Mar. 13, 1917.

THE ore is passed down a shoot in which it is mixed with a suitable chemical and heated by the products of combustion from a furnace below the shoot. The hot mixture falls into a horizontal cylindrical rotary roaster, the wall of which is provided with longitudinal scooping members having triangular recesses which cause the mixture to move towards the outlet, whence it is removed by an ejector to a rotary horizontal cylindrical ore tank connected with a condenser.—T. H. B.

XI.—ELECTRO-CHEMISTRY.

Refractory magnesia [for furnace linings]. Gosrow. See IX.

PATENTS.

Electrodes for use in electrolytic gas generators. I. H. Levin, New York. Eng. Pat. 108,477, Oct. 27, 1916. (Appl. No. 10,113 of 1917.) Under Int. Conv., Dec. 20, 1915.

THE anode and cathode in a gas generator are formed from, or have their active surfaces composed of, cobalt and iron respectively, and the surfaces are first prepared by dissolving away a small quantity of each metal by using each electrode as anode in a solution of a suitable salt of the metal of which the electrode is formed, and passing an electric current through the liquid.—B. N.

Electric batteries. J. M. Flannery, Pittsburgh, Pa., U.S.A. Eng. Pats. 110,652 and 110,653, Dec. 14, 1916. (Appl. Nos. 17,998 and 17,999 of 1916.)

SEE U.S. Pats. 1,217,738 and 1,217,739 of 1917; this J., 1917, 510.

Apparatus for oxidising gases. U.S. Pat. 1,242,988. See VII.

XII.—FATS; OILS; WAXES.

Emulsification; Theory of—based on pharmaceutical practice. H. W. G. Crockett and R. E. Oesper. J. Ind. Eng. Chem., 1917, 9, 967–969.

THE conclusions drawn in a previous communication (this J., 1917, 394) have been confirmed by the determination of the critical proportions required to form emulsions with other systems. The materials used as internal phases were carbon tetrachloride, chloroform, benzene, oil of turpentine, almond oil, and mineral oil of sp.gr. 0.853; whilst the emulsifying agents were powdered gum

arabic, tragacanth, extract of Irish moss, and soft soap. It was found that the size and shape of the vessel in which the emulsion is made has a distinct influence upon the critical point. In the case of tragacanth emulsions better results are obtained by adding the right proportion of water to the previously mixed internal phase and emulsifier, than by adding the water in instalments and shaking after each addition. No emulsion is formed when the critical amount of tragacanth is mixed with water, and the mucilage then shaken with the internal phase, but the critical points are not affected by allowing the dried internal phase to stand in contact with the emulsifier before adding the water. Emulsions made with Irish moss extract are not affected by the addition of small amounts of alcohol, but are immediately broken up by the addition of a trace of soap, either before the addition of water, or after emulsification. Larger quantities of soap, however, promote emulsification by means of Irish moss. The addition of glycerin prevents this action of a trace of soap, and re-emulsifies emulsions which have thus been broken, but glycerin does not directly aid Irish moss as an emulsifier. Gum arabic emulsions are not broken up by a trace of soap; on the contrary the emulsification is promoted, but the soap cannot replace part of the critical amount of gum arabic. Viscous oils show less distinct critical points than those of less viscosity. Tragacanth is an unsuitable agent for emulsifying mixtures of fixed oils with water, since it produces a thick mass.—C. A. M.

PATENTS.

Hydrogenised fat or oil; Removing nickel from—M. C. Whitaker, Assignor to The Southern Cotton Oil Co., New York. U.S. Pat. 1,242,624. Oct. 9, 1917. Date of appl., June 12, 1913.

NICKEL in suspension or solution in hydrogenised oil or fat is removed by treating the oil or fat in a liquid form with fullers' earth below its temperature of dehydration.—A. DE W.

Recovering soap; Process for—H. M. Gray, Los Angeles, Assignor to M. A. Neal and E. W. Jones, San Francisco, Cal. U.S. Pat. 1,242,435. Oct. 9, 1917. Date of appl., June 1, 1915.

DIRTY soap-suds are treated with kerosene and alkali, and the lower layer of purified soap solution is separated for further use.—A. DE W.

Processes for expressing liquid from materials containing the same. Eng. Pat. 110,379. See I.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Shellac derivatives; Imbibition exhibited by some—A. P. Laurie and C. Ranken. Roy. Soc. Proc., 1917, A, 94, 53–59.

THE solid which separates on cooling a solution of shellac in boiling sodium carbonate, when immersed in cold water, expands rapidly and ultimately disintegrates to a flocculent precipitate. If immersed in water and allowed to expand to a point short of disintegration, subsequent immersion in strong sodium carbonate solution causes contraction; on being replaced in water expansion again occurs, and so alternate expansion and contraction can be obtained. Measurements were made of the expansion in water and in solutions of salts (sodium chloride and sulphate, ammonium acetate, and potassium chloride) of different concentrations, of this compound and of that obtained by dissolving shellac in borax solution and solidifying

by cooling, and it was found that expansion is inversely proportional to the concentration of the solution. The soluble portion of the compound fully expanded in water is precipitated by strong but not by dilute salt solutions, thus differing from colloids. The differences between the behaviour of the compound and that of substances such as gelatin and gum tragacanth are largely explained by this insolubility of the soluble portion in strong salt solutions. On allowing gum tragacanth to expand in a medium containing a constituent in which it is insoluble, *e.g.*, the alcohol in a medium of alcohol and water, similar behaviour was observed, the expansion being inversely proportional to the concentration of the alcohol. Since the shellac compound is permeable to salt molecules, the mechanism of the expansion seems to be accounted for by the passage of the salt molecule through the diaphragm, the soluble nucleus dissolving in the presence of the salt solution, and the amount that can dissolve controlling the consequent osmotic pressure.—A. DE W.

PATENTS.

Varnish material: Process of making—C. Ellis, Montclair, N.J., Assignor to Ellis-Foster Co., and Indestructible Paint Co., Ltd., London. U.S. Pat. 1,242,161, Oct. 9, 1917. Date of appl., Mar. 29, 1915.

RESIN esters are produced by agitating a mixture of resin or its anhydride and unchanged or cracked Congo copal gum with glycerin in the presence of aluminium at a temperature above 300° C. at ordinary pressures. The esterified product may then be re-cracked.—A. DE W.

Hardening resins and products thereof: Process for—F. S. Low, Buffalo, N.Y. U.S. Pat. 1,243,312, Oct. 16, 1917. Date of appl., Jan. 31, 1916.

SOFT natural resins (*e.g.*, rosin) are hardened and rendered more resistant to air and light and less fusible, whilst retaining substantially their general properties, by heating under pressure with formaldehyde in the presence of water vapour.—A. DE W.

Phenolic condensation compounds: Process of producing—[Phenolic] condensation product and method of preparing same. L. V. Redman, Evanston, and A. J. Weith and F. P. Brock, Assignors to Redmanol Chemical Products Co., Chicago, Ill. U.S. Pat. (A) 1,242,592 and (B) 1,242,593, Oct. 9, 1917. Date of appl., June 19, 1916.

(A) A FUSIBLE "potentially reactive moulding product" is obtained by mixing a phenolic compound with an active methylene-amine compound in such proportion that the phenolic compound is in considerable excess of one phenolic group to each methylene group, eliminating ammonia by heating, blowing out of the mass a considerable percentage of the free phenolic compound, and incorporating a small proportion of creosote oil and sufficient methylene-amine compound to be capable of converting the product to the infusible state. The product is then blended and fused without effecting conversion to the final infusible state. (B) A phenolic condensation product is produced by heating a phenolic compound with an active methylene compound in the proportions of an excess of considerably more than one phenolic group to each active methylene group, and then incorporating into the fusible mass a filler and a cyclic compound having no readily reactive group, *e.g.*, creosote oil.—A. DE W.

Linoleum: Manufacture of—H. Wade, London. From Titanium Alloy Manufacturing Co., New York. Eng. Pat. 110,324, June 14, 1917. (Appl. No. 8564 of 1917.)

SEE U.S. Pat. 1,236,367 of 1917; this J., 1917, 1019.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Rubber: Depolymerisation and oxidation of raw—A. van Rossem, Communications of the Netherlands Govt. Inst. for Advising the Rubber Trade and Rubber Industry. Int. Assoc. for Rubber Cultivation in the Netherland Indies. 1917, Part IV., 111—121.

WHEN rubber is worked on normally heated rolls the most marked decrease in viscosity occurs in the first ten minutes, but on prolonged treatment, *e.g.*, for 89 minutes, it is found that first latex crepe rubbers of different initial viscosity appear to tend towards identical final viscosity, which on account of its diminution is best estimated in 10% solution. Experiments with raw Congo rubber indicate that washing with cold water and subsequent drying effect a considerable decrease in the viscosity; the method of drying is of influence, the use of a vacuum desiccator yielding the most trustworthy results. Experiments with hard fine Para rubber showed that although working on the rolls beyond the normal period of ten minutes causes a decided further decrease in viscosity, the proportion of constituents soluble in acetone remains unaltered throughout, the only marked change in composition being a reduction in the proportion of moisture present. Rubber undergoes "depolymerisation" also when heated in solution (see Van Rossem, this J., 1917, 1104) or in the solid state, and this probably accounts for the fact that on drying rubber *in vacuo* at 50° C., a greater reduction in viscosity is observed than when the drying is effected at the ordinary temperature. It was also found that subsequent storage for 13 days did not restore the original viscosity but actually caused a slight further decrease. These tests were made with Congo rubber. If rubber (Hevea crepe in the experiments cited) is heated at 130° or 140° C. in an atmosphere of carbon dioxide for several hours, the viscosity undergoes very marked reduction, but unlike the original rubber, the heated rubber is not completely soluble in benzene and the insoluble fraction probably contains some of the more viscous constituents; heating in air at 80° C. also causes a diminution in viscosity but the decrease is less marked, probably because the treated rubber obtained under these conditions is entirely soluble in benzene. In any case this effect of heat on the mechanical properties of rubber deserves serious consideration in connection with the ordinary process of smoking freshly coagulated rubber. The depolymerisation of rubber can also be accelerated by exposing solutions to ordinary or ultraviolet light, whether in the presence of air or of an inert gas; chemical influences also can be active in this direction, the viscosity of rubber solutions being notably reduced on treatment with potassium permanganate (Harries, this J., 1901, 830), with small quantities of an acid, with bromine, or, at higher temperatures, with oxygen, the effect apparently being catalytic. When a Hevea rubber which has been worked on the rolls is kept for 20 days there is a slight increase in the viscosity, but after such storage further treatment on the rolls has a very unfavourable influence on the viscosity; much higher viscosity values were obtained with a rubber-sulphur mixing which immediately after the first treatment on the rolls was passed a further ten times between the rolls, than with a part of the same mixing which was given a similar additional treatment but on the following day: the frequent practice of storing masticated rubber for a period and then re-masticating therefore appears to be detrimental. With respect to the oxidation of rubber, the view is held that this is a secondary process which can only occur

after previous depolymerisation to a definite critical viscosity, and the oxidation process is believed to involve the intermediate formation of peroxide compounds. The injurious action of copper compounds on rubber is confirmed and is regarded as due to a depolymerising effect rather than to a process of oxidation.—D. F. T.

PATENTS.

Rubber or rubber compounds; Treatment [vulcanisation] of—C. Hofer, Trenton, N.J. U.S. Pat. 1,242,189, Oct. 9, 1917. Date of appl., May 2, 1917.

A FORM is dipped in rubber solution, the surface of the rubber cured by means of sulphur chloride fumes, and the article then vulcanised in steam on the form.—E. W. L.

Rubber; Process for vulcanising—, and product obtained thereby. I. Ostromislensky, Petrograd, Russia, Assignor to New York Belting and Packing Co. U.S. Pat. 1,242,586, Oct. 9, 1917. Date of appl., Nov. 24, 1916.

UNVULCANISED rubber, or similar material, is mixed with a halogen (chlorine) derivative of rubber adapted to produce vulcanisation, and vulcanisation is induced to take place under the action thereof.—E. W. L.

Rubber compound and method of making same. E. E. A. G. Meyer, Detroit, Mich., Assignor to Morgan and Wright. U.S. Pat. 1,242,886, Oct. 9, 1917. Date of appl., Mar. 7, 1914.

CEYLON rubber is mixed, in the presence of open steam, with a relatively small amount of aniline oil, and an unctuous softening agent, such as "petrolatum," in such proportions as to impart to the compound, after vulcanisation, softness, a high degree of elasticity, and smoothness of texture. The mixture is afterwards subjected to the action of steam at a temperature which will ensure thorough penetration of the "petrolatum" to produce a homogeneous material.—E. W. L.

India-rubber and the like; Manufacture of articles from—combined with fibrous material. A. E. Alexander, London. From Rubber Regenerating Co., New York. Eng. Pat. 110,178, Sept. 12, 1916. (Appl. No. 12,897 of 1916.)

SEE U.S. Pat. 1,211,351 of 1917; this J., 1917, 297.

Rubber waste; Process of recovering—W. J. Meilersh-Jackson, London. From The Mechanical Rubber Co., New York. Eng. Pat. 110,661, Jan. 4, 1917. (Appl. No. 176 of 1917.)

SEE U.S. Pat. 1,215,941 of 1917; this J., 1917, 396.

Vulcanised rubber; Process of treating—F. V. O'Neill, Boston, Mass., Assignor to H. Carmichael, Malden, and W. W. MacKusick, Boston, Mass. U.S. Pat. 1,243,623, Oct. 16, 1917. Date of appl., Oct. 28, 1913.

SEE Eng. Pat. 12,271 of 1914; this J., 1915, 970.

XV.—LEATHER; BONE; HORN; GLUE.

Tannin; Effect of hard water on—E. Schell, La Halle aux Cuirs, Aug. 12, 1917. J. Amer. Leather Chem. Assoc., 1917, 12, 569—570.

ANALYSES of chestnut extract made with boiled and filtered Paris water containing 0.004 grm. of calcium carbonate per 100 c.c., showed 2—2½% less tannin than analyses made with distilled water. The discrepancy was removed if the water was first boiled, filtered, and acidified. A factory using 500 tons of extract a month would lose

20,000—25,000 lb. of tannin per month if using water similar to the above. The loss of tannin was proved by direct experiment to be caused by calcium and magnesium carbonates.—F. C. T.

Tannins; Notes on the analysis of—L. E. Levi and A. C. Orthmann. J. Amer. Leather Chem. Assoc., 1917, 12, 515—518.

THE authors define tannin as "tannic acid and its homologues, either separate or in combination, that will combine with hide fibre, either physically or chemically, to render the same imputrescible." The hide powder method of analysis does not determine this factor, but each and every substance, including much colouring matter, that combines with, or is mechanically absorbed by, hide. This difficulty the authors claim to overcome in a measure by analysis with their "reagent No. 33," which leaves colouring matters in the non-tannin solution. A factor is necessary, however, for the various materials when analysed by the special reagent. The reagent contains the compound $\text{Cr}_2\text{SO}_4(\text{C}_2\text{H}_3\text{O}_2)_2\text{CrO}_4$; its preparation is described in this J., 1911, 1269.—F. C. T.

Sole leathers; Wear resistance of—III. L. Balderston. J. Amer. Leather Chem. Assoc., 1917, 12, 523—529. (See also this J., 1916, 935, 1072.)

A MACHINE is described and illustrated, which is designed to imitate the action of the foot in walking. No standard method of testing has yet been arrived at, as difficulties have arisen in preparing a suitable wearing surface corresponding to pavements. One series of tests with a concrete slab showed that betting leather will outwear some sole leathers.—F. C. T.

Gelatin solutions; Sol and gel condition of—L. Arisz. Kolloidchem. Beilhefte, 1915, 7, 1—90. J. Soc. Leather Trades' Chem., 1917, 45—51.

EXPERIMENTS were carried out with solutions of purified gelatin in glycerin containing 32% of water. It was found that above 65° C., solutions of gelatin show permanent loss of viscosity due to partial hydrolysis, and this effect becomes more marked with increasing temperature. When temperature changes occur below 65° C. there are two kinds of viscosity change, both reversible, occurring simultaneously. One is the ordinary change due to temperature alone, and the other a change dependent on time, but slow, and always tending to a definite "inner" equilibrium viscosity which is fixed for any temperature with a given solution. If temperature change is infinitely slow, the "inner" equilibrium-viscosity curve is followed; if the change is rapid, viscosity varies with temperature alone, though its absolute value depends on how much slow viscosity change has taken place before the rapid temperature change commenced. The slow change is probably due to the formation or dissolution of molecular complexes. Thus a 10% jelly suddenly raised to a temperature slightly above the gelatinising point does not at once melt, and continues to lose viscosity for many hours. On the other hand, if it is rapidly cooled and gelatinised at 35° C., and at once heated to the gelatinising temperature (44° C.), it first melts, and only gradually resumes the gelatinised condition. Gelatinisation is best regarded as a point of rapid increase of viscosity, and a viscosity can be fixed which is the limit of gelatinisation for all temperatures, and below which all solutions are liquid. At lower temperatures the viscosity is diminished by mechanical agitation, which breaks up the complexes. This effect is imperceptible above 65° C. The Tyndall effect is affected by time, temperature change,

and previous history, in the same directions as viscosity. There is no kink in curves of viscosity or Tyndall effect at the gelatinisation or melting point, though as gelatinisation is gradual, a change in the curve may possibly have been overlooked. The properties of jellies seem more or less common to the liquid solutions—for instance, double refraction under stresses. Gelatin-glycerin solutions are more viscous than aqueous gelatin solutions of the same concentrations and have higher setting points, though in very dilute solutions the reverse is the case; a $\frac{1}{2}\%$ glycerin solution of gelatin will never set.—F. C. T.

PATENT.

Tanning. A. Turnbull and T. B. Carmichael. Liverpool. Eng. Pat. 110,470, Feb. 24, 1917. (Appl. No. 2717 of 1917.)

THOROUGH absorption of tanning materials by hides from relatively strong solutions of the tanning agents is attained by mixing starch with the solution of tanning material, heating the mixture until a jelly is formed, and steeping the prepared hide in the cooled jelly. For instance, 500 lb. of chrome alum is dissolved in 125 galls. of hot water, 64 lb. of soda ash previously dissolved in 250 galls. of hot water is added slowly, the liquid is heated above 180°F. (82.5°C.) and about 250 lb. of powdered starch stirred in. Basic chrome alum tannage or basic aluminium sulphate tannage may be applied alone, or in combination with vegetable tannage, by adding to the above bath 750 lb. of gambier before the starch, or a plain vegetable extract, e.g., 500 galls. of a strength of 125° barkometer, may be used for gelatinising 250 lb. of starch.—J. F. B.

XVI.—SOILS; FERTILISERS.

PATENT.

Fertilisers for seeds and plants. N. A. Barbieri. Rome. Eng. Pat. 110,338, Sep. 29, 1917. (Appl. No. 14,070 of 1917.) Under Int. Conv., Aug. 20, 1917.

THE fertiliser consists of 30–35 parts of potassium sulphate, 20–25 parts of acid potassium phosphate, 20–35 parts of calcium phosphate, 20–25 parts of magnesium phosphate, and 20–25 parts of calcium sulphate, with 5% of silica, 5% of calcium carbonate, and 0.02% of manganese sulphate. The seeds to be sown are mixed with suitable proportions of the fertiliser.—J. H. J.

XVII.—SUGARS; STARCHES; GUMS.

PATENT.

Processes for expressing liquid from materials containing the same. Eng. Pat. 110,379. See I.

XVIII.—FERMENTATION INDUSTRIES.

Vinegar; Notes on the manufacture of —. C. A. Mitchell. J. Inst. Brewing, 1917, 23, 357–372.

IN vinegar manufacture, in which the aim is to obtain as high a yield of alcohol as possible, a malt of fairly high diastatic capacity (say about 80) is used and mashing is effected at a much lower temperature than in breweries. In some vinegar works the first mash is made at about 140°F. (60°C.), and the second mash at about 140° to 150°F. (60° – 65.5°C.), and the goods are then sparged with water at 150° to 160°F. (65.5° – 71°C.) Better results may be obtained by making the

first mash at about 120°F. (49°C.) and, after starting the rakes, gradually raising the temperature to about 150°F. (65.5°C.). Naked steam may be admitted for this purpose from pipes below the false bottom of the tun without having any injurious effect upon the mash. In cooling the wort it is permissible to leave it at a much higher temperature than is possible in a brewery. In fact when using certain yeasts it is advisable to have the wort at a temperature of 72° to 74°F. (22° – 23°C.) so as to prevent too vigorous growth and to obtain a better attenuation. If these conditions are complied with there should be no difficulty in attenuating a wort of sp. gr. 1.055 to about 1.001. It is an advantage to store the gyle for several months before acetification as it gradually becomes acid and thus saves time in the acetifiers. New wash should not be used in the acetifying apparatus, since the suspended yeast cells interfere with the action of the acetic bacteria, and form a slimy deposit on the acetifying medium. Alcoholic fermentation may even start again when new wash is pumped over in an acetifier at a temperature which is too low to kill the yeast cells. Very many species of acetic bacteria have been described, but there is reason to believe that some of these are not distinct species. *Bacterium xylinum* isolated by Brown (J. Chem. Soc., 1886, 39, 432) from sour malt wort, is the species of most common occurrence in this country. The formation of its zoogloal form (the tough leathery pellicle known as "vinegar plant" or "mother-of-vinegar,") is promoted by the presence of only a limited supply of air, and its excessive formation is not an uncommon occurrence in acetifiers to which air is not being supplied in sufficient quantity. The acetifying medium then becomes rapidly choked with "mother," and the acetifier must be stopped and cleaned. Acetic bacteria are affected by sunlight, and experiments made by Giunti and by Tolomei have shown that the violet rays of light inhibit acetic fermentation. Hence there was scientific justification for the precautions taken by the old vinegar makers to exclude daylight from the acetifying rooms, although the results obtained by Tolomei in a series of acetic fermentations beneath glass of different colours show that the use of windows of red or orange glass would have been quite as effectual a safeguard as working in the dark. Now that large acetifiers have replaced small barrels it is quite unnecessary to keep the acetifying rooms, or "stoves" as they are technically termed, in darkness, for these large vats are closed, and the effect of the small amount of light which can find its way through the aeration holes is negligible. So far few attempts have been made to use pure cultures of acetic bacteria, although it has been shown by Villon that the use of specific cultures affected not only the speed of acetification, but also the flavour and aroma of the vinegar. The most important factor in acetification is to supply the correct proportion of air to the bacteria, and various porous media, such as shavings, twigs, or basket work, upon which the bacteria can develop, are used for charging the acetifiers. It is essential that the total area of the air holes below the false bottom should approximately equal the area of the regulated ventilator or of the holes through which the spent air leaves the top of the vat. To prevent the irregular aeration due to the formation of channels in beds of shavings and the like, the so-called plate acetifiers have been introduced into some vinegar works. Bersch's acetifier, for instance, is rectangular in form, and is packed above the false bottom with frames fitted with slats of wood, leaving spaces of about $\frac{1}{2}$ in. between the slats. Theoretically, this offers a very large surface for aeration, and it is claimed by the inventor that it will give a theoretical yield of

vinegar. This is not borne out by the author's experiments with this acetifier under English conditions of working. For example, the best result obtained was a yield of 0.96% of acetic acid in 24 hours at the cost of 0.97% of alcohol by weight. Moreover, this acetifier loses its efficiency in a short time owing to the frames becoming choked up with mother-of-vinegar, which is very difficult to remove when the frames are cleaned. The optimum temperature for acetification varies with the species of bacteria. On the Continent wine and spirit vinegars are acetified at about 86° to 95° F. (30°—35° C.), and above this higher limit acetification proceeds very slowly, and the bacteria are weakened or destroyed. In this country acetic bacteria produce the best results

in the milk has the same effect as the addition of water upon the constant, but since formaldehyde in sufficient quantity to preserve the milk does not affect the results, it is possible to keep samples for 12 days before examining them by this method. On the other hand, the cryoscopic method is more accurate for the detection of a small amount of added water, and is therefore preferable for the examination of fresh milk.—C. A. M.

Cacao; Fermentation of Philippine — H. C. Brill. *Philippine J. Sci.*, 1917, 12, A, 1—15.

SAMPLES of cacao produced in the Philippine Islands on analysis compared favourably with the produce of other parts of the world (see table).

	Other cacaos.*											Average composition of Philippine cacao.
	Bahia.	Surinam.	Java.	Trinidad.	Ariba.	Cauracao.	Granada.	Tabasco.	Machalic.	Maracaybo.	Criollo.	Forastero.
Fat	44.77	43.44	37.64	46.61	46.06	39.42	46.57	51.75	49.75	44.77	51.99	50.06
Theobromine	1.14	0.98	1.22	0.90	0.91	1.20	0.79	1.17	0.81	1.09	0.97	0.88
Albuminoids	7.97	10.82	9.76	12.70	10.77	11.33	10.31	7.98	13.45	12.25	12.15	13.24
Glucose	1.13	1.33	1.30	1.47	0.44	2.94	1.91	0.95	1.70	1.15	0.46	0.27
Sucrose	0.54	0.37	0.54	0.34	6.76	1.67	0.58	2.76	0.49	1.44	0.51	0.98
Starch	8.01	3.81	5.45	5.32	1.67	4.08	6.61	3.57	1.43	1.79	5.24	4.89
Ulgina	8.36	4.11	6.43	6.03	4.88	3.51	5.85	6.54	6.30	7.59	—	—
Cellobiose	14.67	17.07	14.60	13.90	14.95	17.50	14.24	12.77	12.00	18.36	14.69	14.51
Extractives	9.56	14.21	9.39	8.88	9.56	13.61	10.29	9.51	9.56	7.20	12.96†	14.41
Ash	3.83	3.21	3.49	3.84	3.06	4.66	2.86	3.11	4.40	4.38	4.99	4.73

* Ridenour, *Amer. J. Pharm.*, 1895, 67, 207.

† Extractive matter direct.

at 105° to 110° F. (40.5°—13° C.). It is possible that this may be partly due to acclimatisation, seeing that the early large acetifiers were fitted with tin steam coils for maintaining a high temperature. At the present day, only a slight initial heating of the gyle is required, and the temperature then rises spontaneously to well over 100° F. (38° C.), through the heat of oxidation. High temperatures are advantageous in preventing the development of vinegar eels within the acetifiers, but, on the other hand, increase the loss of acetic acid by volatilisation. After acetification the crude vinegar, which contains about 6% of acetic acid, is stored for a month or two to develop its aroma and to facilitate the subsequent filtration, and is then diluted to the strength required by the trade. The different "trade numbers" (Nos. 16, 18, 20, 22, and 24) used to designate the various strengths of vinegar are said to denote the number of grams of sodium carbonate neutralised by 1 oz. of the vinegar, but the evidence points rather to their indicating the price in pence at which a gallon of vinegar was sold.—C. A. M.

Fermentation of Philippine cacao. Brill. See XIXa.

Regular and irregular antiseptics. Richet and Cardot. See XIXb.

XIXa.—FOODS.

Milk; Detection of added water in — by means of a simplified molecular concentration constant. L. W. Ferris. *J. Ind. Eng. Chem.*, 1917, 9, 957—959.

EXAMINATION of 31 samples of milk showed that the molecular concentration constant of Mathien and Ferré (this J., 1914, 214) varied from 71.1 to 82.6, and that the method was capable of detecting 8% of added water. The development of acidity

A study was made of the action of enzymes and also of yeast on cacao, and fermented samples compared with those which had not undergone fermentation. Changes produced by fermentation are not easily demonstrated by chemical analysis, but have a considerable effect on the organoleptic properties of the cacao. Sack's statement (*Bull. Dept. Agric. Surinam*, 10) that during fermentation a glucoside is hydrolysed with formation of theobromine and cacao-red, could not be confirmed. The sucrose content diminishes, frequently to zero; the glucose (including maltose) first decreases, and then increases slightly as a result of diastatic hydrolysis of the starch. The starch content is not notably altered, but it is probable that the so-called "break" of fermented cacao is a change in the character of the starch. The most evident change shown by analysis is a decrease in astringent matter, and this accounts in part for the improvement in the flavour of the fermented cacao. The free acid of the cacao butter increases with the duration of fermentation, but only slowly, as Philippine cacao does not contain a lipase. The best results in fermentation are obtained by the combined action of the enzymes of cacao and of yeasts. Cacao fermented by the action of yeasts or taka-diastase on beans which had been heated in water to destroy the enzymes present, was inferior to that fermented by the agency of the cacao enzymes alone, i.e., in presence of toluene, chloroform, or alcohol. In addition to the enzymes mentioned previously (this J., 1916, 136), an emulsin-like enzyme has been detected which is somewhat more active in the unfermented seeds than in the fermented product.—L. A. C.

Coal tar colours [in foodstuffs]: Modification of the Price method of separating — to include Tartrazine. E. H. Ingersoll. *J. Ind. Eng. Chem.*, 1917, 9, 955—957.

By Food Inspection Decision, U.S.A., No. 164, Tartrazine may be added to the seven coal tar colours allowed, under certain restrictions, to be

used in food. To include this colour the following modification of Price's scheme (U.S.A. Dept. Agric., B.A.I. Circular 180) has been devised:—From 0.1 to 0.2 gm. of the sample of colour is rubbed in a mortar with 25 c.c. of a saturated solution of ammonium sulphate, and the liquid filtered. If the filtrate is red the residue is washed with successive portions of 10 to 15 c.c. of the ammonium sulphate solution until the washings are no longer red. The filtrate and washings, which will contain the greater part of the Amaranth, with some Naphthol Yellow S, and some Tartrazine, are shaken with ethyl acetate to remove the Naphthol Yellow S, and then with acetone to extract the Amaranth and Tartrazine. The acetone extract is diluted with an equal volume of water, the acetone evaporated, and the aqueous solution saturated with sodium chloride, and shaken with 10 c.c. of alumina cream. The precipitate is separated, washed free from Tartrazine, and the Amaranth recovered by suspending the alumina precipitate in saturated ammonium sulphate solution and shaking with acetone. The portion of the original sample insoluble in the ammonium sulphate solution is dissolved in water, the solution acidified with acetic acid, and shaken with successive portions of ether to remove Erythrosine, the ethereal extract washed, and the Erythrosine extracted from the ether with dilute ammonia solution. The ether is evaporated from the residual acetic acid solution, which is then saturated, while hot, with sodium chloride, an excess being finally added, and filtered. The precipitate is washed with saturated sodium chloride solution, and, if necessary, the "salting out" and washing is repeated. The combined filtrate and washings may contain Light Green S.F. Yellowish, Naphthol Yellow S, Tartrazine, traces of Orange I, and possibly Amaranth, not completely removed by the first extraction with ammonium sulphate. Naphthol Yellow S is separated by extracting the liquid with acetone, and the extract is washed several times with saturated sodium chloride solution to remove traces of Tartrazine and Light Green S.F. Yellowish, and then diluted with an equal volume of water, and heated on the water-bath to remove the acetone. The aqueous solution is acidified and shaken with amyl alcohol to remove traces of Orange I, and the amyl alcohol evaporated from the aqueous layer, which will then contain the Naphthol Yellow S. To separate Light Green S.F. Yellowish from Tartrazine, the acetone is evaporated from the aqueous salt solution, which is then treated, while warm, with 0.5 gm. of fuller's earth for each 10 c.c. of solution. After thorough mixing and settling, the liquid is filtered from the precipitated Light Green S.F. Yellowish, which may then be dissolved in hot acetic acid and identified. In the presence of Tartrazine the filtrate will be yellow and not decolorised by hydrochloric acid, whereas any traces of Naphthol Yellow S not previously separated would be decolorised by the acid. The precipitate containing Orange I, Ponceau 3R, and Indigo Disulpho Acid, and excess of sodium chloride is dissolved in water and extracted with three successive portions of ethyl acetate, which will remove the Orange I. The united extracts are washed with saturated sodium chloride solution, and the Orange I may then be extracted with water. The aqueous residue from the ethyl acetate extraction is heated on the water-bath until free from ethyl acetate, then treated with 10 grms. of granulated calcium chloride, and, after 15 mins., with 15 c.c. of a freshly prepared stannous chloride solution containing the equivalent of 3% of metallic tin and 12% of hydrochloric acid (sp. gr. 1.19). The mixture is allowed to stand until the solution shows no blue colour, and the precipitated Ponceau 3R is filtered off, washed with 25% calcium chloride solution, and dissolved in

dilute ammonia solution. The filtrate, which should be practically colourless, is treated with 3% hydrogen peroxide solution, which, in the presence of Indigo Disulpho Acid, will produce a deep blue coloration.—C. A. M.

Fibrin: Comparative analyses of— from different animals. R. A. Gortner and A. J. Wuerz. J. Amer. Chem. Soc., 1917, 39, 2239—2242.

FIBRIN was prepared from the blood of cattle, sheep, and swine, and the hydrolytic products from the various samples were examined by the Van Slyke method. The results were as concordant as could be expected from the method employed and are regarded as evidence that fibrin from the named sources can be used interchangeably for experimental purposes.—D. F. T.

PATENTS.

Butter, margarine and the like: Preparation of a substitute for— J. Schortinghuis, Zoeterwoude, Holland. Eng. Pat. 110,293, Mar. 26, 1917. (Appl. No. 4372 of 1917.)

MILK powder is made into an emulsion with water, salt being added if desired, and the product is heated to 40—60°C. and intimately mixed with olive oil or other vegetable oil. Natural butter and vegetable fat are then added in order to obtain the proper consistency and increase the amount of volatile fatty acids, and the whole is forced through a sieve to form a homogeneous mass. This is melted at 40—60°C., cooled, mixed, allowed to stand for 24 hours, and then turned over.—J. H. J.

Food and process of preparing the same. M. Quinane, Bayonne, N.J., U.S.A. Eng. Pat. 110,401, Oct. 19, 1916. (Appl. No. 14,873 of 1916.)

THE food is prepared by boiling separately rice and wheat bran, then mixing, and introducing as hot sprays, first a suspension of precipitated calcium phosphate in water, and then olive oil. Sugar may be added if desired. The finished food contains 40% of rice, 32% of bran, 3% of calcium phosphate, 7% of olive oil, and 18% of water or sugar solution.—J. H. J.

XIXb.—WATER PURIFICATION; SANITATION.

Antiseptics: Regular and irregular— C. Richet and H. Cardot. Comptes rend., 1917, 165, 491—496. (See this J., 1917, 610.)

IN the previous note a definition of regular and irregular antiseptics has been given, the criterion being the mean relative variation in the acidity produced in a given fermentation process under the influence of the antiseptic. In the present note, this factor has been calculated, from the results of about 10,000 experiments made in 1909 on lactic fermentation. Taking the relative mean variation for the blank as 100, the value found varied from 83 for sodium fluoride to 870 for silver nitrate. The antiseptics fell into four classes. 1. Extremely regular—sodium fluoride (the only one which increased the regularity of the fermentation process). 2. Fairly regular—creosote, lead nitrate. 3. Irregular—phenol, copper sulphate. 4. Very irregular—salts of zinc, silver, mercury. Thus with salts of mercury, at the limiting antiseptic concentration, it is uncertain whether the fermentation will cease altogether or will continue intensively.—H. J. H.

PATENTS.

Sewage and other foul liquids; Apparatus for aerating—R. Ames, Brighton. Eng. Pat. 110,197, Oct. 13, 1916. (Appl. No. 14,547 of 1916.) Addition to Eng. Pat. 104,361, Feb. 25, 1916 (this J., 1917, 519).

THE original apparatus is improved by providing above the tank a rotary chamber, to which the incoming sewage is supplied. From this chamber the sewage flows into troughs, fixed to the chamber on either side, from which depend open-topped vertical pipes with bell-mouth bottoms reaching to within a few inches of the bottom of the tank. The compressed air supply comes from an air chamber on the top of the sewage chamber, the air being conveyed by pipes which pass down the inside of the vertical sewage pipes and end in atomisers situated in the bell-mouths of the sewage pipes.—J. H. J.

Insecticide, sheep-dip, and the like. G. J. Lemmens, Wateringbury, and P. J. Fryer, Tunbridge. U.S. Pat. 1,242,954, Oct. 16, 1917. Date of appl., Jan. 16, 1917.

SEE Eng. Pat. 106,433 of 1916; this J., 1917, 734.

Insecticide, sheep-dip, animal-wash, and the like. G. J. Lemmens, Wateringbury, and P. J. Fryer, Tunbridge. U.S. Pat. 1,242,955, Oct. 16, 1917. Date of appl., Jan. 16, 1917.

SEE Eng. Pat. 105,525 of 1916; this J., 1917, 611.

Processes for expressing liquid from materials containing the same. Eng. Pat. 110,379. See 1.

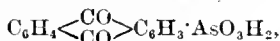
Treatment of refuse, fibrous, or like material. Eng. Pat. 110,394. See V.

Apparatus for detecting firedamp in mines. Eng. Pat. 110,439. See XXIII.

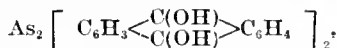
XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS.

Arsenic compounds of the anthraquinone group. L. Benda. J. pr. Chem., 1917, [ii.], 95, 74—106. J. Chem. Soc., 1917, 112, i., 599—601.

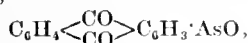
α -AMINOANTHRAQUINONE, by diazotisation in concentrated sulphuric acid, was converted into the corresponding diazo-compound, which on treatment with a solution of sodium arsenite in the presence of sodium carbonate, gave rise to colourless anthraquinone-1-arsinic acid,



colourless needles. This substance is reduced by sodium hydrosulphite in alkaline aqueous solution at 50° C. with formation of 1.1'-arsenoanthranol,



a deep brownish-red substance, which gives yellow solutions in alcohol and ether, but a blood-red solution in aqueous sodium hydroxide; when exposed to the atmosphere this alkaline solution undergoes rapid oxidation with re-formation of the arsenic acid, but in the presence of sodium carbonate, atmospheric oxidation of the arseno-anthranol proceeds only to yellow anthraquinone-1-arsenoxide,



for the further oxidation of which to anthraquinonearsinic acid hydrogen peroxide is necessary. Anthraquinone-1-arsinic acid, when heated strongly, undergoes decomposition with formation of erythrohydroxyanthraquinone, arsenious oxide, and water; on reduction with sodium

amalgam in alkaline solution, it undergoes fission into anthraquinone and arsenious acid, the ease of this change probably accounting for the high toxicity of the arsenic acids of the anthraquinone group.

Anthraquinone-2-arsinic acid, prepared by a similar process to that adopted for its 1-isomeride, forms yellow needles, which remain unfused at 270° C.; like the 1-compound, it gives precipitates with calcium chloride and with magnesia mixture in ammoniacal solution at the ordinary temperature. It is relatively resistant to the action of sodium amalgam and aqueous alkali, this behaviour being in accord with the fact that it is much less poisonous than the isomeric 1-arsinic acid.

4-Aminoanthraquinone-1-arsinic acid, $\text{C}_{14}\text{H}_{10}\text{O}_5\text{NAs}$ (sodium salt, red needles with $4\text{H}_2\text{O}$), was obtained as a red, crystalline powder, m.pt. indistinct at 278° C. (decomp.), by the interaction of an alkaline solution of sodium arsenite with the product formed on diazotising 1.4-diaminoanthraquinone in dilute sulphuric acid. The product of diazotisation in concentrated sulphuric acid, using an excess of nitrosylsulphuric acid, reacted with sodium arsenite, forming 4-hydroxyanthraquinone-1-arsinic acid, $\text{C}_{14}\text{H}_8\text{O}_5\text{As}$, yellow needles, decomp. above 200° C. (sodium salt, brownish-yellow needles); this yielded a brownish-red precipitate with magnesia mixture at the ordinary temperature, and in solution in sulphuric acid could be nitrated to 3-nitro-4-hydroxyanthraquinone-1-arsinic acid, $\text{C}_{14}\text{H}_7\text{O}_5\text{NAs}$, yellow needles, decomp. near 230° C. Reduction of 3-nitro-4-hydroxyanthraquinone-1-arsinic acid with a restricted quantity of ferrous hydroxide yielded 3-amino-4-hydroxyanthraquinone-1-arsinic acid, $\text{C}_{14}\text{H}_{10}\text{O}_5\text{NAs}$, violet, silky needles, m.pt. near 265° C. The product yields a crystalline diazo-compound (needles), which couples with R-salt and with resorcinol, producing violet- and blue-coloured solutions respectively; it is also reduced by sodium hydrosulphite to an orange-coloured vat, which imparts a violet stain to filter-paper. 1.5-Diaminoanthrarufin was converted by way of its chocolate-brown, crystalline tetrazo-compound into 4.8-dihydroxyanthraquinone-1.5-diarsinic acid (anthrarufindiarsinic acid), $\text{C}_{14}\text{H}_{10}\text{O}_{10}\text{As}_2$, a yellow, microcrystalline powder, decomp. above 270° C. On nitration in sulphuric acid at 80° C. this arsenic acid yielded 3.7-dinitro-4.8-dihydroxyanthraquinone-1.5-diarsinic acid, $\text{C}_{14}\text{H}_8\text{O}_{10}\text{N}_2\text{As}_2$, a greenish-yellow, microcrystalline powder. By treatment in alkaline aqueous solution with sodium amalgam, the dinitro-diarsinic acid was reduced to 3.7-diamino-4.8-dihydroxyanthraquinone-1.5-diarsinic acid, $\text{C}_{14}\text{H}_{12}\text{O}_{10}\text{N}_2\text{As}_2$, a dark violet powder with metallic reflex.

Citrus fruits; Method for the determination of the volatile oil content of—C. P. Wilson and C. O. Young. J. Ind. Eng. Chem., 1917, 9, 959—960.

THE whole fruit is cut up and thoroughly mixed, and 200 grms. is mixed with 700 c.c. of water, and rapidly distilled in a current of steam. The distillate is collected in a special oil flask holding about 200 c.c., and having a neck containing about 2 c.c. and graduated in 0.1 c.c. divisions. After about 200 c.c. has been collected, hot water is added to bring the oil up into the neck of the flask, which is then centrifuged, and the volume of oil read. The volume multiplied by 0.849, the average sp.gr. of Californian lemon oils, and by 0.996, the factor for determinations made at 25°/25° C. in air, gives the weight of oil. Determinations of oil in the peel gave lower results than those obtained with the entire fruit.—C. A. M.

Theory of emulsification based on pharmaceutical practice. Crockett and Oesper. See XII.

PATENTS.

Ethyl chloride; Process of manufacturing——. B. S. Lacy, Swaren, N.J., Assignor to The Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,242,208, Oct. 9, 1917. Date of appl., July 21, 1914.

A MIXTURE of chlorine with a large excess of moist ethane is heated to 300°–550° C., the products are washed with water to remove hydrogen chloride, and the ethyl chloride is separated from unchanged ethane by suitable cooling and pressure.—F. W. A.

Solution having a low freezing-point. G. E. Ferguson, New York, Assignor to Pyrene Manufacturing Co. U.S. Pat. 1,243,149, Oct. 16, 1917. Date of appl., Oct. 20, 1914.

A SOLUTION having a low freezing-point is obtained by dissolving thymol in carbon tetrachloride.—F. W. A.

Ureas and thio-ureas of the aromatic series; Production of mixed——. Farbenfabr. vorm. F. Bayer und Co., Leverkusen, Germany. Eng. Pat. 8592, June 10, 1915. Under Int. Conv., June 12, 1914. Addition to Eng. Pat. 9472 of 1914 (this J., 1914, 825).

SEE Ger. Pat. 289,163 of 1914; this J., 1916, 438.

XXII.—EXPLOSIVES; MATCHES.

Distillation of mixtures of sulphuric and nitric acids. Pascal. See VII.

PATENTS.

[Blasting] explosives. Kynoch Arklow, Ltd., and L. H. Pirmez, Arklow, Ireland. Eng. Pat. 110,237, Nov. 27, 1916. (Appl. No. 16,989 of 1916.)

BLASTING explosives suitable for use in places where it is desired to avoid or minimise the risk of ignition of inflammable gases, e.g., in coal mines, are prepared by adding fluorides or mixtures of fluorides, e.g., fluorspar or cryolite, to the explosives in proportion varying with their heat of combustion. To blasting powders giving a temperature of less than 2000° C., it is sufficient to add up to 20% of fluorides. For blasting gelatins, giving temperatures up to 3000° C., up to 35% of fluorides may be added. Examples: (A) Nitroglycerin, 11%; ammonium nitrate, 65%; wood meal, 5%; calcium fluoride, 19%. (B) Nitroglycerin, 50%; nitrocotton, 3%; potassium nitrate, 17%; calcium fluoride, 30%. The addition of fluorides reduces the temperature of explosion, with only a slight decrease in the rate of detonation, and renders the explosive less hygroscopic.—F. Sp.

Centrifugal [nitrating] machines. Eng. Pat. 110,215. See I.

XXIII.—ANALYSIS.

Iron; Calorised—— as an element for thermo-couples. O. L. Kowalke. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 6 pages.

As tested in combination with constantan in thermo-couples, at temperatures up to 1000° C.,

calorised iron (iron having a surface coating of rich aluminium alloy) was found to have the same electro motive force and constancy as uncalorised iron, but a much longer life. A heavy wire, lightly calorised, is the most suitable for thermo-couples.—W. E. F. P.

Gas volumeter; A universal——. H. G. Deming. J. Amer. Chem. Soc., 1917, 39, 2145–2151.

A MODIFICATION of Lange's universal gas volumeter is described in which a scale of mgrms. is substituted for the scale of c.c. usually engraved on the correction tube, and the volume of gas collected in the measuring tube gives the percentage of any desired constituent directly, if measured when the mercury in the correction tube has been adjusted to a mark corresponding to the weight of substance taken for analysis.—F. Sp.

Colorimetric determination of small amounts of aniline. Elvove. See III.

Determination of sulphur dioxide [in smelter gases, etc.]. Sweeney and others. See VII.

Influence of added substances on the iodometric titration of hydrogen sulphide. Jayson and Oesper. See VII.

Determination of available oxygen in pyrolusite. Barnebey. See VII.

Determination of iron in glass sand. Ferguson. See VIII.

Method for the commercial analysis of ferrosilicon. Lowe. See X.

"Stellite" as a substitute for platinum. Haynes. See X.

Spectroscopic determination of small amounts of lead in copper. Hill and Luckey. See X.

Notes on analysis of tannins. Levi and Orthmann. See XV.

Detection of added water in milk by means of a simplified molecular concentration constant. Ferris. See XIXA.

Modification of the Price method of separating coal tar colours [in foodstuffs] to include Tartrazine. Ingersoll. See XIXA.

Determination of the volatile oil content of citrus fruits. Wilson and Young. See XX.

PATENT

Firedamp in mines; Apparatus for detecting——. T. J. Thomas, Porth, Glamorgan. Eng. Pat. 110,439, Nov. 29, 1916. (Appl. No. 17,158 of 1916.) Addition to Eng. Pat. 15,694, Oct. 26, 1915 (this J., 1916, 1273).

THE apparatus described in the principal patent is modified by the introduction of a resistance in parallel with the catalytic body, so that when the latter fuses in the presence of firedamp, the current passes through the resistance to the lamp, thereby giving a light of reduced intensity.—F. Sp.

Official Notices.

PROHIBITED EXPORTS.

An Order-of-Council, dated 18th December, 1917, makes the following alterations in the list of export prohibitions* :—

The following headings are deleted :—(A) Coke, petroleum; (B) Coke, except petroleum coke; (A) Firebricks and fireclay; (B) Fuel, manufactured; (C) Zinc-barium pigments made from zinc salts and barium sulphate (except zinc oxide); (C) Matches; (B) Terebene, and articles containing terebene; (B) Turpentine (oil and spirit) and articles containing turpentine; (A) Turpentine substitute, not otherwise specifically prohibited, and articles containing such substitute; (B) Varnishes containing shellac, oil, or turpentine, not otherwise prohibited.

The following headings are added :—(A) Coke and manufactured fuel; (A) Fireclay, and articles manufactured of fireclay, including firebricks; (A) Incandescent gas mantle rings; (A) Matches; (A) Terebene, and articles containing terebene; (A) Turpentine (oil and spirit), and articles containing turpentine; (A) Turpentine substitute, and articles containing turpentine substitute.

PURCHASE OF PYRITES MINED IN THE UNITED KINGDOM.

It is officially announced that the Ministry of Munitions is prepared during the period of hostilities to purchase iron pyrites mined in the United Kingdom. The pyrites must contain not less than 37½% of sulphur and not over 1% of arsenic. The price payable will be 35s. per ton of pyrites f.o.r. for quantities of not less than one truck load, but the Minister reserves the right to revise the price after 31st December, 1918, or, if over 5000 tons are delivered from one deposit before that date, the price may be revised in respect of further deliveries from such deposit forthwith. In the first instance samples of all ore tendered will be selected by the Local Agent of the Ministry, and if, upon analysis, the ore proves suitable, payment of 75% of the amount of the purchase price for each consignment will be made on receipt of the railway company's certificate that the pyrites has been put on rail. The balance will be paid within 16 days of the receipt of correct accounts. Producers can obtain detailed particulars on application to the Department of Explosives Supplies, Storey's Gate, Westminster, S.W.1.

DEALINGS IN ACETIC ACID.

With reference to the Order of the Minister of Munitions, dated 1st October, including acetic acid among the war materials to which Defence of the Realm Regulation 30A applies, the Minister has given notice that, as from 18th December, all applications for permits to deal in acetic acid, and other applications and enquiries regarding the

above-mentioned Order, should be addressed to the Director of Propellant Supplies, Explosives Supply Department, 32, Old Queen Street, Westminster, London, S.W.1. The notice cancels the footnote to the Order which directed applications and enquiries to be addressed to the Chemical Section, Trench Warfare Supply Department.

TRADING IN TUNGSTEN ORES, MOLYBDENITE AND METAL, AND PRODUCTS THEREFROM.

The Minister of Munitions has made an Order, dated 30th November, ordering that the "War Material" to which Regulation 30A of the Defence of the Realm Regulations applies shall include the following :—All tungsten-bearing ores and tungsten metal and alloys and salts derived or produced therefrom, and all molybdenite and molybdenum metal and alloys and salts produced or derived therefrom. Under this Order returns are required respecting stocks of the above material, the weekly output and deliveries from mines in the United Kingdom, consignments from outside the United Kingdom, receipts and consumption, output and deliveries of manufactures from such material, receipts from producers, and consumption in manufacture. The returns are to be made on the prescribed forms to the Controller of Non-Ferrous Materials Supply, Ministry of Munitions, 8, Northumberland Avenue, London, W.C. 2. Applications for permits under this Order should be made to the Controller as above.

All ore to which the above Order applies imported into the United Kingdom will be taken possession of by the Minister of Munitions and at a price which will be notified from time to time by the Minister of Munitions. Ores to which the above Order applies imported into the United Kingdom under a contract made before 1st September, 1915, will be released by the Minister of Munitions for delivery in pursuance of such contract, but only for delivery to a consumer for manufacture in his own works and in no case for resale. All other ores must be dealt with as directed by the Controller. Ores ready for delivery will be sampled and assayed by analysts appointed or approved by the Minister of Munitions. The Minister of Munitions will from time to time fix the maximum prices at which ores and products to which the above order applies may be bought and/or sold. Permits to sell for export will be granted only to manufacturers or producers for sale to a consumer at a price approved by the Controller.

Application for permits to export to Allied Countries must be made through the Commission Internationale de Ravitaillement. No application for a permit to purchase will be considered unless the applicant states in detail :—(A) The class and quantity of material it is proposed to purchase; (B) the use to which the material is to be put; (C) the period for which the supply will suffice; and (D) the name of the manufacturer by whom the material is to be supplied.

VEGETABLE PARCHMENT PAPER.

The Army Council have made an Order, under date 3rd December, giving notice that it is their intention to take possession of all stocks of vegetable parchment paper, excepting stocks of less than 10 cwt., that are at present or may hereafter

* The prohibition of exports is as follows :—

Goods marked (A), to all destinations;

Goods marked (B), to all ports and destinations abroad other than ports and destinations in British Possessions and Protectorates;

Goods marked (C), to all destinations in foreign countries in Europe and on the Mediterranean and Black Sea, other than France and French Possessions, Russia, Italy and Italian Possessions, Spain and Portugal, and to all ports in any such foreign countries, and to all Russian Baltic ports.

arrive in the United Kingdom. All persons having in their custody or control any such stocks are required to make a return thereof, with full particulars of quantity, description and cost price to the Director of Army Contracts, Room 35A, Imperial House, Tothill Street, London, S.W. 1, together with all such further and other particulars as to their business as may be required by or on behalf of the Director of Army Contracts.

POTASSIUM COMPOUNDS FOR MEDICINAL PURPOSES.

The Controller of Potash Production has licensed until further notice the purchase by any person of potassium compounds coming within the terms of the Order of 17th October restricting dealings in such compounds, notwithstanding that such purchases may exceed an aggregate of 3 lb. per month, *provided that the compounds so purchased are used solely in B.P. form or in B.P. preparations for purely medicinal purposes.* By this general licence retail druggists, hospitals and similar institutions, medical men and others, are relieved of the onus of applying for individual licences to purchase compounds coming within the conditions indicated in italics above, and wholesale druggists and others may supply such compounds for use as above set out without the necessity of verifying that the purchaser holds an individual licence to purchase or take delivery. It will, however, be necessary for the wholesaler in making his returns to the Controller to state the aggregate amount and value of his sales of compounds for purely medicinal purposes during the period covered by each return. Special forms of return will be provided for this purpose. All sales of compounds, other than those exceeding 3 lb. aggregate per month per person, and the sales for medicinal purposes now licensed, must be conducted strictly under purchasers' licences as prescribed by the Order, and, together with an aggregate statement of sales under 3 lb., and of those for medicinal purposes, must be shown on the returns as at present.

EXPORTS FROM THE UNITED STATES.

The following is taken from a list of articles the conservation of which has been declared to be necessary on account of the limited supply, and the needs of the United States in its successful prosecution of the war (the "Conservation List"). Licences for the export from the United States of the articles included in the list may be granted when they are destined for actual war purposes or when they will directly contribute thereto. Licences may also be granted in certain unusual cases when such exports will contribute directly to the immediate production of important commodities required by the United States, and also in certain other cases when these commodities may be exported in limited quantities without detriment to the country.

Acetone. Alcohol. Aluminium. Ammonia salts. Amorphous phosphorus. Ammonia nitrate. Anhydrous ammonia. Animal fats. Arsenate of lead. Arsenate of soda. Babbit metal and other anti-friction metals. Bichromate of potash. Bismuth salts. Brass, articles of. Bronze, articles of, unless containing less than 10% of copper. Carbolic acid (phenol). Castor oil and castor beans. Caustic potash. Caustic soda. China wood oil. Chrome nickel steel. Chrome steel. Chromium: ore; any metal, ferro-alloy, or chemical extracted therefrom. Cobalt: ore; any metal, ferro-alloy, or chemical extracted therefrom. Copper: ore; any metal, ferro-alloy, or chemical extracted therefrom, unless containing less

than 10% of copper. Cottonseed oil. Crucibles. Cyanide of sodium. Diamonds (industrial). Ferrochrome. Ferrocobalt. Ferromolybdenum. Ferromanganese. Ferronickel. Ferrosilicon. Ferrotungsten. Ferrovanadium. Glycerin. Graphite electrodes. Hydrofluoric acid. Lard. Lard compound. Manganese: ore; any metal, ferro-alloy, or chemical extracted therefrom. Mercury. Mercury salts. Molybdenum. Molybdenite. Naxos emery. Nitrate of soda. Nitric acid. Nickel and nickel alloys. Nickel (more than 5%); ore; any metal, ferro-alloy or chemicals extracted therefrom. Nitric salts. Oil cake. Oil cake meal. Phosphoric acid. Phosphorus. Pig iron. Plumbago (graphite, imported, and articles manufactured therefrom). Potash, and chloride of potash. Potassium salts. Sal ammoniac. Saltpetre. Scrap iron. Scrap steel. Scheelite. Soaps. Sodium phosphate. Sodium sulphite. Solder. Spiegeleisen. Stearine and stearic acid. Sugar. Sulphate of ammonia. Sulphur and sulphuric acid. Superphosphate. Tallow. Tin and any metallic alloy containing tin: chloride of tin; tin ore; tinfoil. Tinplate. Tungsten: ore; any metal, ferro-alloy, or chemical extracted therefrom. Toluol. Type metal. Vanadium. Vegetable oils. Wolframite. Yellow phosphorus.

The War Trade Board has determined that the following derivatives of benzol, phenol, and toluol will require an export licence when shipped to any country of the world. Such of these, however, as are not on the "Conservation List" will proceed to Canada, as heretofore, under the special licence issued through the Customs service: Acetanilide; aniline oil; aniline salts; amidoazobenzol; amidophenol (*p*-amidophenol); benzol; betanaphthol; carbolic acid (phenol); chlorbenzol (monochlorbenzol); cresols; dinitrobenzol (*m*-dinitrobenzol); dinitrochlorbenzol; dinitrophenol; dimethylaniline; diphenylamine; nitroacetanilide (*p*-nitroacetanilide); nitroaniline; nitrobenzol; nitrophenol (*p*-nitrophenol); nitrotoluol (*o*-nitrotoluol, *p*-nitrotoluol); nitroxylols; nitrocresols; nitronaphthalenes; nitrochlorbenzol (*p*-nitrochlorbenzol); nitrosodimethylaniline; naphthalene; *p*-nitraniline; phenol (carbolic acid); tetranitroaniline; tetranitromethylaniline; tetranitroethylaniline; toluol; trinitrotoluol; toluidine (*o*-toluidine, *p*-toluidine); xylydine; xylol.

UNITED STATES: PROHIBITED EXPORTS.

A Proclamation of the President of the United States, dated 28th November, prohibits the importation of the undermentioned articles into the United States, except under licence:—Antimony, antimony ore or any chemical extracted therefrom; asbestos; beans of all kinds; balata; castor seed; castor oil; cotton; chrome, chrome ore, or any ferro-alloy or chemical extracted therefrom; coconut oil; cobalt, cobalt ore or any ferro-alloy or chemical extracted therefrom; copra; diamonds, industrial; ferro-alloys, of all kinds; flax; gutta, joolatong; gutta percha; gutta siak; hemp; hides and skins; jute; iridium; leather; manganese, manganese ore or any ferro-alloy or chemical extracted therefrom; mica; molybdenum, molybdenum ore or any ferro-alloy or chemical extracted therefrom; Naxos emery and Naxos emery ore; nickel, nickel ore, matte, or any ferro-alloy or chemical extracted therefrom; nitrates of sodium, potassium or calcium; optical glass; palm oil; platinum, plumbago; pyrites; rubber, raw, reclaimed, waste or scrap; scheelite; shellac; sisal; soya bean oil; spiegeleisen; sugars; tanning materials; tin in bars, blocks, pigs or grain or granulated, tin ore and tin concentrates or any chemical ex-

tracted therefrom; titanium, titanium ore or any ferro-alloy or chemical extracted therefrom; tungsten, tungsten ore, or any ferro-alloy or chemical extracted therefrom; vanadium, vanadium ore, or any ferro-alloy or chemical extracted therefrom; wolframite; wool.

NORWAY: PROHIBITED EXPORTS.

Decrees have been issued prohibiting the exportation of the undermentioned articles from Norway:—Antifouling composition containing copper; dry cells, all kinds; fish glue; lead and alloys thereof in any form, materials and goods which contain lead or lead alloys in any substantial proportion; spent oxide from the manufacture of gas; turpentine produced in Norway.

SWEDEN: PROHIBITED EXPORTS.

Exportation of the following goods from Sweden has been prohibited as from November 25:—Compressed ammonia gas; caustic ammonia; chromate of sodium and bichromate of sodium, also chromic acid; tartar emetic and other compounds of antimony, not being colours (the export of "emetic salt" was already prohibited); thorium nitrate and other compounds of rare metallic earths (the export of thorium nitrate was already prohibited); tungstic acid; salts of gold, platinum, and radium; nitrate of lead; chromium sulphate, chromium chloride, chromium sulphochloride, basic, solid or liquid, containing a variable amount of sodium sulphate or sodium chloride; sulphofatty acids, chromate and bichromate of ammonium, chlorine gas dissolved in water, diphosphates, perborates, dinitrobenzol, trinitrobenzol, nitrotoluol, dinitrotoluol, trinitrotoluol, liquid bisulphite of calcium, nitrite of potassium and of sodium, salts of fatty acids and chemical preparations not specially mentioned (in the tariff) consisting of or containing compounds of vanadium, molybdenum, chrome, tin, lead, cadmium, copper, or nickel. Essential vegetable oils and perfumes and cosmetics, the following—Bitter-almond oil, even if artificial; nitrobenzol (mirbane oil); heliotropin, coumarin, musk, and other scented substances, not specified (in the tariff), natural or artificial, for use in the manufacture of perfumery, not being essential vegetable oils; liquid scents and toilet waters containing ether or spirits; hair-dye; laboratory appliances, not specially mentioned (in the tariff), such as test-tubes, retorts, pipettes, and the like.

Nottingham Section.

WASTE LAND AND AGRICULTURE.

Lecturing on the above subject, Dr. E. J. Russell, F.R.S., said that there were in Great Britain some 56,000,000 acres of land of which we cultivated only something like 32,000,000, leaving a balance of 24,000,000 acres which were not cultivated. A little less than half of that—something over 11,000,000 acres—was occupied by towns, cities, railways, and roads and in the nature of things could not be cultivated, but there were some 13,000,000 acres that were not so occupied, that were not fully used agriculturally and might be called either waste land or undeveloped land, whichever expression was preferred. In a country like England, it was presumed that any land that was not cultivated could not be cultivated, or, at any rate, not

profitably. It by no means followed that these 13,000,000 were all hopeless, and in the march of science and the progress that had been made in general agricultural investigation it had often been found possible to deal with land that otherwise could not have been touched, though the process still remained expensive. That night he wanted to show some of the methods for dealing with those lands which in the past had had the reputation of being irredeemable.

The problem of dealing with waste land had always attracted attention from thoughtful people interested in the land, but nothing much had been done in recent years in this country. A great deal had been done in the early days of the last century, but of late there had been so little progress that the extent of waste land had rather increased than diminished. In order that land might be cultivated it was obviously essential that the conditions should be favourable to the growth of crops. Limits might be set either by the climate or the soil; so that generally speaking there were two sets of conditions which had to be taken into account in deciding whether land could be cultivated or not. Unfortunately the climatic conditions seemed to be outside our control altogether. It seemed impossible to alter the amount of sunshine or rainfall. The only way was to attack the other side of the problem and alter the land by proper breeding methods, and produce something which was rather better adapted to the climate than the plants we grew. This was being done to a great extent in several parts of the world, and it was proving effective in circumventing the effect of climate. It was also necessary to determine what soil conditions were needed by the crop. It must have nutrient materials, air, water, and suitable temperature, and there must be an absence of injurious conditions. Any of these that was lacking constituted a limiting factor which prevented the plant from making growth. In any attempt at reclamation the first thing to do was to find out the limiting factor. Taking waste and uncultivated land generally, it would be found that there were some four or five limiting factors. There might be an insufficiency of plant-nutrients, an excess of water or a deficiency of water, a deficiency of temperature or shallowness or insufficient depth of soil.

In the fen district it was frequently necessary that water should be kept out of the land, and this was accomplished by draining on broad engineering lines. A second type of wet land, and one that was far more common, was the case where the land owed its wetness to the fact that the water could not escape. All over the country there were considerable areas of such land, and the proper way to deal with them was to find a way out for the water, which in practice was not always easy. The ancient method was to dig a ditch or open drain at certain intervals so that the proper area was drained. The disadvantage of this method was that the walls of the ditch were apt to fall in. In Roman times it was customary to fill the bottom up with stones and put soil on the top so that the water would find its way down and so get away. Draining, though an old art, was forgotten for a long time; it was not mentioned in British books in the great revival of the 16th century. Gervase Markham, for instance, wrote books on almost every branch of farming, but never one on draining. By the middle of the 17th century, however, it was common, and it was dealt with in Blith's "Improver Improved." But it was not until Puritan times that men began to realise that it was necessary to take levels in order to lay ditches properly.

The next great improvement was to try prevention instead of cure. In the 18th century a young man named Elkington inherited a very wet farm from his father, who was a Warwickshire

farmer; the land lay on the side of a hill, and much of it was very wet and boggy. Elkington described how his sheep died in hundreds and his crops were ruined. Drainage was of no use, and in desperation one day he took a crowbar from a labourer who was digging a trench and drove it with great force into the ground. To his astonishment out ran a stream of water. He then realised that he had struck a spring, and it occurred to him that if he carried his drain right down to the level of the spring so that the water was carried away at the source he would have no further trouble. He therefore sank a deep drain, got down below the spring, and made a broad ditch which carried the water away. He applied the principle to the rest of his farm, and it became beautifully dry so that he was able to cultivate it properly. That led to a considerable amount of draining in the Midlands and other parts of England, and Parliament voted Elkington £1000 for his discovery. From about 1800 to 1850 a very great amount of deep drainage was done, but the very success of Elkington's method proved its undoing. The underlying principles were not really understood, and consequently it was used in all sorts of cases where it was wholly unsuitable, so that it fell into disrepute. Drains were made four or five feet deep with the idea of tapping the sub-soil water before it came to the surface, but often there was no sub-soil water to tap. In some cases the method answered extraordinarily well, in others it failed, and hundreds of thousands of pounds were wasted. It was not realised until many years afterwards that water may come from two sources—some from below and a great deal from rain; so somewhere about 1860 shallow draining was adopted so that as the rain came in it could be got away. Eventually it was realised that both principles contained a great deal of truth.

The next development was pipe drainage, which was followed by the great Government undertakings of the last century. There was no better illustration to be found for the necessity of basing great schemes like these on a foundation of scientific principles. The work was carried out empirically, and a great deal of it wrongly. Some of it proved extremely ineffective and also very costly—anything from £5 to £10 an acre—and in modern days most people had not been able to carry it out; consequently drainage fell for some time into disuse, and probably during the last 20 years there had been very little done systematically. A good deal of our uncultivated land owed its sterility to the fact that the drainage had not been attended to.

A method of drainage which had come into considerable use was by means of the mole plough, which imitated the action of the mole. A steel cylinder with a pointed end was forced through the soil from 9 to 18 inches below the surface, and it was found that this tunnel was remarkably stable; it would last for some years—there were many cases on record where it had lasted from 10 to 15 years without tumbling in. The system had the obvious advantage of cheapness, the cost being about £1 per acre, especially in the Midlands. This promised to be one of the most effective methods where the conditions were suitable—the surface even and the soil free from stones. But, like others, the mole system was not entirely new, there having been mole ploughs in 1800. If, however, any drainage scheme was to be a success the whole of the area must be treated uniformly. One other reform would have to be brought about, and that was to have Drainage Boards whose duty it would be to see that ditches were kept open and water-courses generally kept clear.

Another great trouble in connection with uncultivated land was its dryness. A good deal of

our waste land owed its uncultivated condition to the fact that it was too dry, the water content being insufficient to allow of growth. The old way of dealing with land of this sort was to have recourse to irrigation, which was done in a great many countries. Direct addition of water is one of the very oldest agricultural practices. When history begins there was already a network of irrigation canals between the Tigris and the Euphrates, and the irrigated land was made to bear two or even three crops of wheat a year, yielding a two hundred to three hundredfold return. In England irrigation presented many difficulties, and consequently it was not usually carried out. The difficulty was got over by making full use of the water already present in the soil or which fell upon the soil. Most of our land received at least 20 inches of rainfall, and if that was husbanded there was sufficient for all ordinary crops.

If the overcoming of wetness was the great triumph of our grandfathers, we could reasonably claim for our generation that it had gone a long way towards overcoming the difficulty of dryness. Considerable parts of Britain were affected in this way, especially the sands and gravels of the eastern and south-eastern counties. The old English farmers hated dry soils; they cultivated the loams and clays but left the dry sands as wastes. Nowadays one sought to increase the stock of water in the soil either by adding more water, or by diminishing the losses.

There were two ways of husbanding the water supply. One was to increase the capacity of the soil for absorbing water. If either clay or organic matter were added to these dry soils their power of holding water was increased. One of the great advantages of farmyard manure and other organic matter was that it enabled the soil to do this. There were two or three ways in which organic matter might be got into the soil. One was to grow the crop and dig it in. Another was to grow the crop and allow it to be eaten by the sheep or cattle on the land, so that their excrement would fertilise the soil. That had many advantages, but also the disadvantages that it required considerable capital, and also a knowledge of the management of sheep and cattle, which an arable farmer did not always possess.

There was great difficulty in reclaiming waste lands where there was an insufficient depth of soil. Unfortunately we did not know how to deal with this problem properly. Land of this sort could not be cultivated with our present methods. The only way in which they could be utilised on our present knowledge was to graze them roughly with sheep, and that was done to some extent, but it was exceedingly difficult to know how to get any further. Such land might serve other purposes. Gravel and coarse sand both made good residential sites, golf courses, etc., but our present methods were of little use for the purpose of converting them into agricultural land. There were cases, however, where soil would accumulate through washing down into the hollows or depressions. It was only when the soil became 5 or 6 inches deep that cultivation became possible, otherwise all that could be done was to improve the grass on the higher parts. One case, however, was susceptible to treatment. If the rock was only a thin layer and was underlain by good material there were possibilities of improvement. Cox Heath, Maidstone, was an example. In its original state the soil was so thin that cropping was impossible; it was, therefore, left waste. But underneath the rock lay mineral matter that had in it the making of a good loam. When the rock was removed, and the upper and lower layers joined, a useful soil resulted. Some of the land now was so good that it let at £2 per acre; it had become valuable agricultural land, whilst formerly

it was waste. The removal of rock was, of course, a serious business. This particular reclamation was brought about between 1814 and 1818, when wheat was higher in price even than it is now, and labour was vastly cheaper. Steam tackle might prove simpler, but under modern conditions it would probably be easier to blow the rock out with dynamite—a mode of "culture" which had already begun to appear before the war, and might develop considerably afterwards.

Dr. Russell next dealt with land that suffered from sourness or acidity—a deficiency of lime or calcium carbonate. The remedy was simply that lime or chalk must be added. The old British method was to dig a pit and raise the chalk—a method almost identical with that described by Pliny. Nowadays it was possible to do the work much better and more expeditiously. Ground limestone was just as effective and far smaller quantities could be used. This was one important factor in the increasing of the productiveness of land and bringing into cultivation some of our waste lands.

Lastly, Dr. Russell referred to the question of supplying nutrients to the soil in the form of fertilisers, including nitrogenous, phosphatic, potassic, and organic. Chemists had found that it was possible to use suitable quantities of various substances for different crops and soils, and the problem of fertilising land had simply become one of supplying these substances at low prices. How to get the most useful results depended upon the proper use of these fertilisers. The reclamation of some of the waste land in this country had been brought about by discovering, first, the limiting factor, and, secondly, what was the best and cheapest way of throwing that limiting factor out of action. The cheapest phosphate was basic slag, which had proved of considerable value on certain types of soil where infertility was due to lack of phosphate. In conclusion, Dr. Russell emphasised the point that the problem of waste lands and how to deal with them rested on a definite scientific and economic basis.

DISCUSSION.

Dr. GOODWIN mentioned the Carr lands in the north of Nottinghamshire and on the borders of Yorkshire. There was a large tract of land about Everton Carr which, owing to the excess of water, did not produce a normal or anything like a decent crop. The question of how to deal with land of this character was of very considerable moment, because it had to be utilised by the farmer. Unfortunately the trials that had been made on this land had not been successful. Again, there was a lot of land round about the Dukeries suffering from lack of moisture. Farmers naturally were on the look-out to find some means whereby these limiting factors could be eliminated.

Mr. DROOP RICHMOND referred to the use of limestone, a method which was still employed. It dated back some 2000 years. Dr. Russell had mentioned the difficulty of reclaiming soil which consisted of sand, especially moving sand. Now Egypt was a case in which that had been done, not by the hand of man but by natural causes, and it always seemed to him to be most interesting. Desert land had been converted into fertile land, and it struck him that possibly the way in which this sandy soil had been converted into fertile land by natural causes was worthy of study as to whether something of the same sort could not be done artificially. The waters which formed the river Nile flowed from mountains which consisted very largely of clay, and owing to the dryness of the climate the clay became hard and broken up, so that when the heavy rains came they carried down this clay in a divided state and containing a good deal of colloidal matter. The clay was deposited on the surface of the sand, and when the

rain ceased and the water gradually ran off the clay, containing a good deal of plant nutriment, was left on the surface of the sand. The clay then caked together to a certain extent and prevented the sand from being absolutely pervious. The people who inhabited that country realised the need of water and devised a very simple system of fetching up the water from the river Nile. The same methods were used to-day as were in use 6000 years ago. The water was brought up by a bucket, weighted with a big weight, at the end of a long stick, and the water lifted high enough so that it would run into a channel and thus flow over the land. It was possible that that might be a means of treating sandy soil in this country.

Dr. RUSSELL, in replying on the discussion, said in regard to Mr. Droop Richmond's remarks in reference to the mingling of clay with the sand, that that was done to some extent already in various parts of England, for example in Lincolnshire, where it was done under the name of "warping." Some of our tidal rivers carried an enormous amount of silt, and by a proper system of sluice gates it was possible to let this silty water flow on to the land. That system was also used in the north of Italy, and wherever it could be adopted it was one of the best methods for dealing with light lands. The total of waste land in England was 13,000,000 acres. Unfortunately it was not known how much of these lands could be cultivated. No survey of them had been made; they had not even been properly classified. These were facts which made all political discussion of the subject rather artificial. The question was whether this land was to be made as productive as it might be or whether it was to be left to look after itself. He had very little doubt as to what the answer of the community would be after the war: it would be decided that no land was to be left waste if it could be cultivated. We could not run the risk of having uncultivated or undeveloped land.

Yorkshire Section.

Meeting held at Queen's Hotel, Leeds, on Monday, November 19th, 1917.

PROF. J. W. COBB IN THE CHAIR.

THE EFFECT OF VARIOUS "THINNERS" ON THE DRYING OF LINSEED OIL, AND THE ACTION OF DRIERS ON TURPENTINE.

BY A. WOODMANSEY, B.SC., A.I.C.

Divergent opinions have been expressed as to the relative value of turpentine and other solvents in the drying of linseed oil. Discussing their respective merits when present in a paint, Toch ("The Chemistry and Technology of Mixed Paints," pp. 103 and 112) says:—"Entirely too much stress is laid upon the value of turpentine as a paint vehicle and the sooner the chemist and the consumer realise that turpentine is simply an auxiliary the sooner will better substitutes be used . . . after all any solvent, whether it be benzene, turpentine, naphtha, benzol, or acetone, is nothing but a solvent and evaporates completely leaving the other vehicles to protect the paint." On the other hand, Jennings ("Paint and Colour Mixing," p. 8) states:—"It is very important that the turpentine used should be pure. American spirit is mostly used. Owing to its price it is sometimes adulterated, with disastrous effects to the paint." These are

types of the diametrically opposed opinions which are so often met with; they are quoted because the volumes referred to are largely consulted by those interested in the practical side of painting.

Experiments were conducted to decide how far different thinners were instrumental in increasing the weight of a drying film of oil under conditions similar to those obtaining in practice.

Effect of thinners on linseed oil.

A weighed quantity of the oil was spread over Petri dishes and 1 c.c. of thinner pipetted in as required, solution being effected by gently agitating the dish. The dishes were then exposed to light and air for six days, a longer period not materially affecting the result. No use was made of the desiccator in any of the weighings, and as no hygroscopic change in weight of an empty dish was apparent in this series a correction was unnecessary. In making the calculation the residue left by 1 c.c. of thinners was deducted.

As pure linseed oil increased in weight very slowly, and in order to approximate to practical conditions, 1% of manganese resinate was dissolved in the raw oil, by warming with a small quantity of oil and then adding the bulk.

Little or no increase in weight was observed over the blank (oil without thinner) when chloroform, carbon tetrachloride, benzene, petroleum ether, or a light turpentine substitute was used, but a very pronounced increase occurred in the case of turpentine or a substitute of higher boiling point.

The following figures may be cited as one experiment:—

Boiled oil, sp. gr. 0.919.

Raw oil (1% Mn resinate), sp. gr. 0.933; iodine value 190.

Turpentine (American), sp. gr. 0.866; b.pt. 159°–160° C.

Substitute (a petroleum fraction), sp. gr. 0.784; b.pt. 140°–198° C.

Petrol (redistilled and collected in two fractions), sp. gr. 0.712, b.pt. 80°–140° C. and 140°–155° C.

	Weight of oil, gm.	Increase in weight, %
Boiled oil	{ 0.3463 0.5565 0.4312	{ 5.95 5.48 5.96
Boiled oil + 1 c.c. CHCl_3	{ 0.3993 0.4465	{ 6.03 5.44
Boiled oil + 1 c.c. turpentine	{ 0.4500 0.5049 0.4226 0.3584	{ 12.70 13.29 10.81 13.34
Boiled oil + 1 c.c. petrol (b.pt. 80°–140° C.)	{ 0.3947 0.4202	{ 6.43 6.66
Boiled oil + 1 c.c. petrol (b.pt. 140°–155° C.)	{ 0.3935 0.4338	{ 8.76 7.93
Boiled oil + 1 c.c. substitute	{ 0.4744 0.3945 0.6169	{ 14.65 15.56 14.89
Raw oil + Mn resinate	{ 0.1476 0.1911 0.1418	{ 10.03 9.94 10.15
Raw oil + MR + 1 c.c. CHCl_3	{ 0.2330 0.1901	{ 9.94 9.36
Raw oil + MR + 1 c.c. turpentine	{ 0.2259 0.1708	{ 21.64 23.47
Raw oil + MR + 1 c.c. petrol (b.pt. 80°–140° C.)	{ 0.2239 0.1856	{ 8.84 10.13
Raw oil + MR + 1 c.c. petrol (b.pt. 140°–155° C.)	{ 0.2486 0.2000	{ 11.66 12.59
Raw oil + MR + 1 c.c. substitute	{ 0.2320 0.2013	{ 21.38 18.58

From the point of view of increase in weight of the oil-film the sample of turpentine used in the above experiments possessed no advantage over a substitute of high boiling point. In drawing up a specification for substitute it would not be wise to require an upper limit above 200° or 210° C., since the drying process would then be too prolonged.

A plausible explanation of the action of a thinner is that it causes the oil to remain liquid and so, by preventing premature formation of an impervious film, enables a greater oxygen absorption to take place in the mass of the oil. A more volatile thinner disappears before such effect is produced. In the case of the substitute this explanation is probably the correct one. Further work with turpentine, however, proved it to be only partially capable of meeting the facts. While the substitute requires several days to evaporate, turpentine largely volatilises in a few hours. We should then expect the substitute to exercise a much greater effect, an anticipation by no means borne out. In some experiments with turpentine also an increase was recorded greater than the theoretical increase, calculated on the basis $\text{O}_2 = \text{I}_2$ (Ingle, this J., June 30, 1913). This increase was finally traced to the turpentine itself, which "resinised" in the presence of the catalyst. No explanation is offered here as to the nature of the resination, though oxidation plays an important part. The gradual atmospheric oxidation of terpenes is well known. Manganese resinate, lead resinate, and red lead were all found to act in the same way towards turpentine, the first named being the most effective.

Effect of red lead on turpentine.

Into each of two weighed 220 c.c. beakers was pipetted 25 c.c. of turpentine (sp. gr. 0.804, b.pt. 156°–163° C.) and 0.7488 gm. of red lead was added to one of them. They were shielded from dust and the contents allowed to evaporate.

	Weight of turpentine.	
	Alone.	In contact with red lead.
	grms.	grms.
In 20 days	11.2019	13.8739
In 29 days	7.1578	10.3709
In 49 days	1.5708	6.0453

The great difference in the amounts and the high viscosity of the second residue in comparison with the first were apparent.

Effect of manganese resinate on turpentine.

Three further points were brought out in the following series of results:—

(1) Samples of turpentine (all obtained from painters' supplies) showed marked differences in the net weight of residue left on evaporation, if the experiments were carried out within a short time after redistillation. After a month these were comparable in magnitude.

(2) Each sample showed a progressive increase in the amount of residue according to the lapse of time after redistillation, and also the "potential" resinisation, as indicated by the weight of residue without driers, gave, for a particular sample and in the earlier series, some idea as to the effect of the addition of a catalyst.

(3) Petri dishes of two sizes were used in duplicate, the larger one of 2½ in. diam. and the smaller of 2 in. diam. The higher result of a pair was observed in most cases to be obtained with the smaller dish, i.e., a lesser surface conducted to slower evaporation and consequently more prolonged contact with the catalyst.

Three samples of turpentine were freshly distilled on the date of the first set of weighings.

- A—Sp.gr. 0.8677; b.pt. 158°—161° C.
 B—Sp.gr. 0.8640; b.pt. 156°—163° C.
 C—Sp.gr. 0.8655; b.pt. 157°—160° C.

The manganese resinate (approx. 1%) was dissolved in benzene, filtered, and measured into the weighed dishes by means of a burette, and the thinners were then introduced by the pipette. The quantity used was 1 c.c. of each. After four days the residues were weighed and the results tabulated. The turpentines were allowed to "age" for 14 days and the series repeated without another redistillation, and again a third time after a further 12 days. The turpentine substitute was used for the purpose of comparison. It had not been redistilled for some months (sp. gr. 0.784, b.pt. 140°—198° C.).

Mr. JAMES E. BEDFORD asked if the author had given attention to the durability and preservative qualities of oxidised linseed oil under different degrees of oxidation. Was the preservative power increased by further oxidation or otherwise?

Dr. H. INGLE said that with regard to the oil alone, the results obtained in small dishes could not be taken as a measure of the absolute gain in weight by complete absorption, as the film was too thick. Theoretically an oil having an iodine value of 190 should increase about 24% in weight. The author had obtained by thinning with turpentine up to 23.47%, which was very near that figure, and higher than usually obtained with oil alone by the plate method (Weger, 18%). It was shown in the paper that too volatile diluents, by allowing the formation of a skin of oxidised oil on the surface, prevented the lower portions from drying; thus the lower the boiling point of the turpentine

	1st Series.		2nd Series. 14 days after 1st series.		3rd Series. 26 days after 1st series.	
	Weight of residue left by evaporation after 4 days.	Net weight of residue after deducting that due to driers and thinners.	Weight of residue after 4 days.	Net weight of residue.	Weight of residue after 4 days.	Net weight of residue.
	grms.	grms.	grms.	grms.	grms.	grms.
1 c.c. turpentine—						
A.....	{ 0.0010	—	0.0023	—	0.0051	—
	{ 0.0008	—	0.0024	—	0.0055	—
B.....	{ 0.0004	—	0.0012	—	0.0059	—
	{ 0.0004	—	0.0014	—	0.0053	—
C.....	{ 0.0005	—	0.0023	—	0.0068	—
	{ 0.0007	—	0.0022	—	0.0072	—
1 c.c. substitute	0.0004	—	0.0003	—	0.0007	—
1 c.c. turpentine + 1 c.c. driers—						
A.....	{ 0.0494	0.0404	0.0571	0.0464	0.0500	0.0362
	{ 0.0474	0.0384	0.0631	0.0524	0.0539	0.0101
B.....	{ 0.0115	0.0030	0.0263	0.0169	0.0440	0.0299
	{ 0.0103	0.0018	0.0303	0.0209	0.0539	0.0398
C.....	{ 0.0236	0.0149	0.0494	0.0390	0.0563	0.0408
	{ 0.0327	0.0240	0.0396	0.0292	0.0636	0.0481
1 c.c. substitute + 1 c.c. driers ..	{ 0.0099	0.0014	0.0094	0.0010	0.0099	0.0007
	{ 0.0094	0.0009	0.0096	0.0012	0.0106	0.0014
1 c.c. driers	{ 0.0081	—	0.0081	—	0.0085	—
	{ 0.0080	—	—	—	—	—

The resultant film formed by turpentine and driers, at first "tacky," set at length with a firm varnish-like appearance.

A consideration of these data led to a comparison of freshly distilled turpentines in conjunction with raw linseed oil (containing manganese resinate) by the preceding methods. As far as the experiments were taken, confirmation was afforded that turpentine "B" was very much less effective than turpentine "A" in producing an increase in weight.

In conclusion, reference may be made to the interpretation of the tests of painted fences in North Dakota (1906) and the assertion of the experienced painter that turpentine is better than a substitute. It may be suggested that this opinion is based on the added quality imparted to the dried paint by the varnish-like film due to turpentine and drier.

Summary.—The presence of a "thinner" normally increases the weight of a drying oil-film.

The magnitude of the increase is in a measure inversely dependent upon the volatility of the thinner. An additional increase may be brought about in the case of turpentine by reason of the "resinisation" due to the action of the drier on the turpentine.

DISCUSSION.

The CHAIRMAN said that the author had set out a number of results which were likely to be useful, without the complication which would have accompanied chemical speculation as to their complete explanation.

the less the increase in weight. Old turpentines gave a greater increase than new ones. He (Dr. Ingle) thought that this was due to the oxidation (resinification) on keeping the turpentine. Referring to a rough test of his, in which the time taken by a strip of paper to dry after immersion in the liquid was noted, he had always considered that the turpentine (not substitutes) which dried the quickest was the best, but evidently the intermediate ones were better as they allowed of more molecular movement before a skin was formed.

Mr. GEORGE WARD said that turpentine had an advantage over a substitute because the former gave a varnish-like finish. Had the author carried out any experiments with wood instead of glass? The resination of turpentine made it better than a substitute for painters' use.

Mr. JAMES MILLER said that the amount of increase in weight on evaporation was not necessarily a good criterion. He had in mind a paint which would not dry, and on examining the turpentine used it was found that on evaporation it left a resinous, sticky residue; evidently the turpentine had resinified owing to age. He agreed with Dr. Ingle's method of testing turpentine. He thought that a new turpentine would yield a better film than an old one.

Mr. WOODMANSEY said, in reply to Mr. Bedford, that he had presented these effects of thinners on oils from the point of view of increase in weight only, and could not say how varying degrees of oxidation affected durability. Regarding linseed oil and not specially in connection with thinners, some

tentative experiments on durability and the other qualities which, though of paramount importance were least amenable to direct measurement, were being carried out. He agreed with Dr. Ingle's theory as to the assistance afforded by volatile diluents. Films of oil of thickness varying between very wide limits had been tried, and the results were found to conform with those quoted. He had not carried out any quantitative work using wood surfaces. He thought hygroscopic difficulties might arise. Mr. Miller's experience of the non-drying property of some old samples of paint had been met with in the case of certain old turps varnishes.

The author read the following extracts from a letter he had received just before the meeting from Mr. W. Gathorne Young:—" . . . I made some determinations of increase of weight on drying of raw linseed oil with and without addition of turpentine spirit, nearly twenty years ago, in order to refute the claims of certain people, who wished to sell deodorised petroleum spirit . . . for use in place of turpentine spirit, that the petroleum spirit was just as good in every way as turpentine spirit and much more economical. . . . I presume you are aware that if you keep a small volume of turpentine spirit exposed to a relatively large volume of air in a confined space, the turpentine spirit resinifies progressively until, if kept long enough, its consistency may become thicker than that of crude rosin oil, and thin films of it will become solid. You can show this very well by putting 20 c.c. of turpentine spirit in a closely stoppered litre flask and allowing it to stand for twelve months at rest, exposed to sunlight. I have . . . always attributed it rather to polymerisation of the terpene than to oxidation. Of course, the increase in weight of linseed oil on drying in presence of turpentine spirit is a different matter."

NOTE UPON THE RATE OF SOFTENING BY THE LIME-SODA PROCESS.

BY JAMES W. WOOD, M.S.C.

The lime process of softening water is based upon that originally devised by Clark, that is, by the addition of caustic lime to a water containing calcium bicarbonate. The water is softened by the precipitation of calcium carbonate, part being produced from the bicarbonate originally in solution and part from the added lime.

One of the first plants employed for utilising this reaction was the Archbutt-Decley plant. For dealing with waters of variable composition and for simplicity the plant was excellent, but in towns, where space is usually limited, the plant occupied too much ground space and moreover it was not sufficiently flexible to meet varying demands for softened water.

In continuous softeners water and reagent are run into the bottom of a large tank, and by taking off water from the top it is possible to obtain a reasonably clear water, provided that the velocity of the water through the tank is not so great as to carry over the precipitate. The flow of water, however, to secure this object must be abnormally slow and ample time is thus allowed for chemical reaction and precipitation to take place. If these softeners are used in conjunction with a filter, however, it is not necessary to wait for the separation of the precipitate to take place by gravity, and the velocity of the water can be greatly increased. Theoretically, it can be increased indefinitely and is only limited by the efficiency of the filter and the rate at which the reactions can take place. The latter is held in many quarters to be quite a negligible time, but the figures given below show that it is other-

wise. This is of considerable importance at the present time, when it may be necessary to work existing softeners beyond their rated capacity, and unless the softeners have been designed with a liberal margin trouble will ensue. Such has been the experience of the author.

The water dealt with is a typical one of the London area with a hardness of 22 to 25 parts CaCO_3 per 100,000. The hardness is almost entirely due to calcium salts, about two-thirds of this being temporary and one-third permanent hardness. Magnesium compounds are present but only in small quantities. For certain purposes water with a hardness of 8 to 9 parts per 100,000 was sufficiently good and therefore softening with lime alone was first experimented upon.

Experimental.

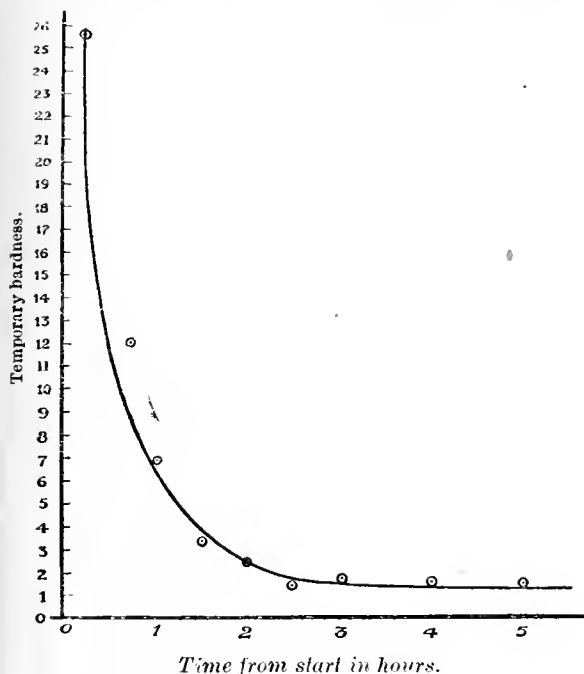
Laboratory tests were made in a bottle of 10 litres capacity, the calculated amount of saturated lime water being added. At intervals portions were withdrawn and titrated with $N/10$ hydrochloric acid as rapidly as possible, especially in the early stages of the experiment. The assumption is made that particles of calcium carbonate which have reached such a state of aggregation as to be no longer effective as hardening agents are not affected appreciably in the short time required for a titration, by an acid of such low concentration as $N/10$ hydrochloric acid.

I have devised and upon several occasions shown a lecture experiment to illustrate the course of the reaction. The water to be softened is placed in a vessel about a foot deep and 5 in. in diameter, through which a powerful beam of light can be projected in a vertical direction by means of a reflector. At first the water is perfectly clear and the beam is not visible as it passes through the water, nor are conditions changed upon the addition of the theoretical amount of clear saturated lime water. With water at ordinary room temperatures the water remains clear for two or three minutes, after which a slight opalescence appears, which gradually becomes more marked until the whole vessel becomes filled with a milky liquid, but no individual particles can be seen. After this stage the particles grow either by the addition of fresh material or by segregation, but in any case they appear to become much fewer in number and the mixture acquires the character of a true suspension with particles of appreciable size, the water between them being perfectly clear. I have said that the particles become visible individually; it would perhaps be more correct to say that they become visible as secondary sources of radiation as in the ultra-microscope. I have made several unsuccessful attempts to measure the size of the particles with the ultra-microscope, trouble being experienced owing to the fouling of the cell walls with the precipitate. After the particles have reached appreciable size they slowly settle, leaving the upper portion perfectly clear. It is interesting to note that for fully three minutes, *i.e.*, the time during which the water remains clear, the determined hardness corresponds almost exactly with the sum of that originally present and that due to the added lime. The liquid is probably supersaturated with regard to CaCO_3 . I have never been able to prolong the supersaturation period beyond five minutes at ordinary temperatures, but I am confident that with care it might be done.

Unless the vessels are scrupulously clean, and especially if an experiment has previously been carried out in the same vessel, the time for the commencement of precipitation may be reduced considerably, whilst if a little wet precipitate be added from a previous experiment it is practically impossible to detect the clear stage and very

little of the milky stage owing to rapid precipitation and growth of the precipitate.

The curve given shows the course of softening in a typical experiment at ordinary temperatures, the curve being of ordinary hyperbolic shape. It will be seen that it takes some 90 minutes to complete the softening to a reasonable degree,



Removal of temporary hardness at 12.7° C. by use of lime alone.

Note.—Total hardness at any point = Temp. hardness + 7°.

i.e., it is inadvisable for the water to take less than an hour and a half to pass through the softener under these conditions. As the water in a plant working at a normal rate usually takes longer than this to pass through a softener the water is usually sufficiently softened at the outlet.

It has been my experience, and the experience of others, that if the velocity is increased above this rate the softening is completed in feed-water heaters or boilers with attendant troubles.

The question now arises as to whether or not the reactions can be hastened under such conditions as obtain in commercial work. I have made use of the usual means adopted for increasing the speed of reaction in chemical work. Raising the temperature is the easiest means to adopt. It is found that raising the temperature from 15° to 20° C. increases the rate of reaction most markedly, but the results have not been sufficiently concordant, and one can only say that the time required is approximately reduced to two-thirds. Softeners are now frequently heated by exhaust steam or condensed water, and in that light are looked upon as heat recoverers or collectors of water not requiring treatment, the useful function of aiding reaction being overlooked. It is merely a question of introducing the steam or hot water at the right point to use it most effectively for this purpose. The addition of excess of reagent increases the rate of softening, but with lime alone this course cannot be well adopted as the use of an amount lime beyond that actually required would again render the water hard, and it is not unknown for water to leave a softener harder than it entered owing to the injudicious use of excess of lime.

The rate of softening by soda alone has not been determined, but there is a marked difference in speed according to whether the lime and soda are mixed immediately before entering the water or whether they enter the water at different points and afterwards mix. This is probably due to the almost immediate precipitation of calcium carbonate in the relatively concentrated solutions of reagents: the calcium carbonate then acts as a "seeding out" agent as already described.

The time required for lime-soda in correct proportions for the water is 50 to 60 minutes as against 90 minutes for lime alone under similar conditions. The addition of extra lime, corrected by extra soda, may further reduce this to 40 minutes, but there is then trouble with excessive amount of solids remaining in the water. A better means would be found in working a larger plant at its normal rate with normal supplies of reagent. Lastly, filtration is a most useful means of acceleration. The ordinary filter most probably acts by providing a surface to which the precipitate may adhere. It is reasonable to suppose therefore that after a filter has been in use for some time the filtering medium becomes coated with precipitate, which then acts as a nucleus upon which further particles—and particularly the smaller particles—may grow. This much is certain, that a filter which has been in use for some little time can be worked at a greater speed and will deliver clearer and softer water than a new filter. As soon as the precipitate becomes loose or too thick upon the surface of the filter, the current of water washes it off and the outlet water becomes turbid again. In using exhaust steam and condensed water it must not be overlooked that a greasy water exerts a marked retarding influence upon the rate of softening.

I am indebted to the Chemical Department of the Battersea Polytechnic for providing facilities for carrying out experiments. The lecture experiment described has been frequently shown to students at that Institution.

DISCUSSION.

The CHAIRMAN said that he had never realised before so clearly how long it might take to precipitate calcium bicarbonate by lime-water. He was doubtful of the resisting power of precipitated calcium carbonate to hydrochloric acid over the very finite period of time required for a titration, but no doubt Mr. Wood had assured himself of the validity of this assumption.

Mr. W. MCD. MACKAY said that the author's device for the optical examination of the rate of precipitation was excellent and might be applied with advantage in other directions. His experience agreed with that of the author, that a slight excess of reagents gave quicker precipitation. The author was working with water lower in magnesium salts than was generally found in the Leeds district; the usual experience was that as the amount of magnesia rose the difficulty of softening increased. He thought it would generally be found that a greater proportion of the magnesium salt (as compared with the lime) remained in the softened water. The author's observation that old precipitate or the use of a vessel for softening that had already been used for the purpose, gave better results, was borne out in practice. His (the speaker's) experience was that in water softening better results were obtained on the works scale than in the laboratory, where naturally clean vessels were used. On the question of quick sedimentation he had found that a tall cylindrical vessel put in a sloping position gave quicker sedimentation than when the vessel stood upright. This observation was due to Mr. Miller after he (the speaker) had

used the sloping tank on works scale for quick sedimentation because of other advantages.

Mr. B. G. McLELLAN said the author had made some interesting statements regarding the length of time required for "completion" of the softening reactions with a moderately hard water, and with the theoretical quantity of chemicals; with very hard water, above 70 parts per 100,000 total hardness, this period was even greater, and plants were often designed which were inadequate in this respect. The result was that the softening was completed on the way to the boilers where it was least desirable. Further research on the reaction velocity of the lime and soda softening process was required. The increase in temperature mentioned by the author as a means of hastening completion was so slight that the method might be adopted even by those who require a cold softened water. The Archbutt-Deeley process of employing old sludge for hastening reaction and settling was interesting; he had tried to adapt this idea to a continuous softener, but so far without success. The idea of a sloping surface mentioned by Mr. Mackey was, he understood, embodied in the French "Desrumaux" plants.

Mr. MACKEY said that he did not think the sloping tank principle was used in the "Desrumaux" system. He thought there was a spiral arrangement for dealing with the precipitate. In the Archbutt-Deeley process his recollection was that the clear or almost clear water was pumped from the upper part of the tank in about twenty minutes after the blowing up of the old precipitate; this showed that the precipitation process was considered to be complete within say half an hour after adding the chemicals.

Mr. WOOD said in reply that if dilute hydrochloric acid be added when the precipitation had reached the "milky" stage, immediate clearing took place, but later on no appreciable change was apparent in the time required for a titration, the inference being that these larger particles were not attacked to any marked extent. The figures given for the removal of hardness by lime alone did not refer to total, but to temporary hardness. It was not possible, using theoretical quantities of reagent, to push the hardness below 3.5°. By the use of excess of soda, however, it was possible to reach 2.6°, but owing to the excess solids in the water giving rise to "priming" there was no advantage in so doing. Softening with the "theoretical" amount of lime as usually calculated was slow. This really amounted to a deficit of lime, as further lime was required to combine with free carbon dioxide in the water, to precipitate part of the magnesium permanent hardness and to allow for impurities in the lime. By adding successive amounts of lime a point had been found at which the hardness was a minimum, and the amount of lime required was in excess of that calculated in the ordinary way. Most of his experiments had been confirmed on the plant as well as in the laboratory.

Communication.

ON THE PERMANENT SET OF RUBBER.

BY O. DE VRIES AND H. J. HELLENDORF.

In the mechanical testing of rubber a study is often made of the permanent set or some other form of set or deformation. A further study of this property seemed desirable, in the first place because little is known of its relationship to other mechanical or chemical properties, so that it is still an open question whether the determination

of permanent set ought to be included in the routine testing of raw rubber or not; in the second place because the permanent set being admittedly dependent upon the state of cure of the vulcanised rubber (the set for instance for rubber-sulphur mixtures being greatest for undercured material and diminishing as the cure proceeds), no definite data have been published up till now to reveal the numerical side of this relationship.

Schidrowitz has laid full stress on the fundamental importance of an exact determination of the state of cure in all mechanical tests on vulcanised rubber and of comparing mechanical properties only for the same or for a comparable state of cure*; much confusion in the literature must be ascribed to neglect of this point. In the present paper we intend to bring forward some data bearing on the study of the relationship between permanent set and state of cure, and between the permanent set at a standard state of cure and other mechanical properties of rubber, especially the "type" after Schidrowitz.

Experimental.

For vulcanisation all samples were mixed in the proportion of 92½ parts of rubber and 7½ of sulphur and vulcanised in steel frames between steel plates in live steam at 148° C. for different lengths of time.† To determine the state of cure some of the rings of one slab were tested on the Schopper stretching machine, whilst others were used for the determination of permanent set.

To express the state of cure three methods might have been chosen, viz., (1) the time of cure at 148° C.; (2) the coefficient of vulcanisation; (3) the position of the curve obtained on the Schopper stretching machine, which we express by giving the length at a load of 1.30 kilos. per sq. mm. (which is determined graphically, by plotting on millimetric paper the average breaking point of the rings tested, and taking the length at a load of 1.30 kilos. by using the slope of the final part of the curve, taken directly from the graphs drawn by the testing machine). For our present purposes we chose the third method, since the second involved a large number of tedious sulphur determinations, and gives figures which run exactly parallel to the "length at 1.30 kilos."; the first is not so exact, as small errors in temperature during vulcanisation are not eliminated.

For the determination of the permanent set we use the method of the "Ryksvoorlichtingsdienst" at Delft. Rings of the same dimensions as used on the Schopper stretching machine (inner diameter of the rings 44.4 mm., breadth 3.75 mm., thickness 5 mm.), are stretched on a specially made glass plate 8 mm. thick, with rounded edges, and cut obliquely at one corner to facilitate putting on and taking off the rings. The length of the glass plate is so chosen that the rings are stretched to five times their original length (elongation four times original length). Before being put on the glass plate the rings are measured on a Schopper testing machine for determination of permanent set, the total weight used for stretching being 200 grms. The original length under this weight of course varies somewhat with the state of cure, the readings differing about 1 mm. After remaining on the glass plate for 24 hours the rings are taken off and six hours later the length is again determined. We take the precaution to put the ring on the glass plate in a fixed position with a mark (series number of the ring) in the middle between the edges, and to put it on the testing machine in exactly the same position before as after stretching, with the mark below. This tends to avoid errors due to small differences in the breadth of the ring

* The Rubber Industry, 1914, p. 212; Rubber Recueil, Batavia, 1914, p. 373.

† For further details see India Rubber Journal, 53, 101.

or to slight unevennesses of the inner surface and to the greater strain the ring has undergone on the edges of the glass plate. The original length (half of the inner circumference) of the rings being 70 mm., a difference of one-half in the permanent set means only 0.35 mm. difference in the measured length or elongation, so that only the average of a fair number of determinations is reliable; the more so as the reading of the length before and after stretching is always more or less conventional, the ring keeping on stretching slowly over several tenths of a millimetre under the applied weight of 200 grms., and even the way in which the weight is applied (smoothly or abruptly) having influence upon the result. We read the length immediately after the ring has come to apparent rest after letting down the weight slowly. The elongation calculated as percentage of the length before stretching (70 mm.) gives the permanent set.

Relationship between permanent set and state of cure.

That the permanent set varies with the state of cure and is greater for undercured than for longer cured rubbers is a well known fact, which needed no further corroboration. But no numeri-

cal data were available as to the relation between permanent set and state of cure, enabling one, for instance, to calculate the permanent set for a chosen (say a fixed standard) state of cure from determinations on a sample cured differently. We therefore collected sufficient lots of homogeneous samples of various types of rubber and determined the permanent set for each of them in several states of cure. Fig. 1 gives four of the curves so obtained, the state of cure being expressed as "Length at a load of 1.30 kilos." (see above). No. 41, a first latex crêpe rubber, has a low permanent set, whilst No. 117 C, a bark crêpe, shows high figures in all states of cure.

Table I. contains data for 15 typical samples of ordinary plantation rubber. From the data of the ordinary types (Nos. 1—10) so obtained we calculated the slope of these curves in the neighbourhood of 990% and of 1025% (see columns 7 and 8 in Table I.) and found the following average values: for a state of cure expressed by a "length at a load of 1.30 kilos." of 990%, the increase in permanent set is 0.08 for an increase of 10 in "length at 1.30 kilos.;" for a state of cure expressed by a "length at a load of 1.30 kilos." of 1025% the increase in permanent set is 0.15 for an increase of 10 in "length at 1.30 kilos."

TABLE I.

1	2	3	4	5	6	7	8	9	10
Sample No.	Description.	Type (Schidrowitz).	State of cure. Length at 1.30 kilos.	Permanent set.	Number of rings tested.	Slope of curve for a "Length at 1.30 kilos."		Permanent set for standard cure (Length at 1.30 kilos. = 990%).	Difference with average curve (Table III.).
						990%	1025%		
41	first latex crêpe	35½	1047 1007 997 977	3.15 2.64 2.56 2.49	16 8 10 4	— — — —	0.13 — — —	— — — —	— — — —
125	lump-crêpe	38	1046 1009 1004 1000 980	3.97 3.54 3.50 3.44 3.30	4 9 5 4 5	— — — — —	— — 0.12 — —	2.54 — — — —	+0.16 — — — —
184	smoked sheet	40	1056 1022 1007 970	4.57 4.25 4.12 3.86	4 5 15 4	— — — —	— — 0.10 —	— — — 4.00	+0.17 — — +0.10
117 C	bark-crêpe	42	1070 998 875	5.90 4.60 4.28	3 2 3	0.07 — —	— 0.18 —	— — 4.10	— — -0.26
13	first latex crêpe	35	1059 1000 982	3.00 2.22 2.24	6 6 4	— — —	— 0.13 —	— — 2.23	— — +0.03
90	first latex crêpe	36	1032 1019 1000 989	3.03 2.90 2.51 2.35	4 6 4 4	— — — —	— 0.16 — —	— — — 2.36	— — -0.17 —
37	first latex crêpe	37	1038 1008 975 960	3.61 2.93 2.72 2.57	3 6 6 6	— — — —	— — 0.06 —	— — — 2.82	— — -0.05 —
59	first latex crêpe	37	1057 1028 1002	3.89 3.25 2.86	8 9 4	— — —	— 0.15 —	— — 2.68	— — -0.19
220	imitation Para-ball	38½	1013 1002 980	4.30 3.93 3.60	5 6 4	— — —	— — —	— — 3.75	— — +0.38
194	scrap-crêpe	40	1056 1024 1007 983	4.60 4.40 3.96 3.75	4 14 3 4	— — — —	— 0.13 — —	— — — 3.81	— — — -0.09
355	washing	41	1075 1022 987	5.15 4.87 4.30	4 10 8	— — —	— — 0.16	— — — 4.4	— — — +0.10
359	washing	44	944 1059 1007 956 932	3.93 7.45 5.92 5.50 5.07	3 2 7 3 5	— — — — —	— — 0.29 — —	— — — 5.8 —	— — — — —
112 S	washing	50	985	10.2	2	—	—	10.3	—
203	washing	51	960 945 930	11.4 11.5 11.3	4 6 4	— — —	— — —	— 11.4 —	— — —
356	washing	53½	1008 940	16.6 15.0	3 2	— —	— 0.24	— —	— 16.2

From these figures the lowest curve in Fig. 1 is constructed, giving the average increase in permanent set for different states of cure. For the correction and reduction of permanent set at different states of cure the following table may

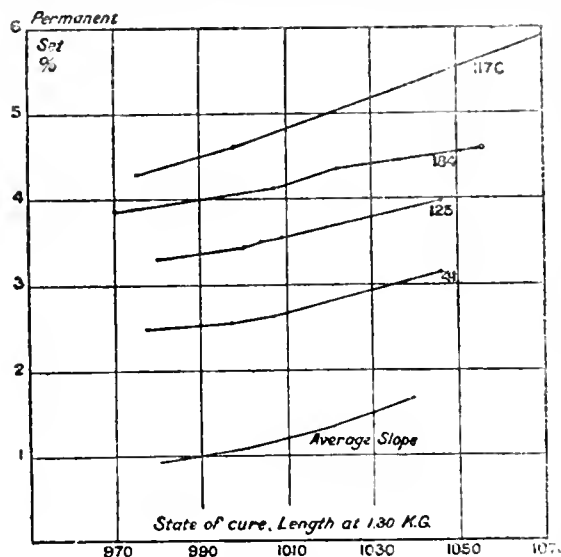


FIG. 1.

Permanent set for different states of cure, four samples from Table I.
Below: average slope of ten samples (Table I.).

be used, which gives in the first column the state of cure at which the permanent set was determined, and in the second the correction to obtain the permanent set at our standard cure (length at a load of 1.30 kilos. = 990 %).

TABLE II.

Length at 1.30 kilos.	Correction in permanent set.
1040	- 0.65
1020	- 0.48
1020	- 0.33
1010	- 0.20
1000	- 0.09
990	—
980	+ 0.07

By simple calculation similar tables can be drawn up for the reduction to other standard states of cure.

The above curve and Table II. give the *average* from our determinations; our experimental data, however, are not sufficient to determine whether the curves in Fig. 1 run parallel in all classes, i.e., if the decrease in permanent set for the same increase in state of cure is the same for all types of rubber. It might be that for rubbers with a high permanent set the curve is somewhat steeper; a large number of determinations would be necessary to settle this point, which we did not deem to be of sufficient importance to justify the amount of work it would involve being undertaken at present.

Relation between permanent set and "type" after Schidrowitz.

The determinations of permanent set for fifteen samples mentioned above enabled us to fix the permanent set of these samples at our standard state of cure, for which we chose the cure at which the length at a load of 1.30 kilos. is 990 % of the original. The values are found in

the ninth column of Table I. These values show a close relationship with the property called "type" by Schidrowitz, which expresses the slope of the stress-strain curve as obtained on the Schopper-machine for high elongations and is calculated by means of the formula: *

(Length at a load of 1.04 kilos. — length at a load of 0.60 kilo.) $\times 0.4$.

Schidrowitz attaches high importance to this factor in judging the quality of the rubber, a low figure for "type" meaning little stretching by a fixed increase in load and therefore a high quality of rubber.

In Fig. 2, the values of permanent set at our standard state of cure are plotted against the "type" of the samples after Schidrowitz: it

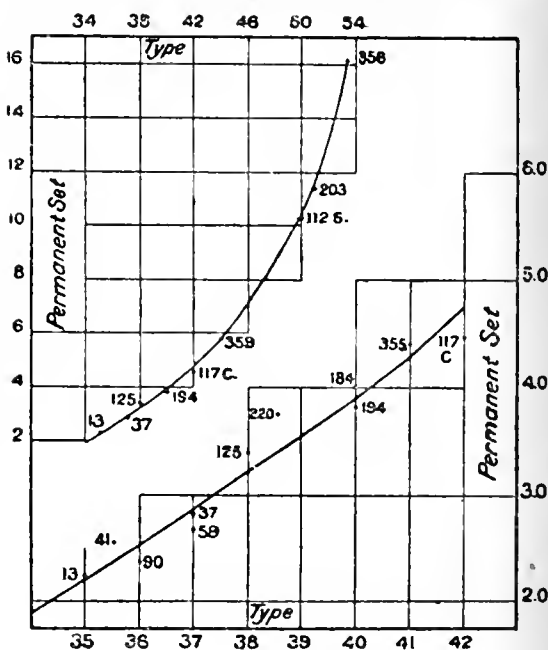


Fig. 2.

Relation between permanent set at standard state of cure, and slope of type of the stress-strain curve after Schidrowitz (see Table III.).

Below: lower part of the curve, representing the normal types of rubber, on an enlarged scale.

will be seen that the points lie very approximately (within the limit of 0.2 in permanent set) on a curved line, which for ordinary rubber with a figure for type of 34 to 40 is nearly a straight one. The following values are found for the line representing the average:

TABLE III.

Type.	Permanent set.
34	1.9
35	2.2
36	2.53
37	2.87
38	3.2
39	3.54
40	3.9
41	4.3
42	4.75

From Table I. it will be seen that the greatest deviations from this average are 0.38 in permanent set for sample 220 (imitation Para-ball) and 0.26 for sample 117 C (bark crêpe), whilst for the

* Schidrowitz and Goldsborough, India Rubber J., 51, 505.

other samples the average deviation is only 0.12 and does not exceed 0.2. As "type" is only determined with intervals of 1, and the permanent set even with a large number of rings is subject to a rather large experimental error, the relation between permanent set and type may be regarded as very close.

To test this relationship further we may make use of our determinations of permanent set on a number of other samples (Table IV.). As the determinations were not all made at the standard state of cure, we reduced the values in column 5 of Table IV. to those of column 7, using the correction from Table II. where needed. In plotting the values so obtained in Fig. 2, it will be seen that for 29 samples the figures do not differ from the curve by more than 0.3 in permanent set, the average difference being ± 0.11 . As the number of rings from which the permanent set is derived was seldom more than 2 or 3, this deviation must be regarded as lying well within the limits of experimental error. Four samples (153 O, P, S, T) show a difference of +0.34 to +0.58; these are smoked sheet coagulated by a solution in water of the gases from burning sulphur. Only four samples show a very marked difference, viz., Nos. 386 and 524 (crêpe prepared from slab rubber) +0.80 and +1.25, No. 33 B (crêpe more than 1 cm. thick) +1.07, and No. 32 (imitation Para-ball) +1.72.

It is interesting to note that these four samples all contain more serum-substances than ordinary estate rubber and are rapid curing; No. 220 however, the imitation Para-ball mentioned in Table I, shows a smaller deviation (+0.38) than that found for this sample No. 32. It may be remarked that sample 134 E, first clot obtained by partial coagulation, which contains more nitrogen, resin, and ash than ordinary crêpe, shows the normal proportion between permanent set and type.

Conclusions.

The permanent set of vulcanised mixtures of 92½ parts of rubber and 7½ parts of sulphur, determined by stretching rings for 24 hours to five times their original length and reading the set after six hours' rest, decreases with advancing state of cure, the average decrease being expressed by the lower curve in Fig. 1 and by the figures in Table II. These data allow one to calculate the set at our (or any other) standard state of cure from determinations at other states of cure.

The permanent set for our standard state of cure shows a very close relationship with the property called "type" by Schidrowitz, being the slope of the stress-strain curve for high elongations. This relationship is expressed by Fig. 2 and

TABLE IV.

1	2	3	4	5	6	7	8
Sample No.	Description.	Type (Schidrowitz).	State of cure. Length at 1:30 kilos.	Permanent set.	Number of rings.	Permanent set at standard state of cure.	Difference with average curve (Table III.).
129 B—E	smoked sheet	39	1005 975	3.7 3.4	4 2	3.53 —	-0.01 —
142	first latex crêpe	38	1013	3.39	4	3.15	-0.05
144 A—E	smoked sheet	36½	1028	3.06	5	2.60	-0.10
145 B	first latex crêpe	37	982	2.75	4	2.80	-0.07
145 C—F	ditto	37	1006	2.93	4	2.78	-0.09
146 A	smoked sheet	37½	994 956	3.0 2.90	2 2	— 2.99	— -0.05
146 B	ditto	38	956 1009	3.03 3.05	2 2	— 3.05	— -0.15
153 C	smoked sheet	39	970 974	3.43 3.76	2 2	— 3.72	— +0.18
153 D	ditto	39	973	3.21	2	3.92	-0.22
153 E	ditto	39½	993 1020	3.86 4.18	3 2	— 3.83	— +0.13
153 G	ditto	38½	979	3.35	2	3.43	+0.06
153 H	ditto	39	973	3.21	2	3.32	-0.22
153 L	ditto	39½	993	3.81	2	3.78	+0.08
153 K	ditto	39	985	3.43	3	3.46	-0.08
154 A	first latex crêpe	38	980	2.93	3	2.94	-0.26
154 C	ditto	38½	993	3.5	3	3.47	+0.10
154 L	ditto	39	974	3.15	3	3.25	-0.29
154 M	ditto	39	991	3.72	3	3.71	+0.17
171	first latex crêpe	37	983	2.79	3	2.84	-0.03
491	first latex crêpe mixed normally	37	1017	3.15	3	2.88	+0.01
491	ditto mixed on very hot rolls	37	1008	3.14	3	2.95	+0.08
134 A	first latex crêpe, after partial coagulation	36	1024 977	2.64 2.58	3 4	— 2.59	— +0.06
134 E	first latex crêpe, first clot in partial coagulation	35½	1007	2.46	2	2.29	-0.07
140 A	first latex crêpe, after partial coagulation	35½	1011	2.7	5	2.49	+0.13
112 R	scrap	39½	1018 987	3.75 3.68	4 3	— 3.70	— -0.02
112 T	lump	38	974 998	3.17 3.07	2 4	— 3.13	— -0.07
113 U	Compo (lump, scrap, bark)	39	1025 998	4.3 3.85	3 3	— 3.83	— +0.29
117 A	scrap	39½	993	3.81	2	3.78	+0.06
117 B	lump	37½	1023	3.48	4	3.10	+0.06
32	imitation Para-ball	39	1007 983	5.4 5.25	2 3	5.26 —	+1.72 —
386	slab-rubber crêped	34	1025 977	3.07 2.53	6 9	— 2.70	— +0.80
524 N	slab-rubber	33½	995	3.04	6	3.0	+1.25
524 N	the same, washed and crêped very thoroughly	33½	1000 969	3.10 2.86	3 3	3.02 —	+1.27 —
33 B	very thick crêpe	36	1056 1000	4.88 3.67	14 5	— 3.6	— +1.07

Table III., and takes the form of a curve, which for ordinary estate rubbers with a figure for "type" of 34 to 40 may be regarded as a straight line. Only for some special cases of rubber with an abnormal content of serum-substances (imitation Parahall, slab rubber after Eaton, rubber completely dried as very thick crêpe) marked deviations were found.

As the "type" in ordinary routine testing of

raw rubber can be determined in the same operation as tensile strength, a separate test for permanent set—when using the above-named mixture of rubber and sulphur only—is superfluous for ordinary samples; only in the case of rubber prepared by special methods a deviation from the above given relationship may occur and lead to valuable conclusions.

Central Rubber Station, Buitenzorg.

Journal and Patent Literature.

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Patents from 1908 to date, L'Imprimerie Nationale, 87, Rue Vieille du Temple, Paris.

I.—GENERAL; PLANT; MACHINERY.

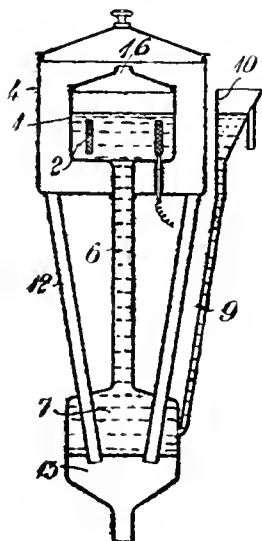
Design and manipulation of gas furnaces. Forshaw. See 11A.

PATENTS.

Heating and boiling pans, heated calendering rollers, heating tables and like apparatus. H. V. Senior, Bracebridge Heath, Lincolnshire, Eng. Pat. 110,803, Nov. 4, 1916. (Appl. No. 15,767 of 1916).

AN oil bath or jacket, provided with an extension to maintain an approximately constant level, is interposed between the boiling pan and the source of heat; the area of oil surface in the extension is large compared with the annular area of the oil bath. The gas and/or the air are preheated on their way to the burners by being passed through coils or around annular partitions in the space between the oil bath and the outer casing. Means are provided for automatically controlling the temperature of the oil.—W. H. C.

Distillation of liquids. O. Stalhane and O. O. Kring, Ludvika, Sweden. Eng. Pat. 110,821, Nov. 27, 1916. (Appl. No. 16,998 of 1916.)



THE water or other liquid is fed into the constant level device, 10, and passes down the pipe, 9, into the reservoir, 7. It then flows up the pipe, 6, into the still, 1, where it is vaporised by the electric heater, 2. The vapours pass out of the aperture, 16, into the outer condensing chamber, 4, and thence through the pipes, 12, into the reservoir, 13.—W. H. C.

Evaporating apparatus. Kestner Evaporator and Engineering Co., Ltd., J. A. Reavell, and W. G. Mann, London. Eng. Pat. 110,921, Oct. 6, 1916. (Appl. No. 14,208 of 1916.)

EVAPORATING apparatus, more particularly for use in de-salting saline solutions, comprises a tubular

heater and a vapour separator. Valved pipes connect the top of the heater with the vapour space of the separator, and the bottom of the heater with the separator at a point just below the liquid level. To ensure better circulation and quicker heating from the cold, an additional valved pipe is provided connecting the bottom of the separator with the pipe leading to the bottom of the heater, or directly with the bottom of the heater. The valve in this pipe is closed after the liquid in the system is heated.—W. F. F.

Refrigerating process and apparatus. C. Cortesi, E. Prassone, E. Erani, and A. Contin, Rome. Eng. Pat. 103,312, Jan. 13, 1917. Under Int. Conv., Jan. 13, 1916. (Appl. No 655 of 1917.) Addition to Eng. Pat. 1853, Feb. 5, 1915.

IN a refrigerating apparatus of the type described in the principal patent, liquid is evaporated in a boiler, the vapour operates an ejector and is condensed, and the condensed liquid returns to the boiler by gravity. Part of the liquid from the condenser circulates through an expansion coil where it is vaporised, and returns to the condenser through the ejector which causes the circulation. Two liquids of different specific gravities which do not mix are now used, the heavier, such as mercury or water, circulating through the boiler, ejector, and condenser, and the lighter, such as ether or benzol, circulating through the condenser, expansion coil, and ejector.—W. F. F.

Pulverising mills. The Raymond Brothers Impact Pulverizer Co., Assignees of R. A. Lachmann and W. B. Senseman, Chicago, Ill., and A. W. Raymond, Evanston, Ill., U.S.A. Eng. Pat. 101,962, July 24, 1916. (Appl. No. 10,411 of 1916.) Under Int. Conv., Oct. 23, 1915.

THE discharge port of a pulveriser is provided with a regulator to control the fineness of the product, consisting of a series of radial arms mounted on a shaft by which it is rotated and along which it can be moved to or from the conical outlet so that the size of the opening is varied. A current of air is passed through the pulveriser to remove the product.—W. H. C.

Grinding mills and the like. W. A. Cloud, London. Eng. Pat. 110,816, Nov. 23, 1916. (Appl. No. 16,817 of 1916.)

THE materials are passed between a number of rotary discs which alternate with fixed discs and are surrounded by a casing. The discs have rows of grinding pins of square or angular cross section mounted on their faces, and the discs themselves are of increasing diameter and set closer together from the inlet to the outlet of the machine. The casing is divided into compartments by fixed or

rotating partitions provided with openings for the passage of the materials from one compartment to the next.—W. H. C.

Tube mills; Liner for —. F. E. Johnson, Salt Lake City, Utah, Assignor to American Manganes Steel Co., Augusta, Me. U. S. Pat. 1,243,742, Oct. 22, 1917. Date of appl., May 26, 1916.

A TUBE mill with central cylindrical portion and conical ends is provided with a liner consisting of a number of lining plates with bevelled edges. The plates are locked and held in position by removable wedge-shaped holding bars, those in the cylindrical part of the mill extending beyond the outer working surface of the lining and those in the conical portion diminishing in height above the outer surface of the plates towards the ends remote from the cylindrical portion of the mill. These ends of the bars lie flush with the face of the lining plate.—J. H. P.

[*Tunnel*] *furnaces*. C. M. Stein et Cie., Paris. Eng. Pat. 106,606, Nov. 24, 1916. (Appl. No. 16,895 of 1916.) Under Int. Conv., May 25, 1916.

IN a tunnel furnace of the kind in which the material passes in succession through a preliminary heating passage, a central maximum temperature passage, and a progressive cooling passage, the two passages of lower temperature are heated by independent supplies of fuel and air without the use of regenerators. The gas and air for heating the central passage, or the air only, pass through continuous or alternate regenerators to the central combustion space of the furnace.—W. F. F.

Furnaces and the like; Method of and means for lining or re-lining —. I. Hall, Birmingham. Eng. Pat. 111,007, Jan. 31, 1917. (Appl. No. 1558 of 1917.)

IN the method of lining, re-lining, or repairing furnaces and the like by the insertion of a core around which the refractory material is placed and subsequently withdrawing the core, the lower part of the furnace is enlarged to form a combustion chamber and a corresponding supplementary annular core is also used. The combustion chamber may be in the form of a frustum of a cone with or without a lower cylindrical portion. An additional core may also be provided to form a tangential inlet to the combustion chamber. The annular core may be made in sections to facilitate withdrawal.—W. F. F.

Extracting dust from gases and vapours, applicable also for collecting particles of flour, cement, and other substances; [Electrical] apparatus for —. G. A. Gallot, Paris, and P. M. N. Poussin, Pantin, France. Eng. Pat. 110,774, Sept. 28, 1916. (Appl. No. 13,826 of 1916.)

To prevent sparking and so allow a current of greater intensity to be used in electrical dust separators, the central electrode, if a wire, is provided at the inlet and outlet with sleeves of glass, mica, or other dielectric medium, mounted concentrically upon the wire and projecting some distance into the surrounding perforated cylindrical electrode. If the central electrode is a wire cylinder then both ends are tapered or rounded off to increase the spark gap.—W. H. C.

Expressing liquid from materials [sewage sludge and fish refuse] containing the same; Process for —. J. W. Hinchley, London, and G. Gorton, Bexhill-on-Sea. Eng. Pat. 110,601, Oct. 26, 1916. (Appl. No. 15,262 of 1916.) Addition to Eng. Pat. 3998, Mar. 13, 1915 (this J., 1916, 1254).

THE process for expressing liquids described in

the principal patent is applied to sewage sludge and fish refuse. The preliminary pressing is carried out at a pressure of about $\frac{1}{2}$ ton per sq. in., the steam admitted at about 200 lb. per sq. in. and at a temperature about 380°F. (193°C.), and the final pressing carried out at about 2 tons per sq. in.—W. F. F.

Desiccating fluids; Means and methods of —. C. E. Rogers, Detroit, Mich. U.S. Pat. 1,243,878, Oct. 22, 1917. Date of appl., Sept. 17, 1914.

THE fluid is sprayed into and falls through a current of heated air in a chamber, and the moist air passes through a screened aperture in the chamber wall near the bottom.—J. H. P.

Dryer. [Process of drying.] C. A. Wendell, Joliet, Ill. U.S. Pat. 1,244,007, Oct. 23, 1917. Date of appl., June 12, 1915.

GRANULAR or lumpy material is fed by a flowing stream to successive sections of an annular mass of the material which is rotated to expel water, and the material is expelled in successive sections by centrifugal force. The discharged section is just in advance of the section which is being fed.—J. H. P.

Liquid and gas contact apparatus. A. M. Webb, Charlotte, N.C. U.S.A. Eng. Pat. 110,724, June 30, 1917. (Appl. No. 9452 of 1917.)

IN an apparatus for intimately mixing vapours or gases with each other or with liquids, e.g., in the manufacture of sulphuric acid, a number of short tubular mixing devices are packed in a tower. Each mixing device comprises a tube spirally corrugated and provided internally and externally with helices corrugated longitudinally and of opposite pitch. The whole is enclosed in an outer tube. The gases enter at the bottom of the tower, passing upwards through the mixing devices, which are arranged in staggered relation, and the absorbing liquid is sprayed into the top of the tower.—W. F. F.

Vacuum pumps and compressors used for the pneumatic transport of grain and granular materials. C. Bentham, and Henry Simon, Ltd., Manchester. Eng. Pat. 110,983, Dec. 16, 1916. (Appl. No. 18,090 of 1916.)

PISTON rings for vacuum pumps or air compressors, for use in pneumatic apparatus for the transport of grain or granular materials, are made wholly or partly of anti-friction metal or alloy so that liquid lubricant is unnecessary. The rings are provided with recesses filled with graphite or other dry lubricant.—W. F. F.

Washing sand; Machines for —. J. Southall, Worcester. Eng. Pat. 111,061, June 26, 1917. (Appl. No. 9147 of 1917.)

A SAND washer comprises a tank the bottom of which is composed of parallel cylindrical sections each provided with a paddle stirring device. All the bearings are above the surface of water in the tank. Sand to be washed is introduced at one end, passes through the compartments of the tank in succession, and is withdrawn from the last compartment by rotating scoops from which it is discharged at the inner ends into the smaller end of a concentric horizontal cone. Suitable drain holes for water are also provided in the scoops. The sand finally passes out from the larger end of the cone, and washing water passes through the tank in the reverse direction to that of the sand.—W. F. F.

Thermostats. H. H. Grundy, London, Eng. Pat. 110,938, Nov. 7, 1916. (Appl. No. 15,962 of 1916.) Addition to Eng. Pat. 5311, Mar. 2, 1912.

Valves for controlling, reversing, and by-passing the flow of gas through scrubbers, purifiers, condensers, and the like. R. Dempster and Sons, Ltd., and J. E. Horsfall, Elland, Eng. Pat. 111,036, Mar. 28, 1917. (Appl. No. 4177 of 1917.)

Adhesive, plastic, or semi-fluid substances; Process and apparatus for extracting fluid from—. A. N. Hood, Newton, Mass., U.S.A. Eng. Pat. 110,737, Sept. 11, 1917. (Appl. No. 13,035 of 1917.)

SEE U.S. Pat. 1,240,816 and 1,212,518 of 1917; this J., 1917, 1191, 1227.

Gas burners for metallurgical and other furnaces. Eng. Pat. 110,960. See IIa.

Method of and apparatus for draining and concentrating coal and other slimes and materials of a like nature. Eng. Pat. 110,994. See IIa.

IIa.—FUEL; GAS; MINERAL OILS AND WAXES.

Coals; The nitrogen content of oxidised—. P. Mahler, Comptes rend., 1917, 165, 634—636.

THE percentage of nitrogen in coal varies from 0.7 to 2.5%. The author confirms the view of H. Fayol that the main effect of the action of air on coal is to oxidise and dehydrogenate the organic matter, with formation of humic matters. Analyses were made of eight samples of Decazeville coals which heat up readily under the action of oxygen and ignite spontaneously. The specimens were taken at the outcrop at Combes in the vicinity of an interstratification of sandstone, where coals with various degrees of oxidation are formed, from those of 8000 cal. and 36% of volatile matter to 5200 cal. and 52% of volatile matter. Calculated on the pure coal substance the carbon ranged from 81.4% to 64.9%, the hydrogen from 5.3% to 3.0%, the nitrogen from 1.7% to 2.5%, the oxygen and sulphur (by difference) from 11.6% to 29.6%. The percentage of humic matter in the raw coal increased from 0.5 to 70%. Allowing for ash and water, the proportion of nitrogen is very little altered except in the coals greatly decomposed and almost completely transformed to humic matter, in which case the nitrogen content appears to increase, approaching the figure met with in ordinary vegetable humic matter.—J. E. C.

Ignition of gaseous mixtures; Temperature of—. J. W. McDavid. Chem. Soc. Trans., 1917, 111, 1003—1015.

MEASUREMENTS of the temperature of ignition of a number of gaseous mixtures were made by igniting a small volume of the mixture contained in a soap bubble by means of a heated body, the temperature of which could be noted as ignition took place. Several forms of ignition apparatus were tested; that finally adopted consisted of a platinum wire wound round mica, and connected with storage batteries, a variable resistance, and an ammeter. Ammeter readings for four known temperatures were taken by melting small quantities of pure salts of known m.p.s. on the wire. A graph was constructed from these readings whereby the temperature could be determined from the amperage. This was found more reliable than using a thermo-couple. Results obtained for the ignition temperature of various mixtures by this method were as follows:—coal gas—air, 878° C.; ethylene—air, 1000° C.; hydrogen—air, 747° C.;

carbon monoxide—air, 931° C.; petrol—air, 995° C.; benzene—air, 1062° C.; ether—air, 1033° C.

—L. A. C.

Flame; "Uniform movement" during the propagation of—. W. Mason and R. V. Wheeler. Chem. Soc. Trans., 1917, 111, 1044—1057.

THE authors discuss deductions of Mallard and Le Chatelier (Ann. des. Mines, 1883, [viii.], 4, 274) and others concerning the speed of flame during "uniform movement," especially that one according to which, in mixtures having the same conductivity for heat, the speed of the flame during the uniform movement should be directly proportional to $T-t$, and inversely proportional to $l-\theta$ (T , t , and θ are respectively the temperatures of the gases during combustion, during ignition, and before ignition.) It is shown experimentally that this relation holds very closely for mixtures of methane and oxygen in which complete combustion takes place; when, however, combustion is incomplete, the above ratio is generally higher than the velocity requires. In measuring the velocities of flame, the tubes employed should be between 5 and 10 cm. in diameter. Under 5 cm., cooling by the walls of the tube reduces the velocity to a considerable extent; above 10 cm., convection currents cause vibratory movements which increase the true velocity. Ignition should be effected at or within 3 or 4 cm. of the open end of the tube; if it takes place within the tube, flame travels in both directions from the point of ignition, resulting in vibratory motion, and very variable speed records are obtained.—L. A. C.

Sulphur; Use of the water from the Lewis-Thompson calorimeter for the determination of— in fuels. P. Falcicola. Annali Chim. Appl., 1917, 8, 77—82.

IN calorimetric determinations of lignite and other fuels in the Lewis-Thompson calorimeter, sulphur is completely oxidised to sulphuric acid. It may be readily determined by evaporating 500 c.c. of water from the calorimeter to a small bulk, acidifying the liquid with hydrochloric acid, and precipitating the sulphur as barium sulphate. The results thus obtained with lignites containing from 1 to 4% of sulphur were about 0.1% higher than those obtained by Eschka's method.—C.A.M.

Gas furnaces; Design and manipulation of—. A. Forshaw. Manchester and District Junior Gas Association, Nov. 2, 1917. Gas J., 1917, 140, 327—331, 372—375.

THE thermal efficiency of coke-fired crucible furnaces is very low, being only 5% for the best pit furnaces and 15% for the best tilting furnaces. The fuel costs are, however, also so low that it is only by studying all the factors that the cost of melting metals by coke and by gas can be compared. Great care should be taken of the linings of gas furnaces, to minimise wear or corrosion by the slagging of spilt metal. Apart from the interference of molten slag with the burners, destruction of the lining leads to enlargement of the combustion space round the crucible and consequent increased fuel consumption. Accumulation of slag should be prevented. Using gas furnaces, melts can be put through more quickly, so that the output of a given number of furnaces can be increased from 50% upwards. Hints are given on the care of crucibles, preliminary annealing, drying, and attention to the action of fluxes. The labour costs of melting by gas are less than by coke firing, no fuel and ash having to be handled. The life of the crucibles is also usually longer. In works practice the gas consumption is determined by a number of factors, which must be taken into consideration in estimating the practical efficiency of melting with gas. The author does

not favour the use of high pressure gas as against air blast. Increased efficiency can be attained by preheating the metal by means of the hot products of combustion, the saving of gas being as much as one-third. On the other hand, recuperation in small gas melting furnaces has not yet been found of any appreciable benefit. Preheating, however, may prove injurious by oxidation of the metal, involving changes of composition and properties. Gas-heated annealing ovens may be of the natural draught or air blast types, or of an intermediate type using air driven by a low-pressure fan at 6 in. water pressure. The ovens are generally heated internally to diminish gas consumption, and it is desirable to provide means for making the atmosphere oxidising or reducing to suit the materials under treatment. Hardening and tempering of steels are discussed and the advantages of salt baths with controlled temperatures are emphasised where precision is important. The manipulation of gas furnaces is facilitated by uniformity of composition, calorific value, and pressure of the gaseous fuel. It is often a great advantage to pass the supply of town gas through a governor before use.—H. J. H.

Carbonising coal; Most economical method of — for supplying light, heat, and power by the gas industry and the maximum supply of munitions of war. J. West. Southern Assoc. of Gas Eng. and Managers, Nov. 8, 1917. Gas J., 1917, 140, 314—320.

THE paper gives results of experiments in the carbonisation of coal for various purposes. Tests made on Kent coal (Beresford seam) were disappointing owing to the low percentage of volatile matter and high ash content. Results at high temperature in retorts of the Glover-West type showed a loss of 5½d., and at low temperature of 11s. per ton of coal carbonised. After a few preliminary trials in horizontal retorts, a coal was found of suitable quality. Thus Haigh Moor coal gave in small horizontal retorts 11,800 cb. ft. of gas of 457 B.Th.U. net, 14.57 galls. of tar, 21.6 lb. of ammonium sulphate, and 70% of good quality coke. 1000 tons of this coal tested in Glover-West vertical retorts at St. Helens gave the following results at high and medium temperatures respectively. Temperature inside retorts, 1362° and 1160° C.; gas per ton, corrected, 14,050 and 13,387 cb. ft.; gross calorific value, 556 and 567.7 B.Th.U.; tar per ton of coal, 16.06 and 16.5 galls.; ammonium sulphate per ton of coal, 23.6 and 26 lb. The profit at high temperature is given as £1 1s. 2d. per ton of coal carbonised, and at medium temperature as 18s. 4d. per ton. When the gas, stripped of benzol and toluol, was re-passed through the charge, the make of gas was slightly increased, the volatile matter in the coke was reduced to zero, and the make of tar was increased by some 2 to 3 galls. per ton. The calorific value of the gas, after being stripped of its illuminants, was never below 450 B.Th.U. The advantages of high temperature carbonisation are summarised as follows:—Less ground area is required for buildings, less carbonising plant, capital, and labour, higher yield of gas, better and harder coke, tar and liquor not reduced in quantity and of better quality for war work. The author gives the following results of continuous steaming in vertical retorts built up in segments of special silica material. Temperature outside retorts, 1395° C.; gas per ton, corrected, 15,487 cb. ft.; gross calorific value, 506 B.Th.U.; tar made, 17.7 galls.; ammoniacal liquor (10 oz.), 32.6 galls. With a temperature of 1415° C. and using steam at 45 lb. pressure through a ½ in. nozzle, the gas per ton reached 17,460 cb. ft. of 494 B.Th.U. gross calorific value, with a satisfactory yield of tar of good quality. The retorts do not appear to have suffered unduly through this admission of steam,

as the steam passes through the coke chambers, and arrives at the retort proper in a dry, superheated condition. By steaming the output may be increased by 20 to 25% and the calorific power may at the same time be maintained above 500 B.Th.U., the author recommending a steam pressure of 40 lb. At the Uddingston Gas Works, a yield of 19,450 cb. ft. of gas has been attained with an output of 23.25 gallons of tar and crude benzol and 52.34 lb. of ammonium sulphate. The following advantages of steaming (with Lanarkshire coal) are claimed:—Greater capacity of plant and reduction in labour costs; increase of gas made by 40 to 50%; lower air:gas ratio of gas with increase of flame temperature; low percentage of non-combustible gases; increase of 60 to 70% in tar products, and of 50 to 60% in ammonia products. At Lurgan a yield of 16,046 cb. ft. of gas per ton of an average calorific value of 500 B.Th.U. was obtained. The retorts at Uddingston and Lurgan do not appear to have sustained any damage by steaming, some of the retorts having been in operation over 2½ years. The author considers gas of 450 to 500 B.Th.U. to be the most suitable and economical that can be made for all purposes. The larger amount of shale now delivered with the coal, as compared with pre-war times, is calculated to be equivalent to a loss of 1206 cb. ft. of gas, 1.4 galls. of tar, and 2.8 galls. of 10 oz. liquor per ton of coal carbonised. The following suggestions are submitted to meet the demand of the Ministry of Munitions for tar for war purposes:—A General Act should be passed for the universal application of the calorific power standard, stripped gas should be used for heating retorts in cases where coke is in great demand, and it should be required that shale is picked out at the colliery before delivery. Further, gas undertakings should see that only gas of good quality is supplied to the public.—J. E. C.

Gas from straw. R. D. McLaurin. Gas J., 1917, 140, 326.

THE author discusses the possibilities of straw as a source of gas, more particularly in Canada, where great quantities of straw are wasted annually. Straw is compressed in a baling machine to a density of 25 lb. per cub. ft. and inserted in a retort of highly refined steel, 7 ft. 6 ins. long, 24 ins. wide, and 6½ ins. deep, enclosed in a casing with fire-box below. The total cost, including a scrubber and gasholder, in Canada, is about £105. The temperature reaches a maximum between 500° and 600° C., and all the gas is removed in about 30 to 45 mins. Each ton of straw gives 11,000 to 12,000 cb. ft. of gas, 6 to 8 galls. of tar and ammoniacal liquor, and 600 lb. of carbon residue (lampblack). About 30% of the gas is used to assist the carbonisation, leaving a surplus of 7000 cb. ft. of a calorific value of 400 B.Th.U. per cub. ft., equivalent to 25 galls. of petrol. The gas consists of methane, hydrogen, and carbon monoxide and may be used in the same manner as coal gas.—J. E. C.

Toluol; Recovery of — from gas-works. Advance proof of Report of Sub-Committee of American Gas Institute on Coal-tar By-products. Gas J., 1917, 140, 366—367.

THE report deals with the possibilities in the way of toluol recovery in gas-works in the United States, where, owing to the extensive manufacture of carburetted water-gas, the conditions differ considerably from those met with in British practice. It is estimated that about 3,000,000 gallons will be recovered in gas-works in 1918, whereas about 9,000,000 gallons could be obtained by including all works capable of producing more than 10,000 gallons per annum. The yield of pure toluol is reckoned at 1.6% of the gas oil used in

carburettling. A plant for stripping the benzolised oil by steam is described and the use of a minimum steam pressure of 100 lb. is recommended. It is estimated that steam equivalent to 1.3 H.P. per gallon of light oil distilled will be required. Tanks for the settling of naphthalene from the wash oil are to be used. The estimated scrubbing capacity is 30 cb. ft. per 1000 cb. ft. of gas washed. It is calculated that the loss of illuminating power due to stripping will be about 34% of the candle power communicated to the water-gas by the original gas oil, provided that the crude benzol fraction be returned to the gas. It is usual to carburet with 3.8 gallons of gas oil per 1000 cb. ft. of gas, and as the loss of illuminating power is 1.95 candles per gallon, the fall in illuminating power will be about 7.4 candles. The average loss in heating value will be 27 B.Th.U. or about 5% of the calorific value. As wash oil, a so-called "straw oil," apparently of mineral origin, is recommended, and also creosote oils such as are available and in general use in this country.—H. J. H.

Gasolene; Synthetic — by electrochemical means. L. B. Cherry. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 20 pages. (See also U.S. Pat. 1,229,886; this J., 1917, 863.)

The author has found that when mixtures of heavy hydrocarbon vapours and methane are passed through heated tubes, and there subjected to the electrical discharge of a high-tension, high-frequency oscillating current, intermediate products are obtained. Working on kerosene (sp. gr. 0.81) and natural gas, at a pressure of 75 lb. per sq. in., with 2-ft. treatment chambers and a current at about 40,000 volts, 56% of the kerosene was converted into distillates boiling between 45° and 160° C., with an average sp. gr. of 0.751. By increasing the voltage and frequency of the current, and using 10-ft. treatment chambers, a 78% conversion was obtained with kerosene, and it is expected that by increasing the length of the treatment chambers to 34 ft. an efficiency approaching 100% conversion will be obtained. The total cost of electrical energy for heating the chambers and supplying the conversion current is estimated at 0.4 cent per gallon, based on a cost of supply of 0.6 cent per kilowatt-hour. A detailed description is given of the specially designed high-frequency installation employed.

—T. St.

Gas firing and the glass industry. Cobb. See VIII.

After-contraction or after-expansion of firebricks in oxidising and reducing atmospheres. Mellor. See VIII.

Hot and cold sizes of firebricks. Mellor. See VIII.

PATENTS.

Coal and other slimes and materials of like nature; Method of and apparatus for draining and concentrating —. S. Hunter, and Simon-Carves, Ltd., Manchester. Eng. Pat. 110,994, Jan. 8, 1917. (Appl. No. 333 of 1917.) Addition to Eng. Pat. 22,189 of 1913 (this J., 1914, 410).

WASHED material from the primary sieve, in which the slimes are separated, is conducted to the shaker sieve, and the concentrated slimes returned to the washed material just prior to delivery to the primary sieve, or, by an intermediate sieve, to the washed material passing over the primary or the shaker sieve.—J. E. C.

Coking-furnace. H. G. Stone, Chicago, Ill. U.S. Pat. 1,243,776, Oct. 23, 1917. Date of appl., June 23, 1915.

COAL is passed downwards through a vertical chamber which is heated by a current of gas at a high temperature admitted near the base. The

chamber is provided with a number of perforated dampers, and an outlet for combustion products is arranged in the space above each damper; an outlet for distillation products is also provided in the upper part of the chamber. Means are provided for preventing the admission of air when charging or discharging the furnace.—A. B. S.

Coke ovens; Controllable and removable gas and air nozzles for — and analogous devices. D. Bagley, Westminster. Eng. Pat. 110,053, May 31, 1917. (Appl. No. 7800 of 1917.)

IN a coke oven or analogous device heated by vertical flues, the supply of gas or of air for combustion is controlled by an adjustable nozzle held in position by wings resting normally on the ledges attached to the sides of the flue. The cap of the nozzle is of screw form, capable of being rotated through an angle of 360°, thus regulating the amount of gas passing through side apertures in the nozzle. A protecting nozzle may be fitted in the flue above the gas nozzle to protect the latter from the effects of radiation from the flues, and both nozzles may be removed or controlled from passages underneath the oven structure.

—J. E. C.

Gas producer. H. A. Driffield, Chicago, Ill. U.S. Pat. 1,243,822, Oct. 23, 1917. Date of appl., Jan. 12, 1915.

The producer consists of a shell to contain the fuel, a bosh adjacent to the lower end of the shell, and a table attached to and below the bosh. An undulating motion is imparted to the table and bosh by suitable mechanism.—J. H. P.

Gas burners for metallurgical and other furnaces. H. J. Yates, Birmingham, S. N. and E. R. Brayshaw, Manchester. Eng. Pat. 110,960, Nov. 21, 1916. (Appl. No. 16,662 of 1916.)

A METALLURGICAL furnace is constructed with a separate combustion chamber of L-shape formed in or inserted in the wall of the furnace for each burner. Gas, with an insufficient supply of air, is admitted into the side of the vertical portion of the combustion chamber, whilst an air nozzle delivers air at the upper end of this portion. This air sweeps across the outlet of the gas nozzle and carries the mixed gas and air to the horizontal portion of the burner for combustion. The horizontal portion has flared or inclined sides to allow the flame to spread laterally as it enters the furnace. The burner is specially designed to work with gas at normal (main) pressure and with air of only a few inches head of water; it may, however, be used with gas under pressure.—J. E. C.

Waste oils from motor garages; Utilisation of —. G. E. Heyl, London. Eng. Pat. 110,631, Nov. 10, 1916. (Appl. No. 16,168 of 1916.)

WASTE oil, collected from garages, is filtered and fractionally distilled in presence of 2½ to 10% of caustic alkali. Finely divided carbon, produced by the cracking of the lubricating oils, is thus retained in the still, giving a clear oil.—L. A. C.

Oil-treating device. F. G. White, Los Angeles, and W. J. Barnhart, Maricopa, Cal. U.S. Pat. 1,242,292, Oct. 9, 1917. Date of appl., Oct. 19, 1915.

OIL is heated by forcing it under pressure through a coil of pipes arranged in a furnace, a predetermined pressure being maintained by means of a pressure valve placed at the discharge end of the pipe coil. The heated oil is discharged into a heating pan where it is further heated, and where the pressure on the oil is relieved. The heating pan consists of an elongated closed receptacle divided into a series of compartments by longitudinal vertical baffles, which extend alternately

from the top and bottom. The oil is thus caused to follow a vertically undulating route in its passage from end to end of the pan. The baffles attached to the bottom extend about half way to the top, and those attached to the top extend progressively nearer to the bottom towards the outlet end. A pipe is provided at the top of each compartment to carry away the vapours given off by the oil in its passage through the heating pan.—T. St.

Motor-spirit; Process for the production of — from heavy hydrocarbons. W. A. Hall, New York. U.S. Pat. 1,242,795, Oct. 9, 1917. Date of appl., Mar. 12, 1914.

HYDROCARBON oil is cracked at a pressure materially above atmospheric and at a temperature not below about 500° C., whereby a mixture of gases and vapours rich in compounds of the ethylene series is produced. The portions having boiling points of about 200° C. and above are separated, leaving a mixture of gases and vapours at a temperature of over 100° C. This mixture is then cooled under a pressure materially above atmospheric to condense a motor fuel.—T. St.

Motor fuel; Producing —. W. A. Hall, New York. U.S. Pat. 1,242,796, Oct. 9, 1917. Date of appl., Apr. 4, 1914.

HYDROCARBON oils are cracked at about 600° to 650° C. under a pressure of about 70 lb. per sq. in. The pressure is then reduced and the temperature lowered to about 200° C. to separate the more readily condensable products. The remaining gases and vapours are afterwards again subjected to a pressure of at least about 70 lb. per sq. in. and still further cooled.—T. St.

Paraffin oil; Process for solidifying —. J. Minuto and J. Porte, London. Eng. Pat. 110,926. (Appl. Nos. 15,797, Nov. 4, 1916, and 6396, May 4, 1917.)

In order to render paraffin oil more or less solid or consistent, soap powder with or without camphor, sawdust, or other ingredients is dissolved in the heated paraffin, with stirring, and the liquid mixture poured into moulds or tins.

—J. E. C.

Burning fuel; Process of —. T. McKenna, London. From Rosenbaum, Stockbridge, and Borst, New York. Eng. Pat. 110,939, Nov. 7, 1916. (Appl. No. 15,964 of 1916.)

SEE U.S. Pat. 1,210,099 of 1916; this J., 1917, 205.

Extraction of cyanides from ammoniacal liquor. Eng. Pat. 110,810. See VII.

IIB.—DESTRUCTIVE DISTILLATION; HEATING; LIGHTING.

PATENTS.

Electron-discharge apparatus and method of preparation. Electron-discharge apparatus and method of operating the same. I. Langmuir, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pats. (A) 1,244,216 and (B) 1,244,217, Oct. 23, 1917. Dates of appl., (A) July 15, 1914, renewed June 25, 1917; (B) Oct. 28, 1915.

(A) THE cathode for an electron-discharge apparatus is composed of tungsten, and is provided with a surface film of thorium material, volatile at a temperature of about 2300° absolute. The surface film is removable by positive ionisation, and has an electron emissivity, independently of and in

the absence of positive ionisation, which is many times greater than that of pure tungsten at the same temperature. (B) The electrode, as described above, is enclosed in an envelope evacuated to a pressure so low that positive ionisation is substantially absent, and a small quantity of a volatile metal, such as potassium, is contained within the envelope, the vapour of the metal preventing the oxidation of the thorium at an elevated temperature.—B. N.

Electrode; Arc-lamp —. W. R. Mott, Lakewood, Ohio, Assignor to National Carbon Co., Inc. U.S. Pats. (A) 1,244,358 and (B) 1,244,359, Oct. 23, 1917. Dates of appl., (A) Feb. 28, 1916, and (B) Nov. 6, 1916.

(A) AN electrode is composed of sodium uranium fluoride, and a conducting body of carbon. (B) The electrode is made by mixing rare-earth metal fluorides containing a small amount of sulphate with barium fluoride, the amount of the latter being one-half to five times the weight of combined sulphuric anhydride, and heating to form barium sulphate. Calcium fluoride and carbon are also contained in the electrode.—B. N.

Candles. Eng. Pat. 110579. See XII.

III.—TAR AND TAR PRODUCTS.

Anthracene, anthraquinone, parabromobenzene, phenanthrene, and iodine; Solubilities of — in various solvents. J. H. Hildebrand, E. T. Ellefson, and C. W. Beebe. J. Amer. Chem. Soc., 1917, 39, 2301—2302.

To determine the solubilities of anthracene, etc., in various solvents, quantities of the solid were agitated with the solvent in a thermostat at 25° C. until equilibrium was attained. A weighed quantity of the solution was then evaporated and the residue weighed. The solutes were from a commercial source, and, in most cases, not purified; the solvents were dried and distilled. The materials were chosen with a view to obtain solubility data for solutions relatively free from complications due to association and ionisation. Average results are given in the following table:—

Solvent.	Solubilities at 25° C. (In grms. per 100 grms. of solvent.)				
	Anthracene.	Anthraquinone.	p-Bromobenzene.	Phenanthrene.	Iodine.
Alcohol	0.328	0.437	10.35	4.91	—
Benzene	1.86	—	83.8	59.5	—
Carbon bisulphide	2.58	—	90.0	80.3	—
Carbon tetrachloride	0.732	—	36.6	26.3	—
Ether	1.42	0.101	71.3	42.9	—
Hexane	0.37	—	25.9	9.15	1.32

—L. A. C.

Nitro- and nitroso-compounds; Reduction of — with platinum and hydrogen. G. Cusmano. Atti. R. Accad. Lincei. 1917, [v.], 26, ii., 87—91. J. Chem. Soc., 1917, 112, i., 641

AROMATIC mononitro-compounds (*p*-nitrophenol, *p*-nitroanisol, and *p*-nitrotoluene) are reduced to amines by hydrogen and platinum-black at the ordinary temperature, no matter what quantity of hydrogen is present. The aromatic nitroso-compounds behave in the same way (*p*-nitrosophenol, *p*-nitrosothymol, *p*-nitrosodimethylaniline, and the nitrosonaphthols). In the same

conditions, terpene nitroso-compounds are reduced quantitatively to the corresponding hydroxylamines; thus, 8-nitrosomenthone is converted into 8-hydroxylaminomenthone.

Quinol; Sulphonation of —. J. Pinnow. Z. Elektrochem., 1917, 23, 243—249. J. Chem. Soc., 1917, 112, ii., 528. (Compare this J., 1915, 1083.)

A CONTINUATION of the previous work; the kinetics of the sulphonation of quinol have been studied at 100°, 80°, 60°, and 50° C. by a slightly modified method, using sulphuric acid from 7.82*M* to 13.39*M*. It is shown that if quinol is added to sulphuric acid in such quantities (1—2%) that the total volume is practically unchanged, the logarithm of the velocity of sulphonation increases proportionally to the concentration of the acid. For unit increase in the molarity of the acid, the increase in the logarithm is 0.643 at 60°, 0.612 at 80°, and 0.696 at 100° C. The logarithm of the velocity for 7*M* H₂SO₄ is 4.500 at 60°, 5.655 at 80°, and 6.637 at 100° C. The equilibrium between quinol, quinolmonosulphonic acid, and aqueous sulphuric acid moves toward the sulphonated acid with decreasing temperature. The temperature-coefficient of the formation and hydrolysis of quinolmonosulphonic acid increases with decreasing concentration of sulphuric acid. The hydrolysis depends chiefly on the monohydrate of sulphuric acid, as was previously shown to be the case in the formation of the monosulphonic acid.

Phenols; Influence of the solvent on the reaction between polyhydric — and alkali bicarbonates. F. von Hemmelmayr. Monatsh. Chem., 1917, 38, 77—89. J. Chem. Soc., 1917, 112, i., 645—646.

THE reaction between potassium bicarbonate and polyhydric phenols under different conditions has been studied. Using anhydrous substances and working at atmospheric pressure, resorcinol, at 120° C., yields 2,4- and 2,6-dihydroxybenzoic acids, catechol and quinol produce no carboxylic acids, and pyrogallol yields 2,3,4-trihydroxybenzoic acid. When the anhydrous substances are heated in closed tubes, catechol at 200° C. yields catecholdicarboxylic acid, resorcinol forms α -resodicarboxylic acid, and 3,5-dihydroxybenzoic acid yields β -resodicarboxylic acid; quinol at 260—270° C. gives a high yield of a dicarboxylic acid, which crystallises in needles with H₂O; pyrogallol at 200° C. forms gallo-carboxylic acid, m.pt. 281° C., the yield being almost the theoretical one; orcinol gives *p*-orsellinic acid. 1,5-Dihydroxynaphthalene at 230° C. yields a dicarboxylic acid, which decomposes at 290° and then melts at 300° C.; the acid and its alkali salts dye wool yellow, and the shade is converted into a very good brown by treatment with chromic acid or chromates. 1,6-Dihydroxynaphthalene reacts with a mixture of potassium bicarbonate and carbonate to form a monocarboxylic acid, in stellate groups of yellow prisms, m.pt. 200° C. By heating with potassium bicarbonate in presence of dry aniline or diphenylamine at atmospheric pressure, resorcinol yield β -resorcylic acid and also α -resodicarboxylic acid, especially with diphenylamine, although this acid loses carbon dioxide most readily if heated alone with the bases. Catechol and quinol do not react, and pyrogallol forms only a monocarboxylic acid. In presence of boiling anhydrous ethyl alcohol, although it boils at a higher temperature than diphenylamine, the yield of α -resodicarboxylic acid from resorcinol is not so great as in the above case.

Recovery of toluol from gas-works. See II A.

PATENTS.

Waste hydrocarbonaceous residues; Obtaining valuable products from — produced in the rectification of crude benzol and homologous hydrocarbons. J. T. Sheard. Sheffield. Eng. Pat. 110,636, Nov. 18, 1916. (Appl. No. 16,556 of 1916.)

THE waste oily residue produced when crude benzol or its homologues are rectified by steam distillation as described in Eng. Pat. 104,999 (this J., 1917, 565), is distilled until the temperature of the vapours at the still-head is about 285° C.; the hot residue is then run off, and after partial cooling is either filtered or the sediment allowed to settle. The oil obtained, of sp.gr. 1.060 or thereabouts, is suitable for use as a lubricant for steam engines and other machinery. The condensed product consists chiefly of water and small quantities of various hydrocarbons.—L. A. C.

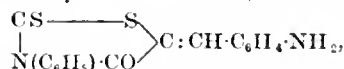
Phenolic bodies from wood-tar oils; Process of producing —. L. F. Hawley. Madison, Wis. Re-issue 14,388, Oct. 30, 1917, of U.S. Pat. 1,199,271, Sep. 26, 1916. Date of appl. Aug. 13, 1917.

SEE this J., 1916, 1149.

IV.—COLOURING MATTERS AND DYES.

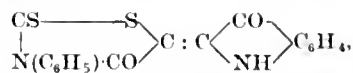
Rhodanines; Substituted — and some of their aldehyde condensation products. R. Andreasch. Monatsh. Chem., 1917, 38, 121—139. J. Chem. Soc., 1917, 112, i., 663—664.

3-PHENYLRHODANINE and *p*-aminobenzaldehyde condense in warm acetic acid to form 3-phenyl-5-*p*-aminobenzylidenetherhodanine,

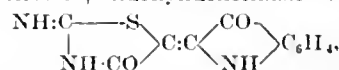


which crystallises in bichromate-coloured, filamentous needles, m. pt. 227—228° C., and dyes skin, wool, or silk yellow. Protocatechualdehyde and 3-phenylrhodanine form 3-phenyl-5-*mp*-di-hydroxybenzylidenetherhodanine, bright yellow needles, m.pt. above 260° C. This behaves like an indicator, for aqueous suspensions give with alkali hydroxides very deep violet solutions, which become yellow again on neutralisation. The compound is in many other respects like alizarin; it is a vat dye, but does not give nice shades. The corresponding 5-*op*-dihydroxybenzylidene compound is an orange-yellow, crystalline powder, m. pt. about 350° C., which gives carmine-red solutions with traces of alkali hydroxide.

Phenylrhodanine and the related ring systems also condense with isatin. 3-Phenyl-5- ψ -indoxylidenetherhodanine,



crystallises as a purple-red, shimmering scale, m. pt. 260° C. "Isothiohydantoin-2-indolindigo" [2-imino-4-keto-5- ψ -indoxylidenethiazolidine],



is a brownish-red powder, m. pt. above 360° C. 2,4-Diketo-5- ψ -indoxylidenethiazolidine is an orange-yellow powder, m.pt. above 370° C. "5- ψ -Indoxylrhodanine" is identical with Felix and Friedländer's "5-thiazolthiol-2-indoleindigo" (this J., 1910, 410).

Influence of the solvent on the reaction between polyhydric phenols and alkali bicarbonates. Von Hemmelmayr. See III.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER.**PATENTS.**

Paper-making machines, pulp-drying machines, pulp vats; Suction roll arrangements for — and for drying cloth or like porous and absorbent material. G. Hellström, London, Eng. Pat. 105,556, Apr. 5, 1917. (Appl. No. 4947 of 1917.)

THE perforated suction roll is revolved in air-tight contact with an external stationary suction box covering the bottom segment of the roll. The web of paper or fabric travels in contact with the major portion of the circumference of the roll not covered by the suction box. The segments between the lips of the external suction box and the points where the web of paper passes on to and off the suction roll are covered by stationary chambers inside the roll in communication with the outside atmosphere and isolated from the suction of the suction box by air-tight packing bars. The suction produced in the external suction box operates inside the revolving roll on the portions covered by the web of paper and draws the water through into the interior of the roll, then out through the lower portion into the external suction box, thus washing the perforations of the roll-shell clear of deposits of fibre.—J. F. B.

Acetylcellulose; Process for producing flowable compounds of —. W. G. Lindsay, Caldwell, N.J., Assignor to The Celluloid Company, New York. U.S. Pats. (A) 1,244,107 and (B) 1,244,108, Oct. 23, 1917. Date of appl., (A) Nov. 6, 1911. Renewed Mar. 19, 1917; (B) Mar. 19, 1917.

(A) 100 PARTS of acetone-soluble acetylcellulose is incorporated with 20 to 50 parts of an arylsulphamide, 40 to 100 parts of methyl or ethyl alcohol, and 10 to 40 parts of a liquid adapted to produce a solution which will flow in the cold, e.g., a mixture of 70 parts of alcohol and 30 parts of chloroform by volume. (B) The arylsulphamide is replaced by an alkylarylacetamide. A triarylphosphoric ester may also be added.—F. Sp.

Acetylcellulose plastics and solvents thereof; Process of making —. W. G. Lindsay, Caldwell, N.J., Assignor to The Celluloid Co., New York. U.S. Pats. (A) 1,244,347 and (B) 1,244,348, Oct. 23, 1917. Date of appl., (A) Nov. 6, 1911. Renewed Mar. 19, 1917; (B) Mar. 19, 1917.

(A) 100 PARTS of acetone-soluble acetylcellulose is incorporated with 20 to 50 parts of an arylsulphamide, e.g., ethyl-p-toluenesulphamide, and 40 to 100 parts of methyl or ethyl alcohol. (B) The arylsulphamide is replaced by an alkylacetanilide having not more than two carbon atoms in the alkyl group.—F. Sp.

Acetylcellulose plastics; Process of making solvents for —. W. G. Lindsay, Caldwell, N.J., Assignor to The Celluloid Co., New York. U.S. Pat. 1,244,349, Oct. 23, 1917. Date of appl., Nov. 6, 1911. Renewed Mar. 20, 1917.

A COMPOUND solvent for acetone-soluble acetylcellulose is made by mixing 40 to 100 parts of ethyl or methyl alcohol and 20 to 50 parts of an arylsulphamide, e.g., a toluenesulphamide. The alcohol may contain 10 to 40% of a liquid, e.g., chloroform, adapted to produce a solution which will flow in the cold.—F. Sp.

Composition for cleansing, decorticating, and for purifying and preserving food. Eng. Pat. 110,567. See VI.

Production of oxalic acid and oxalates. Eng. Pat. 110,837. See VII.

VI.—BLEACHING; DYEING; PRINTING; FINISHING.

Pigment-forming enzyme of the skin; Specific —. Dopaoxydase. B. Bloch. Z. physiol. Chem., 1917, 100, 226—254. J. Chem. Soc., 1917, 112, i., 675.

WHEN a frozen section of human or other skin is treated with a 1% solution of 3,4-dihydroxyphenylalanine (termed "dopa"), oxidation and condensation occur with the formation of a dark brown or black pigment (dopamelanin) at certain definite places owing to the action of an intracellular oxidising enzyme, dopaoxydase. The oxydase is present in the protoplasm (not the nuclei) of the basal cells of the epidermis and the cells of the hair follicles, and is of a highly specific nature, exerting no action on tyrosine, quinol, homogentisic acid, pyrogallol, tryptophan, adrenaline, and other substances more or less closely related to 3,4-dihydroxyphenylalanine. A parallelism is observed between the pigmentary changes occurring in sections of skin under the action of chemically active light rays and those immersed in "dopa," and the conclusion is drawn that the natural pigment is probably formed in the living organism from 3,4-dihydroxyphenylalanine or a substance very similar to it in chemical constitution.

PATENTS.

Fulling; Process of —. A. Pinagel, Aachen, Germany. Eng. Pat. 106,608, Mar. 9, 1917. (Appl. No. 3519 of 1917.) Under Int. Conv., May 25, 1916.

FOR the fulling of woollen fabrics an aqueous alkaline solution of saponin, alone or with the addition of a little alcohol, is employed. Part of the fat or oil contained in the usual fulling agents or soaps may be replaced by saponin.—J. F. B.

Composition for cleansing, bleaching, decorticating, and for purifying and preserving food. A. Poulson, Widnes. Eng. Pat. 110,567, Oct. 9, 1916. (Appl. No. 14,315 of 1916.)

A MIXTURE of equal parts of crystalline or anhydrous sodium carbonate and sodium bicarbonate is suitable for use as a general cleansing agent for household and laundry purposes; as a cleanser of paint and varnish work, for removing the print from calico and also newspapers, as a decorticating agent for flax and other fibrous material, as a "purifier" of tainted fish, hams, etc., or as a food preservative. A scouring composition for pots and pans is obtained by mixing the powder with saponifiable oil or fat and ground pumice. (Reference is directed in pursuance of Sect. 7, Sub-sect. 4, of the Patents and Designs Act, 1907, to Eng. Pat. 1331 of 1870.)—A. DE W.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS.

Hydrogen; Action of — on sulphuric acid. F. Jones. Mem. Manchester Phil. Soc., 1917, 61, No. 3, 1—3. J. Chem. Soc., 1917, 112, ii., 530.

IN the hulk of a non-tubulated retort, the open end of the neck of which dips under water, is placed some strong sulphuric acid, the remainder of the retort being filled with pure hydrogen. When the whole is left at the ordinary temperature for a few days the water gradually rises in the neck of the retort, owing to reduction of the sulphuric acid by the hydrogen with formation of sulphur dioxide.

Alum: Residues from the manufacture of— and possible means of utilising them. P. Falcicola. *Annali Chim. Appl.*, 1917, 8, 82—87.

A LARGE proportion of the alum made in Italy is derived from leucite, a double silicate of aluminium and potassium, which occurs in the form of isolated crystals or in basaltic and other rocks. After removal of the gangue the mineral contains up to 98% of true leucite, though it is not economical to aim at a higher degree of purity than 90%. Alum is obtained by digesting leucite with dilute sulphuric acid at about 70° C., decanting the liquid from silica, and leaving it to crystallise. The mother liquors still contain about 10% of the double salt, and at least 15% of alum, which does not repay the cost of recovery. The alum from the first crystallisation contains salts of iron and silicon, together with other impurities, and a second crystallisation is necessary to obtain a pure white salt. The residue from the digestion with acid is regarded as a waste product. For every 438 kilos. of leucite 210 kilos. of silica is obtained; or in the case of 70% leucite every 100 kilos. yields about 76 kilos. of silica containing about 80% SiO_2 . A sample of the insoluble residue contained 16.6% of moisture and had sp. gr. 0.897. When dried at 100°—105° C. it had the following composition:—Total silica, 79.39; sulphuric anhydride, 6.43; ferrous oxide, 0.71; aluminium oxide, 1.83; calcium oxide, 5.90; magnesium oxide, 0.24; potassium oxide, 2.16; and sodium oxide, 4.14%. Loss on ignition, 3.35%. Only a small amount of the silica was in a combined state. By fractional sedimentation of the residue with 12 times its volume of water it could be separated into three fractions of different degrees of fineness, the first (7%) containing 65% of silica, and the third (44%), 93.7% of silica. Mixtures of 20 parts of the original residue with 100 parts of potters' clay (Vicenza clay) and 40 or 60 parts of calcium carbonate were baked at about 1000° C., and proved satisfactory for ornamental pottery. Mixed with litharge as a glaze it gave excellent results. For the manufacture of glass the best results were obtained by the use of the following formulæ:—(a) Residue (12% water), 100; Solvay soda, 41; calcium carbonate, 12. (b) Residue, 100; Solvay soda, 50; and calcium carbonate, 15 parts. Another possible use of the residue is for soaps and detergents.—C. A. M.

Chlorates: Identification of—in the presence of hypochlorites. P. Wischo. *Pharm. Post*, 1917, 50, 381. *J. Chem. Soc.*, 1917, 112, ii., 539.

THE following behaviour of the two substances towards brucine and hydrochloric acid can be used for the identification of sodium chlorate in the presence of sodium hypochlorite in Dakin's solution. When a solution of sodium hypochlorite (5 c.c.) of approximately the same concentration as Dakin's solution (about 0.5%) is treated with brucine hydrochloride or sulphate (0.05 gm.) and dilute hydrochloric acid (5 drops), a yellow coloration is developed which becomes cherry-red when the solution is boiled; the latter coloration remains unchanged when the solution is boiled with a further 10 c.c. of dilute acid. On the other hand, a similar solution of potassium chlorate is not coloured by brucine (0.05 gm.) and dilute hydrochloric acid (5 drops) in the cold; when boiled the solution becomes yellow, and, subsequently, cherry-red, but the colour is discharged when boiling is continued after a further addition of dilute hydrochloric acid (10 c.c.). This decoloration on subsequent boiling with much dilute hydrochloric acid is characteristic of the presence of chlorate; it also occurs when 5 c.c. of a solution containing

0.01 gm. of sodium hypochlorite and 0.02 gm. of potassium chlorate in water (10 c.c.) is tested as described above.

Bromides: Determination of—. E. Rupp. *Arch. Pharm.*, 1917, 255, 303—304. *J. Chem. Soc.*, 1917, 112, ii., 540.

THE bromate method of estimating the bromide in alkali bromides or their mixtures ("*bromum compositum*") is modified as follows to avoid the use of hydrogen peroxide (compare this *J.*, 1917, 924). Twenty c.c. of official dilute sulphuric acid, 50 c.c. of N/100 potassium bromate, 0.2 gm. of iodine, and 0.15 gm. of the bromide are diluted to 200 c.c., and the mixture is boiled after the addition of a little talc or powdered pumice until the volume has been diminished to 75 c.c. in not less than 40 minutes. The mixture is cooled to the ordinary temperature, 0.5—1 gm. of potassium iodide is added, and the iodine liberated by the excess of the bromate is titrated with N/10-thiosulphate after three to five minutes. When the bromide is being estimated in the presence of more than about 25% of chloride, the undiluted mixture of the sulphuric acid, potassium bromate, and iodine is concentrated to about half its volume by boiling for 15 minutes, the solution of the haloid is added, the mixture diluted to 200 c.c., and the procedure mentioned above followed. The result is 0.2—0.3 c.c. too high if the preliminary boiling is omitted.

Ferric oxide and alumina. F. H. Scheetz. *J. Phys. Chem.*, 1917, 21, 570—572.

FOLLOWING Keene's observation (this *J.*, 1917, 138) that the yellow colour in bricks is due to finely divided anhydrous ferric oxide, stabilised by alumina, the author endeavoured to produce this colour artificially by precipitating solutions of ferrous and aluminium sulphates with sodium carbonate, sodium hydroxide, and lime water respectively, and heating the precipitates to 1000° C. Sodium hydroxide and carbonate were unsatisfactory, but lime produced the required colour, providing there was not more than 8% of Fe_2O_3 in the mixed oxides.—A. B. S.

Zinc perhydrates [hydroperoxides]. F. W. Sjöström. *Z. anorg. Chem.*, 1917, 100, 237—248. *J. Chem. Soc.*, 1917, 112, ii., 533. (Compare de Forcrand, this *J.*, 1902, 505, 1041; Ebler and Krause, 1911, 892; Riesenfeld and Nottebohm, this *J.*, 1916, 536.)

WHEN a solution of zinc sulphate is added to excess of a solution of sodium hydroxide containing hydrogen peroxide, the zinc is totally precipitated as hydroperoxide. The amount of hydrogen peroxide used cannot, however, be estimated volumetrically on account of its rapid decomposition in alkaline solution. For a more thorough examination of zinc hydroperoxide the following method of preparation was used. Freshly ignited pure zinc oxide was left for several hours with the calculated quantity of 30% hydrogen peroxide solution at —10° C. A product was obtained which above 2° C. formed a pasty mass, and when dried on a porous plate at 35°—40° C. over soda-lime was obtained as a white powder. This was analysed by estimating active oxygen, zinc oxide, and water. It contained 8.04% active oxygen, and corresponded almost exactly with the composition $\text{Zn}_2\text{O}(\text{OH})\text{O}_2\text{H}$. Towards water, alcohol, or ether at the ordinary temperature it is quite stable, and is only slowly decomposed by 2N sodium hydroxide. It does not appear, however, to be a simple chemical individual, since by trituration with water it can be separated into fractions containing varying quantities of active oxygen. Another preparation, fractionated in this manner before drying, gave three similar

fractions, each containing about 12% of active oxygen and corresponding with no particular formula. Similar products were obtained by boiling zinc carbonate with excess of 30% hydrogen peroxide solution. It is concluded that zinc perhydrate generally consists of a mixture of substances, derived from the two compounds $\text{Zn}(\text{OH})_2$ and H.O.Zn.O.Zn.OH , the hydroperoxides being of the types HO.Zn.O.OH and $\text{Zn}(\text{OH}).\text{O.Zn.O.OH}$. Hydrogen peroxide, since it decomposes zinc carbonate, acts as a monobasic acid.

Disodium nitrite; an additive compound of sodium nitrite and sodium. E. B. Maxted. Chem. Soc. Trans., 1917, 111, 1016—1019.

A BRIGHT yellow compound of the empirical formula, Na_2NO_2 , was prepared by two methods:—(1) A known weight of sodium was dissolved in anhydrous liquid ammonia, and freshly fused, finely divided sodium nitrite added in the proportion of one mol. to each atom of sodium. The completion of the reaction was marked by the discharge of the deep blue colour. The disodium nitrite settled out as a yellow precipitate, from which the ammonia was removed by evaporation. (2) By electrolysis of sodium nitrite in anhydrous liquid ammonia, using platinum electrodes, a yellow deposit of disodium nitrite was obtained on the cathode. The compound is very readily decomposed by water.—L. A. C.

Hydrous ferrous oxide sols; Precipitation, stability, and constitution of—. I. M. Neidle. J. Amer. Chem. Soc., 1917, 39, 2334—2350. (See also this J., 1917, 290.)

PERFECTLY clear colloidal solutions of hydrous ferrous oxide were prepared as follows:—1 grm.-equivalent of ferrous chloride was dissolved in 400 c.c. of water, the solution filtered and completely oxidised with 3% hydrogen peroxide. This solution, diluted to 4 litres, was dialysed in the cold for three days, and then portions of it, further diluted, dialysed at 80° C. for five days. By diluting equal portions of these solutions with standard dilute hydrochloric acid and distilled water to the same volume, a series of solutions was obtained having a constant iron, and variable chlorine content; similar series were obtained, each with a different iron content. The relative stability of these solutions was measured by the amount of potassium sulphate necessary for their complete precipitation. The data show that for a given iron concentration the stability increases with the chlorine content, while for solutions of given purity, i.e., given ratio, equivalents Fe: equivalents Cl, the stability decreases as the concentration increases. The maximum purities corresponding to four iron concentrations were obtained by graphical extrapolation. The maximum purity obtainable decreases as the iron concentration increases. Clear hydrous ferric oxide sols containing ferric ions are concluded to contain a colloidal oxychloride of definite ratio, $21(\text{Fe}/\text{Cl})$: 1 (Cl); further evidence of the formation of this colloid is deduced from the behaviour of ferrous sulphate solutions when oxidised by air. Decrease in the concentration of the ferric ion with progressive removal of hydrochloric acid from the oxychloride sols results in hydrolysis and the formation of a series of colloids of increasing Fe: Cl ratio. Lack of agreement between colloid precipitation data of different investigators is shown to be due very largely to the varying purities and concentrations of solutions employed.—L. A. C.

Hydrogen peroxide. V. Macri. Boll. Chim. Farm., 1917, 56, 417—418. J. Chem. Soc., 1917, 112, ii., 529—530.

HYDROGEN peroxide prevents the precipitation of phosphomolybdate when solutions of ammonium

molybdate and phosphoric acid are mixed. Hydrogen sulphide does not affect the reaction between hydrogen peroxide and chromic acid if the chromic acid is added to the solution of hydrogen peroxide and hydrogen sulphide. When hydrogen peroxide is treated with ammonia in presence of calcium chloride, a precipitate, CaO_2 , is formed. When hydrogen peroxide is evaporated in a platinum dish in the presence of hydrogen chloride, a certain amount of chloroplatinic acid is formed. The estimation of free acid in hydrogen peroxide may be effected by titration with permanganate, the end-point being shown by the appearance of a brownish-yellow coloration.

Solubilities of anthracene, anthraquinone, p-bromobenzene, phenanthrene, and iodine in various solvents. Hildebrand and others. See III.

Potash from cement dust. See IX.

PATENTS.

Nitric acid; Production of—. E. C. R. Marks, London. From Tentelev Chemical Works, Petrograd. Eng. Pat. 110,637, Nov. 21, 1916. (Appl. No. 16,671 of 1916.)

COMMERCIAL nitric acid is added gradually to a hot solution of nickel or zinc nitrate (or other suitable nitrate) of such a concentration that it can be maintained at 126° to 170° C., or an even higher temperature. The pure acid evaporates immediately without decomposition, leaving impurities (e.g., sulphuric acid and iron) in the solution, and is condensed.—L. A. C.

Oxalic acid and oxalates; Production of—. Allen Bros. and Co., Ltd., and C. F. Cross, London. Eng. Pat. 110,837, Jan. 4, 1917. (Appl. No. 223 of 1917.)

THE bark of *Shorea robusta*, known as "sal bark," which contains calcium oxalate, is leached with water to dissolve the tannins and then treated with a cold 10% solution of hydrochloric acid for three hours. The liquor is separated, and the bark washed with water which is added to the liquor. The mixture is concentrated by boiling, the hydrochloric acid distillate collected, and the residue neutralised with lime to precipitate the calcium oxalate. The hydrochloric acid may be replaced by sulphuric acid of 5% strength and the mixture boiled. The liquid is neutralised with lime, and the mixed calcium sulphate and oxalate treated with sulphuric acid of 20% strength to convert the oxalate into sulphate and liberate oxalic acid. When the bark is required to be disintegrated for paper making, the acid may be replaced by sodium carbonate of 10% strength at a pressure of 50 lb. per sq. in. The liquor is then separated and treated for the recovery of oxalic acid.—W. F. F.

Hydrofluoric acid from silicon fluoride; Manufacture of—. H. F. Chappell, New York, N.Y. U.S. Pat. 1,244,032, Oct. 23, 1917. Date of appl., Apr. 17, 1917.

AN aqueous solution of hydrofluosilicic acid is heated to convert it into hydrofluoric acid, silicon fluoride, and water vapour. The resulting products are maintained at such a temperature that the water vapour acts on the silicon fluoride to produce hydrofluoric acid and silicon hydroxide.—J. H. P.

Salt; Process of recovering— from its admixture with impurities in crude brine. W. W. Skinner and W. F. Baughman, Washington, D.C. U.S. Pat. 1,244,380, Oct. 23, 1917. Date of appl., July 14, 1917. (Dedicated to the public.)

PURE sodium chloride is separated from admixed impurities in crude brine, particularly barium salts,

by treating the brine with sodium sulphate and lime and pumping air through the mixture. This ensures thorough mixing, and ferrous bicarbonate in the brine is decomposed into the hydroxide, which is precipitated along with barium sulphate. Pure sodium chloride is obtained from the resulting liquor by crystallisation.—J. H. P.

Titanium-oxygen compounds; Process of producing —. Det Norske Aktieselskab for Elektrokemisk Industri Norsk Industri-Hypotekbank, Christiania, Norway. Eng. Pat. 102,059, Oct. 30, 1916. (Appl. No. 15,471 of 1916.) Under Int. Conv., Nov. 1, 1915.

TITANIFEROUS iron ores (ilmenite, etc.) are partially decomposed by a quantity of decomposing agent (mineral acid, fusion with alkali carbonates, bisulphates, etc.) less than that which is theoretically required. The material thus obtained is lixiviated with a solution of salts of titanium and iron obtained by lixiviation of another portion of decomposed material. The residue is decomposed further and again lixiviated, the process being repeated until extraction of titanium is complete. Lixiviation is carried out on the counter-current principle, using the smallest possible quantity of solvent, and keeping the solutions cold. A small quantity of water only is used for the final washing. By this means, after precipitation of titanium hydroxide (by heating), the concentration of iron and decomposition agent in the residual liquid is high; thus recovery of these substances is simple. The same series of operations may be performed any number of times on the product in order to obtain titanium oxide of any desired degree of purity.—L. A. C.

Potassium; Process of treating minerals or rocks containing —. O. Rayner, Paris. Eng. Pat. 102,493, Nov. 22, 1916. (Appl. No. 16,720 of 1916.) Under Int. Conv., Nov. 30, 1915.

MINERAL or rock containing potassium is mixed with carbonaceous ash of marine plants and heated to 800°–1100° C. in a current of air. Iodine is distilled off and is condensed, and the residue is leached with water to dissolve potassium compounds, which may then be treated as desired. The residue containing aluminium and silicon is treated with dilute acid to dissolve and recover the aluminium compounds.—W. F. F.

Ammoniacal liquor; Extraction of cyanides from —. H. Baker, Barrow-in-Furness. Eng. Pat. 110,819, Nov. 25, 1916. (Appl. No. 16,906 of 1916.)

CRUDE ammoniacal liquor from coal gas manufacture is boiled with one or more of the alkaline compounds of potassium, calcium, or sodium such as the oxide, hydroxide, or carbonate, with or without the addition of any other alkali or alkaline-earth. Ammonia is liberated and recovered in the usual way, and the residual liquid is boiled with any salt of silver, aluminium, tin, or nickel, which precipitates the corresponding cyanides of the metals.—W. F. F.

Air; Method and apparatus for [electrically] treating —. W. T. Hoofnagle, Glen Ridge, N.J., Assignor to Electro-Chemical Products Co., New York. U.S. Pat. 1,243,524, Oct. 16, 1917. Date of appl., May 25, 1915.

A CURRENT of air, or other gas to be treated electrically, is passed successively through a water chamber where water vapour is added in excess of the amount required to saturate it, and a reaction chamber at a pressure below that of the atmosphere. An exhaust mechanism is connected to the re-

action chamber, and means are provided for shunting any desired part of the current of gas past the water chamber.—B. N.

Lime; Process of slaking —. W. E. Carson, Riverton, Va. U.S. Pat. 1,244,421, Oct. 23, 1917. Date of appl., Sep. 28, 1915.

COMMUNUTED lime is placed in a tall, strong-walled receptacle and is mixed with sufficient water to form a slurry, without leaving a damp or moist final product. The materials are mixed quickly enough to prevent substantial hydration prior to the formation of the slurry, which is then run rapidly into a tall vertical vessel where the reaction is allowed to proceed quietly, under its own pressure, for at least 8 hours.—A. B. S.

Sulphuric anhydride and sulphuric acid; Production of —. C. Ellis, Montclair, N.J., U.S.A. Eng. Pat. 110,776, Oct. 2, 1916. (Appl. No. 13,985 of 1916.)

SEE U.S. Pats. 1,204,141 to 1,204,143 of 1916; this J., 1916, 1260.

Ammonia; Producing —. O. Bosch and A. Mittasch, Assignors to Badische Anilin und Soda Fabr., Ludwigshafen, Germany. U.S. Pat. 1,244,580, Oct. 30, 1917. Date of appl., Aug. 16, 1912.

SEE Fr. Pat. 449,010 of 1912; this J., 1913, 487.

Ammonia; Process of extracting — from ammoniacal liquor. N. Schuster, Assignor to British Coke Ovens, Ltd., London. U.S. Pat. 1,244,903, Oct. 30, 1917. Date of appl., Mar. 15, 1915.

SEE Eng. Pat. 6061 of 1914; this J., 1915, 787.

Liquid and gas contact apparatus. Eng. Pat. 110,724. See I.

Dental cement. U.S. Pat. 1,244,296. See VIII.

Evaporating apparatus. Eng. Pat. 110,921. See I.

Process for extracting tungsten trioxide from its ores. U.S. Pat. 1,244,082. See X.

VIII.—GLASS; CERAMICS.

Gas firing and the glass industry. J. W. Cobb. Soc. Glass Tech., Nov. 21, 1917.

IN the old types of glass furnace, where the fuel is burnt close to the work, the heat available is only a small percentage of the whole, due to the fact that the fall in temperature of the flame from entry to exit is only small. There is great danger, too, in the light ash which is formed, being carried forward to exercise its baneful effects as a flux on furnace linings, etc., and also its decolorising effects on any glass with which it may come in contact. The waste heat from direct-fired furnaces may be utilised, say for steam raising, but only in a makeshift manner. Attempts, too, have been made to utilise this waste heat to pre-heat the air required for combustion, but owing to difficulties of furnace design these attempts are far from being successful. A fact often lost sight of in heating air by passing it through hot flues, is that the air is transparent to radiant heat and is only affected by actual contact with the hot walls of the flue. Thus pre-heating by passing air through hot flues of large cross-section is very ineffective. A great step in furnace work was the introduction of the Siemens regenerative furnace. Coal is burnt away from the furnace proper with the formation of carbon monoxide, which is delivered into the furnace together with air, and burns there to carbon

dioxide. In addition, the waste hot gases leaving the furnace are made to pass through chambers filled with chequered brick work. By suitable means, the ingoing air and gas is afterwards passed through this hot brick work and so is heated before entering the furnace, resulting in an enormously increased temperature of combustion. In addition the regenerative chambers serve as filters for the dust or ash in the gases. In the Siemens producer the depth of fuel is large and there is considerable frictional resistance to movement of gas. The use of forced draughts causes the temperature to rise to such an extent as to cause clinkering. In order to keep down the temperature near the fire bars, steam is blown in, preventing clinkering, and also forming a mixture of carbon monoxide and hydrogen, the production of which is accompanied by an absorption of heat from the layer of hot coal near the fire bars. There are limits to the amount of steam that can be blown in; any excess results in the formation of carbon dioxide, or may even pass on into the furnace chamber unaltered, where it has the harmful effects of an inert gas. The best proportions of air and steam have to be determined by practice. Details were given of the Taylor producer, the Kerpely producer, and producers of the Mond type. The production of ammonia, low temperature regeneration, and the washing of producer gas by the Mond system were also discussed.

Pottery ovens; Firing of —. S. T. Wilson. Trans. Ceram. Soc., 1917, 16, 304—316.

IN firing china biscuit an oxidising atmosphere containing about 50% excess air in the oven is essential. To secure this, the doors of the fireplaces and the dampers are opened, and the fires are gradually allowed to get hotter until the contents of the oven are at red heat, after which the fire must be regulated carefully. The length of flame is controlled by varying the space above the fuel in the fireplace and by adjusting the port-holes admitting hot air. In an up-draught oven, the flame should be kept at a length which causes a short clear flame to issue from the shoulder holes as long as possible. When the "bags" begin to cool and change colour, more coal is supplied to the oven, this process of heating and cooling being repeated until trials show that the goods are slightly translucent. After this, the flame is allowed to reach just to the shoulder holes and the heating is continued until the top trials are satisfactorily fired. The bottom of the oven is then finished by admitting more air over the fuel and driving the flames to the lower part of the oven. There should be a slight outward pressure at the level of the top trial hole, during full fire. A down-draught oven is fired similarly, but as there are no shoulder holes for guidance, the length of the flame is judged by its appearance in the sight hole. As only about 9% of the heat of the fuel used is employed in an actually useful form, it is important to save the 91% of heat lost. A continuous regenerative oven of the Siemens type, according to the author, is impracticable for pottery because it does not allow sufficient time for the oven temperature to become uniform, and some saggers would have a temperature nearly equal to that of the flame itself. When hot air is used to facilitate combustion this difficulty is increased and the dimensions of each chamber in the oven would have to be so small that the fall in temperature of the gases during their path across the firing space will not exceed the limits which the ware will allow. This would make the chambers impracticably small, and the author concludes that the only type of continuous oven likely to be suitable for china and earthenware is a tunnel oven of small dimensions.—A. B. S.

Firebricks; After-contraction or after-expansion of — in oxidising and reducing atmospheres. J. W. Mellor. Report to Refractory Materials Committee of Institution of Gas Engineers. Trans. Ceram. Soc., 1917, 16, 268—269. (See this J., 1917, 701.)

SILICA bricks tend to expand less and fireclay bricks to contract more in a reducing than in an oxidising atmosphere on account of ferrous compounds having a greater fluxing effect than ferric compounds. The magnitude of this fluxing effect depends on the strength of the reducing atmosphere, the rate of penetration of the gases into the bricks, and the temperature and time of exposure to the reducing atmosphere. For these reasons, it is desirable that tests of the contraction of clay on heating should be conducted in a neutral atmosphere.—A. B. S.

Firebricks; Hot and cold sizes of —. J. W. Mellor. Report to Refractory Materials Committee of Institution of Gas Engineers. Trans. Ceram. Soc., 1917, 16, 270—273. (See this J., 1917, 701.)

MEASUREMENTS of the sizes of bricks at various temperatures were made with Coppée's apparatus (J. Iron and Steel Inst., 1915, 88, 32) consisting of two cathetometers mounted on the same base, each focussed on a pointed platinum wire fitted tightly into a vertical saw-cut near the end of the brick to be measured. The distances apart of the cathetometers and therefore of the platinum points is measured by means of an "invar" scale on a separate stand. If a brick is imperfectly burned, the effects of an after-contraction or after-expansion are superposed on the effects of thermal expansion, so that the brick does not regain its original volume on cooling; the difference between the cold sizes of the brick before and after heating show the magnitude of the after-contraction or after-expansion. In all such cases, a brick may show a smaller volume at (say) 1180° C. than at 1060° C., the effects of thermal expansion being wholly masked by the after-contraction. The coefficient of expansion of fireclays and silica bricks decreases with rise of temperature. Thus one fire-brick had a coefficient of expansion of 0.0000081 from 15° to 940° C. and 0.0000060 from 15° to 1180° C.—A. B. S.

Refractories for steel furnaces from the consumer's point of view. W. J. Brooke. Trans. Ceram. Soc., 1917, 16, 205—236.

Silica bricks. Some silica bricks exhibit excessive expansion, causing the walls or roofs of furnaces to break from excessive lateral stresses. This expansion is usually due to the brick not having been dried or burned sufficiently during manufacture. The "running" or fusion of silica bricks may be due to inferior material or to careless manipulation of the furnace. Softening or breaking away in lumps sometimes occurs without any sign of true fusion or spalling; this may be due to the body of the brick being coarsely ground and the proportion of binding material out of balance to the average constitution of the bulk. "Spalling" is probably due to insufficient burning and consequent incomplete inversion of the silica. The author suggests that the roof of a large steel furnace is the best place to test silica bricks, specially severe conditions existing between the crown and skew-back over the tap-hole for a distance of two to five feet on either side of the transverse centre line of the furnace, and at this point all the defects previously enumerated may be observed. The abrasion of bricks by furnace gases is usually due to the velocity of the moving gases, especially where one stream is broken into several smaller ones or a change occurs in the

direction of the gases. Alternate reducing and oxidising conditions are probably of secondary importance, but a kind of "surface combustion" may be highly destructive to brickwork. For furnace linings, bricks and blocks must be accurate in size and shape so as to make close joints. A variation in size of $\frac{1}{4}$ in., absent corners, or lack of "squareness" are all serious defects which ought not to occur, and manufacturers cannot attach too much importance to avoiding them. The author has found that certain silica bricks made of "outcrop quartzite" containing 92% SiO₂ are quite satisfactory in an iron blast furnace.

Magnesite bricks are usually employed in the bottom of the furnace, below the basic lining. They should be perfect in shape and size, of fine texture, with low porosity, great hardness and density, and a finely crystalline semi-vitreous fracture; they should "ring" like metal and be free from tendency to spall. The Styrian bricks fulfil all these requirements, but are costly, and supplies were always irregular. British-made magnesite bricks, in the past, have been of very poor quality, partly owing to the attempt of British manufacturers to burn magnesite bricks in kilns built of silica instead of magnesite and at a much lower temperature. The Austrian bricks owe their value to fine grinding, high preliminary burning, powerful hydraulic pressure in making, and very high temperature in burning so as to secure the formation of β -magnesia. If iron oxide is required to form a bond, it may be added in the form of "waste pickle." Typical analyses of magnesite bricks, silica bricks, and ganister are cited.—A. B. S.

Furnace conditions; Effects of—on basic refractories used in smelting operations. A. Wasum. Verh. Vereins Beförd. des Gewerbleisses, 1884, 63, 104. Trans. Ceram. Soc., 1917, 16, 317—326.

Four series of bricks were made using (1) dolomite, (2) lime, (3) magnesia, and (4) magnesite as the chief ingredient, with one of the following bonds: clay, silica, calcium phosphate, ferric oxide, ferrous oxalate, hammer scale (ferrosoferric oxide), ferric phosphate, ferrous phosphate, trimanganic tetraoxide, and basic converter slag. The bricks were fired in a commercial oven along with basic bricks at "the highest white heat." The following conclusions were reached. Good bricks may be made without a bond from dolomite, limestone, or magnesia, but not from magnesite as it does not possess sufficient plasticity. By the addition of clay up to 5%, still better bricks may be made and magnesite may then be used. The bricks must be burned for a long time at a "very high white heat." Dolomite and lime bricks produced without a bond, have a durability of about three weeks in dry air; their durability is considerably increased by the addition of clay as bond. Magnesia and magnesite bricks, with or without a clay bond, will last over three months in dry air. A high burning temperature is essential to durability. The dolomite, lime, and magnesite bricks contracted 24% on burning, but those made of strongly calcined magnesia only contracted 1%. Lime and dolomite bricks are strongly attacked by slags and the oxides of iron, much less so by silica, phosphoric acid, and manganese. The foregoing results are strongly in favour of highly calcined magnesia as the best basic material, but the cost of such magnesia bricks is so great that to be profitable their durability in use should be three or four times as great as that of dolomite or lime bricks. According to the author this is not the case.—A. B. S.

Fireclay goods; Black cores in—. J. W. Mellor. Trans. Ceram. Soc., 1917, 16, 259—267.

WHEN clays are heated so rapidly that surface

fusion occurs before the carbonaceous material in the interior has been fully oxidised, black cores are produced. To prevent the formation of these cores, ventilation must be good and the heating must be slow during the oxidation period, especially from 600° to 900° C., at which temperature the capillaries in the material begin to close. The precise boundary temperature depends on the clay and must be found by trial. If the temperature has been raised to 1000° C. without oxidising all the carbon, any ferrous compounds present will probably unite with the clay to form a fusible slag and no subsequent firing will then remove the core. In bad cases the gas bubbles entangled in the fused slag cause the bricks to swell and become lighter than an equal volume of water. Other things being equal, plastic-made bricks of fine texture or with coarse particles of bituminous matter will form cores more readily than dry-pressed and more porous bricks, with woody carbonaceous matter (sawdust).—A. B. S.

Ferric oxide and alumina. Scheetz. See VII.

Residues from the manufacture of alum and possible means of utilising them. Falcicola. See VII.

A resistance electric furnace. Thornton. See XI.

PATENTS.

Glass or like material; Process for drawing molten— in cylindrical form [tubes and rods]. E. C. R. Marks, London. From The Libbey Glass Co., Toledo, Ohio, U.S.A. Eng. Pat. 110,642, Nov. 29, 1916. (Appl. No. 17,133 of 1916.)

THE molten glass flows around a hot, inclined, rotating blowpipe, then through a hot, rotating, conical passage surrounding a part of the blowpipe, thus regulating the thickness of the stream, and through a cooler rotating cylinder; both the cone and cylinder are made of fireclay. The glass, which is now in the form of a soft tube, is supported on a long bench and is drawn at uniform speed (e.g., 140 ft. per min.) by any suitable mechanism, and is then cut into pieces of the desired length. The glass tubes thus produced have walls of uniform thickness; the glass solidifies before it has time to become distorted, and the finished tubes are more perfect in form and contain less air-bubbles than those produced in the customary manner. The air-pressure used is very small, but it must be constant. Solid rods may be made by shutting off the air-supply.—A. B. S.

[Glass lehr.] Channel oven, drying oven or the like. H. I. F. Strandh, Forserum, Sweden. U.S. Pat. 1,243,777, Oct. 23, 1917. Date of appl., Dec. 21, 1915.

A LEHR or tunnel oven for annealing glass wares is provided with a rectangular track, one side of which extends within the lehr and the opposite side extends outside it, forming outlet and inlet races. The goods to be annealed are carried on boards fitted with rollers which continuously rest on the track. The track is fitted with rollers at right angles to those on the boards and arranged in such a manner that only rolling friction between the boards and the races is obtained not only whilst transporting the boards on the different races, but also at every moment of the transfer between two adjacent races.—A. B. S.

Casting pottery and like articles; Process of—. B. J. Allen, Blythe Bridge, Staffs., and R. Y. Ames, Gidea Park, Essex. Eng. Pat. 110,649, Dec. 11, 1916. (Appl. No. 17,787 of 1916.)

THE articles are made by pouring a suitable slip into a porous mould encased with iron, and reducing the pressure between the mould and the casing. The rate of evaporation of the absorbed fluid and

the absorbing power of the mould are thus increased and a rapid deposit of normal thickness or a deposit much thicker than can be obtained with ordinary moulds is produced. The absorbing power of the mould may also be supplemented by applying perforated or porous vessels containing dried calcium chloride and the like so as to produce an uneven or graduated deposition of the casting material. The jacket or casing may be provided with studs to support the mould and also facilitate the removal of the moisture from those parts of the mould where the deposit is required to be thickest and *vice versa*, so that articles of varying thickness may be cast without special treatment of the mould. In casting crucibles or open-top glass-house pots, it is preferable to use a mould to give both the inside and outside shapes, and to apply suction to both the inside and outside mould. The inside mould is removed as soon as the deposit is sufficiently hard. In making large gas retorts or furnace blocks, a product with an open, porous structure may be obtained, or a mixture which is too thick and plastic to cast under ordinary conditions may be used. (See also this J., 1917, 549.)—A. B. S.

Abrasive articles; Method of making —. H. Urtel, La Salle, Assignor to The Carborundum Co., Niagara Falls, N.Y. U.S. Pat. 1,243,783, Oct. 23, 1917. Date of appl., Jan. 31, 1914.

ABRASIVE articles, made of a mixture of fused crystalline alumina and a bond containing liquid sodium silicate and zinc oxide, with or without flint, are fired to a temperature sufficiently high to form a double silicate of sodium and zinc which is insoluble in water, but not to dissolve alumina in amount sufficient to dull the grains of abrasive. —A. B. S.

Firebrick and furnace linings; Composition for making —. R. R. Zell, Birmingham, Ala., Assignor to Silicrete Refractories Co., Irondale, Ala. U.S. Pat. 1,244,275, Oct. 23, 1917. Date of appl., Feb. 8, 1917.

A REFRACTORY material containing "silicrete" 100, aluminium hydroxide 5, dehydrated gypsum 5 parts, and sufficient of a 10% solution of caustic potash to render the mass plastic, but not alkaline. —A. B. S.

Dental cement. W. S. Crowell, Philadelphia, Pa., Assignor to The S. S. White Dental Manufacturing Co. U.S. Pat. 1,244,296, Oct. 23, 1917. Date of appl., Jan. 26, 1917.

A DENTAL cement consisting of zinc oxyphosphate or other cement powder and an acid phosphate liquid containing a mercury salt.—A. B. S.

Tunnel ovens. C. Dressler, Marlow. Eng. Pat. 110,918, Aug. 11, 1916. (Appl. No. 11,383 of 1916.)

SEE U.S. Pat. 1,225,318 of 1917; this J., 1917, 618.

[*Tunnel*] *furnaces*. Eng. Pat. 106,606. See I.

Machines for washing sand. Eng. Pat. 111,061. See I.

IX.—BUILDING MATERIALS.

Potash from cement dust. Canadian Chem. J., 1917, 1, 161.

FROM theoretical considerations and practical data relating to 20 cement factories in Canada, it is

estimated that, per year of 300 working days, 21,555 short tons of potash (K_2O), valued at nearly \$11,000,000 (£2,291,700), is at present lost in the form of dust containing 12% K_2O in the case of the dry, and 21% K_2O in the wet process of manufacture. The combined rated daily capacity of the plants in question is 47,900 barrels, a barrel being about 350 lb. and representing 625 lb. of raw mix containing 9.8% K_2O . It is assumed that 60% of the potash entering the kilns is liberated and expelled with the gases. The potash content of the feed could be increased to about 2.5% (by the addition of felspar, etc.), without detriment to the clinker produced. Of the numerous methods tried for the collection of cement mill dust, the Cottrell process of electrical precipitation has proved the most successful commercially. This process is already in use in four plants having a combined rated capacity of 15,500 barrels per day, and is now being applied to four others having a combined rated capacity of 7000 barrels per day.—W. E. F. P.

PATENTS.

Preserving wood; Method of —. H. Foersterling, R. N. Sargent, and F. A. Kaufmann, Perth Amboy, N.J., Assignors to the Roessler and Hasslacher Chemical Co., New York. U.S. Pat. 1,242,168, Oct. 9, 1917. Date of appl., Dec. 27, 1915.

Wood is preserved by precipitating an insoluble metallic cyanide (e.g., copper cyanide) within its intercellular spaces; this may be effected, for example, by causing first a solution of copper sulphate and then one of sodium cyanide to enter the wood.—A. B. S.

[*Cement*] *slurry; Treatment of* —. C. Pontopidan, Brooklyn, Assignor to F. L. Smidth and Co., New York. U.S. Pat. 1,242,236, Oct. 9, 1917. Date of appl., Sep. 18, 1915.

SLURRY for use in the manufacture of Portland cement is mixed with an electrolyte, such as sodium carbonate, to increase its fluidity and reduce its water content.—A. B. S.

Mineral wool; Art of making —. W. Fay, St. Louis, Mo. U.S. Pat. 1,242,537, Oct. 9, 1917. Date of appl., Feb. 23, 1917.

MINERAL wool is made by forcing a hot dust-settling fluid, such as a mixture of oil and steam, at a high velocity into a stream of molten scoriaceous material. The mineral wool-fibres and fluid are projected into a receiving chamber, and the fluid is allowed to pass out through restricted openings so as to create a pressure in the chamber and cause the fibres to float or circulate slowly but freely in the fluid.—A. B. S.

Cement, etc.; Process for the manufacture of —. L. P. Basset, Paris. U.S. Pat. 1,241,280, Oct. 23, 1917. Date of appl., Mar. 4, 1914.

SEE Fr. Pat. 466,518 of 1913; this J., 1914, 964.

[*Electrical*] *apparatus for extracting dust from gases and vapours, applicable also for collecting particles of flour, cement, and other substances*. Eng. Pat. 110,774. See I.

Process of slaking lime. U.S. Pat. 1,244,421. See VII.

Composition for making firebrick and furnace linings. U.S. Pat. 1,244,275. See VIII.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY.

Steel; Special properties of eutectoid —. P. Y. Saldau. Rev. Soc. russe de Mét., 1916, 1, 112—148. Rev. Mét., 1917, 14, Ext., 193.

FROM a study of different carbon steels, having lamellar or granular, pearlitic structures, it is concluded that, in physical properties, eutectoid steel is differentiated sharply from other steels of similar composition. In eutectoid steel, the hardness, resistivity, and resistance to rupture and compression are at the maxima after annealing, the lamellar pearlite not being rendered granular by heating at 700° C. for 7 hrs. A rectilinear diagram is not applicable for representing the physical properties of iron-carbon alloys in the eutectoid region. These properties are probably associated with the high degree of dispersion (i.e., ratio of surface to volume) of the metal in the eutectoid region of the iron-carbon series.—W. E. F. P.

Chrome steel; Some peculiarities in the manufacture of — in the Martin furnace. N. N. Menchikh. Rev. Soc. russe de Mét., 1916, 1, 176—188. Rev. Mét., 1917, 14, Ext., 233—235.

IN the author's experience, the chromium content of the metal produced in the Martin furnace depends entirely on the operation of the furnace and not on the initial chromium content of the charge. The high loss of chromium (often two-thirds of the total) experienced in ordinary working occurs mainly during fusion, particularly if the atmosphere is sufficiently oxidising. When fusion is complete, the chromium content of the metal bath increases with the temperature at which the operation is continued. The author is of opinion that, at high temperatures, the chromium of the slag passes into the metal in the form of an oxide (other than that present in the slag), which is very stable and soluble under these conditions.

—W. E. F. P.

Steel tools; Use of high-speed cast —. Grenet. Rev. Mét., 1917, 14, 547—550.

STEELS of the following composition are described:

	A. Extra hard.	B. Hard.	C. Normal.
Carbon	2.7	1.2	0.7
Chromium	19.4	6.6	3.5
Tungsten	24.9	23.0	19.0
Vanadium	0.4	0.8	0.8

Steel A was cast in rectangular steel moulds 10 mm. wide and 15 mm. deep; the lower, thoroughly chilled part was used. The alloy was very brittle unless annealed for 2 hours at 550° C., but even after annealing it could only be used with the greatest care and could not be utilised in the works. Steel B was cast and annealed like A; on semi-hard steel it could be used at much higher speed than the best high-speed steels and lasted 4—10 times longer than the best forged tools. It was brittle enough to require cautious use. The cutting speed of steel C was not much higher than that of forged tools, while it lasted about 1½ times as long. The brittleness was not pronounced enough to render annealing indispensable, but annealing at 500° C. is recommended. The presence of manganese is prejudicial to hardening, as it prevents the change from γ - to α -iron during the chilling.—W. R. S.

Gold; Effect of sulphides on solutions of — in potassium cyanide. V. Pasoukhine. Rev. Soc. russe de Mét., 1916, 1, 161—172. Rev. Mét., 1917, 14, Ext., 237—240.

CONTRARY to the statements of certain English

authors, artificial and natural sulphides of copper, iron, lead, zinc, etc., were found not to act as precipitants of gold from cyanide solutions. As confirming this result, 100, 75, and 65 % of the gold present in artificially-prepared, auriferous sulphides of copper, iron, and lead, respectively, was extracted by a dilute solution of potassium cyanide.—W. E. F. P.

Furnace for melting brass; Resistance type —. T. F. Baily. Amer. Electrochem. Soc., Oct., 1917. [Advance copy.] 9 pages.

DETAILS of running tests of an electric tilting furnace of the resistance type are given. The furnace is of the non-crucible type, having a cylindrical shell provided with inner walls and roof forming the furnace chamber. The bottom of the chamber provides a bowl-shaped hearth for the metal when melted. The resistance element is contained in a circular trough made of refractory material; in this trough the resistance material (broken carbon) forms contact with the electrodes, which are placed diametrically opposite each other with their ends projecting into the trough. The rated electrical capacity is 105 kw. for a furnace 7 ft. in diam. having a hearth capacity of 1500 lb. and an average melting rate of 600 lb. per hour. The quality and uniformity of the product were satisfactory. On the basis of the power consumed, viz., 450 and 300 kilowatt-hours per short ton of bearing bronze and cartridge brass (average of six tests each), respectively, the melting costs compared favourably with those in non-electric furnaces.—W. E. F. P.

[Bronzes, etc.] *Test-bars and actual castings; Some comparative tests on* —. W. M. Corse and G. F. Comstock. J. Amer. Inst. Metals, 1917, 11, 250—256.

WITH a view of preventing the application of specifications based on standard test-bar results to test-pieces cut from actual castings, attention is drawn to a number of cases in which considerable discrepancies were shown in the tests of various bronzes and aluminium alloys.—W. E. F. P.

White metal alloys; Analysis of —. Determination of lead, copper, and antimony. R. Howden. Chem. News, 1917, 116, 235.

Lead. One grm. of the alloy is dissolved in nitrohydrochloric acid, 5 c.c. of concentrated sulphuric acid and 1 grm. of tartaric acid are added, and the mixture is heated until red fumes cease to be evolved. The mixture is then cooled and diluted and the lead sulphate collected, washed, and weighed. **Copper.** The filtrate from the lead sulphate is treated with sulphur dioxide and the copper precipitated as cuprous iodide or thiocyanate. The precipitate is collected, dissolved in nitric acid, and the copper determined iodometrically. **Antimony.** One grm. of the alloy is dissolved in hydrochloric acid with the addition of potassium chlorate, and the solution is treated with stannous chloride solution, added drop by drop, until the yellow colour due to the copper is destroyed; air is then passed through the solution for about 20 mins. in order to re-oxidise the copper. One drop of methyl-orange solution is then added and the mixture titrated with potassium bromate solution until the colour of the indicator disappears. The bromate re-oxidises the antimony, and if the bromate solution contains 4.639 grms. of potassium bromate per litre, each c.c. is equivalent to 1 % of antimony when 1 grm. of alloy is taken for the determination.—W. P. S.

[Tin and wolfram ores.] *Slime treatment on Cornish frames, with particular reference to the effect of surface.* S. J. Truscott. Inst. Min. and Met., Nov., 1917. [Advance copy.] 68 pages.

LABORATORY tests with slimes containing tinstone

or wolfram were conducted on a frame 16 in. wide and 30 in. long, covered with pine wood, cement, plate glass, fluted glass, or rubber. The following conclusions were reached. A suitably adjusted, transversely fluted surface is more effective than a plane surface, the flutes causing the mineral to deposit at the upper end of the frame, where it gradually accumulates and continually displaces the gangue from the next lower flute. The flutes tend strongly to prevent channels, banks, and irregular distribution which would lead to loss of mineral. They provide a bed of mineral, which is the most effective means of holding fine material. The size and shape of the flutes must be adjusted to the kind of material treated; if they are too deep, the gangue particles settled at the bottom do not become dislodged by subsequently arriving mineral particles. The conclusions apply to wolfram as well as to cassiterite. Among plane surfaces wood was the most effective material, but its surface wears in the course of time. The size of the material should be as uniform as possible, *i.e.*, all finer than 120-mesh, at least 80% passing a 200-mesh. The inclination of the frame and the pulp ratio are interdependent, and the best conditions, as well as the length of the frame, must be ascertained in each case. Increase in temperature of the water, like lack of water, gives a bulkier but less valuable concentrate. An increase in the rate of pulp feed makes a richer concentrate at the cost of lower recovery, but the tailing can again be subjected to a similar treatment. It is recommended to adopt the principle of taking out a sufficiently rich concentrate which will require a minimum of further treatment, and repeating this process on each successive tailing. By this means and the use of fluted surfaces, an improvement of 10% in the slime recovery may be expected.—W. R. S.

Design and manipulation of gas furnaces. Forshaw. See IIA.

Refractories for steel furnaces from the consumer's point of view. Brooke. See VIII.

Effects of furnace conditions on basic refractories used in smelting operations. Wasum. See VIII.

A resistance electric furnace. Thornton. See XI.

PATENTS.

Ingot-iron and steel; Manufacture of —. Deutsch-Luxemburgische Bergwerks- u. Hütten-Akt.-Ges., Bochum, and A. Klinkenberg, Dortmund, Germany. Eng. Pat. (A) 105,548, Mar. 6, 1917. Under Int. Conv., Mar. 27, 1916. (Appl. No. 3316 of 1917), and (B) 105,902, Mar. 7, 1917. Under Int. Conv., Apr. 18, 1916. (Appl. No. 3397 of 1917.)

(A) IN the manufacture of ingot iron and steel by deoxidation of molten metal rich in oxygen, carbohydrates, *e.g.*, sugar, in the proportion of 2.5 parts to steel 1000 parts, may be added to the molten metal. (B) In the process described in (A) for making ingot iron and steel, the carbohydrates for deoxidising may consist of packages of wood wool, shavings, sawdust, or the like, which are placed in the tapping ladle just before pouring in the molten metal.—W. F. F.

Malleable cast iron or steel; Furnaces for the manufacture of —. L. Geuze, Paris. Eng. Pat. 103,996, Feb. 2, 1917. (Appl. No. 1717 of 1917.) Under Int. Conv., Feb. 8, 1916.

A FURNACE for the manufacture of malleable cast iron or steel comprises three adjoining communicating chambers, the central melting chamber being heated by generator gas. Steel or iron turnings or scrap are placed in one of the side

chambers and preheated by hot gases from the central chamber, and cast iron is similarly preheated in the other side chamber. These charges are gradually pushed into the central chamber by the addition of fresh charges of material, and the mixture is melted and run off.—W. F. F.

Steel; Compound for tempering —. C. C. Trinkle, Romney, Ind. U.S. Pat. 1,213,899, Oct. 23, 1917. Date of appl., Feb. 19, 1917.

THE compound comprises sodium bicarbonate, willow charcoal, sal ammoniac, sulphur, copperas, and table salt.—T. H. B.

Carbonising metal articles; Process and apparatus for —. W. Fennell, Gloucester, Eng. Pat. 110,937, Nov. 7, 1916. (Appl. No. 15,959 of 1916.)

A FIREBRICK conduit passes vertically through a furnace chamber so that its middle portion is strongly heated. Articles to be carbonised, mixed with carbonising material, are fed into the conduit from a hopper at the top so that the conduit is practically full. A rotating plate is arranged just below the open lower end of the conduit, and a fixed scraper removes the articles and material from the plate so as to allow a gradual discharge from the conduit on to the plate. The rate of discharge may be varied by adjusting the position of the scraper, or the speed or height of the table. Alternatively an adjustable sleeve may be provided on the lower end of the conduit.—W. F. F.

Copper and nickel; Electro-deposition of — from solutions obtained from ores. M. V. Garin, Paris. Eng. Pat. 104,678, Feb. 23, 1917. Under Int. Conv., Feb. 29, 1916. (Appl. No. 2701 of 1917.)

IN the electro-deposition of copper and nickel from weak solutions containing sulphurous acid, obtained from ores, an insoluble anode, *e.g.*, of lead, is used and the cathode surface is continuously rubbed or wiped. The rubber is of animal or vegetable fibre carrying filaments of gelatin. If the gelatin has not first been rendered insoluble, the temperature of the bath is kept below 20° C. The rubber may also be formed of organic membranes containing gelatin which gradually dissolves, *e.g.*, parchment skins. The cathode may be a rotating horizontal cylinder, and the anode may surround it except at the top where the rubber rests on its surface. Hydrogen bubbles are thus removed from the surface of the cathode and deposition of copper sulphide is prevented.—W. F. F.

Ores; Flotation process of treating — and apparatus for use therein. K. Sundberg, Guldsmidshyttan, Sweden. Eng. Pat. 110,717, June 4, 1917. (Appl. No. 8002 of 1917.)

ORE pulp and oil are fed into the first of three adjacent chambers, and the mixture is caused to rotate horizontally by jets of air from suitable nozzles. The mixture passes through an opening in the side of the chamber into a vessel having a conical bottom from which the foam overflows, and the heavier material passes to the second chamber adjacent to the first chamber. It is subjected to similar treatment in this chamber and the heavier residue is similarly transferred to the third chamber, from the bottom of which the final residue free from metallic particles is withdrawn.—W. F. F.

Complex [sulphide] ores; Recovery process for the treatment of — and apparatus for same. C. J. Inglis, Hobart, Tasmania. Eng. Pat. 110,948, Nov. 10, 1916. (Appl. No. 16,166 of 1916.)

COMPLEX ores containing mixed sulphides, *e.g.*, of iron, zinc, and bismuth, are ground and mixed

with three times their weight of water. The mixture is delivered upwards through a central pipe and sprayed into a gas-tight chamber to which a mixture of hydrogen chloride and chlorine gases is continuously supplied. Reactions take place resulting in the solution of the metals and precipitation of sulphur, and to facilitate chemical action the chamber may be warmed by the introduction of steam. The outlet of the spray pipe may be regulated by a disc adjustable towards and away from the outlet, and the cover of the chamber may be water-sealed.—W. F. F.

Sulphides; Method of reducing — R. F. Bacon, Pittsburgh, Pa., Assignor to Metals Research Co., New York. U.S. Pat. 1,243,681, Oct. 23, 1917. Date of appl., Jan. 15, 1913.

THE sulphides of silver, mercury, arsenic, antimony, and platinum are treated with a hydrocarbon in a non-oxidising atmosphere at a relatively low temperature in such a way as to reduce the sulphides to metal quantitatively and convert the sulphur into hydrogen sulphide. For example, the hydrocarbon is allowed to drop on a heated mass of the precipitated sulphide at a suitable rate.

—T. H. B.

Zinc; Refining — G. C. Fricker, Luton, Eng. Pat. 110,970, Nov. 29, 1916. (Appl. No. 17,138 of 1916.)

THE distilling vessel and condensing vessel are placed in adjacent chambers which communicate by a controlled passage, so that the temperature of the condensing vessel is maintained slightly above the melting point of zinc. The surface of the impure molten zinc is covered by a thick layer of floating, inert, porous, refractory material, such as small pieces of foundry coke or fireclay, which retains lead vapour and other impurities, leaving pure zinc to pass over to the condensing vessel. In an alternative form, the separate condensing vessel may be omitted and the zinc vapour condensed in the distilling chamber itself. The wall dividing it from the heating chamber is not perforated and heating is effected by conduction through the wall.—W. F. F.

Electric welding or fusion-deposition of metals. The Quasi-Arc Co., Ltd., London, and L. Tweedale, Castleton, Lancs. Eng. Pat. 111,026, Mar. 9, 1917. (Appl. No. 3185 of 1917.)

IN the method of electric welding described in Eng. Pats. 1274 and 11,079 of 1912, and 13,538 of 1914, the work is carried on a table which is moved longitudinally or turned according to the joint to be made, and a rapid to-and-fro movement of about 0.25 in. amplitude is imparted to the work in a direction at right angles to the first movement. The latter movement causes the oscillation of the electrode over the line of the weld, and is caused by an eccentric shaft acting on a saddle mounted on the table. One or more electrodes are carried in suitable holders above the work and are stationary except for a feeding movement as the electrode burns, which is effected by gearing from the shaft which actuates the table. The feed for the electrode may be actuated by hand through a friction clutch so that the rate of feed may be varied as desired without affecting the other movements. The work is normally moved by a screw shaft and worm, and means are provided to allow for adjustment of the table by hand. A trip device may also be provided to stop the feed at any position of the table. In an alternative form the electrode may be moved to-and-fro with respect to the work instead of the work being moved.—W. F. F.

Gold and silver; Process for separation of — from minerals. R. Reyes, Mexico. U. S. Pat. 1,243,976, Oct. 23, 1917. Date of appl., Nov. 9, 1914.

THE finely divided mineral is added to a solution of sodium chloride or other suitable salt, and an electric current is passed through the solution, whereby the metals are deposited on the cathode. The mixture is agitated during the passage of the current by discharging gases upwards through it.

—T. H. B.

Chlorination of minerals; Apparatus for the —. R. Reyes, Mexico. U.S. Pat. 1,243,977, Oct. 22, 1917. Date of appl., Aug. 6, 1915.

A CHLORINATION tank consists of a receptacle for containing a solution to be electrolysed, the top of which has openings for ladders which are arranged to support electrodes in the receptacle at any desired height. One of the openings and ladder is large enough for use by a workman.

—T. H. B.

Tungsten trioxide; Process for extracting — from its ores. L. Rosenstein, San Francisco, and E. H. Simonds, Oakland, Cal. U.S. Pat. 1,244,082, Oct. 23, 1917. Date of appl., Sep. 27, 1916.

PULVERISED tungsten ore is mixed with water sodium carbonate and hydroxide are added, and the whole boiled; the mixture is filtered, excess of sodium carbonate removed by lime, and after separation of the calcium carbonate, a soluble barium compound is added, the mixture is boiled and the barium tungstate treated with hydrochloric acid to form tungsten trioxide.—T. H. B.

Molten metals; Treatment of — to increase their density. A. Rollason, Long Eaton, Derbyshire, Eng. Pat. 110,860, Mar. 2, 1917. (Appl. No. 3077 of 1917.)

THE molten metal, e.g., steel and its alloys, or rare metals and their alloys, containing combined or dissolved oxygen, is treated with 0.5—1.0% of metallic uranium, the proportion depending on the amount of oxygen or the desired density of the metal. The uranium combines with the oxygen and passes away with the slag.—W. F. F.

Concentrating alluvial ores or the like; Apparatus for —. J. F. Lobb, Wood Green, Middlesex, Eng. Pat. 110,977, Dec. 7, 1916. (Appl. No. 17,621 of 1916.)

Iron and steel; Process of changing the composition of —. H. Wade, London. From B. Ford, Philadelphia, U.S.A. Eng. Pat. 110,946, Nov. 9, 1916. (Appl. No. 16,093 of 1916.)

SEE U.S. Pat. 1,205,611 of 1916; this J., 1917, 88.

Furnace for smelting ores. C. J. Beaver and E. A. Claremont, Cheshire. U.S. Pat. 1,243,798, Oct. 23, 1917. Date of appl., Apr. 17, 1916.

SEE Eng. Pat. 6675 of 1915; this J., 1915, 1150.

Coating iron, steel, or other metals with metal; Process of —. E. Bernheim, Düsseldorf, Germany, Assignor to C. F. Burgess, Madison, Wis., and C. J. Kirk, New Castle, Pa. U.S. Pat. 1,244,414, Oct. 23, 1917. Date of appl., Mar. 20, 1914.

SEE Fr. Pat. 458,707 of 1913; this J., 1913, 1072.

Gas burners for metallurgical and other furnaces. Eng. Pat. 110,960. See IIA.

Method of making an insecticide [from smelter fumes]. U.S. Pat. 1,243,323. See XIXB.

XI.—ELECTRO-CHEMISTRY.

Furnace; A resistance [electric] —. F. Thornton, jun. Amer. Electrochem. Soc., Oct. 6, 1917. [Advance copy.] 12 pages.

EXPERIMENTS have been made on the heating of furnaces by resistors, placed either on the hearth or on a shelf around the walls. Such furnaces would be suitable for use in forging, heat-treating, tempering, and annealing steel, melting copper and brass, and firing ceramics and enamelled ware. Carbon does not form a satisfactory resistor material; it is necessary to use a very pure carbon, and owing to its negative temperature coefficient the temperature beneath the resistor bed becomes very high and the furnace lining suffers. Better results were obtained with silicon carbide blocks, bricks, or rods, and these were satisfactory with temperatures up to 1200° C., when resistors were provided in the roof of the furnace as well as on the hearth. Under these conditions there is an oxidising atmosphere in the furnace, but a reducing atmosphere may be obtained by spreading granular carbon over the resistor.—B. N.

Edison storage battery; Effect of lithium upon the capacity of the —. L. C. Turnock. Amer. Electrochem. Soc., Oct. 6, 1917. [Advance copy.] 8 pages. (See also this J., 1916, 1023.)

TESTS were made with an alkaline battery, in which lithium hydroxide was added to the 21% solution of potassium hydroxide in amounts up to 50 grms. per litre (a saturated solution of lithium hydroxide at about 24° C.). With increasing amounts of lithium hydroxide, an increased capacity up to a maximum of 12% was obtained over that given with pure potassium hydroxide, in spite of an increased resistance of 21% in the electrolyte.—B. N.

Synthetic gasoline by electrochemical means. Cherry. See IIA.

Resistance type furnace for melling brass. Bailly. See X.

Determination of copper as sulphide and by electrolysis. Hahn. See XXIII.

PATENTS.

Furnace; Electric —. I. R. Valentine, Schenectady, N.Y., Assignor to General Electric Co. U.S. Pat. 1,242,275, Oct. 9, 1917. Date of appl., May 12, 1917.

THE furnace is provided with a refractory division wall extending upwards from the base, part of the way to the upper wall, and a conductor, forming a stationary electrode, is located on the base, near one side of the wall. One or more movable electrodes, projecting through the roof of the container, co-operate with the stationary electrode to form an arc or arcs, and the space on the opposite side of the wall, adapted to receive material to be heated, is shielded by the wall from heat radiated directly from the arcs.—B. N.

Electrode and process of making the same. J. E. Thomsen, Assignor to The Joseph Dixon Crucible Co., Jersey City, N.J. U.S. Pat. 1,243,009, Oct. 16, 1917. Date of appl., Feb. 2, 1917.

A HARD, non-inflammable body is produced from a mixture of finely divided carbon particles of different sizes, 64%, tar, 33%, and a formaldehyde derivative, 3%, or cresols and phenols may be used in place of tar. The mixture is pressed into blocks, and calcined at a temperature above the decomposition point of the condensation product present.—B. N.

Galvanic cell. J. F. Sanders, Assignor to O. P. Coshov, Roseburg, Oreg. U.S. Pat. 1,243,111, Oct. 16, 1917. Date of appl., July 19, 1915.

A CATHODE for a galvanic cell is composed of a combination of palladium and rhodium.—B. N.

Electrolytic gas generators. 1. If. Levin, New York. Eng. Pat. 102,933, Oct. 27, 1916. (Appl. No. 15,357 of 1916.) Under Int. Conv., Dec. 26, 1915.

SEE U.S. Pat. 1,214,934 of 1917; this J., 1917, 391.

Method and apparatus for [electrically] treating air. U.S. Pat. 1,213,524. See VII.

[*Electrical*] *apparatus for extracting dust from gases and vapours, applicable also for collecting particles of flour, cement, and other substances.* Eng. Pat. 110,774. See I.

Electron-discharge apparatus and method of preparation. Electron-discharge apparatus and method of operating same. U.S. Pats. 1,244,216 and 1,244,217. See IIB.

Process for the separation of gold and silver from minerals. U.S. Pat. 1,243,976. See X.

Apparatus for chlorination of minerals. U.S. Pat. 1,243,977. See X.

XII.—FATS; OILS; WAXES.

Castor oil used for lubricating aeroplane motors; Detection of foreign oils in —. C. Frabot. Ann. Chim. Analyt., 1917, 22, 217—223.

THE acetyl value is capable of indicating the presence of 1 to 2% of foreign oils in castor oil, but the other constants are of little value for the purpose. In the special case of castor oil adulterated with arachis oil the solidification point and the solubility in alcohol are the most sensitive tests (limit, 5%). For smaller amounts of arachis oil the turbidity temperature of the alcoholic solution may be determined. A solution of 1 vol. of pure castor oil in 95% alcohol remains clear when chilled below -20° C.; but in the presence of arachis oil the solution becomes turbid at temperatures ranging from +5° or +6° C. for 5% to -2° or -3° C. for 2% of arachis oil. An alcoholic solution of castor oil containing 1% of arachis oil becomes opalescent at -4° to -5° C. and turbid at -9° C. Foreign oils may be separated from castor oil by shaking 20 c.c. of the sample with 80 c.c. of petroleum spirit of b.pt. 35° to 70° C. in a stoppered graduated cylinder. After settling, the volume of the lower layer containing the castor oil will show an increase of about 11 to 12 c.c. if the oil is pure, or more if foreign oils are present. On evaporating 50 c.c. of the petroleum spirit layer a residue is left, which in the case of 12 samples of pure castor oil ranged from 8.35 to 8.70% of the original oil. Mixtures containing from 30 to 1% of arachis oil gave residues ranging from 38.61 to 10.04% and by deducting from these the average value for pure castor oil (8.52%), the results agreed closely with theory. The method also effects a concentration of the arachis oil, which facilitates the detection of arachidic acid by Bellier's method. For example, the petroleum spirit extract from castor oil containing 5% of arachis oil will contain 36.7% of that oil.—C. A. M.

Residues from the manufacture of alum and possible means of utilising them. Falcicola. See VII.

PATENTS.

Candles. G. F. Powell and S. W. Bush, Bath. Eng. Pat. 110,579, Oct. 24, 1916. (Appl. No. 15,932 of 1916.)

A COLOURLESS varnish or paraffin wax stiffened

with a pulverulent combustible such as powdered precipitated cellulose, is applied to candles as an exterior coat to prevent guttering.—A. DE W.

Composition for cleansing, bleaching, decorticating, and for purifying and preserving food. Eng. Pat. 110,567. See VI.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS.

Abietic acids; Optical isomerism of the —. F. Schulz. Chem.-Zeit., 1917, 41, 666—667. J. Chem. Soc., 1917, 112, i., 619.

ABIETIC acid may be prepared by extracting American colophony with dilute alcohol or by precipitating the alcoholic solution with hydrogen chloride, but whereas the alcoholic solution of the resin is dextro-rotatory, the solution becomes laevorotatory on addition of hydrogen chloride, so that the products above mentioned are probably not identical. When the resin is dissolved in boiling alcohol and dry hydrogen chloride passed into the cold solution, white crystals of abietic acid are obtained, the constants of which gradually alter on recrystallisation from acetone, from $[\alpha]_D = -77.9^\circ$ and m.pt. 161°C. to $[\alpha]_D = -98.8^\circ$, m.pt. 171°C. Further recrystallisation from acetone raises the m.pt. to 173°C. The molecular weight by titration is found to be 304. On exposure to air, the rotation alters owing to oxidation, and it changes also on heating at 200°C. American colophony, type H, extracted with dilute alcohol, yields an oil which gradually sets to a mass of crystals, from which by crystallisation from acetone a portion is obtained having $[\alpha]_D = -22^\circ$, whilst another part has $[\alpha]_D = +49^\circ$. An almost inactive fraction, $[\alpha]_D = +2.6^\circ$, is also obtained. On treatment with mineral acid, the rotation of the two last became negative. From technical resin oil the author has extracted an acid which he names oilsylvic acid (*Oelsylvinssäure*), m.pt. $171^\circ\text{—}173^\circ \text{C.}$, $[\alpha]_D = +53^\circ$, which does not alter in rotation when warmed with mineral acids, and in contradistinction to the abietic acid from colophony does not absorb oxygen from the air and does not turn yellow in light. The abietic acids can readily be esterified by boiling their alcoholic solutions with 30% of concentrated sulphuric acid for an hour.

PATENTS.

Lead pigments; Process of producing —. A. S. Ramage, Buffalo, N.Y., Assignor to International Color and Chemical Co., Inc., Detroit, Mich. U.S. Pat. 1,243,762, Oct. 23, 1917. Date of appl., Jan. 8, 1916.

LEAD pigments are produced by roasting a sulphide ore of lead to form lead sulphate and oxide, converting the lead sulphate into carbonate by treating with an aqueous solution of a carbonate, dissolving the mixed lead carbonate and oxide in caustic alkali solution, and re-precipitating lead carbonate by carbon dioxide. The lead carbonate is finally converted into a basic salt by treatment with caustic alkali.—A. DE W.

Calcimine [dislemper] and process of making same. R. W. Cornelison, Assignor to The Cott-A-Lap Co., Somerville, N.J. U.S. Pat. 1,244,033, Oct. 23, 1917. Date of appl., Mar. 27, 1914.

A PREPARED calcimine contains, in addition to solid ingredients the bulk of which is insoluble in water, a lake-forming colouring-matter and a precipitant for it, and an effervescent material to assist disintegration of the product when brought into contact with water.—A. DE W.

Phosphorescent colours; Art of making —. R. F. Langer, San Francisco, Cal. U.S. Pat. 1,244,058, Oct. 23, 1917. Date of appl., Mar. 15, 1916.

A BASIC composition consisting of lithium carbonate, sulphur, barium carbonate, water, and alcohol is first applied to the surface, followed by a second composition of manganese sulphite, strontium carbonate, sodium chloride, sulphur, anhydrous sodium carbonate, and ethyl alcohol.—A. DE W.

XIV.—INDIA-RUBBER; GUTTA-PERCHA.

Vulcanisation tests. L. E. Campbell. Bull. Dep. Agric., Ceylon, No. 32. India Rubber J., 1917, 54, 725—727. (Cf. this J., 1917, 92, 604.)

EXPERIMENTS were made to ascertain the effect of dilution of the latex upon the vulcanisation and mechanical properties of the rubber. The apparent difference in the rates of coagulation appears to depend not so much upon the rate at which the emulsoid phase is destroyed as upon the rate at which the rubber particles cohere. Generally speaking the results of the experiments are inconclusive. The effect of dilution on the rate of cure is not very marked. All samples from undiluted or slightly diluted latex gave good mechanical tests; in some cases those from greatly diluted latex gave distinctly low results. The results were, however, too irregular to allow definite conclusions to be drawn. The diminution effected by dilution in the quantities of mineral constituents, protein, and resin in the rubber, may, however, be of importance.—E. W. L.

PATENT.

Rubber latices; Process for the treatment [coagulation] of —. C. A. Hcken and St. V. B. Down, Singapore. Eng. Pat. 110,560, Sept. 20, 1916. (Appl. No. 13,650 of 1916.)

PRIOR to coagulation with the mixture of alcohol and petroleum benzene described in Eng. Pat. 8487 of 1915 (this J., 1916, 854), latex is mixed with glycerin, $\frac{1}{2}$ oz. per gallon, or with a mixture of glycerin, 1; alcohol, 4; and water, 5 parts, in the proportion of $\frac{1}{2}$ oz. per gallon. When, after 8 hours, a spongy coagulum is formed, 1 oz. (per lb. of rubber present) of the coagulating mixture is injected into the container. On standing overnight the clot discharges much of its serum, and it is then pressed or mangled and finished as desired. Other polyhydric alcohols or their derivatives or glycerol esters may be used in place of glycerin.—E. W. L.

XV.—LEATHER; BONE; HORN; GLUE.

PATENT.

Plastic masses from casein or other swelling substances; Apparatus for the manufacture of —. R. Weiss, Hamburg, Germany. Eng. Pat. 107,769, July 5, 1917. (Appl. No. 9726 of 1917.) Under Int. Conv., July 7, 1916.

WITHIN the nozzle of a forcing machine, or bar press, for preparing plastic materials in the form of bars, thin sieve-plates, with fine holes, and each supported by a thicker plate with large holes, are arranged one in front of the other, with the object of eliminating enclosed air-bells, and producing a perfectly solid bar.—E. W. L.

XVI.—SOILS; FERTILISERS.

Soil acidity; Nitrification as a measure of the availability of different forms of calcium carbonate when employed as correctors of —. P. S. Burgess. Soil Sci., 1917, 4, 327—336.

CALCIUM carbonate, in the forms of soft coral

limestone and coral sand, was applied to a sample of an acid soil from Hawaii in sufficient quantity to effect neutralisation, and the mixtures were incubated and the nitrate present determined every two weeks for twenty weeks. Similar mixtures with addition of dried blood and of ammonium sulphate were included in the experiment. The results showed that one form of calcium carbonate was as effective as the other on the soil alone. When a fertiliser was added, the finely ground coral limestone was one and a half times as effective as the best grade of coral sand. In the soil alone, larger quantities of nitrogen were converted into nitrate from blood than from ammonium sulphate, but in the presence of either form of calcium carbonate the reverse was the case.—J. H. J.

Ammonification; Further studies of the nature of — K. Miyake. *Soil Sci.*, 1917, 4, 321—325.

SPECIMENS of various soils were mixed with leucine and with tyrosine and incubated at 30° C. for 16 days, the ammoniacal nitrogen produced being determined at intervals. In the case of leucine, this amounted to about 80% of the possible, and in the case of tyrosine, 40—80%. The process was found to be an autocatalytic reaction, proceeding in accordance with the author's equation previously given (see this J., 1917, 227).—J. H. J.

Phosphorus; Determination of soil — C. O. Rost. *Soil Sci.*, 1917, 4, 295—311.

A COMPARISON was made of four methods for the determination of phosphorus in soil, namely, fusion with sodium carbonate, extraction with *aqua regia*, ignition and extraction with nitric acid, and evaporation with hydrofluoric acid, together with two modifications of the last. It was found that the fusion method gave accurate results, only traces of phosphate remaining in the separated silica, and evaporation with magnesium nitrate before ignition was unnecessary, as was also an initial precipitation of the phosphate along with iron and aluminium hydroxides. In the method of double extraction with *aqua regia* with ignition in between, there was no loss from volatility of phosphorus, but a large amount of the phosphate was left undissolved in the residue. The method of extraction with nitric acid after ignition, gave complete extraction in one case but not in another. The hydrofluoric acid method was found to leave a considerable amount of phosphate in the residue, owing to the formation of difficultly soluble iron and aluminium phosphates. A modification of the method, in which the soil is evaporated with nitric acid previous to ignition, gave still lower results, due to a considerable amount of phosphate being contained in the filtrate from the ammonium molybdate precipitate. The author found that this method could be rendered accurate when modified as follows: 1 gm. of soil is ignited at a dull red heat, and when cold, 10 c.c. of distilled water, 10 c.c. of nitric acid, and 5 c.c. of hydrofluoric acid are added, the mixture is well stirred and is evaporated to a volume of about 5 c.c., when a further 5 c.c. of hydrofluoric acid is added and the mixture evaporated to dryness. Then the residue is evaporated two or three times with small quantities of nitric acid, after which it is dried at 110° C. for an hour, taken up in 3 c.c. of nitric acid and 7 c.c. of water, and the liquid boiled and filtered. The filtrate is precipitated with ammonium molybdate, and the precipitate redissolved and finally converted into magnesium pyrophosphate. It was found that the titanium oxide present in soils did not affect the determination of phosphate.—J. H. J.

Phosphorus; Production of available — from rock phosphate by composting with sulphur and manure. P. E. Brown and H. W. Warner. *Soil Sci.*, 1917, 4, 269—282.

AN investigation was conducted to determine whether mineral phosphates would be decomposed by sulphuric acid produced by bacterial action in manure heaps. Preliminary experiments were made to determine if horse and cow manures and compost contained the necessary sulphur-oxidising bacteria, and it was found that they oxidised as much sulphur to sulphuric acid as rich loam soil. These manures were then mixed with finely ground rock phosphate containing about 12% of total phosphorus and with precipitated sulphur, and were kept at the temperature of the laboratory and analysed periodically during 15 weeks. In the manures mixed with sulphur there was a slight increase in the amount of available phosphorus, but in those with rock phosphate there was a distinct depression in the amount. In presence of both sulphur and rock phosphate there was a continual increase in the available phosphorus throughout the whole period with each manure, the increase amounting to 24% of the total phosphorus. This increase was greater when the materials were intimately mixed with the manures than when they were added in layers.—J. H. J.

Phosphates; Vegetation experiments on the availability of treated — J. G. Lipman and H. C. McLean. *Soil Sci.*, 1917, 4, 337—343.

POT culture experiments on several crops were made with rock phosphate which had been composted with sulphur, in order to compare its availability for plant use with that of acid phosphate (superphosphate). It was found that the treated phosphate was about as available as the superphosphate. Untreated rock phosphate had little effect in promoting growth except in the case of buckwheat, which utilised this form of phosphate equally as well as the other two forms.

—J. H. J.

Basic slag; Chemical composition of — C. van R. Janssens. *Versl. Landbouwk. Onderzoek. Rijklandsproefstat.*, No. 20, 26—33. *Bull. Agric. Intell.*, 1917, 8, 1105.

SINCE the beginning of the war two types of basic slag have been put on the Dutch market, one with a low content of phosphate, the other with a high content. The average analyses of these two types were respectively as follow: phosphoric anhydride, 7—8% and 15—19%, silica, 13—17% and 6—14%, alumina, 2—3% and 1—4%, total iron, 28—32% and 11—18%, manganese oxides, 4—5% and 6—13%, total lime, 37—43% and 46—52%, magnesia 3—4% and 1—3%. The high standard slag is equal to normal slag, but this is not the case with the low standard slag, since the high content of iron causes formation in the soil of iron phosphate, which is useless for fertilising.

—J. H. J.

Calcium cyanamide; Determination of the cyanamide nitrogen in — A. D. Berkaut, R. D. Hendricksz, and G. Wind. *Versl. Landbouwk. Onderz. Rijklandsproefstat.*, 1917, No. 20, 43—51. *Bull. Agric. Intell.*, 1917, 8, 1105—1106.

A SOLUTION of calcium cyanamide is prepared by mixing 2 grms. of the finely ground substance with small quantities of water at a time, and decanting into a litre flask until nearly full. The flask is then shaken vigorously for an hour, the contents made up to the mark and filtered. 100 c.c. of the filtrate is measured into a 200 c.c. flask, neutralised with nitric acid (10%) and 5 c.c. of ammonia (2.5%) added. N/10 silver nitrate is added from a burette with continual shaking until the precipitation of the cyanamide is complete. The contents of the flask are then made up to the mark,

shaken, and filtered through a double filter. The excess of silver nitrate is determined by Volhard's method. Alternatively the determination may be completed by collecting the precipitate of silver cyanamide quantitatively, washing, and submitting the filter and contents to Kjeldahl's process.

—J. H. J.

Manures and foods: Growth of international trade in —. J. Hendrick. Trans. Highland and Agric. Soc. Scotland, 1917. [Reprint.] 36 pages.

THE author deals chiefly with the growth in the volume of trade in manures, with some remarks on food. International trade in manures began about 1810, when Peruvian guano was first exported to Europe, chiefly to Britain. Guano continued to be the imported manure in greatest use until 1880, by which time the deposits had been mostly worked out. Since 1880 other countries have surpassed Britain in the importation of artificial manures. *Nitrogenous manures.* The annual export of sodium nitrate from Chili has increased from 3000 to 3,000,000 tons between 1886 and 1916. In Britain the net imports have risen from 99,000 metric tons to 143,000 metric tons between 1905 and 1913. The production of ammonium sulphate has developed with the gas industry. In 1870 Britain produced about 40,000 tons and in 1913 over 400,000 tons, of which only a quarter was used at home, the rest being exported. On the other hand, Germany, Belgium, and the United States imported more than they produced. The world's production has risen from nearly half a million tons in 1900 to one and a half million tons in 1913. The production of synthetic nitrogenous manures has increased very rapidly also during the few years it has been in operation. Calcium cyanamide has increased from 26,000 metric tons in 1910 to 156,000 metric tons in 1913, none of which was produced in Britain. Calcium nitrate has been produced in Norway only; in 1905, 127 metric tons was made, whereas in 1913, 73,000 metric tons was made, most of which was exported to Germany. In the latter year Germany imported 78,000 metric tons of all the synthetic manures, the United States 14,000 metric tons, and France 10,000 metric tons, while Norway exported over 100,000 metric tons, compared with 25,000 metric tons in 1911. *Phosphoric manures.* Bones were earliest used. India is the largest exporter with over 100,000 metric tons in 1913. Britain uses about 100,000 tons a year, of which 40,000 tons is imported. The world's production of mineral phosphates in 1903 was 2½ million metric tons, and in 1913 nearly 7 million metric tons, of which the production in North Africa formed 350,000 tons and 2½ million respectively. The imports of mineral phosphates into Britain during the same period increased only slightly. Most mineral phosphates are converted into superphosphate, of which Britain produced 620,000 metric tons in 1900 and 820,000 metric tons in 1913. France nearly one million and nearly two million metric tons respectively, and Germany 600,000 and 1,800,000 metric tons. The use of basic slag has increased along with the use of the basic process of steel making, from 10,000 tons in 1880 to 1½ million tons in 1900. Since 1900, the production in Britain has increased from 120,000 tons to 400,000 tons, of which 100,000 tons is exported; that of Belgium from 100,000 to 650,000 tons, of which over 500,000 tons is exported; and that of Germany from 1 million to 2½ million tons, of which only a quarter of a million is exported. *Potash manures.* The German deposits have formed almost the sole source of potash for all purposes, the output growing from 2200 tons in 1861 to over 11 million tons in 1913, mainly due

to an increase in the agricultural use of potash, this being 42% of the output in 1880 and nearly 90% in 1910. Germany uses practically as much potash for agriculture as all other countries put together. In Britain the consumption increased rapidly between 1900 and 1913, Scotland using the largest amount per acre of arable land. *Crop production.* It was reasonable to suppose that those countries which were rapidly increasing their consumption of fertilisers were also increasing the crops produced, and this was found to be the case. Crop production in Germany, in the case of wheat, averaged 13.2 million tons in 1879—83 and 26.9 million tons in 1909—13; and the average per acre was 10.24 centals and 17.86 centals, respectively. In England the yield of wheat per acre per annum was 29.5 bushels in 1885—9 and 31.2 bushels in 1909—13. In Germany the corresponding figures were 19.8 and 31.6. The figures for potatoes were: England, 5.9 and 6.2 tons; Germany, 3.4 and 5.4 tons. Before the war Germany and Austria produced twice as much wheat and rye as France and Britain, more than twice as much of other cereals, and more than three times as much potatoes. Calculated per head of population, these amounts become:—

	Central Powers.	Britain.	France.
	lb.	lb.	lb.
Wheat and rye	460	77	570
Other cereals	440	210	330
Potatoes	1200	320	760

—J. H. J.

XVII.—SUGARS; STARCHES; GUMS.

Cane sugars; Filtration of syrups prepared from raw — in the refinery. H. Pellet. Bull. Assoc. Chim. Sucr., 1917, 35, 183—186.

IT has been suggested by Manoury (J. Fabricants de Sucre, 1916, June 21) that difficulties of filtration in the refining of raw cane sugars might be avoided by first raising the purity of the sugars to 99%. The author states that in a large Parisian refinery it is now the practice to bring all raw cane sugars to 99% by a preliminary washing, but the difficulty of filtration still remains and varies considerably in different cases. It is due to particles of bagasse, to gummy matters, and also probably to small quantities of silica, part of which is in a colloidal form. The amount of these impurities present in a raw sugar depends on the method of manufacture. Cane mills which by repeated crushings extract a very high proportion of sugar, e.g., 94—95% or even more, necessarily extract a large amount of these impurities also. Ordinary defecation of the raw cane juice, with or without sulphitation, does not eliminate them, though carbonatation does. Their presence renders the centrifuging of raw cane sugars a more protracted operation than that of beet sugars. Even when brought to a purity of 99% by washing, raw cane sugars do not yield clear solutions, and in the refinery they require a much greater filtering surface than beet sugars, in some cases three times as great.—J. H. L.

Sugar; Action of basic lead acetate on invert —. H. Pellet. Bull. Assoc. Chim. Sucr., 1917, 35, 186—194.

THE author suggests that the conflicting conclusions published on the one hand by Davis (this J., 1916, 203) and on the other by various chemists (see, e.g., Deerr, this J., 1916, 1075), respecting

the precipitation of reducing sugars by basic lead acetate, are due to a difference in the composition of the liquids studied. In liquids, such as molasses, which contain a considerable amount of salts, the lead precipitate invariably carries down some reducing sugar. This is not necessarily the case with liquids containing organic matters, but almost or entirely free from salts, as in Parkin's experiments with sugar solutions containing tannin (see Davis, *loc. cit.*). The plant extracts studied by Davis would probably belong to the second class.—J. H. L.

Arsenic in glucose [; *Determination of* —]. A. Kling. *Ann. Falsif.*, 1917, 10, 438—450.

THE author made a comparative study of the accuracy of three methods of determining small quantities of arsenic (in solutions free from organic matter), viz., the Marsh-Berzelius, the Gutzeit, and a so-called diaphanometric method in which the arsenic is reduced to the elementary state by hypophosphorous acid in presence of sulphuric acid and estimated from the cloudiness of the liquid in comparison with a series of test solutions of known arsenic-content treated in the same way at the same time. The possible error of all three methods was found to be of the same order, about one-tenth of the amount of arsenic determined, but the Gutzeit method is not considered so trustworthy as the others for quantitative purposes. The diaphanometric method is somewhat more expeditious than the Marsh-Berzelius method; it is rendered inexact by the presence of traces of nitrates or nitrites. From solutions containing sugars, traces of arsenic can, after oxidation with bromine, be completely precipitated by entrainment in precipitates of ammonium magnesium phosphate formed in the solutions. Modifying a procedure described by Vuaffart (*Ann. Falsif.*, 1916, 272), the author applied this method to commercial glucoses; the phosphate precipitate was dissolved in nitric acid, all traces of the latter were then eliminated by evaporation with sulphuric acid, and the sulphuric acid solution was used for the determination of arsenic by the diaphanometric method. Experiments described indicate that traces of arsenic in beer-wort are not eliminated to any extent during fermentation or fining of the fermented beer.—J. H. L.

Potatoes; Utilisation of rotten — in the manufacture of starch. Ducomet and A. C. Girard. *Comptes rend. l'Acad. d'Agric. de France*, 1917, 3, 716—719. *Bull. Agric. Intell.*, 1917, 8, 1191.

SPOILED potatoes are suitable for starch manufacture provided decomposition has not gone very far. According to Ducomet's observations, even when the tubers are in a deliquescent state, the starch is still undecomposed, and only at a later stage does it undergo liquefaction. It is therefore advisable to collect all potatoes attacked by damp rot, whether caused by frost, or mildew or other organisms, and extract the starch, which after proper sterilisation is fit for consumption by man or animals. The period during which spoiled potatoes can be kept before treatment may be considerably prolonged by covering them with water and changing this from time to time. It is pointed out by Girard that about 75% of the nitrogen and 90% of the potash contained in the tubers is carried off in the water in which they are washed. On the farm this water might be absorbed by manure heaps or even by the soil, to utilise the valuable constituents. If it is first brought to the boiling point, about half of the contained nitrogen is precipitated as protein, which after deposition could be fed directly to stock.—J. H. L.

XVIII.—FERMENTATION INDUSTRIES.

Yeast; Behaviour of — towards different sugars at various concentrations, and the influence of addition of alanine on fermentation. E. Abderhalden. *Fermentforsch.*, 1916, 1, 229. *Woch. Brau.*, 1917, 34, 138.

THE course of fermentation was studied by the aid of a registering balance designed to record automatically the loss of weight due to evolution of gas. In sucrose solutions containing 10—30 grms. in 250 c.c., fermented at 30° C. by equal quantities of beer yeast, the rate of production of carbon dioxide was found to be independent of the initial concentration of sugar, but this was not the case when yeast juice or dried yeast was used. Addition of alanine, up to a certain limit of concentration, accelerated fermentation by living yeast. The rate of fermentation of dextrose was somewhat slower than that of laevulose, and was not independent of the concentration of sugar. Fermentations effected by pressed yeast juice or by dried yeast, were characterised by a very slow initial rate which afterwards increased rapidly.—J. H. L.

Enzymes; Chemical composition and formation of —. XIII. Alterations in the amount of enzyme in kephir grains and in *B. lactis acid.* H. Euler and E. Griese. *Z. physiol. Chem.*, 1917, 100, 59—68. *J. Chem. Soc.*, 1917, 112, i., 679—680. (Compare Euler and Cramér, *this J.*, 1914, 97, 272.)

KEPHIR grains which have been grown previously once or twice in a mixture of whey and galactose, with and without the addition of phosphates, contain a larger quantity of enzyme in relation to dry weight than is contained in the original material. In other words, the same weight of kephir grains produces a more rapid and a greater evolution of carbon dioxide after propagation in a suitable medium than in the original condition. When the lactic acid bacillus is similarly grown in successive fresh quantities of a medium of whey containing 4% of galactose, the rate of formation of lactic acid by a standard number of bacilli is increased. If, however, 6% of sodium dihydrogen or disodium hydrogen phosphate is also present in the medium, the formation of the lactic acid soon diminishes, and, instead, an increasing quantity of carbon dioxide is produced. By suitable preliminary treatment, therefore, it is possible to stimulate the production of one or other of the enzymes in the living cell.

Glycolysis. G. G. Wilenko. *Z. physiol. Chem.*, 1917, 100, 255—263. *J. Chem. Soc.*, 1917, 112, i., 680.

THE fermentation of dextrose by yeast occurs without the formation of carbon dioxide when the hydroxyl-ion concentration of the medium is maintained within certain limits. This can be effected by adding a buffer-mixture of sodium dihydrogen and disodium hydrogen phosphates in the proportion of one of the former to ten or more (depending on the kind of yeast) of the latter. The same result can be achieved without phosphates by the simple addition of a slight excess of N/1 sodium hydroxide solution. If the yeast at the end of an experiment is collected and treated with fresh dextrose solution, ordinary fermentation with evolution of carbon dioxide ensues, indicating that in the original experiment the hydroxyl ions are associated with the dextrose or its degradation products rather than directly with the enzyme.

Alcoholic fermentation at different concentrations of hydroxyl ion. H. Euler and K. Haldin. Z. physiol. Chem., 1917, 100, 69—73. J. Chem. Soc., 1917, 112, i., 680. (Compare Wilenko, preceding abstract.)

THE fermentation of dextrose by yeast proceeds even in the presence of alkalinity equivalent to *N*/20-ammonium hydroxide solution. If an adequate proportion of ammonium phosphate is also added, the production of carbon dioxide is greatly diminished, although the amount of dextrose fermented may be as great as it was before the addition of the ammonium phosphate, similar conditions of time, temperature, and concentration being maintained.

Yeast; Increase of dry weight of — when urea is used as the source of nitrogen. T. Bokorny. Biochem. Zeits., 1917, 82, 359—390. J. Chem. Soc., 1917, 112, i., 680.

A NUMBER of experiments are quoted which show that a considerable growth of yeast (as measured by increase in dry weight) can take place when the organism is grown on urine containing sugar. The urea, and not hippuric acid, acts as the source of nitrogen. The growth is especially vigorous in presence of air.

Saccharophosphatase of yeasts and the fermentation of sucrose-phosphoric acid. K. Djenab and C. Neuberg. Biochem. Zeits., 1917, 82, 391—411. J. Chem. Soc., 1917, 112, i., 680—681.

YEASTS contain an enzyme "saccharophosphatase," which can hydrolyse the salts of synthetic sucrose-phosphoric acids, prepared originally by Neuberg and Pollak (hesperonal). Scission of inorganic phosphate takes place. The enzyme is found in both top and bottom yeasts. It is to be distinguished from the already known hexophosphatase in that the latter acts only in yeast juices separated from the living cell, whereas the new saccharophosphatase will act in the living cell, and produce alcoholic fermentation of the synthetic sucrose-phosphate. It is also insensitive to the action of antiseptics, both when fresh yeast is used or maceration juice. It acts between the temperatures of 22° and 37° C. and in neutral, alkaline, and weakly acid (acetic acid) solutions. The soluble sodium salts of the synthetic sucrose-phosphoric acid can be hydrolysed to the extent of 67% by fresh yeast and 45% by maceration juice.

Sugar fermentation and assimilation of sugar; Relationship between —. T. Bokorny. Allg. Braun- u. Hopfen-Zeit., 1917, 57, 447—480. J. Chem. Soc., 1917, 112, i., 681—682.

THE influence of fractional addition of sugar, of nitrogen nutriment, and of addition of alkali are considered. The increase in dry substance in the fermenting yeast is regarded as a criterion of the extent of assimilation. Under unfavourable conditions a loss in weight occurs, but, in better circumstances, the extent of assimilation exceeds that recorded by Pasteur, according to whom about 1% of the sugar is assimilated. Repeated addition of sugar without alteration in the total quantity appears beneficial. Urea, even in pure aqueous solution, is a more suitable source of nitrogen than ammonia; apparently this is more effective when gradually formed than when applied in the preformed state. Similarly, assimilation is favoured by the substitution of sucrose for dextrose. Assimilation is promoted by free potassium hydroxide at certain concentrations, preferably at about 0.01%. Previous experiments on the application of dextrose as a food for moulds and for the formation of starch in *Spirogyra* are discussed; in the latter instance, the influence of light and of access of oxygen is particularly noticeable.

Beer; Sterilisation of —. P. Petit. Brasserie et Malterie, 1917, 7, 1—4, 17—20, 33—36.

AMONG the numerous processes which have been proposed for sterilising beer, to render it stable indefinitely, the only one extensively used hitherto is pasteurisation. This process, however, has certain disadvantages; it is liable to affect the flavour of beers, and to give rise to turbidity, which sometimes appears only after a few days. The turbidity might perhaps be prevented by a peptonising treatment such as Wallerstein's (see this J., 1916, 1170), but the practical difficulties associated with pasteurisation, especially as applied to beer in bulk, render unlikely any further developments of importance in this method of sterilising beer. Relatively little attention has been devoted, within recent years, to the possibility of sterilising beer by filtration. Filters of the Chamberland type are impracticable, on account of their very limited capacity and because they deprive beer of certain valuable colloidal constituents. Ordinary pulp filters, on the other hand, do not retain bacteria. Between these extreme types, however, there are possibilities which were explored to some extent by Thevenot, who experimented with infusorial earth and pipe-clay as filtering media. Recently a sterilising filter of this type, with batteries of filtering tubes, has been installed in a number of American breweries and appears to have given satisfaction. The largest models have a capacity of about 750 galls. per hour. Information is at present lacking as to whether these filters are suitable for European beers which are required to show a stable creamy head. This character is not possessed in the same degree by American beers; it depends on the presence of certain colloidal matters, the retention of which by the filter would be a serious disadvantage. The bottling of sterilised beer, without infection, demands a standard of biological cleanliness, as regards pipes, racking apparatus, and bottles, which has not hitherto been attained in practice. Some of the practical problems involved are discussed by the author. The sterilising filter referred to above is combined with an automatic plant for the cleansing and sterilising of bottles, which appears to represent a considerable improvement on existing systems.—J. H. L.

Italian wines; Application of Halphen's ratio to —. F. Scurti and E. Rolando. Annali Chim. Appl., 1917, 8, 47—77.

HALPHEN (Bull. Soc. Chim., 1906, 35, 879) based a test of the purity of wines on the ratio between the acidity and the alcoholic strength. Applying this test to typical Italian wines, the authors conclude that in the case of acid wines 25% of water may be added without interfering with the ratio. The test is of no value as an absolute criterion of purity, although it may be of use as a supplementary test in deciding whether a wine of unknown origin is genuine.—C. A. M.

[Distillers'] mashes; Saccharification of — by means of malt. A. Vasseux. Bull. Assoc. Chim. Sucr., 1917, 35, 237—238.

THE following method of saccharifying distillers' mashes by means of a small proportion of malt, has given good results, and is recommended to distillers who wish to abandon saccharification by means of acid in order to produce spent grains suitable for feeding purposes. The raw grain is cooked as usual and transferred hot into small closed vats similar to those used in the amylo-process (see this J., 1914, 562). When full, the vats are cooled, and sterilised air is introduced meanwhile. When the temperature has fallen to 55° C. a mash of green or dried malt (representing 3—5% of the charge of grain) is added, and the charge is kept in motion, without further cooling,

for an hour, within which period saccharification is complete. There is little risk of infection, but antiseptics may be used if necessary. Cooling is then resumed and the yeast is introduced when the temperature has fallen to 35° C. At 24° C. cooling is stopped, and after fermentation has become vigorous, the charge is transferred to open vats in which the fermentation is completed as usual.

—J. H. L.

Starch; Formation of—by mould fungi. F. Boas. *Biochem. Zeits.*, 1917, 78, 308. *Woch. Brau.*, 1917, 34, 47.

In experiments with *Aspergillus niger* and *Penicillium glaucum*, cultivated in solutions of sucrose, dextrose, levulose, or dextrin, containing ammonium salts, the liquids after some time acquired the property of yielding with iodine a blue coloration which vanished on warming. A substance coloured blue by iodine was also observed in the mycelial cell-walls of the moulds. Under the influence of diastase the liquids lost their power of reacting with iodine. Alcohol precipitated the starch-like substance from solution in a flocculent form. The formation of this substance is attributed to the influence of the free acidity liberated in consequence of the assimilation of the nitrogen of the ammonium salts by the moulds, for similar results were obtained also in sugar solutions, and in beer wort, treated with free tartaric, phosphoric, or sulphuric acid (see also this J., 1917, 1024).

—J. H. L.

Specific pigment-forming enzyme of the skin. Dopa-orydase. Bloch. See VI.

Determination of arsenic in glucose. Kling. See XVII.

Analytical examination of acorns and horse-chestnuts. Baker and Hulton. See XIXA.

Enzymic degradation of inulin in the root of chicory. Wolff and Geslin. See XIXA.

PATENT.

Fermented beverage; Non-intoxicating—and process of making the same. C. A. Nowak, St. Louis, Mo. U.S. Pat. 1,243,440, Oct. 16, 1917. Date of appl., Mar. 22, 1915. Renewed Mar. 15, 1917.

Wort of approximately 25°–35° Balling, relatively poor in readily fermentable carbohydrates, is fermented at a fairly high temperature, e.g., 23°–35° C., by yeast in presence of acid-forming bacteria. For instance, the fermentation, lasting 6–12 hours, may be effected by means of vinegar ferment. The product may be diluted with hopped water. —J. H. L.

XIXA.—FOODS.

Margarines and butter substitutes; Nutritive value of—with reference to their content of the fat-soluble accessory growth substance. W. D. Halliburton and J. C. Drummond. *J. Physiol.*, 1917, 51, 235–251. *J. Chem. Soc.*, 1917, 112, i, 673.

The fat-soluble accessory growth substance of beef-fat and “oleo-oil” is present in margarines prepared on such a basis. Such margarines are nutritively equivalent to butter. Coconut oil, cotton-seed oil, arachis oil, and hydrogenated vegetable oils contain little or none of this accessory substance. Margarines from these, and nut butters prepared from crushed nuts, are not equal to butter in nutritive value. Lard substitutes from vegetable oils are equal to lard in nutritive value, both alike being destitute of the fat-soluble accessory substance.

Cottonseed products; Methods for approximating the relative toxicity of—. F. E. Carruth. *J. Biol. Chem.*, 1917, 32, 87–90.

Raw cottonseed kernels are highly toxic to animals owing to the fact that they contain about 0.6% of gossypol, a phenolic plant pigment. The meal obtained when the oil is extracted by hot pressing is usually not markedly toxic, since the gossypol is readily changed by oxidation into a substance which is insoluble in oil and ether; this oxidised product yields a blue coloration with alcoholic potassium hydroxide solution. In the cold pressing process most of the gossypol passes into the oil and is removed from the latter during refining operations. The presence of gossypol may be detected by treating a portion of the meal with a drop of concentrated sulphuric acid and immediately examining the mixture under the microscope; if numerous red areas appear where the acid touches the more or less broken up “glands,” the presence of toxic unchanged gossypol is indicated. To determine the quantity of gossypol present, a quantity of the meal sufficient to yield about 10 grms. of oil is extracted with ether, the ethereal solution evaporated, and the residue of oil, after filtration, is mixed with about 10% of its weight of aniline; the mixture is warmed on a water-bath and then set aside. If, after several days, no precipitate is formed, the meal may be considered to be free from gossypol. In the presence of gossypol, however, a yellow crystalline precipitate separates; this is collected, washed first with a mixture of ether and petroleum spirit (1:2), then with petroleum spirit, dried at 100° C., and weighed. The compound appears to be the dianiline salt of gossypol ($C_{30}H_{25}O_8$, $2C_6H_5NH_2$) and its weight is multiplied by 0.74 to obtain the quantity of gossypol. Cottonseed meals containing 0.24% or more of gossypol proved fatal to rats within 10 days; meals containing smaller quantities were injurious to the animals.—W. P. S.

Acorns and horse-chestnuts; Analytical examination of—. J. L. Baker and H. F. E. Hulton. *Analyst*, 1917, 42, 351–355. (See also this J., *Auld*, 1913, 173; *Rousset*, 1913, 243; *Goris*, 1917, 1107.)

The outer, green husk of fresh horse-chestnuts accounts for about 67% of their total weight. The nuts themselves consist of 22% of brown integument with 37% of water, and 78% of kernel (cotyledons) with 46.5% of water. Acorns as picked consist of 16% of shell with 43.7% of water and 84% of kernel with 46.4% of water. The accompanying table shows the percentage composition of samples of nuts and acorns prepared by peeling, grating, drying at 55° C., and then grinding finely in a handmill. The starch values were determined on the material after

	Peeled chestnuts.				Peeled acorns.	
	1.	2.	3.	4.	1.	2.
Moisture	2.6	3.5	1.85	2.4	1.45	3.32
Ash	2.9	2.8	2.45	2.77	2.25	2.70
Ether extract (oil) ..	6.1	5.0	7.1	7.2	5.0	4.7
Protein (N×6.25) ..	9.8	10.8	7.25	7.62	6.65	7.5
Reducing sugars as dextrose	3.6	9.1	3.29	1.6	4.9	8.18
Sucrose	8.1	11.1	7.27	17.5	1.9	0.1
Starch (Lintner)....	47.8	21.9	42.8	42.2	57.1	55.7
Starch (Taka diastase)	38.4	15.2	39.0	38.2	44.3	43.4
Pentosans	4.75	—	—	5.44	3.2	—
Crude fibre	2.0	—	—	2.6	2.2	2.28
Cold water extract ..	34.9	48.4	32.56	36.2	13.2	17.24

extraction with ether and water. Those obtained by acid hydrolysis (Lintner) are too high, owing

to the formation of reducing sugar from a non-amylaceous substance, probably a constituent of the membranes which enclose the groups of starch granules. This substance, amounting to 13% or more of the dried chestnut kernels, swells to a jelly in water, and a dried sample of it gave the following results on analysis:—protein 12%, crude fibre 27.3%, ash 2%, pentosans 21.4%. The cold water extracts of the nuts and acorns contained besides sugars, 90% of the total mineral matters, widely varying proportions of the total protein (e.g., 30–70% for chestnuts and 20% for acorns), and no glucosides; those from the chestnuts contained about 16% of the total pentosans. Of the total matter extracted by cold water, 9.5–23% in the case of chestnuts, and 2.8–5.3% with acorns, could not be accounted for; similar instances of undetermined soluble matters occur in malt, cocoa, etc. Acorns were found to be almost entirely destitute of diastase, but chestnuts contained considerable amounts, of much greater saccharifying than liquefying power. Slight evidence of invertase activity was found in acorns before but not after germination. The starch granules of both chestnuts and acorns vary much in shape and size; they have well defined hila and inconspicuous striae. The average maximum diameter of the granules of acorn starch is 6–25 μ , and of horse chestnut starch 10–40 μ . Ground horse-chestnuts and acorns were boiled with 2% sulphuric acid for 3 hours under a reflux condenser, and the filtered and neutralised liquids were fermented with brewers' yeast. In both cases the yields of alcohol obtained amounted to about 27% of the dried peeled kernels, corresponding to 12% on the fresh horse-chestnuts or acorns (deprived of the outer green shell).—J. H. L.

Soy bean; Nutritive value of the—. A. L. Daniels and N. B. Nichols. J. Biol. Chem., 1917, 32, 91–102.

THE soy bean contains 36% of protein, 17.5% of fat, 12% of digestible carbohydrates, and 5.3% of mineral matter, as well as a sufficient quantity of water-soluble growth-promoting substance. Experiments on rats show that the bean is a valuable food, but that the mineral content needs supplementing by the addition of sodium chloride and calcium salts.—W. P. S.

Inulin; Enzymic degradation of— in the root of chicory. J. Wolff and B. Geslin. Comptes rend., 1917, 165, 651–653.

AFTER chicory roots have been gathered there occurs in the course of weeks a slow enzymic hydrolysis of inulin, with production of "inulides," corresponding to the dextrins from starch, and finally of levulose. The inulides are non-reducing, and are not coagulated by inulo-coagulase (see this J., 1916, 553); they are fermentable by yeast, though not to the same extent by all races. The enzyme of the root which effects their further degradation into sugar, appears to be identical with invertase, and is without action on inulin itself.—J. H. L.

Growth of international trade in manures and foods. Hendrick. See XVI.

Utilisation of rotten potatoes in the manufacture of starch. Ducomet and Girard. See XVII.

PATENTS.

Cheese: Manufacture of—. J. W. Trevan, London, and J. S. White, Spalding, Lines. Eng. Pat. 110,621, Nov. 2, 1916. (Appl. No. 15,695 of 1916.)

IN the manufacture of cheese, a non-poisonous soluble calcium salt, preferably the chloride, is added either to the milk direct, or mixed with

the rennet or pepsin. By this means curdling is effected at a lower temperature, and a smaller proportion of ferment is necessary. Good results may be obtained by the addition of 0.05 to 0.2% of calcium chloride to the milk.—L. A. C.

Margarine: Method and apparatus for crystallising—. M. Larsen and A. C. A. Zeuthen, Silkeborg, Denmark. Eng. Pat. 110,872, Mar. 20, 1917. (Appl. No. 4507 of 1917.)

THE apparatus consists of an emulsifying machine discharging the margarine emulsion continuously into a cooling trough provided with a shaft and paddles, which transmit the emulsion in contact with a stream of cooling water passing through the trough in the same or an opposite direction. During the passage through the trough the emulsion is thoroughly worked up with the water so that it is both cooled and washed. At the end of the trough the margarine is delivered to an inclined pipe in which is situated a worm and kneading device so that the product issues in a finished condition.—J. F. B.

Milk: Apparatus for use in pasteurising and like treatment of liquids such as—. A. C. A. Zeuthen and M. Larsen, Silkeborg, Denmark. Eng. Pat. 110,897, July 31, 1917. (Appl. No. 11,042 of 1917.)

APPARATUS having a vertical rotating drum-shaped member for stirring the liquid passing through in a continuous current is employed for pasteurising milk, the heat contained in the pasteurised milk being utilised for heating the cold liquid entering the apparatus. The rotating drum must always be filled with liquid, and for this object it is furnished with a neck, the upper end of which is bent over to form a depending collar, and an annular feeding funnel or chamber the inner wall of which projects freely up between the neck and collar, whereby the surplus liquid thrown out from the neck is prevented from entering the space between the rotating drum and the outer container but can be led through a pipe. By arranging this pipe at a suitable level and prolonging the lip of the depending collar, a liquid seal can be retained in the funnel so that the outer air cannot gain access to the space between the drum and container.—J. F. B.

Skimmed milk and vegetable-fat compounds; Apparatus for the production of—. J. F. Enz, Denmark, Wis. U.S. Pat. 1,213,275, Oct. 16, 1917. Date of appl., Apr. 9, 1917.

SKIMMED milk and a vegetable fat are conveyed through pipes from separate heating vessels to a mixing chamber from which the air is exhausted. The ends of the pipes in the mixing chamber are near together and are provided with sprayers adapted to mix the sprays of milk and melted oil.—W. P. S.

Bread manufacture. A. S. Wahl, Assignor to The Wahl Efficiency Institute, Chicago, Ill. U.S. Pat. 1,242,396, Oct. 9, 1917. Date of appl., Jan. 11, 1916.

READILY soluble, paste-like precipitated calcium sulphate, prepared as described in U.S. Pat. 1,156,448 of 1915 (this J., 1915, 1160), is added to the water used in making the dough.—W. P. S.

Shortening composition [for dough] and method of producing the same. Method of producing a shortening composition. H. A. Kohman, T. M. Godfrey, and L. H. Ashe, Pittsburgh, Pa., Assignors to Ward Baking Co., New York. U.S. Pats. (A) 1,242,883 and (B) 1,242,884, Oct. 9, 1917. Date of appl., Mar. 9, 1916.

(A) A FAT having m.pt. about 57° C. is mixed with a pulverulent carrier so as to produce a homo-

geneous finely-divided mixture. (B) Fat of m.pt. about 57° C. is heated at 200° C. and atomised into a closed chamber where the spray is absorbed by a pulverulent carrier; the carrier is kept in a state of agitation in the chamber until it has absorbed about one-fifth of its weight of fat.

—W. P. S.

Vegetables; Art of conserving fresh —. J. Schneible, Chicago, Ill. U.S. Pat. 1,242,728, Oct. 9, 1917. Date of appl., Aug. 8, 1917.

FRESH or green vegetables are immersed in 1% sodium bicarbonate solution at about 65° C.

—W. P. S.

Cocoa; Method of making so-called alkaliized —. W. C. Bladen, Jersey City, N.J. U.S. Pat. 1,243,244, Oct. 16, 1917. Date of appl., Nov. 24, 1916.

"COCOA liquor" is treated with gaseous ammonia under pressure in a closed vessel provided with rotating peripheral agitators.—W. P. S.

Milk; Substitute for — made from soya beans and arachis (pea) nuts. W. J. Melluish, Parkstone. U.S. Pat. 1,243,855, Oct. 23, 1917. Date of appl., Oct. 22, 1915.

SEE Eng. Pat. 9626 of 1915; this J., 1916, 903.

[*Electrical*] *apparatus for extracting dust from gases and vapours, applicable also for collecting particles of flour, cement, and other substances.* Eng. Pat. 110,774. See I.

Composition for cleansing, bleaching, decorticating, and for purifying and preserving food. Eng. Pat. 110,567. See VI.

XIXB.—WATER PURIFICATION ; SANITATION.

Fumigation as a disinfecting agency. C. T. Kingzett, H. F. Bottomley, and J. E. Brimley. Medical Press, Aug. 29, 1917. Chem. News, 1917, 116, 202–203.

A CHAMBER of 1018 cub. ft. capacity was constructed of brickwork lined with porcelain tiles, having a window opening from the outside and double doors. A broth culture of *B. typhosus* was absorbed on strips of filter paper which were placed on glass plates on the floor and 4 ft. and 6 ft. 4 in. above the floor. Some strips were tied up in three layers of fine muslin and placed in the same positions. Fumigation was carried out for 2 hrs. The strips were then transferred to broth tubes and incubated at 37° C. for 3 days. The fumigants used were formaldehyde generated from paraform tablets and from formalin by heat, and by the action of permanganate on formalin; the mixed vapours of formaldehyde and sulphur dioxide; and sulphur dioxide from a sulphur candle, alone and with aqueous vapour. It was found that formaldehyde had the same disinfectant action whether generated from paraform or formalin, and whether associated with aqueous vapour or not, but that the permanganate method of generation was less advantageous. The minimum found to be effective was the vapour from 17 grms. of paraform. Formaldehyde and sulphur dioxide mixed were effective when generated from 2.75 oz. of sulphur and 11 grms. of paraform, or from 2.5 oz. of sulphur and one fluid oz. of formalin, in an apparatus designed to burn the sulphur quickly and to generate sufficient heat to vaporise the paraform and formalin completely. Sulphur dioxide was found to be more efficient with aqueous vapour than when dry; the minimum required was the gas from 9 oz. of sulphur with 6 oz. of aqueous vapour. The experiments were made at different times of the year and at atmospheric temperatures ranging from 38° F. to 80° F. (3°–27° C.).—J. H. J.

Identification of chlorates in presence of hypochlorites. Wischo. See VII.

PATENTS.

Sewage; Method of treating —. W. H. Sawyer, Auburn, Me. U.S. Pat. 1,242,986, Oct. 16, 1917. Date of appl., Feb. 1, 1917.

THE suspended organic matter in sewage, except that of a fibrous nature, is reduced to a finely divided state, and when in this condition the fibrous matter and the water of suspension are removed. The fibrous matter is dried after removal.—J. H. J.

Boiler-water; Purifying —. H. Kriegsheim, Assignor to The Permutit Co., New York. U.S. Pat. 1,243,191, Oct. 16, 1917. Date of appl., Aug. 18, 1917.

HARD water is passed through a bed of base-exchanging silicate, the filtrate is mixed with oily condensation water, and an aluminium salt (e.g., the sulphate) added; the gelatinous hydrated aluminium oxide formed collects the oily globules.—J. H. J.

Insecticide [from smelter fumes]; Method of making an —. W. R. Macklind, Cleveland, and E. C. Holton, Olmsted Falls, Assignors to The Sherwin-Williams Co., Cleveland, Ohio. U.S. Pat. 1,243,323, Oct. 16, 1917. Date of appl., Mar. 13, 1915.

THE precipitated dust from smelter fumes is treated with an excess of a hydroxide, e.g., calcium hydroxide, to render the arsenic content available for use as an insecticide.—J. H. J.

Process for expressing liquid from materials [sewage sludge and fish refuse] containing the same. Eng. Pat. 110,601. See I.

XX.—ORGANIC PRODUCTS ; MEDICINAL SUBSTANCES ; ESSENTIAL OILS.

Morphine; Colorimetric methods for the estimation of very small quantities of —. A. Heiduschka and M. Faul. Arch. Pharm., 1917, 255, 172–191. J. Chem. Soc., 1917, 112, ii., 554.

1. *Georges and Gascard's iodic acid method* (this J., 1906, 779). The authors employ a modification of this method. Instead of using a Duboseq colorimeter, they prepare a scale of colours by diluting a faintly acid solution of morphine in about N/10-hydrochloric acid to a concentration of 1 in 1000 and then prepare from this a series of solutions of concentrations down to 1 in 10,000. Equal volumes (10 c.c.) of these solutions are treated with 5 c.c. of 5% iodic acid solution, and the yellow colorations are examined after about half a minute. The differences in colour are more pronounced in the more dilute solutions. Whilst morphine can be thus detected at a concentration of 1 in 12,500, quantitative observations can only be made at concentrations between 1 in 1500 and 1 in 5500. The method is rendered more sensitive if 1 c.c. of 10% aqueous ammonia is added about five minutes after the addition of the iodic acid. Morphine can thus be detected at a concentration of 1 in 18,500 and estimated at concentrations between 1 in 5000 and 1 in 16,500.

II. *Estimation with Marquis's reagent.* One c.c. of the morphine solutions prepared as above is evaporated in a small basin, the residue is treated with 1 c.c. of Marquis's reagent (2–3 drops of 40% formaldehyde solution, 3 c.c. of conc. sulphuric acid), and the violet solution is washed into the comparison tube with 4 c.c. of sulphuric acid. The colours are examined by transmitted light, since in reflected light an actual colour change from blue to bluish-brown renders the comparison untrustworthy. Morphine can thus be estimated

at concentrations between 1 in 1400 and 1 in 11,000, and, the dilution with the sulphuric acid being omitted, can be detected at a concentration of 1 in 25,000.

Two samples of ripe poppy capsules examined by these methods were found to contain 0.017 and 0.068% of morphine respectively; in neither case did the seeds contain morphine.

Mandelonitrile-glucoside, sambunigrin, and similar substances; Synthesis of—E. Fischer and M. Bergmann, Ber., 1917, 50, 1047—1069. J. Chem. Soc., 1917, 112, i., 657—659.

DRY, molten ethyl *dl*-mandelate was shaken with acetobromoglucose and silver oxide and so converted into a mixture of the ethyl tetra-acetylglucosidoamandelates. The mixture was converted into the unacetylated amides by means of methyl-alcoholic ammonia, and these were separated by crystallisation from a mixture of pyridine and ethyl acetate. A pyridine compound of *l*-mandelamideglucoside crystallised out, and this lost pyridine in a warm vacuum desiccator and on solution in water, leaving the pure amide as a glassy mass. The isomeride is also a viscous mass. Both were converted into crystalline tetra-acetates by treatment with acetic anhydride and pyridine. These were dehydrated to the nitriles by warming with phosphoryl chloride. The *l*-tetra-acetylglucosidomandelonitrile agreed with the tetra-acetate of natural *l*-mandelonitrileglucoside (see especially Power and Moore, this J., 1909, 258), whilst the *d*-isomeride coincides with the tetra-acetate of sambunigrin. These tetra-acetates are hydrolysed by means of warm methyl-alcoholic ammonia, but racemisation takes place and the product is *dl*-mandelonitrile-glucoside, identical with natural prulaurasin (see especially Caldwell and Courtauld, this J., 1907, 437). The mixture can be separated by crystallisation from a mixture of amyl alcohol and benzene (1:6). *d*-Mandelonitrile-glucoside, identical with sambunigrin (Bourquelot and Danjou, this J., 1905, 1123), crystallises out, and *l*-mandelonitrile-glucoside may be recovered from the mother liquor. Both glucosides are hydrolysed under the influence of emulsin, which is surprising, unless it is due to the rearrangement of one into the other isomeride by the enzyme.

Cantharidin. VI. Isocantharidin. VII. Reduction products of cantharic acid and hydrobromocantharic acid. J. Gadamer, Arch. Pharm., 1917, 255, 277—302. J. Chem. Soc., 1917, 112, i., 657—658. (Compare Rudolph, this J., 1917, 1027.)

THE formula of cantharidin advocated by Rudolph (*loc. cit.*) explains all the known facts except two: first, the formation of α -hemimellitic acid by the pyrogenic decomposition of barium cantharate, and secondly, the properties of isocantharidin and of isocantharidic acid. The second discrepancy is now removed by the author's discovery that the isocantharidin and isocantharidic acid of Anderlini and Ghira (this J., 1891, 944) are in reality acetylhydratocantharic anhydride, $C_{12}H_{14}O_5$, and acetylhydratocantharic acid, $C_{12}H_{16}O_6$, respectively.

In consequence of the genetic relationships recorded in this paper, the author re-names *d*-cantharic acid ($[\alpha]_D = +87.5^\circ$ to 90°) *l*-cantharic acid. When *l*-cantharic acid dissolved in rather more than the calculated quantity of sodium carbonate solution is reduced by Mannich's modification of the Paal-Skita method, only one product is formed, namely, *l*-dihydrocantharic acid, $C_{10}H_{14}O_4$, m. pt. 264° — $267^\circ C.$, $[\alpha]_D = -52.5^\circ$ in alcohol ($c=2$), and this is regarded by the author as evidence in favour of Rudolph's formula of cantharidin.

When an alkaline solution of *l*-cantharic acid

in aqueous sodium hydroxide is energetically reduced by hydrogen and palladium (on bone charcoal), *l*-dihydrocantharic acid and desoxy-cantharidin (or its hydrate, desoxycantharidic acid) are produced. The latter is optically inactive and agrees in all its properties with the desoxycantharidin obtained from the "dibromide" by Rudolph (*loc. cit.*). The author has obtained evidence which seems to indicate the existence of a second modification of desoxycantharidin, which is amorphous, sinters strongly at $100^\circ C.$, and is completely molten at about $115^\circ C.$

Veronal, acetanilide, salicylic acid, and phenacetin; Identification of—O. Tunmann, Apoth.-Zeit., 1917, 32, 289—292, 298—299. J. Chem. Soc., 1917, 112, ii., 551—553.

Veronal.—Zinc chloriodide solution is added to the sublimate from the veronal residue beneath a cover slip; numerous, generally small (up to 40μ long and 20μ wide), flat, tabular, and prismatic crystals are immediately formed, which vary in colour from pale grey to blackish-red. Acetanilide and salicylic acid do not react with zinc chloriodide. The veronal sublimate is dissolved by hydriodic acid, and crystals are slowly deposited at the edges of the solution; these are relatively large (up to 150μ long and 50μ wide), flat, red, or sometimes grey. With bromine-potassium bromide solution, a red colour is developed, due to a mixture of flesh-coloured and red needles and leaflets, which attain a length of 50 — 80μ , whilst, also, very small groups of yellow crystals are formed. The red crystals disappear in course of time, whilst the yellow are more stable. If the veronal sublimate is dissolved in ammoniacal copper solution and the latter allowed to evaporate, a mixture of pink to violet lamellae and coarse plates is obtained, which shines in polarised light.

Acetanilide.—Well-formed crystals are obtained by sublimation and recrystallisation from water. With hydriodic acid, reddish-brown drops are formed immediately, from which strongly dichroic (reddish-brown and pale yellow) crystals of iodoacetanilide separate after a few minutes. Bromoacetanilide is prepared by the addition of bromine-potassium bromide solution to the sublimate dissolved in hot water; a yellow solution results, from which, on addition of water, colourless needles separate, which are transformed partly into prismatic aggregates and partly into small, monoclinic crystals.

Salicylic acid.—Sublimation can be effected without decomposition of the acid into carbon dioxide and phenol. Better crystals are obtained after solution of the sublimate in water. They consist of prismatic rodlets and coarse, generally rectangular prisms. If the sublimate is treated with ammonia, the solution allowed to evaporate, and silver nitrate added to the moist residue, a mixture of crystals is formed containing well-developed, oblique prisms of silver salicylate, up to 100μ long and 15μ wide.

Phenacetin.—The sublimate should be recrystallised from water, from which the phenacetin separates in two forms. The first of these consists mainly of flat prisms with oblique ends, at which twin-formation is frequently evident; they are 15 — 20μ wide and 100 — 150μ long. The subsidiary form comprises very long, flat, rectangular prisms, which invariably exhibit strong, oblique grooves. Platelets, as with acetanilide, are not formed. Characteristic nitrophenacetin crystals are prepared by mixing the sublimate with water and nitric acid and warming (without cover glass) until a yellow rim is formed. Groups of yellow needles soon separate, and slender needles, prisms, or long, flat, rectangular crystals with direct extinction are also produced. When similarly treated, salicylic acid, acetanilide, or antipyrine

yield only a colourless rim and white crystals. The phenacetin sublimate does not give the carbylamine reaction.

Methyl alcohol: Pyrogenic decomposition of — at high temperatures. E. Peytral. *Comptes rend.*, 1917, 165, 703—705.

METHYL alcohol decomposes rapidly at high temperatures, forming hydrogen, formaldehyde, and carbon monoxide, which may be explained either by the simultaneous reactions:—(1) $\text{CH}_3\text{OH} = \text{H}\cdot\text{CHO} + \text{H}_2$, (2) $\text{CH}_3\text{OH} = \text{CO} + 2\text{H}_2$, or by the successive reactions (1) $\text{CH}_3\text{OH} = \text{H}\cdot\text{CHO} + \text{H}_2$, (3) $\text{H}\cdot\text{CHO} = \text{CO} + \text{H}_2$. In the first case the ratio of carbon monoxide to formaldehyde would be independent of the duration of the reactions. In the second case, the ratio would vary with the duration of the reactions, and for small intervals of time would be proportional to it. Let x be the molecular mass of formaldehyde produced in time Δt , and z be the fraction of x decomposed in time Δt according to equation (3). The average mass of free aldehyde during time Δt is $\frac{x}{2}$, and if c is the velocity constant of reaction (3),

$z = C \frac{x}{2} \Delta t$, or $\frac{z}{x} = \frac{c}{2} \Delta t$. Measurements were made of p_1 (ratio of carbon monoxide to formaldehyde), p_2 (value of $\frac{z}{x}$), and n (number of mrgm.

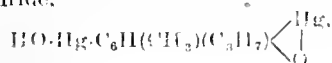
mols. of gas passing per second) when a constant rapid current of methyl alcohol vapour was passed through a platinum tube of 2 mm. bore and 11 cm. in length heated to about 1150° C. Other factors being equal, the mean duration of the reaction is inversely proportional to n , and if the reaction proceeds by the successive equations (1) and (3), np_2 should be constant. The values found in six experiments varied only between 0.58 and 0.69, whereas p_1 varied from 0.87 to 16.75. Equations (1) and (3) therefore correctly represent the reactions.—F. Sp.

Nitriles: Delicate reaction of the —. S. Dezani. *Atti R. Accad. Sci. Torino*, 1917, 52, 826—833. *J. Chem. Soc.*, 1917, 112, ii., 519.

WHEN a solution of a nitrile (aliphatic or aromatic) is treated with an equal volume of hydrogen peroxide (12 vols.) and 2—3 drops of a 5% solution of ferric chloride, hydrogen cyanide is produced on boiling. This can be detected by test papers made by treating filter-paper with picric acid (1%), drying, and then immersing the paper in a 10% solution of sodium carbonate. If much nitrile is present, the paper turns blue, but with smaller quantities a red or brownish-red coloration is observed. Very small quantities of nitrile can be detected in this way, the limit being about 2×10^{-6} gm. of HCN.

Hydrargyrum thymolo-aceticum: Constitution of —. E. Rupp. *Arch. Pharm.*, 1917, 255, 191—197. *J. Chem. Soc.*, 1917, 112, i., 670—671.

THE so-called thymol-mercuric acetate does not contain ionisable mercury, and it is now shown that the substance is really 2,6-diacetato-mercurithymol, $\text{HO}\cdot\text{C}_6\text{H}(\text{CH}_3)(\text{C}_2\text{H}_5)(\text{Hg}\cdot\text{C}_2\text{H}_3\text{O}_2)_2$, since its mixture with glacial acetic acid and potassium nitrate is converted by sulphuric acid in the cold into 2,6-dinitrothymol. It is converted by hot 10% sodium hydroxide into the sodium derivative of 2,6-dihydroxymercurithymol, $\text{C}_{10}\text{H}_{13}\text{O}_3\text{NaHg}_2\cdot 3\text{H}_2\text{O}$, colourless plates, an aqueous solution of which is converted into the anhydride,



by carbon dioxide, into 2,6-dichloromercurithymol, colourless crystals, by a saturated solution of sodium chloride, and into 2,6-dinitratomercurithymol, colourless crystals, by 5% nitric acid. 2,6-Diiodomercurithymol has also been prepared.

The mercury in organic substances can be estimated by heating 0.3 gm. of the substance with 5 c.c. of sulphuric acid and 1 gm. of potassium nitrate, boiling the solution for ten to thirty minutes until it is colourless, cooling, adding permanganate until a permanent pink coloration is obtained, and, after the addition of a drop of hydrogen peroxide, titrating with *N*-10-thiocyanate with iron alum as indicator.

Oils: Some Indian essential —. P. Singh. *Indian Forest Records*, 1917, 5, [8]. *Perf. and Essent. Oil. Rec.*, 1917, 8, 325—329.

EXPERIMENTAL distillations of leaves of *Eucalyptus globulus* from the plantations on the Nilgiris led to the following conclusions:—(1) The leaves should be shade-dried *in situ*; (2) iron stills are suitable for distillation, and a catch still will hold back impurities and very heavy sesquiterpenes, giving as good an oil as is obtained by redistillation; (3) special plantations should be started for purposes of leaf supply. The oils produced contained about 56% of eucalyptol and were very uniform in composition. Distillation of Nilgiri Geranium (*Pelargonium graveolens*, L'Herit) plant gave a normal oil of good quality, and it is recommended that its cultivation be encouraged as an auxiliary to eucalyptus production. Comparative distillations of *Gaultheria fragrantissima* from Assam and the Nilgiris showed that the former plant is superior for commercial purposes, giving a higher yield of oil of wintergreen. Shillong is recommended as the best site for a distillery, but it is pointed out that to ensure a regular supply of the material it is necessary to foster the growth of the shrubs in the forests or to allow private enterprise to cultivate the plant.—L. A. C.

Solubilities of anthracene, anthraquinone, p-bromobenzene, phenanthracene, and iodine in various solvents. Hildebrand and others. *See* III.

Reduction of nitro- and nitroso-compounds with platinum and hydrogen. Cusmano. *See* III.

Influence of the solvent on the reaction between polyhydric phenols and alkali bicarbonates. Von Hemmelmayr. *See* III.

Determination of bromides. Rupp. *See* VII.

PATENTS.

Metal albumin combinations: Manufacture of —. O. Imray, London. From Soc. of Chemical Industry in Basle. Eng. Pat. 410,935, Nov. 7, 1916. (Appl. No. 15,931 of 1916.)

ALBUMIN is extracted from a physiologically or pathologically modified part of the human or animal system, purified, and treated with a solution of a metallic salt such as ferric chloride, copper sulphate, gold chloride, etc. The resulting insoluble compound is washed and sterilised. It contains the metal in non-ionised condition, and the usual chemical reactions are given only after hydrolysis with a suitable enzyme. The compounds are used in testing for the corresponding condition or disease by reaction with the extracted serum from the suspected part, and then testing for the metal. For example, pregnancy may be tested for by reaction between an iron or copper placenta-albumin compound and the serum extracted from the blood of the patient. Cancer, syphilis, tuberculosis, etc., may be tested for in similar manner, using the metal preparation from a cancerous, syphilitic, tuberculous, or otherwise affected organ.—B. V. S.

Formaldehyde; Manufacture of—E. J. Boake, and A. Boake, Roberts and Co., Ltd., London, Eng. Pat. 110,787, Oct. 28, 1916. (Appl. No. 15,418 of 1916.)

THE reaction vessel in which a mixture of methyl alcohol and air is subjected to the action of catalytic agents for the production of formaldehyde, is heated by a suitable electric heater instead of by gas or fire.—J. F. B.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES.

PATENTS.

Two-colour screens for use in the production of photographs in colours; Making of—E. H. Tarlton, London, Eng. Pat. 110,993, Jan. 6, 1917. (Appl. No. 295 of 1917.)

A TWO-COLOUR screen in red and blue-green is obtained by forming one colour by dusting or printing or other suitable means on a transparent base, coating with a suitable emulsion, exposing through the screen, developing, and staining the resulting image to the other colour.—B. V. S.

Colouring of films for colour cinematography. H. Shorrocks, Manchester, Eng. Pat. 111,051, (Appl. Nos. 8127, June 7, and 10,386, July 19, 1917.)

THE positive film, containing alternating sets of pictures to be coloured red and green respectively, is passed through a bleaching bath, the series to be coloured green being first protected by covering with adhesive tape or by other suitable method. After washing and removal of the protection the film is passed through a composite staining bath containing Rhodamine, which stains the bleached pictures red, and an acid ferri-cyanide-citrate mixture, which stains the unbleached images blue-green. This method of staining red and green in one operation is applicable to other arrangements of the two sets of pictures.—B. V. S.

XXII.—EXPLOSIVES; MATCHES.

Reduction of nitro- and nitroso compounds. Cusumano. See III.

PATENTS.

Explosive compound; Process for producing an—R. H. Twining and R. W. G. Wyckoff, Geneva, N.Y. U.S. Pat. 1,242,900, Oct. 9, 1917. Date of appl., Apr. 10, 1916.

A SALT of an alkali-metal with a "common inorganic acid" is heated with a non-volatile aromatic substance containing a negative group; e.g., sodium benzenesulphonate and sodium nitrate are heated together at the fusing temperature of sodium nitrate.—T. St.

Explosives; Manufacture of—R. G. Smith, Derry Village, N.H., Assignor to Raymond, Pynchon, and Co., New York, U.S. Pats. (A) 1,243,231 and (B) 1,243,351, Oct. 16, 1917. Date of appl., Feb. 3, 1916.

EXPLOSIVE compositions are produced by mixing the following ingredients in approximately the proportions given by weight:—(A) ammonium perchlorate 82, finely divided zinc 10, petroleum jelly 5, asphaltum varnish 3; (B) potassium perchlorate 53, ammonium perchlorate 18, sulphur 5, finely divided zinc 8, petroleum jelly 5, asphaltum varnish 3, alcohol 6, benzol 2.—T. St.

XXIII.—ANALYSIS.

Copper; Determination of— as sulphide and by electrolysis. F. L. Hahn. Z. anorg. Chem., 1917, 99, 201–248. J. Chem. Soc., 1917, 112, ii., 543.

IT is not possible to obtain pure cuprous sulphide by heating cupric sulphide in hydrogen, as the temperature at which the second atom of sulphur is completely driven off in a reasonable time is very close to that at which reduction to metallic copper takes place. Heating in carbon dioxide in a Rose crucible gives variable results. Many experiments with different kinds of tubes are described, the precipitates being heated in various atmospheres and at known temperatures. If air enters the tube or crucible, oxygen is always absorbed in time, even at moderate temperatures, sulphate being formed with increase of weight. At high temperatures oxygen causes a loss of weight, owing to the formation of cuprous oxide or metallic copper. Two methods have been found to give satisfactory results. One consists in heating the sulphide in a mixture of hydrogen sulphide and hydrogen, the proportions of which may vary within wide limits. A glazed Rose crucible is used, heating strongly over a Meker burner or blowpipe. During the first part of the heating the gas used is chiefly hydrogen sulphide, and towards the end chiefly hydrogen, separate bubbling tubes being used for the two gases. Two minutes suffices for 0.2 gm. of sulphide, ten minutes for larger quantities. The weight becomes quite constant, and the precipitate, being highly crystalline, is not hygroscopic. Ignition at first in hydrogen sulphide and then in carbon dioxide saturated with methyl alcohol also gives good results.

Copper may be estimated electrolytically in nitric acid solution. When pure platinum electrodes are used, platinum is dissolved at the anode, but platinum-iridium anodes are not attacked. Stationary gauze cathodes or rotating apparatus may be used, and the trace of copper remaining in solution is estimated colorimetrically.

Use of the water from the Lewis-Thompson calorimeter for the determination of sulphur in fuels. Falcicola. See IIa.

Identification of chlorates in presence of hypochlorites. Wischo. See VII.

Determination of bromides. Rupp. See VII.

Hydrogen peroxide. Macri. See VII.

Analysis of white metal alloys. Determination of lead, copper, and antimony. Howden. See X.

Detection of foreign oils in castor oil used for lubricating aeroplane motors. Frabot. See XII.

Determination of soil phosphorus. Rost. See XVI.

Determination of the cyanamide nitrogen in calcium cyanamide. Berkant and others. See XVI.

Determination of arsenic in glucose. Kling. See XVII.

Application of Holphen's ratio to Italian wines. Scurti and Rolando. See XVIII.

Methods for approximating the relative toxicity of cottonseed products. Carruth. See XIXa.

Colorimetric methods for estimation of very small quantities of morphine. Heiduschka and Paul. See XX.

Identification of veronal, acetanilide, salicylic acid, and phenacetin. Tunnann. See XX.

Delicate reaction of the nitriles. Dezan. See XX.

Constitution of Hydrargyrum thymoloaceticum. Rupp. See XX.

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1908. Baird, M. M., Westfield, Rutherglen, Glasgow, Analytical Chemist.
1891. Baird, Wm., c/o Lewis Berger and Sons, Ltd., Homerton, N.E., Technical Chemist.
1895. Baird, W. Raymond, 271, Broadway, New York City, U.S.A., Patent Lawyer.
1890. Bairstow, John, Burley, Queen's Park, Chester, Chemical Works Manager.
1903. Baker, Arthur, "Denhurst," Earnsdale, Darwen, Lancs., Paper Mill Chemist.
1916. Baker, Arthur J., Yate Chemical Works, Yate, near Bristol, Works Chemist.
1916. Baker, Bertram, 44, Melton Road, West Bridgford, Nottingham, Analytical Chemist.
1913. Baker, Bertram F., Mayfield, New Chester Road, Bromborough, Cheshire, Technical Chemist.
1902. Baker, Chas. F., Technical College, Sunderland, Lecturer in Chemistry.
1910. Baker, C. Kerslake, 16, Change Alley, Sheffield, Analytical Chemist.
1901. Baker, F. Guy Stirling, The Brewery, Chiswell Street, London, E.C., Brewer's Chemist.
1883. Baker, Harry, Epworth House, Moughland Lane, Runcorn, Analytical Chemist.
1904. Baker, John T., c/o J. T. Baker Chemical Co., Phillipsburg, N.J., U.S.A., Manufacturing Chemist.
1892. Baker, Julian L., Ardingley, Linden Avenue, Maidenhead, Brewing and Sugar Chemist.
1886. Baker, Theodore, 488, Du Pont Building, Wilmington, Del., U.S.A., Analytical Chemist.
1910. Baker, Dr. Thos., 4, The Crescent, Doncaster Road, Rotherham, Chemist and Metallurgist.
1912. Balch, Prof. Alfred W., 41, Linden Street, Brookline, Mass., U.S.A., Professor of Biological Chemistry.
1914. Baleon, 2nd Lt. P. C. (R.E.), "Bodryn," Cadnant Park, Conway, N. Wales, Chemist.
1912. Baldraceo, Cav. Prof. Dr. Giacinto, R. Conceria Scuola Italiana, Corso Cirié, ang. Via Biella, Turin, Italy, Leather Trades Chemist.
1903. Baldwin, F. H., Bergenport Chemical Works, Bayonne, N.J., U.S.A., Superintendent.
1903. Baldwin, Dr. H. B., 927, Broad Street, Newark, N.J., U.S.A., Chemist (Dept. of Public Health).
1903. Ball, S. F., 289, East 201st Street, New York City, U.S.A., Analytical Chemist.
1889. Ballantyne, Horatio, 75, Chancery Lane, London, W.C., Analytical and Consulting Chemist.
1903. Ballantyne, W. H., 111, Hatton Garden, London, E.C., Patent Agent's Assistant.
- O.M. Ballard, Edw. G., 8, Lansdowne House, Lansdowne Road, Holland Park, London, W., Alkali Works Inspector (retired).
1915. Balmforth, Charles, 29, Avondale Road, Morecambe, Lancs., Analytical Chemist.
1910. Baly, Prof. E. C. C., F.R.S., 14, Sunnyside, Prince's Park, Liverpool, Professor of Inorganic Chemistry.
- O.M. Bamber, H. Keway, Outram House, Addiscombe, Surrey, Consulting Chemist.
1894. Bamber, H. K. G., Ingress House, Greenhithe, Kent, Cement Works Manager.
1917. Bamfield, Albert E., c/o Brazil Straker & Co., Ltd., Lodge Causeway, Fishponds, Bristol, Engineer.
1898. Bamford, Harry, 70, Duckworth Terrace, Bradford, Yorks, Dyer.
1906. Baneroff, John, Wilmington, Del., U.S.A., Bleacher and Dyer.
1916. Banker, S. G., Belle Vue, 36, Chowpaty, Bombay, India, Leather Chemist.
1913. Banks, A. J., c/o The Ogilvie Flour Mills Co., Ltd., Montreal, Canada, Analyst.
1916. Banner, George E., c/o S. Banner & Co., Ltd., 8, Fazakerley Street, Liverpool, Managing Director.
- O.M. Bannister, W., "Dunloc," Bramley Hill, South Croydon, Manufacturing Chemist.
1910. Barbary, Capt. J. Ewart (R.A.), Mt. Whistle, Camborne; Journals, Ministry of Munitions, C.M.4 (T.), Grand Hotel, London, Explosives Chemist.
1909. Barber, C. Douglas, 20, Champion Road, Upminster Essex, Chemist.
1914. Barber, Charles F. L., 12, Queen's Terrace, Station Road, Otley, Yorks., Leather Chemist.
1915. Barber, Christopher, British General Tar Products, Ltd., Hayes Road, Cadishead, near Manchester, Chemical Engineer.
1908. Barber, Percy S., The Reform Food Stores, 3, Richmond Street, Liverpool, Chemist.
1917. Barber, Thos. W., 10, Esplanade, Seaford, Sussex, Consulting Engineer.
1912. Barclay, William R., 31, Glenalmond Road, Ecclellah, Sheffield, Manager of Electroplating Factory and Lecturer in Electro-Metallurgy.
1892. Barden, Alf., Far Bank, Shelley, near Huddersfield, Glue and Size Maker.
1907. Bardorf, C. F., c/o St. Lawrence Sugar Refineries, Ltd., Montreal, Canada, Chief Chemist.
1915. Bardsley, J. R., "Bunawang," Lea Avenue, Five Dock, Sydney, N.S.W., Australia, Hat Manufacturer.
1902. Barker, Hugh S., 32, Cumberland Avenue, Sefton Park, Liverpool, Laboratory Furnisher.
1916. Barker, John E., 295, Mansfield Road, Little Chester, Derby, Glass Works Manager.
1912. Barker, Dr. Jonathan T., Victoria Villa, Halkyn Street, Flint, North Wales, Chemist.
1916. Barker, W. R., 61, Grove Street, Barnsley, Yorks, Glass Works Manager.
1895. Barlow, Clinton W., 104-112, East 25th Street, New York City, U.S.A., Merchant.

1901. Barlow, John J., Broadway, Accrington, Calico Printer's Chemist.
1916. Barlow, Walter, II., 29, Warwick Gardens, Ilford, Chemist.
1899. Barlow, Wm., 23, Alton Terrace, Fairfield, Manchester, Analytical Chemist.
1908. Barnes, Alfred, Box 556, Pretoria, Transvaal, Dealer in Minerals.
1906. Barnes, A. G., c/o Hasland Coking Co., Grassmoor Collieries, Chesterfield, Colliery Proprietor.
1914. Barnes, Edward A., c/o American Barium Co., South San Francisco, San Mateo Co., Cal., U.S.A., Chemical Engineer.
1905. Barnes, F. V., Gas Works, Todmorden, Engineer and Manager.
1884. Barnes, H. J., Phoenix Chemical Works, Haekney Wick, N.E., Manufacturing Chemist.
1916. Barnes, John F., Oil Mills, Stanningley, Leeds, Oil Manufacturer.
1884. Barnes, Jonathan, 301, Great Clowes Street, Manchester, Analytical Chemist.
- O.M. Barnes, Jos., Highbrake, Arnside, Westmorland, Analytical Chemist.
1916. Barnes, Wm. H., c/o Follows and Bate, Ltd., Engineers, Gorton, Manchester, Manager and Representative.
1912. Barnett, E. de Barry, 9, Collingham Road, South Kensington, S.W., Chemist.
1917. Barnett, Walter Leigh, 18, Carden Road, Peckham Rye, London, S.E., Chemist.
1904. Baron, Wm. Briscoe, "Ingleside," Woodfield Road, Cheadle Hulme, Stockport, Chemist.
- O.M. Barr, J., Dinting Vale, Dinting, near Manchester, Chemical Manager.
1916. Barr, James C., 180, West Regent Street, Glasgow, Chemical Merchant.
1915. Barraclough, C. E., c/o J. Crossley & Sons, Ltd., Dean Clough Mill, Halifax, Yorks., Chemist.
1914. Barraclough, Dennis H., North Brierley Sewage Works, Oakenshaw, Bradford, Chemist.
1890. Barraclough, Wm. H., Westholme, Chapeltown, near Sheffield, Analytical Chemist.
1890. Barrett, Arthur A., 139, Viale San Martino, Messina, Sicily, Manufacturer of Essential Oils.
1907. Barrett, Maurice, 138, Woodsley Road, Leeds, Technical Chemist (Leeds Fireclay Co.).
1912. Barrow, Jas. V., c/o Messrs. H. Holmes and Sons, Portland Road, Newcastle-on-Tyne, Works Chemist.
1900. Barrow, Jos., c/o Messrs. Edward Cook & Co., Ltd., The Soapery, Bow, E., Chemist.
1915. Barrowcliff, M., 13, Shirley Road, Nottingham, Research Chemist.
1906. Barrs, Chas. E., "Buena Vista," 58, South Hill Park, Hampstead, N.W., Analyst.
1905. Barry, Eugene, Ayer, Mass., U.S.A., Leather Manufacturer.
1916. Barlett, Edward E., c/o Mellon Institute, Pittsburg, Pa., U.S.A., Treasurer.
1915. Barton, B. Cyril, c/o Messrs. Barton & Waterhouse, Sun Chambers, Lowgate, Hull, Seed Crusher.
1893. Barton, G. E., 227, Pine Street, Millville, N.J., U.S.A., Technical Chemist.
1903. Barrio, Geo. F., 42, Brock Street, Luton, Beds., Managing Chemist.
1905. Baruch, Edgar, 704, Wright & Callender Building, Los Angeles, Cal., U.S.A., Chemical Engineer.
1910. Barwick, F. W., Chamber of Commerce Testing House, Royal Exchange, Manchester.
1915. Bashore, E. G., La Tourette Hotel, Bayonne, N.J., U.S.A., Chemist.
1895. Baskerville, Dr. Chas., College of the City of New York, New York City, U.S.A., Professor of Chemistry.
1884. Bassett, H., 26, Belitha Villas, Barnsbury, N.
1908. Bassett, Professor Henry, jun., The Myrtles, Southwood Road, New Eltham, S.E., Professor of Chemistry.
1899. Bassett, Wm. H., Main Street, Cheshire, Conn., U.S.A., Chemist.
1890. Bate, William, Upton Villa, Hayle, Cornwall, Technical Chemist (National Explosives Co., Ltd.).
1903. Bateman, A. H., Eridge, Shooter's Hill, Woolwich, S.E., Chemist.
1913. Bateman, James T., 34, Bridge Avenue, Hammer-smith, W., Engineer and Works Manager.
1912. Bates, D. M., Lewiston Bleachery and Dye Works, Lewiston, Maine, U.S.A., General Manager.
1914. Bates, John S., 700, University Street, Montreal, Canada, Superintendent. (Forest Products Laboratory.)
1914. Battersby, W. H., Corporation Gas Works, Elton, Bury, Lanca., Chief Chemist.
1885. Batty, R. B., Wharnciffe, Erdington, near Birmingham, Nickel Works Manager.
1910. Battye, Horace G., 28, Roman Place, Street Lane, Roundhay, Leeds, Chemist and Works Manager.
1903. Baty, E. J., c/o Thermo-electric Ore Reduction Corporation, York Street, Luton, Beds., Chemist.
1903. Bauer, Geo. W., 660, Sacramento Street, San Francisco, Cal., U.S.A., Vice-President and Chemist (Hop and Malt Co.).
1915. Baumann, Dr. L., Manufacture Emile Zündel, Moscow, Russia, Managing Director of Printworks.
1910. Baxter, F. Stanley, 5, York House, College Place, St. Pancras, London, N.W., Chemist.
1913. Baxter, Harold R., c/o Aktiebolaget J. and G. Cox, Kungsgatan 13, Gothenburg, Sweden, Manager (Glue Works).
1898. Baxter, John G., Glenarm, Lennox Avenue, Gravesend, Kent, Chemist.
1915. Bayley, Frank, The Bungalow, Pound Road, Warley, Langley Green, Birmingham, Technical Chemist.
1908. Bayly, Percival G. W., Mines Dept. Laby., Spring Street, Melbourne, Victoria, Australia, Government Metallurgical Chemist.
1886. Beadle, Clayton, Oakbank, Lansdown Road, Sidcup, Kent, Consulting Chemist.
1917. Bean, Philip L., No. 3 Staff Quarters, Eastriggs, Dornock, Dumfriesshire, Works Chemist.
1911. Beard, Stanley D., Lederle Antitoxin Laboratories, Pearl River, N.Y., U.S.A., Biological Chemist.
1907. Beardsley, Dr. Alling P., 119, East Maple Avenue, Bound Brook, N.J., U.S.A., Chemist (New Haven Gas Co.).
1909. Bearpark, Arthur F., P.O. Box 497, Durban, South Africa, Consulting Chemist and Chemical Engineer.
1908. Beasley, Fred. G., Chartley Croft, Gateacre, near Liverpool, Metallurgical Chemist.
1905. Beasley, Jno. K., c/o The Borneo Co., Kuching, Sarawak, Metallurgical Chemist.
1897. Beaver, Chas. J., Rangemoor, Crescent Road, Hale, Cheshire, Chemist.
1905. Beckers, Dr. Wm., East 83rd Street and Ditmar Avenue, Brooklyn, N.Y., U.S.A., Manufacturing Chemist.
1909. Becket, Fredk. M., 403, Jefferson Avenue, Niagara Falls, N.Y., U.S.A., Chief Metallurgist, Electro Metallurgical Co.
1912. Beckett, Dr. E. G., No. 1, Sandhilla, Ardeer, Stevenston, Ayrshire, Analytical Chemist.
1899. Bedford, Alf. C., c/o Standard Oil Co., 26, Broadway, New York City, U.S.A., Chemical Merchant.
1891. Bedford, Chas. S., Recella, Weetwood, Headingley, Leeds, Manufacturing Chemist.
1891. Bedford, James E., "Arnccliffe," Shire Oak Road, Headingley, Leeds, Chemical Manufacturer.
1911. Bedford, G. E., Aspley Dyeware Mills, Huddersfield, Works Chemist.
- O.M. Bedson, Prof. P. Phillips, Armstrong College, Newcastle-on-Tyne, Professor of Chemistry.
1901. Beevers, Clifford J., c/o The Shipley Grease and Fertiliser Co., Westfield Works, Wrose Hill, Shipley, Yorks, Analyst.
- O.M. Beilby, Sir George T., F.R.S., 11, University Gardens, Glasgow, Chemical Engineer.

1912. Belaiew, Col. Nicolai T., c/o Russian Government Supply Committee, India House, Kingsway, London, W.C., Lecturer in Metallurgy and Chemistry.
1884. Bell, Sir Hugh, Bart., Middlesbrough-on-Tees, Soda and Iron Manufacturer.
1900. Bell, Hugh P., Census and Statistics Office, Ottawa, Canada.
1886. Bell, J. Ferguson, Derby Gas Light and Coke Co., Derby, Gas Engineer.
1917. Bell, Jerome B., jun., c/o Canadian Explosives, Ltd., Transportation Building, Montreal, Canada, Chemical Manager.
1907. Bell, Marcus, Defence Dept., Melbourne, Victoria, Chemist.
1905. Bell, Miss M. M., Tulane University Library, New Orleans, La., U.S.A., Librarian.
1915. Bell, Wm., c/o Parry and Co., Ranipettai, North Arcot Dt., Madras Presidency, India, Works, Chemist.
- O.M. Bendix, D., 371, Romford Road, Forest Gate, E., Managing Chemist, British Alizarin Co., Ltd.
1903. Benham, Keith, Deans Hill, Stafford, Analytical and Consulting Chemist.
1917. Benjamin, Edward O., 177, Hillside Avenue, Newark, N.J., U.S.A., Chemist and Engineer.
- O.M. Benjamin, Dr. M., Smithsonian Institution, Washington, D.C., U.S.A., Consulting Chemist.
1899. Bennett, Alex. H., Via Giuseppe La Farina, Messina, Sicily, Analytical Chemist.
1907. Bennett, H. Garner, 115, Grovehill Road, Beverley, Yorks, Leather Chemist.
1915. Bennett, Walter, 37, Town Street, Bramley, Leeds, Analytical Chemist.
1909. Benson, George F., Edwardsburg Starch Co., Cardinal, Ontario, Canada, President and Managing Director.
1901. Bentley, Wm. H., 12, Cromwell Terrace, Irlam, near Manchester, Technical Chemist.
1890. Bentz, Ernest, 30, Manley Road, Whalley Range, Manchester, Technical Chemist.
1893. Berk, Fred. W., 1, Fenchurch Avenue, London, E.C., Chemical Manufacturer.
1907. Berk, Paul F., 1, Fenchurch Avenue, London, E.C., Chemical Manufacturer.
1916. Berkeley, Cyril J., 2412, Alder Street, Vancouver, B.C., Canada, Agricultural Chemist.
1900. Birmingham, John, jun., c/o Union Powder Corporation, 50, Church Street, New York City, U.S.A., Superintendent.
1889. Bernard, Jas., jun., c/o The United Alkali Co., Ltd., Netham Works, Bristol, Chemical Works Manager.
1897. Berry, Albert E., Abbotsleigh, Wanstead, Essex, Works Manager.
1911. Berry, Arthur G. V., c/o Sir Boyerton Redwood, Bart., 4, Bishopsgate, London, E.C., Analyst.
1906. Berry, Arthur J., 14, Regent Street, Cambridge, Chemist.
1883. Berry, E. E., Bordighera, Italy, and (Jourole c/o C. H. Grinling, 17, Rectory Place, Woolwich, S.E., Technical Chemist.
1913. Berry, Prof. R. A., The Agricultural College, Blythswood Square, Glasgow, Prof. of Agric. Chemistry.
1903. Berry, W. G., 200, Claremont Avenue, Manhattan, New York City, U.S.A., Chemist.
1909. Beekow, K. J., Södra Storgatan 19, Helsingborg, Sweden, Head Engineer.
1914. Best, Ronald L., 55, Derwent Road, Palmer's Green, London, N., Analytical Chemist.
1886. Best, Dr. T. T., Hardshaw Brook Chemical Works, St. Helens, Lancashire, Technical Chemist.
1914. Bettsworth, A. E. A., 394, St. Paul Street West, Montreal, Canada, Managing Director.
1901. Betts, Anson G., Box 792, Ashville, N.C., U.S.A., Chemist.
- O.M. Bevan, E. J., 4, New Court, Lincoln's Inn, London, W.C.; Journals to c/o The Viscose Development Co., Pembroke Road, Bromley; Public Analyst and Consulting Chemist.
1900. Bevan, Jno. W., Morriston Spelter Works, Morriston, R.S.O., Glamorgan, Manager of Metallurgical Works.
- O.M. Beveridge, Jas., Springfield House, Chatham, N.B., Canada, Pulp and Paper Manufacturer.
1909. Bewick, R. M., "Lynton," Park West, Hcswall, Cheshire, Traveller.
1916. Beynon, D. E., 80, Hogarth Avenue, Toronto, Canada, Rubber Chemist.
1896. Bibby, John, c/o J. Bibby and Sons, Formby Street, Liverpool, Chemist.
- O.M. Biekerdike, W. E., Bryers Croft, Wiltshire, near Blackburn, Manufacturing Chemist.
1907. Bickerstaffe, Robert, 10, Abbey Street, Carlisle, Chemist.
1903. Bierwith, L. W., c/o Du Pont Powder Co., Haskell, N.J., U.S.A., Civil Engineer.
1910. Bigelow, Chas. A., c/o Actna Explosive Co., 120, Broadway, New York, U.S.A., Superintendent.
1912. Bigelow, Edward P., Mellin's Food Library, 291, Atlantic Avenue, Boston, Mass., U.S.A., Chemist.
1884. Biggart, J. Wm., 29, Cathcart Street, Greenock, Scotland, Analytical Chemist.
1891. Biggart, Wm. L., Rossarden, Kilmacolm, Scotland, Public Analyst.
1911. Biggins, J. E., c/o Gulf Refining Co., Port Arthur, Texas, U.S.A., Chemist.
1910. Biggs, J. W. H., 326, High Street, Plumstead, S.E., Chemist.
- O.M. Billing, H. S., 42, Kingsley Road, Mutley, Plymouth, Chemist.
1896. Billington, Chas., Heimath, Porthill, Longport Staffordshire, Metallurgist.
1911. Bingham, H. C., 7, Gracechurch Street, London, E.C., Consulting Engineer.
1917. Birch, Allen E. W., Kimberley Reefs Gold Mine, Bindura, Rhodesia, Cyanide Manager.
1907. Bird, Charles S., jun., Messrs. F. W. Bird and Son, Library Dept., East Walpole, Mass., U.S.A., Paper Maker.
1895. Bird, Wm. R., (communications) 125, Goddard Avenue; (Journals) Laboratory, G.W.R. Works, Swindon, Wilts., Analytical Chemist.
1902. Bird, W. Robt., 217, Newport Road, Cardiff, Oil Merchant.
1915. Birley, J. Harold, c/o Chas. Macintosh and Co., Ltd., Cambridge Street, Manchester, Indianrubber Manufacturer.
1883. Bishop, A. Conway, Three Mills Lane, Bromley-by-Bow, E., Manufacturing Chemist.
1884. Bishop, Fred., c/o Burmah Oil Co., P.O. Box 67, Rangoon, Burmah, Technical Chemist.
1903. Bishop, Howard E., 119, Pierce Street, Easton, Pa., U.S.A., Chemist.
1903. Bishop, J. T. F., Manchester Chemical Club, Victoria Hotel, Manchester, Secretary.
1905. Bixby, Willard G., 46th Street and 2nd Avenue, Brooklyn, N.Y., U.S.A., Blacking Manufacturer.
1905. Bjerregaard, A. P., P.O. Box 676, Bedford, Ohio, U.S.A., Varnish Chemist.
1912. Björnström Steffanson, G., Hovedpostkontoret, Kristiania, Norway, Pulp and Paper Works Manager.
1909. Blacher, Prof. Charles, L'Ecole Technique de Mescow, Russia, Chemical Engineer.
1904. Black, J. Wyelf, 62, Falcon Avenue, Edinburgh, Analytical Chemist.
1902. Black, W. Geoffrey, Morningthorpe, Mount Pleasant, Norwich, Chemist.
1910. Blackie, Archibald, 223, James Street, Winnipeg, Canada, Chemist.
1894. Blackmore, H. S., P.O. Box 145, Mount Vernon, N.Y., U.S.A., Industrial Chemist.
1896. Blagden, Victor, 4, Lloyd's Avenue, London, E.C., Chemical Merchant.
1883. Blagden, W. G., 245, Preston Road, Brighton, Chemical Merchant.
1897. Blair, Andrew A., 406, Locust Street, Philadelphia, Pa., U.S.A., Analytical Chemist.

1915. Blake, Azel F., Atlantic Sugar Refineries, Ltd., St. John, New Brunswick, Canada, Chief Chemist.
1884. Blake, Jas., Thames Sugar Refinery, Silvertown, London, E., Manager.
1910. Blakeley, A. G., P. and R. Coal and Iron Co., Pottsville, Pa., U.S.A., Chemist.
1893. Blears, John, c/o Langworthy Bros. and Co., Ltd., Greengate Mills, Salford, Dyer and Calico Printer.
1908. Blichfeldt, S. H., Vine Cottage, Southall, Middlesex, Bacteriologist and Fermentation Chemist.
1905. Bliss, H. J. W., United University Club, Pall Mall East, London, S.W., Chemist.
1916. Bloch, J. J., 85, Deansgate Arcade, Manchester, Chemist.
1889. Bloed, Victor G., Station D., Baltimore Md., U.S.A., Manufacturing Chemist.
1908. Blomeley, Adam Y., c/o Arbuckle Bros. Sugar Refinery, Brooklyn, N.Y., U.S.A., Chemist.
1916. Blondel, Paul, La Revue des Produits Chimiques, 196, rue La Fayette, Paris, France, Director and Proprietor.
1891. Bloomer, Fred J., Penpont, Clydach, R.S.O., Glamorgan, Nickel Works Manager.
1886. Blount, Bertram, Laboratory, 76 and 78, York Street, Westminster, S.W., Analytical Chemist.
1888. Bloxam, A. G., 29, Southampton Buildings, Chancery Lane, London, W.C., Chemist and Patent Agent.
1916. Bluman, Nicholas J., Ceylon House, 49-51, Eastcheap, London, E.C., Chemical Engineer.
1903. Blumenthal, Lionel. See Blundell, Lionel.
1903. Blundell, Lionel, Hill-side, Prestwich Park, Manchester, Managing Director.
1886. Blundstone, E. R., 79, York Street, Westminster, S.W., Consulting Chemist.
1906. Blyth, M. Wynter, Lacton House, Tankersley near Beamsley, Yorks. Analytical and Consulting Chemist.
1908. Blythe, Jas. R., Craiglea, Aulcoshaw near Manchester, Leather Trades Chemist.
- O.M. Boake, A., Watton Road, Stratford, E., Manufacturing Chemist.
1888. Boake, Edmund J., Witford Lodge, Chelmsford, Essex, Manufacturing Chemist.
1912. Boan, Robt., Laboratory, Government Railway Offices, Spencer Street, Melbourne, Vic., Australia, Engineer-in-charge.
1915. Boardman, Fred., 58, King William Street, Greenwich, S.E., Metallurgical Chemist.
1899. Boehm, Fred., 16, Jewry Street, London, E.C., Chemical Agent and Merchant.
1910. Boehringer, Dr. R., Essex and First Streets, Harrison, N.J., U.S.A., Chemist.
1898. Bogert, Prof. Marston T., Department of Organic Chemistry, Columbia University, New York City, U.S.A., Professor of Organic Chemistry.
1915. Boiling, E. H., 6, Leyland Road, New Cross, S.E., Analytical and Research Chemist.
1903. Bo'am, Dr. H. W., Queen Margaret College, Glasgow, Lecturer on Chemistry.
1909. Bolden, Wm., Dalmellington Iron Works, Dunaskin, Ayrshire, Chemist.
1916. Bolsover, G. R., 31, Rossington Road, Brocco Bank, Sheffield, Metallurgist.
1901. Bolton, E. Richards, 46, Stamford Brook Road, Hammersmith, W., Manufacturing Chemist.
1905. Bond, John, Crowlands, Southport, Engineer.
1905. Bond, Josiah, Alto, Arizona, U.S.A., Mining Engineer.
1912. Bone, S. C., 30, Long Lane, Garston, Liverpool, Chemical Works Manager.
1905. Bone, Prof. W. A., F.R.S., "Montrose," Harpenden Road, St. Albans, Herts, Professor of Chemical Technology.
1917. Bonnyman, Jas S., 134, Cambridge Drive, Kelvin-side N., Glasgow, Analytical Chemist.
1892. Bookman, Dr. S., 48, East 82nd Street, New York City, U.S.A., Chemist.
1914. Boon, Dr. A. Archibald, Chemistry Dept., Heriot Watt College, and (Juls.) 87, Warrander Park Road, Edinburgh, Assistant Professor of Chemistry.
1888. Boor, Leonard G., 21, Mincing Lane, London, E.C., Chemical Merchant.
1912. Boorne, Wm. H., Bush Lane House, Cannon Street, London, E.C., Metallurgist.
1916. Booth, Jas., jun., 99, Gawthorne Street, New Basford, Nottingham, Chemist.
1908. Booth, Jos. W., George E. Kunhardt Mills, Lawrence, Mass., U.S.A., Superintendent.
1904. Booth, N. Parr, Laboratory, Cadbury Bros., Ltd., Bourneville, near Birmingham, Chemist.
1916. Boothman, John, Oak Villas, Whitley Bridge, S.O., Yorks, Works Chemist.
1903. Boral, Robin, Rhodes Mount, Rhodes, near Manchester, Works Manager.
1897. Borland, C. R., Concord, Mass., U.S.A., Smokeless Powder Manufacturer.
- O.M. Borland, W. D., Beacon Lodge, Bean. *via* Dartford, Kent, Manufacturer of Explosives.
1908. Bose, R., 92-95, Upper Circular Road, Calcutta, India, Chemical Works Manager.
1890. Bost, W. D. Ashton, Cartvale Chemical Works, Paisley, Chemical Manufacturer.
1912. Boswell, Maitland C., Chemistry and Mining Building, University of Toronto, Canada, Lecturer on Organic Chemistry.
- O.M. Bothamley, C. H., Weston-super-Mare, Somerset, County Director of Technical Instruction.
1890. Bott, Dr. W. Norman. See Norman-Bott, Dr. W.
1901. Bottomley, Dr. J. Frank, c/o The Thermal Syndicate, Ltd., Neptune Road, Wallsend-on-Tyne (Journals to Kearsney, Westfield Avenue, Gosforth, Newcastle-on-Tyne), Consulting Chemist.
1906. Bottomley, W., c/o The United Alkali Co., Ltd., Chief Engineer's Office, Widnes, Chief Engineer.
1915. Boulter, E. C., 113, Lawrence Road, Wavertree, Liverpool, Chemist.
- O.M. Boulton, H. E., (Journals to c/o Messrs. Burt, Boulton and Haywood Ltd., Totton, near Southampton), Chemical Manufacturer.
- O.M. Boulton, Sir Samuel B., Bart., 64, Cannon Street, London, E.C. (Journals to c/o Burt, Boulton & Haywood, Ltd., Latresne (Gironde), France), Chemical Manufacturer.
1883. Boulton, T. S., 14, Freegrove Road, Caledonian Road, London, N., Manager.
1905. Bourne, Lyman, M., 210, Waterman Street, Providence, R.I., U.S.A., Chemist.
1917. Bousquet, Calixte F., 130, Laval Avenue, Montreal, Canada, Chief Chemist.
1888. Bower, Frank, Brewery House, Spitalfields, E., Analytical Chemist.
1909. Bower, Joshua, c/o Kynoch, Ltd., Lion Works Wotton, Birmingham; Journals to 45, St. Peter's Road, Handsworth, Birmingham, Chemist.
1897. Bower, Wm. H., 29th Street and Gray's Ferry Road Philadelphia, Pa., U.S.A., Chemical Manufacturer.
1892. Bowes, Harry, 9, Park Road, Heaton Moor, Stockport, Analytical Chemist.
1915. Bowis, Dr. H. J., 9, Rectory Road, West Bridgford, Nottingham, Technical Chemist.
1883. Bowley, Jos. John, Wellington Works, Battersea Bridge, London, S.W., Chemical Manufacturer.
1899. Bowley, J. Plunkett (retain Journals), Varnish Manufacturer.
1908. Bowman, Fred C., 1632, University Avenue, New York City, U.S.A., Chemist.
1884. Bowman, R., c/o Bowman's Ltd., Moss Bank Works, Widnes, Chemical Manufacturer.
1907. Bowman, Richard S., Quarr Cottage, Great Sankey, near Warrington, Chemist.
1896. Bowman, Walker, 39, Cortlandt Street, New York City, U.S.A., Chemist.
1917. Bowyer, John J., 41, Heath Road, Runcorn, Cheshire, Chemist.
1904. Boyce, Framroze H., 86, Hugh's Road, Chaupaty, Bombay, India, Technical Chemist.
1893. Boyce, Frank, 48, Duchy Road, Harrogate, Technical Chemist.

1910. Boyce, James, Route 8, Holland, Mich., U.S.A., Chief Chemist.
1913. Boyd, Robert, c/o British Columbia Sugar Refining Co., Ltd., Vancouver, B.C., Canada, Chemist.
1885. Bradburn, J. A., 311, Montgomery Street, Syracuse, N.Y., U.S.A., Manufacturing Chemist.
1912. Bradford, Francis L. W., 109, Rotton Park Road, Edgbaston, Birmingham, Chemist and Works Manager.
1895. Bradford, Henry, Strettington, Goodwood, near Chichester, Analytical Chemist.
1915. Bradley, G. W. J., By-Products Dept., The Ebbw Vale Steel, Iron and Coal Co., Ltd., Ebbw Vale, Mon., Chemist.
1917. Bradshaw, Hamilton, Experimental Station, Henry Clay, Del., U.S.A., Director.
1917. Brady, Dr. Oscar L., 10, Blonden Terrace, Plumstead, S.E., Research Chemist.
1896. Bragg, Everett B., 1838, Chicago Avenue, Evanston, Ill., U.S.A., Manufacturing Chemist.
1891. Braithwaite, Isaac, Ghyll Close, Kendal, Westmoreland, Drysalter.
1897. Braithwaite, Jno. O., Holme Lacey, Warren Road, Chingford, Essex, Pharmaceutical Research Chemist.
1903. Brame, Prof. J. S. S., 3, Vanbrugh Fields, Blackheath, S.E., Professor of Chemistry.
- O.M. Bramham, W., Bank Chambers, 300, Mare Street, Hackney, N.E., Chemical Engineer.
1902. Brangan, Jas. Aug., 12, Park Avenue, Millbourne, Delaware Co., Pa., U.S.A., Chemical Salesman.
1915. Branson, F. H., 14, Commercial Street, Leeds, Manufacturing Chemist.
- O.M. Branson, F. W., Wynneholme, Far Headingley, Leeds, Pharmaceutical Chemist.
1903. Brassard, Fred A., 46, Viciar Lane, Bradford, Yorks, Aniline Dyestuff Importer.
1901. Brearley, Harry, c/o The Amalgams Co., Ltd., Attercliffe Road, Sheffield, Analytical Chemist.
1906. Breckenridge, John E., American Agricultural Chemical Co., Carteret, N.J., U.S.A., Chemist.
1917. Breithaupt, J. Edward, c/o The Breithaupt Leather Co., Kitchener, Ont., Canada, Chemical Engineer.
1900. Brewis, E. T., 31, Belgrave Road, Leyton, E., Analytical Chemist.
1894. Breyer, Theodor, 725, Washington Avenue, Wilmette, Ill., U.S.A., Chemist.
1916. Briant, Arthur, Fern Villa, Helsby, Cheshire, Works Chemist.
1885. Briant, L., 24, Holborn Viaduct, London, E.C., Analytical Chemist.
1916. Brierley, Michael, c/o Anseo Co., Research Laboratory, Binghamton, N.Y., U.S.A., Chemist.
1890. Brierley, J. T., Highfield, Golden Hill, Leyland, near Preston, Lancs., Analytical Chemist.
1893. Briggs, J. F., 3, Hartington Street, Derby, Technical Chemist.
1912. Briggs, Capt. O. W. H., c/o Harborough Rubber Co., Market Harborough, Chemist.
1885. Briggs, T. Lynton, 188, Central Avenue, Flushing, Long Island, N.Y., U.S.A., Technical Chemist.
1917. Brightman, R., Price's Co., Ltd., Belvedere, Kent, Research Chemist.
1914. Brinsley, Frank, 9, Crowthorn Road, Ashton-under-Lyne, Demonstrator in Physical Chemistry.
1910. Brisbane, James W., H.M. Works, Queensferry, Chester, Analytical Chemist.
1917. Briscoe, H. V. A., 40, Cyril Mansions, Prince of Wales Road, Battersea Park, S.W., Consulting Chemist.
1905. Bristol, Dr. H. Stanley, c/o Fibre Finishing Co., Greendale, Worcester, Mass., U.S.A., Chemist.
1886. Bristow, G. W., c/o Walter J. Crook, 10, Eastcheap, London, E.C., Chemical Manager.
1912. Britland, Wm. J., Pear Tree Cottage, Alvanley, near Helsby, Cheshire, Chemist.
1917. Britton, Reginald P. L., 58, The Crescent, Wimbledon Park, London, S.W.
1887. Broadbent, H., c/o Goodall, Backhouse and Co., Sovereign Street, Leeds, Chemist.
1889. Breck, Arthur, Firework Factory, Sutton, Surrey, Firework Manufacturer.
1910. Brodribb, Noel K., Cordite Factory, Ascot, Vale, Melbourne, Victoria, Australia, Chemist.
1912. Bromley, Henry S., 1000, Wissahickon Avenue, Mount Airy, Philadelphia, Pa., U.S.A., Lace Manufacturer.
1896. Brooke, C. B., jun., Colna House, Brantham, near Manningtree, Xylonite Manufacturer.
1900. Brooke, Jno. R., Government Opium Factory Singapore, S.S., Superintendent.
1884. Brookes, E. A., c/o Braden Copper Co., Ltd., Sewell Rancagua, Chile, Chemist.
1916. Brooks, Prof. B. T., 593, Cardon Road, Westfield, N.J., U.S.A., Prof. of Chemical Engineering.
1906. Brooks, Cecil J., c/o M. M. Siman, Benkoelen, Sumatra, Ned. India, Metallurgist.
1916. Brot, Dr. Maurice, Oleum Works, La Rochelle, France, Consulting Chemist.
1911. Brothers, Horace E., Higher Knutsford Road, Latchford, Warrington, H.M. Inspector of Factories.
1909. Brothers, Wm., Meadow House, Tunstead Milton, near Whaley Bridge, Derbyshire, Chemical Manufacturer.
- O.M. Brotherton, Colonel E. A., City Chambers, Leeds, Ammonia Distiller.
1884. Brown, Prof. A. Crum, F.R.S., 8, Belgrave Crescent Edinburgh, Professor of Chemistry.
1905. Brown, Prof. Adrian J., Kinside, West Heath Road, Northfield, near Birmingham, Professor of Brewing.
1902. Brown, A. H. M., 133, Kent Street, London, Ont., Canada, Metallurgist.
1891. Brown, Caesar R., 141, Victoria Avenue, Prittlewell, near Southend, Works Foreman.
- O.M. Brown, D., 93, Abbey Hill, Edinburgh, Chemical Manufacturer.
- O.M. Brown, D., Donaghmore, Tyrone, Ireland, Soap Manufacturer.
1890. Brown, Edw. Hilton, c/o N. 12, Aptakers Prospect, Petrograd, Russia, Analytical Chemist.
1894. Brown, Geo. E., c/o "The British Journal of Photography," 24, Wellington Street, Strand, London, W.C., Chemist.
1910. Brown, Geo. Winslow, Assabet Mills, Maynard, Mass., U.S.A., Chemist.
- O.M. Brown, Henry, Benskins Brewery, Watford, Herts., Brewing Chemist.
1899. Brown, Dr. Henry C., The Chemical Works, King's Lynn, Chemical Manufacturer.
- O.M. Brown, Dr. Horace T., F.R.S., 52, Nevern Square, Kensington, S.W., Brewing Chemist.
1905. Brown, Hugh B., c/o Messrs. Carr, White and Co., Ltd., Wigton, Cumberland.
1917. Brown, Le Roy, 55, Summit Avenue, Sault Ste. Marie, Ontario, Canada, Civil Engineer.
1917. Brown, Norman B., Shawinigan Falls, Quebec, Canada, c/o Shawinigan Electro-Metals Co., Assistant Superintendent and Chemist.
1892. Brown, Reginald B., 45, Finsbury Square, London, E.C., Technical Chemist.
1901. Brown, Samuel B., Marringhurst, Marple, Cheshire, Calico Printer.
1916. Brown, W. F., 2, Flora Villas, Whalebone Avenue, Chadwell Heath, Essex, Gas Works Chemist.
- O.M. Brown, Walter, c/o Jas. H. Dennis and Co., Ltd., Widnes, Technical Chemist.
1900. Brown, Walter B., Victor Chemical Works, 1805, Fisher Building, Chicago, Ill., U.S.A., Chemist and General Superintendent.
1901. Browne, Dr. Arthur L., 215, East Fayette Street, Baltimore, Md., U.S.A., Analytical Chemist.
1906. Browne-Cave, E. J. C. See Cave-Browne-Cave, E. J.
1905. Browning, Prof. K. C., 11, Barton Terrace, Dawlish, S. Devon, Professor of Chemistry.
- O.M. Browning, W., Bentcliffe, Acerington, Calico Printer.
1917. Brownlee, Richard, P., 43, Bloxridge Street, Langley, Birmingham, Technical Chemist.

1902. Brownson, Dr. H. W., King's Norton Metal Co., Ltd., King's Norton, Birmingham, and (Jns.) 109, Oxford Road, Mosely, near Birmingham, Works Chemist.
1902. Bruce, Alex., Laboratory, Hyde Park Corner, Colombo, Ceylon, Chemist.
1911. Bruce, Joseph, Jnls. to General Manager, Dynamite Factory, West Somerset, Cape Colony, Secretary.
1908. Bruce, Robert, 44, High Street, Leven, Fifeshire, Works Chemist.
1900. Bruce, Wm. T., 3, Lombard Court, London, E.C., and (Jnl.) c/o T. C. Allehin, Longfield, Kent, Director.
1911. Brunet, Louis, "Revue Générale des Sciences," 97, Boul. Montmorency, Paris XVI, France, Chemist and Secretary.
1916. Brunjes, Thos., 67, Waller Road, New Cross, S.E., Tar Distillery Chemist.
1894. Brunner, H. Bertram, The Hollies, Hartford, Cheshire, Chemist and Electrician.
1887. Brunner, J. F. L., M.P., c/o Brunner, Mond, and Co., Ltd., Caxton House, Westminster, S.W., Chemical Manufacturer.
- O.M. Brunner, Rt. Hon. Sir J. T., Bart., Silverlands, Chertsey; and (Journals) c/o Brunner, Mond, and Co., Ltd., Northwich, Cheshire, Chemical Manufacturer.
1902. Brunner, Roscoe, The Winnington Hall Club, Winnington, Northwich, Alkali Manufacturer.
1894. Bruntton, J. Dixon, Wire Mill, Musselburgh, Scotland, Wire Manufacturer.
1904. Bryant, Arthur P., c/o Clinton Sugar Refining Co., Clinton, Iowa, U.S.A., Chemist.
1908. Bryce, Chas. C., 43-45, Great Tower Street, London, E.C., Merchant.
1916. Bryce, James, United States Finishing Co., 389, Charles Street, Providence, Rhode Island, U.S.A., Print Works Manager.
1894. Bryce, Thos., Tharsis Mines, Huelva, Spain, Chemist.
1897. Bryson, Jas., Pumpherson Oil Works, Mid-Caldor Scotland, Oil Works Manager.
1892. Buchanan, D. G., 39, Inverness Terrace, Hyde Park, London, W., Analyst.
1908. Buchanan, Duncan G., 27, Woodlawn Avenue East, Toronto, Canada, Chemist (Rubber Works).
1904. Buchanan, E. F., 11432, Prairie Avenue, Chicago, Ill., U.S.A., Chemist.
1888. Buchanan, Jas., Caledonia Foundry, Brasenose Road, Liverpool, Engineer.
1904. Buchanan, John L., Braehead, Mill Road, Bromborough, Cheshire, Analytical Chemist.
1904. Buchanan, Joshua D., c/o Nobel's Explosives Co., Ltd., Polmont Station, Scotland, Analyst.
1910. Buchanan, Walter G., c/o Lantaro Nitrate Co., Ltd., Talta, Chile, Chemist.
1897. Buck, Chas. A., Prospect and Park Avenues, Bethlehem, Pa., U.S.A., Chief Chemist (Bethlehem Iron Co.).
1911. Budde, Dr. Carl, 1, Belford Road, Sunderland, Chemical Engineer.
1909. Buell, W. H., c/o Winchester Repeating Arms Co., New Haven, Conn., U.S.A., Chemist.
1915. Bugge, E. R., Instow, Mycenae Road, Blackheath, S.E., Manufacturing Chemist.
1909. Buggy, Thos., Butte, Montana, U.S.A., Assayer and Chemist.
1917. Bull, Bertram A., 14, North Road, West Bridgford, Nottingham, Works Chemist (Boots Pure Drug Co.).
1902. Bull, Irving C., 100, Maiden Lane, New York City, U.S.A., Chemist.
1899. Bult, Herbert J., 63, Addiscombe Road, Croydon, Chemist.
- O.M. Bumby, H., Bellevue, Sandbach, Cheshire, Iron and Chemical Works Director.
1915. Bunce, A., c/o The Morgan Crucible Co., Ltd., Church Road, Battersea, S.W., Works Chemist.
- O.M. Bunker, H. E., 310, Kingston Road, Toronto, Ont., Canada, Technical Chemist.
1901. Bunting, Henry H., Oficina de Ensayes F. C. C. del P., Callao, Peru, Analyst.
1893. Burbridge, Jas., India-rubber Mills, Tottenham, N., India-rubber Manufacturer.
1896. Burford, Samuel F., The Ridgeway, Rothley, near Leicester, Analytical Chemist.
1889. Bürger, Dr. J., 9, Vincent Avenue, Chorlton-cum-Hardy, Manchester, Technical Chemist.
1889. Burgess, Geo., Sydney Cottage, Halebank, Widnes, Chemist.
1901. Burgess, Prof. Chas. F., C. F. Burgess Laboratories, Madison, Wis., U.S.A., Chemical Engineer.
1889. Burgess, Wm. T., 26, Priory Road, Bedford Park, London, W., Analytical Chemist.
1902. Burkard, Dr. Ernst, Solothurn, Switzerland, Chemist.
1917. Burke, Henry U., c/o The British American Tobacco Co., Ltd., Ashton Gate, Bristol, Works Manager.
1891. Burnet, Henry K., North Brook Vitriol Works, Bradford, Yorks, Sulphuric Acid Maker.
1897. Burnet, Sir Jno. Jas., 18, University Avenue, Glasgow, and (Journals) 1, Montague Place, Bedford Square, London, W.C., Architect.
1909. Burnett, Arthur, The Haven, Buxton Road, Chinley, Derbyshire.
1893. Burnham, J. C., Analytical Chemist.
1900. Burr, Edmund C., 1722, Vallejo Street, San Francisco, Cal., U.S.A., Manufacturer.
1917. Burr, Richard J., 247, Browning Road, Manor Park, Essex, Works Chemist.
- O.M. Burrell, B. A., 8, Springfield Mount, Leeds, Analytical Chemist.
1910. Burrell, Keith, Burrell's Wharf, Millwall, London, E., Manufacturer.
1906. Burrough, Ernest J., Cale Distillery, Hutton Road, Lambeth, S.E., Rectifier.
1912. Burt-Gerrans, J. T., 46, Dewson Street, Toronto, Canada, Electro-Chemist.
1901. Burton, A.H., Canadian Dyers' Association, Ltd., 2-16, Liberty Street, Toronto, Canada, Dyer and Finisher.
1914. Burton, Donald, Westbourne, St. Andrew's Avenue, Morley, near Leeds, Research Assistant.
1903. Burton, Jno., 2, Green Street, Bethnal Green, E., Dye and Chemical Manufacturer.
1911. Burton, Tom F., "Manna Mead," Upper Warlingham, Surrey, Editor.
1904. Burton, T. E., c/o Scott, Greenwood, and Son, 8, Broadway, Ludgate Hill, London, E.C., Technical Journalist.
1889. Burton, Wm., Carisbrook, Park Crescent, Victoria Park, Manchester, Potter's Chemist.
1915. Bury, Ernest, Skinningrove Iron Co., Ltd., Carlin How S.O., Yorks, Works Manager.
1906. Busby, Fred. E., Arnold Print Works, North Adams, Mass., U.S.A., Chemist.
1913. Bush, Dr. Harry T., 7, Gracechurch Street, London, E.C., Chemical Engineer.
1897. Bush, J. M., c/o W. J. Bush and Co., Ltd., Ash Grove, Hackney, E., Manufacturing Chemist.
1897. Butler, David B., 6, Earl Street, Westminster, S.W., Cement Expert.
1913. Butler, Geo. B., Adelaide Villa, Belle Vue Grove, Grove Hill, Middlesbrough, Assistant Blast Furnace Manager.
1890. Butler, Paul, Lowell, Mass., U.S.A., Ammunition Manufacturer.
1885. Butler, Samuel, The Cedars, Compton, Wolverhampton, Brewer.
1905. Butler, Dr. T. H., c/o Wm. Butler and Co., Ltd., Crews Hole, Bristol, Chemist (Tar and Rosin Distillery).
1886. Butler, W. W., c/o Mitchells & Butlers, Ltd., The Brewery Library, Cape Hill, Birmingham, Brewer.
1892. Butterfield, W. J. A., 66, Victoria Street, Westminster, S.W., Analytical Chemist.

1897. Butters, Charles, 54, New Broad Street, London, E.C., and (Journals) 6272, Chabot Road, Oakland, Cal., U.S.A., Metallurgist.
1900. Butterworth, Elwell R., c/o Reversible Collar Co., 111, Putnam Avenue, Cambridge, Mass., U.S.A., Chemist.
- O.M. Byard, A. G., c/o Burt, Boulton, and Haywood, Apartado 8, Bilbao, Spain. Technical Chemist.
1905. Byrne, F. A., 2, Ludgate Hill, Birmingham, Director of Chemical Co.
1893. Byrom, T. H., 58, Hornsey Rise, Upper Holloway, London, N., Analytical Chemist.
1915. Bywaters, H. W., 9, Henleaze Avenue, Bristol, Chemist.
- C
1884. Cabot, Godfrey L., 940, Old South Building, Boston, Mass., U.S.A., Manufacturing Chemist.
1907. Cabot, Samuel, 141, Milk Street, Boston, Mass., U.S.A., Chemical Manufacturer.
1906. Caddick, Arthur, Casa Fundición, Miras de Río Tinto, Huelva, Spain. Works Chemist.
1889. Cadett, Jas., Ashtead, Surrey, Chemical Engineer.
1905. Cain, Dr. J. C., 24, Aylestone Avenue, Brondesbury Park, N.W., Colour Chemist.
1891. Caines, G. S. A., 68, Hilldrop Crescent, Camden Road, London, N.W., Analytical Chemist.
1917. Calam, Harold, 18, Melton Road, West Bridgford, Nottingham. Research Chemist (Boots Pure Drug Co.).
1905. Calder, Prof. Edwin E., Long Meadow R.I., U.S.A., Professor of Chemistry.
1897. Calder, W. A. S., 449, Hagley Road, Birmingham, Chemical Manufacturer.
1912. Caldwell, Wallace, L., Apartment "F," Fitzgerald Apartment, Birmingham, Ala., U.S.A., Engineering Chemist.
1888. Caldwell, Wm., Murray Street, Paisley, Scotland, Drysalter.
1917. Caley, John, Premier Oil Extracting Mills, Ltd., Hull, Managing Director.
1912. Callan, Dr. Thomas, 2, Spring Bank, Crumpsall Lane, Higher Crumpsall, Manchester, Technical Chemist.
1902. Calm, Dr. Klas. E., California Club, Los Angeles, Cal., U.S.A., Manufacturing Chemist.
1904. Calvert, Dr. Harry T., Ministry of Munitions, Dept. of Explosives Supplies, Storey's Gate, Westminster, S.W., Chemist.
1895. Cambier, Jacob, 1401, Carteret Avenue, Pueblo, Colo., U.S.A., Chemist.
1916. Cameron, Alex. M., Beechleigh, Lasswade, Midlothian, Analytical Chemist.
1904. Cameron, Walter S., 239, West 136th Street, New York City, U.S.A., Manufacturing Perfumer.
1908. Cameron, Wm., c/o The Asiatic Petroleum Co., Barrow-in-Furness, Asst. Refinery Manager.
- O.M. Cammack, J., "Fernsholme," Preseot Road, St. Helens, Technical Chemist.
1886. Campbell, Andrew, 1, Park Road, Beckenham, Kent, Chemist (Mineral Oil).
1912. Campbell, Arthur F., 9, Fort Road, Sedgley Park, Manchester, Research Chemist.
1908. Campbell, Fred. A., The Working Men's College, Latrobe Street, Melbourne, Victoria, Australia, Principal.
1907. Campbell, John A., c/o British South African Explosives Co., Modderfontein, Transvaal, Analytical Chemist.
1912. Campbell, Kennedy, c/o British Dycwood Co., Ltd., Parkhead, Glasgow, Chemist.
1901. Campbell, Kenneth F., 1, Peel Street, Huddersfield, Civil Engineer.
1911. Campbell, L. E., 5, St. Matthew's Avenue, Surbiton, Surrey, Chemist.
1909. Campbell, Peter, Kearny, N.J., U.S.A., Linoleum Manufacturer.
1915. Campbell, Wm. B., 197, Wilson Avenue, N.D.G., Montreal, Canada.
1911. Campbell, Wm. E., c/o Gutta Percha and Rubber Ltd., O'Hara Avenue, Toronto, Canada, Industrial Chemist.
1914. Camus, Edward C. A., 8, Rue de Mondovi, Paris I., France, Chemical Merchant.
1909. Candee, Chas. N., 39, South Drive, Toronto, Canada, Rubber Manufacturer.
1908. Canning, Ernest R., 137, Great Hampton Street, Birmingham, Manufacturer.
1891. Carden, Albert J., 20—21, Harp Lane, Gt. Tower Street, London, E.C., Distiller.
1917. Carder, Frederick, Stenben Glass Works, Corning, N.Y., U.S.A., Chemist and General Manager.
1915. Cardwell, David, 50, Alexandra Road South, Manchester, S.W., Chemist.
1893. Carey, Arthur, Orient House, Gateacre, Liverpool, Chemist.
1906. Carey, W. Gordon, c/o United Alkali Co., Ltd., Allhusen Works, Gateshead-on-Tyne, Chemist.
1904. Cargill, J. T., c/o Finlay, Fleming, and Co., Rangoon, Burma, East India Merchant.
1915. Carlos, Arthur S., 42, Foxley Road, North Brixton, S.W., Analytical Chemist.
1896. Carmichael, Herbert, Bureau of Mines, Victoria, British Columbia, Public Analyst and Assayer.
1884. Carnody, Prof. Patrick, Lostwithiel, Cornwall, Analytical Chemist.
1897. Carnell, Wm. C., 1141, Arret Street, Frankford, Philadelphia, Pa., U.S.A., Chemist.
1916. Carothers, A., 164, Roseberry Street, St. James, Winnipeg, Canada, Pharmaceutical Chemist.
1893. Carpenter, Dr. C. C., South Metropolitan Gas Co., 709A, Old Kent Road, London, S.E., Civil Engineer.
1908. Carpenter, Edwin P., Culvert Works, Sheepcote Lane, Battersea, S.W., Manager of Cascin, Ltd.
1900. Carpenter, Frank B., 11, South 12th Street, Richmond, Va., U.S.A., Analytical Chemist.
1900. Carpenter, Harry B., c/o Lister's Agricultural Chemical Works, Newark, N.J., U.S.A.
1915. Carpenter, Henry A., R. F. D., No. 3, Sewickley Pa., U.S.A.
1904. Carr, Francis H., Westhorpe, Ruddington, Notts., Manufacturing Chemist.
1917. Carriek, Peter McAl., 329, Railway Street, Vancouver, B.C., Managing Director.
1907. Carrier, C. F., jun., 1567, Lee Street, Charlestown, W. Va., U.S.A., Manufacturing Chemist.
1904. Carter, A., Cuba Street, Petone, Wellington, New Zealand, Works Manager.
1905. Carter, Robert A., 4923, Osage Avenue, Philadelphia, Pa., U.S.A., Chemist.
1917. Carter, Sidney R., The University, Birmingham, Chemistry Lecturer.
1895. Carter, Stewart F., 229, President Street, Passaic, N.J., U.S.A., Technical Chemist.
1903. Carter, Thomas, West End View, Ravensthorpe, Dewsbury, Yorks, Works Chemist.
1886. Carter, W. Chas., c/o Dominion Iron and Steel Co., Sydney, C.E., Canada, Analytical Chemist.
1916. Cartwright, T. T. F., c/o New Explosives Co., Stowmarket, Suffolk, Chemist.
1911. Carty, Ronald D., The Laboratories, Public Works Ministry Gardens, Cairo, Egypt, Analytical Chemist.
1889. Carulla, F. J. R., 84, Rose Hill Street, Derby, Chemical Manufacturer.
1906. Carveth, Dr. H. R., Niagara Electrochemical Co., Niagara Falls, N.Y., U.S.A., Works Manager.
1914. Casey, John V., Charlemont, Moy, Co. Tyrone, Ireland, Waterproof Manufacturer.
1903. Caspari, Dr. W. A., c/o Messrs. Evans, Sons, Lescher, and Webb, Ltd., 60, Bartholomew Close, London, E.C., Chemist and Physicist.
1917. Cass, Wilfred G., Brimstage, Birkenhead, Abstractor.
1899. Castro, J. Paul de, 1, Essex Court, Temple, London, E.C., Barrister-at-Law.

1909. Caulkin, Howard A., "The Glen," Cumberhill Road, Duffield, Derbyshire, Analyst.
1906. Cave-Browne-Cave, E. J., c/o Thos. Ness, Ltd., Littleburn Tar Works, Durham, Works Chemist.
1917. Cave-Browne-Cave, E., 567, Hornby Street, Vancouver, B.C., Canada, Merchant.
1896. Caven, Dr. Robt. M., University College, Nottingham, Lecturer in Chemistry.
1914. Caw, Wm., No. 3 Staff Hostel, Eastriggs, Doonack, Annan, Chemist.
- O.M. Cawley, G., 82, Victoria Street, Westminster, S.W., Chemical Engineer.
- O.M. Cawley, J., 609, Mt. Prospect Avenue, Newark, N.J., U.S.A., Analytical Chemist.
1897. Cawley, Thos. A., British Gelatin Works, Ltd., New Bedford Road, Luton, Gelatin Manufacturer.
1906. Chadsey, Stanley B., 476, Brunswick Avenue, Toronto, Canada, Chemist.
1916. Chadwick, George B., c/o The Paterson Manufacturing Co., Ltd., 172, King Street East, Toronto, Canada, District Manager.
1917. Challenger, Dr. Fredk., The University, Edmund Street, Birmingham, University Lecturer.
1910. Challinor, Richard W., Chemical Laboratory, The Technical College, Sydney, N.S.W., Australia, Teacher of Chemistry.
1894. Chaloner, G. W., 26, Eagle Wharf Road, Hoxton, N., Chemical Manager.
1901. Chamberlain, G. E., 641, West Prairie Avenue, Decatur, Ill., U.S.A., Chemist.
1917. Chamberlain, John, 133, Embleton Road, Lewisham, S.E., Gas Engineer.
1910. Chambliss, Prof. Hardee, c/o Commercial Acid Co.'s Plant, R.F.D. No. 1, East St. Louis, Ill., U.S.A., Assistant Commissioner of Public Health.
- O.M. Chance, A. M., Wolcot, Torquay, Devon, Chemical Manufacturer.
1912. Chance, Clinton F., Messrs. Chance and Hunt, Ltd., Oldbury, near Birmingham, Managing Director.
1909. Chance, Edwin M., 1330, F Street N.W., Washington, D.C., U.S.A., Chemist.
1916. Chance, Kenneth M., British Cyanides Co., Ltd., 49, Queen Victoria Street, London, E.C., Managing Director.
1917. Chandhuri, J. K., Digboi, P.O., Upper Assam, India, Chemist (Assam Oil Co., Ltd.).
- O.M. Chandler, Dr. C. F., 51, East 54th Street, New York City, U.S.A., Professor of Chemistry.
1912. Chandler, Lee L., Research Laboratory, Pittsburgh Plate Glass Co., Creighton, Pa., U.S.A., Assistant.
1893. Chaplin, Dr. Edw. M., Public Analyst's Laboratory, Wakefield, Yorks, Analytical Chemist.
1890. Chapman, A. Chaston, 8, Duke Street, Aldgate, E.C., Public Analyst and Consulting Chemist.
1906. Chapman, Arthur J., Baronsmere, Stanhope Avenue, Church End, Finchley, N., and (Journals) c/o F. Claudet, Ltd., 6 and 7, Coleman Street, London, E.C., Analytical Chemist.
1906. Chapman, E. A., c/o Messrs. Boots Drug Co., Ltd., London Road Branch, Nottingham, Chemist.
- O.M. Chapman, Spencer, 36, Mark Lane, E.C., Chemical Manufacturer.
1894. Charlier, A. C. J., Benyoulin, 154, Worple Road, Wimbledon, S.W., Consulting Chemist.
1915. Charlton, W. W. S., c/o The Cotton Powder Co., Uplees, Faversham, Kent, Manufacturing Chemist.
1917. Charpy, Jean F., 12, Briardale Road, Rock Ferry, Perfumer-Chemist.
1900. Chase, March F., c/o Commercial Acid Co., 1916, Boatmen's Bank Building, St. Louis, Mo., U.S.A., Chemist.
1889. Chase, R. L., Arnold Printworks, North Adams, Mass., U.S.A., Manager.
1898. Chattock, Herbert E., 23, Apsley Road, Clifton, Bristol, Oilcake Manufacturer.
1910. Chattopadhyaya, P. C., 27, Narikeldanga Main Road, Harrison Road P.O., Calcutta, India, Chemist.
1915. Chazan, Simon, 188, Elizabeth Street, Hightown, Manchester, Works Chemist.
1901. Cheetham, Howard, 18, St. Ann Street, Manchester, Chartered Patent Agent.
1894. Cheney, John P., c/o Messrs. Cheney Bros., South Manchester, Conn., U.S.A., Chemist and Silk Manufacturer.
1915. Cheng, Pinzen, West Gate, Kia-ting-Lsien, near Shanghai, China, Analytical Chemist.
1916. Chetwin, H. W., 24-26, Wilson Street, Poplar, E., Manufacturing and Analytical Chemist.
1913. Chiaravaglio, Dr. Dino, Piazza Esquilino 23, Rome, Italy, Director, Explosives Laboratory.
1905. Chick, Oliver, 31, Auckland Road, Cranbrook Park, Ilford, Essex, Analytical Chemist.
1917. Chitty, Charles W., Charlton Mill, Dover, Flour Miller.
1890. Chorley, Jno. C., Bewsey, Oxford Road, Birkdale, Lancs., Analytical Chemist.
1917. Chorley, Percy, "High Cross," Kirkburton, near Huddersfield, Research Chemist.
- O.M. Christie, J., Levenfield, Alexandria, Scotland, Dyer and Printer.
1903. Christie, John, c/o Nobel's Explosives Co., Ltd., Pembrey, South Wales, Analytical Chemist.
1914. Christie, John T., c/o Messrs. John Miller and Co., Sandilands Chemical Works, Aberdeen, Analytical Chemist.
1908. Christie, Malcolm, Hornock Cottages, Coatbridge, Scotland, Analytical Chemist.
1910. Christie, Dr. M. G., c/o The Otto-Hilgenstock Coke Oven Co., Post Office House, Leeds, Assistant General Manager.
1898. Christison, Geo., 2, Kelvinside Gardens Glasgow, Engineer.
1907. Christopher, George, Walkden Works, Verney Road, South Bermondsey, S.E., Consulting Chemist.
1907. Christopher, J. E., Solvay Coke Works, Kirkless, Wigan, Assistant in Charge.
- O.M. Chrystal, W. J., 7, West George Street Glasgow, Chemical Manufacturer.
1908. Chrystall, E. R., c/o Curtis's and Harvey, Ltd., Cliffe at Hoo, Kent, Research Chemist.
1906. Church, Sumner R., c/o Barrett Manufacturing Co., 17, Battery Place, New York City, U.S.A., Chemical Engineer.
1907. Churchill, Wm., Corning Glass Works, Corning, N.Y., U.S.A., Chemist.
1915. Chute, Robt. J., 347, Pape Avenue, Toronto, Canada, Manufacturer.
1896. Clafin, Alan A., 176, Federal Street, Boston, Mass., U.S.A., Manufacturing Chemist.
1909. Claffin, Albert W., 190, Waterman Street, Providence, R.I., U.S.A., Manufacturing Druggist.
1917. Clague, Thos. M., 24, Grainger Street West, Newcastle-on-Tyne, Pharmaceutical Chemist.
1900. Clamer, Guillian H., 46, Richmond Street, Philadelphia, Pa., U.S.A., Chemist.
1885. Clanahan, H. C., 79, Mosley Street, Manchester, Chemical Merchant.
1905. Clapp, Geo. A., 49, Federal Street, Boston, Mass., U.S.A., Chemist.
1891. Clapp, Ralph R., c/o B. P. Clapp Ammonia Co., Providence, R.I., U.S.A., Manager.
1889. Clapperton, J., jun., Analytical Chemist.
1916. Clare, Geo. R., 54, York Street, Runcorn, Cheshire, Works Chemist.
1917. Clark, Alexander P., 62, Fernwood Park Avenue, Toronto, Ont., Canada, Chemist.
1913. Clark, A. Stanley, 16, Richmond Hill, Langley Green, near Birmingham, Technical Chemist.
1910. Clark, Arthur W., c/o Heath and Milligan Manufacturing Co., 1832, South Canal Street, Chicago, Ill., U.S.A., Superintendent.
1904. Clark, Arthur Wayne, c/o Johnson and Johnson, New Brunswick, N.J., U.S.A., Chemist and Bacteriologist.
1908. Clark, Chas. T., 1303, Sixth Street, Bay City, Mich., U.S.A., Manufacturing Chemist.
1913. Clark, Francis W., 43, Braemar Avenue, Wood Green, London, N., Chemist.

1917. Clark, Prof. Friend E., West Virginia University, Morgantown, W. Va., U.S.A., Prof. of Chemistry.
1910. Clark, Henry, 24, Eastcheap, London, E.C., Oil Refiner.
1900. Clark, Jno., Broadway Works, Millwall Docks, London, E., Manufacturing Chemist.
1916. Clark, John A., Scottish Co-operative Flour Mills, and 11, Walmer Terrace, Ibrox, Glasgow, Analyst.
1906. Clark, M. H., c/o Goodyear's Metallic Rubber Shoe Co., Naugatuck, Conn., U.S.A., Chemist.
1916. Clark, Dr. Robt. H., University of British Columbia, Vancouver, B.C., Canada, Professor of Chemistry.
1902. Clark, Robt. M., 138, Bath Street, Glasgow, Chemist.
1915. Clark, T. W. Firth, "Tilehurst," Pollard Road, Mitcham, Surrey, Technical Chemist.
1906. Clark, Wm. B., Larkfield, Earlestown, Lancashire, Chemist.
1907. Clark, Wm. H., 26, Barry Street, Dunston-on-Tyne, Analytical Chemist.
1912. Clark, William M., Euclid Glass Division, East 152nd Street, Cleveland, Ohio, U.S.A., Chemist.
1908. Clarke, Arthur F., c/o White's South Africa Cement Co., Ventersburg Road, Orange Colony, South Africa, Analytical Chemist.
1916. Clarke, Thos. C., 111, Broadway, New York City, U.S.A., Metallurgical Engineer.
1897. Clarke, Wm. B., c/o Edison-Swan Electric Co., Ltd., Ponders End, S.O. Middlesex, Electro-Chemist.
1889. Claus, Wm. H., c/o Claus and Co., Ltd., Clayton, Manchester, Manufacturing Chemist.
1909. Clayton, Ellis, 3, Princess Gardens, Marino, near Belfast, Lecturer on Bleaching, Dyeing, and Printing.
1895. Clayton, Dr. G. C., c/o The United Alkali Co., Ltd., 30, James Street, Liverpool.
1894. Clayton, Robt. H., 1, Parkfield Road, Didsbury, Manchester, Chemist.
1910. Clayton, Will, Cliffe House, Accrington, Works Chemist.
1905. Clayton, W. E., Admiralty Victualling Yard Grangemouth, Scotland, Superintendent.
1917. Cleghorn, Andrew T., 2657, 2nd Avenue West, Vancouver, B.C., Manufacturing Chemist.
1907. Clement, Leonard, 11, Agnew Street, Lytham, Lanes., Chemist.
1917. Clements, Percy J. N., c/o J. S. MacArthur, Ltd., Loch Lomond Radium Works, Balloch, Dumbartonshire.
1893. Clemes, J. H., 111, Mount Wise, Newquay, Cornwall, S.E.; retain Journals; Chemist.
1905. Clepton, Thos. J., 285, Congress Street, Boston, Mass, U.S.A., Manager (A. Klipstein and Co.).
1915. Clibborn, John W., 12, Weirwood Park, Baillieston Glasgow, Assistant Works Manager.
1906. Clifford, Jos., Laboratories, Public Works Ministry Gardens, Cairo, Egypt, Chemist.
1913. Clifford, Sydney G., 51, Peak Hill, Sydenham, S.E., Analytical Chemist.
1900. Clifford, Wm., Sewage Outfall Works, Wolverhampton, Sewage Works Manager.
- O.M. Clond, T. C., 20, Bucklersbury, London, E.C., Metallurgist.
- O.M. Clowes, Dr. F., The Grange, College Road, Dulwich, S.E.; retain Journals; Chemist.
1891. Clutton, J. H., Fonderie Mines de l'Aude, Villanière par La Cour (Aude), France, Metallurgist.
1911. Clymer, Wm. R., Publicity Department, National Carbon Co., Cleveland, Ohio, U.S.A., Manager.
1899. Coates, Chas. E., jun., Louisiana State University, Baton Rouge, La., U.S.A., Professor of Chemistry.
1917. Coates, H. B., No. 2 Staff Quarters, East Riggs Township, Annap, Chemist.
1911. Coates, Jos. E., c/o Thos. Tyrer & Co., Stirling Chemical Works, Stratford, E., Lecturer.
1888. Coats, John T., 105, Broughton Street, Edinburgh, Manufacturing Chemist.
1915. Cobb, Ernest B., c/o Standard Oil Co. (N.J.), Bayonne, New Jersey, U.S.A.
1893. Cobb, Prof. Jno. W., The University, Leeds, Prof. of Coal Gas and Fuel Industries.
1891. Coblentz, Dr. Virgil, c/o Chemists' Club, 52, East 41st Street, New York City, U.S.A., Research Chemist.
1899. Cochran, Alfred, 559, Madison Street, Brooklyn, N.Y., U.S.A., Chemist.
1901. Cockburn, John A., Mayville, Stevenston, Ayrshire, Analytical Chemist.
1902. Cocking, Allan T., c/o Kynoch, Ltd., Lion Works, Witton, Birmingham, Ammunition Manufacturer.
1905. Coes, Chas. S., 1024, East River Street, Hyde Park, Mass., U.S.A., Oil Chemist.
1903. Coggeshall, Dr. G. W., 2229, California Street, Washington, D.C., U.S.A., Chemical Engineer.
1887. Coghill, P. de G., Borax Works, Old Swan, Liverpool, Technical Chemist.
1884. Cogswell, W. B., Syracuse, N.Y., U.S.A., Chemical Engineer.
1915. Cohen, A. M., 19, Wyndcote Road, Mossley Hill, Liverpool, Chemist.
- O.M. Cohen, Dr. J. B., 1, North Grange Mount, Headingley, Leeds, Professor of Organic Chemistry.
1897. Cohn, Alfred I., *See* Cone, Alfred I.
1901. Cohn, Sigmond, 13, Dutch Street, New York City, U.S.A., Metallurgical Chemist.
1901. Cohoe, Prof. W. P., 50, East 41st Street, New York City, U.S.A., Professor of Chemistry.
1891. Colby, Albert L., 447, Lehigh Street, South Bethlehem, Pa., U.S.A., Metallurgical Engineer.
1899. Colby, E. A., Baker Platinum Works, Newark, N.J., U.S.A., Metallurgical Chemist.
- O.M. Colby, W. H., 80, Coldharbour Road, Redland, Bristol.
1917. Cole, Douglas S., Explosives Dept., Imperial Munitions Board, Ottawa, Canada, Chemical Engineer.
1917. Cole, Fredk. C. P., 22, Adelphi Road, Wellfield, Huddersfield.
1916. Coleman, H. S., 3, Wyndham Road, Edgbaston, Birmingham, Electro-Chemist.
1893. Coleman, W. H., 1, Athole Gardens, Newlands, Glasgow, Chemical Engineer.
1916. Coles, Leonard A., Ludlow House, Wakefield Road, Huddersfield, Works Chemist.
1915. Coloy, H. Edwin, 6, Bury Court, St. Mary Axe, E.C., Chemical Manufacturer.
1913. Colgate, R. T., 25, Denmark Road, Reading, Works Chemist.
1905. Collett, John H., Sunnycroft, Tuffley, Gloucester, and (Juls.) The Librarian, Free Library, Gloucester, Chemical Manufacturer.
1887. Collett, J. M., Wynstone Place, Brookthorpe, Gloucester, Chemical Manufacturer.
1908. Collier, F. C., Inland Revenue Laboratory, 317, Queen Street, Ottawa, Canada, Analytical Chemist.
1903. Collier, Pierre, Companhia Industrial Pernambucana, Pernambuco, Brazil, Civil Engineer.
1893. Collin, Dr. C. A., Ferguslie Threadworks, Paisley, Textile Chemist.
1913. Collinge, H. G., Rua Tenente Costa 183, Todos os Santos, Rio de Janeiro, Brazil, Technical Chemist.
1898. Collingridge, Frank, Highstone, New Road, Llanelly, South Wales, Chemist.
1899. Collins, S. Hoare, 9, Cavendish Place, Newcastle-on-Tyne, Agricultural Chemist.
1888. Collins, W. Hepworth. *See* Hepworth Collins, W.
1913. Collinson, R. W., c/o Messrs. J. and J. Colman, Ltd., Starch Dept., Carrow Works, Norwich, Starch Manufacturer.
1899. Collis, Walter F., 12, St. Peter's Road, Harborne, Birmingham, Chemist.
1910. Collitt, Bernard, 15, Massey Road, Lincoln (Journals to Chemical Laboratory, Ruston, Proctor and Co., Ltd., Lincoln), Chemist.
1910. Colman, Fred. J., c/o Brotherton and Co., Ltd., Wear Tar Works, Sunderland, Tar Works Chemist.
1891. Colman, Dr. H. G., Woodthorpe, New Malden, Surrey, Analytical Chemist.
1892. Colquhoun, Ludovic, Dynamite Factory, Modderfontein, Transvaal, Analytical Chemist.

1894. Colquhoun, W., Endcliffe, Endcliffe Crescent, Sheffield, Engineer.
1901. Colwell, J. Kearn, Finsbury Town Hall, Rosebery Avenue, E.C., Analytical and Consulting Chemist.
1906. Comber, A. W., 23, Courtenay Gardens, Upminster, Essex, Metallurgical Chemist.
1917. Comber, Capt., Norman M., No. 2 Training Reserve Battalion, Rugeley Camp, Staffordshire, Lecturer in Agricultural Chemistry.
1900. Comey, Dr. Arthur M., Upland Avenue, opposite Summit Street, Chester, Pa., U.S.A., Technical Chemist.
1911. Comey, Robert H., Wenonah, N.J., U.S.A., Bleacher.
1906. Compton, Miss N. J., Library, University of Nebraska, Lincoln, Neb., U.S.A., Librarian.
1897. Cone, Alfred L., "Edorado," 302, Central Park West, New York City, U.S.A., Chemist.
1901. Connah, Jas., Laboratory, Custom House, London, E.C., Government Analyst.
1891. Conradson, Pontus H., Galena Oil Works, Franklin, Pa., U.S.A., Analytical Chemist.
1889. Conroy, Dr. Jas. T., 9, The Serpentine, Grassendale, Liverpool, Chemist.
1887. Constable, W. H., Australian Alum Works, Runcorn, Analytical Chemist.
1909. Cook, E. Bernard, 23, Cross Street, Finsbury, London, E.C., Manufacturing Chemist.
- O.M. Cook, H. J., The Firs, Woodford Green, Essex, Soap Manufacturer.
1903. Cook, Jas. W., London and Provincial Dye Works, Hackney Wick, E., Dyer.
1898. Cook, Thos. Alex., East London Soap Works, Bow, E., Soapmaker.
1916. Cooke, Frank, Trafford House, Marley Hill, Swallow, S.O., Co. Durham, Chemist.
1916. Cooke, Norman, 23, Woodville Grove, South Reddish, Stockport, Research Chemist.
1904. Cooke, W. Tennent, The University, Adelaide, South Australia, Lecturer in Chemistry.
1910. Coombs, Frank A., Technical College, Sydney, N.S.W., Australia, Lecturer on Tanning.
1910. Cooper, Leonard H., Royal Crown Soap Co., Calgary, Alberta, Canada, Chemist.
1901. Cooper, T. S., Beekfoot, Birch Hall Lane, Manchester, Calico Printing Chemist.
1891. Cooper, Walter J., The Elms, Laverdock, nr. Penarth, South Wales, Cement Works Manager.
1916. Cooper, W. F., Cooper Laboratory for Economic Research, Rickmanworth Road, Watford, Herts, Synthetic Chemist.
1917. Cooper, William R., 113, Tulse Hill, London, S.W., Consulting Engineer.
1914. Corder, Walter S., Messrs. Williamson and Corder, Ltd., Low Walker, Newcastle-on-Tyne, Chemical Manufacturer.
1916. Coriolis, E. G. de, 137, McGill Street, Montreal, Canada, Consulting Chemist.
1916. Corker, Jas. S., c/o Chas. Macintosh & Co., Ltd., Cambridge Street, Manchester, Rubber Works Chemist.
1899. Cornelison, Dr. Robt. W., 275, West Summit Street, Somerville, N.J., U.S.A., Consulting Chemist.
1909. Cornell, Fred, 16, Place Royal, Montreal, Canada, Chemical Merchant.
1894. Coste, J. H., Utopia, Gloucester Road, Teddington, Chemist.
1913. Cotterill, John W., 5, King Alfred's Place, Birmingham, Analyst.
1917. Cottrell, Alin. A., Staff Quarters, Eastriggs, Annan, N.B., Acids Section Manager.
1916. Couch, Daniel L., 88, Rue de Chezy, Neuilly/Seine, near Paris, France, Technical and Analytical Chemist.
1915. Coulton, C. P., Room 114 I, Trench Warfare Supply Dept. (Ministry of Munitions of War), King Charles Street, Whitehall, S.W., Chemist.
1912. Coupe, Geoffrey, "Hainault," Havering Road, Romford, Essex, Chemist.
1917. Course, Herbert E., c/o Secondee Water Works, Secondee, Gold Coast, Chemist.
1894. Cousins, W. J., Cromwell House, High Holborn, W.C., Consulting Chemist and Director.
1909. Coventry, Bernard O., Lahore, Punjab, India, Deputy Commissioner of Forests.
1903. Cowan, A. Wallace, 58, Garscube Terrace, Murrayfield, Edinburgh, Analytical Chemist.
1906. Cowan, George D., Meynell House, Rowlands Gill, Co. Durham, Manager, Desilverising Works.
1912. Cowan, H. W., 22, Cornish Road, Moore Park, Toronto, Canada, Water and Sewage Specialist.
1893. Cowan, W. J., 12, Park Avenue, Wood Green, N., Fine Colour Manufacturer.
1910. Coward, Dr. Hubert F., Dept. of Scientific and Industrial Research, 15, Great George Street, Westminster, London, S.W., Lecturer in Chemistry.
1897. Cowburn, Arthur W., 20, Mount Street, Manchester, Chemical Merchant and Analytical Chemist.
1907. Cowburn, J. Robert, 10, Eastwood Road, South Woodford, Essex, Technical Chemist.
1916. Cowdery, Walter, Price's Patent Candle Co., Ltd., 36, Elspeth Road, Clapham Common, London, S.W., Chemist.
1891. Cowper-Coles, Sherard Osborn, 1 and 2, Old Pye Street, S.W., and (Inds.) The Cottage, French Street, Sunbury-on-Thames, Metallurgical Engineer.
1905. Cox, Harold N., c/o Lalanc and Grosjean Mfg. Co. Woodhaven, N.Y., U.S.A., Chemist.
1917. Cox, Samuel J., 4, Cross Road, New Southgate, N., Works Chemist.
1915. Coye, Chas. H., c/o C. H. Dexter and Sons (Inc.), Windsor Locks, Conn., U.S.A., Paper-Maker.
1915. Craggs, J. W., 1, Gladstone Terrace, Whitley Bay, Northumberland, Analytical Chemist.
1884. Craig, Geo., Chemical Laboratory, 95, Bath Street, Glasgow, Technical Chemist.
1916. Craig, Robert, "Benmore," Bromborough, Cheshire, Technical Manager (Lever Bros.).
1895. Craig, Dr. Thos. J. L., 97, Clyde Street, West Didsbury, Manchester, Chemist.
1908. Craig, Wm. J., Casa Colon, Huelva, Spain, Analytical Chemist.
1901. Crane, Fred. D., 28, Hillside Avenue, Montclair, N.J., U.S.A., Consulting Chemist.
1902. Crane, Jasper E., Chemical Dept., E.I. du Pont de Nemours & Co., Wilmington, Del., U.S.A., Chemist.
1903. Cranmer, Ridgeway, 170, 88th Street, Bay Ridge, Brooklyn, N.Y., U.S.A., Chemist.
1902. Craven, Alfred B., "Northcote," Thorpe Road, Selby, Yorks., Analytical Chemist.
1906. Craven, J. A., 119, Moorside, Armley, Leeds, Chemist.
1906. Craven, John L., Norumbega, Hebers Ghyll, Ilkley, Yorks, Chemist and Salesman.
- O.M. Crawford, D., 60, Holly Avenue, Jesmond, Newcastle-on-Tyne, Manager.
1913. Crawford, John, 76, Forsyth Street, Greenock, Scotland, Works Chemist.
1908. Crawford, Lawrence, Littleburn Tar Works, Durham, Analytical Chemist.
1890. Crawshaw, E., 25, Tollington Park, London, N., Dye Merchant.
1914. Creese, Guy T., 2, Poplar Street, Danvers, Mass., U.S.A., Leather Manufacturer.
- O.M. Cresswell, C. G., Ermyngarth, Ashted, Surrey, Chemist.
1916. Cresswick, John A., I.M. Factory, Langwith, near Mansfield, Analyst and Inspector.
1901. Cribb, Cecil H., 60, Greek Street, Soho Square, London, W., Analytical and Consulting Chemist.
1908. Crighton, Adam M., "London Place," Agecroft Print Works, Pendleton, Manchester, Calico Printer's Chemist.
1910. Crighton, David T., 1315, Queen Insurance Buildings, 10, Dale Street, Liverpool, Buying Manager.
1905. Crighton, W. H., The Brough Lead Works, Bradwell, via Sheffield, Chemist.
1890. Cripser, Wm. R., c/o Messrs. D. Waldie and Co., Konnagar, near Calcutta, India, Manufacturing Chemist.

1911. Croasdel, Jas. F., 2, Moorland Terrace, Leeds, Engineer.
1901. Cronquist, G. W., S. Trädgårdsgatan 2, Helsingborg, Sweden, Consulting Ceramic Engineer.
1915. Cronshaw, Cecil J. T., c/o Levinstein, Ltd., Ellesmere Port, near Chester, Research Chemist.
- O.M. Crookes, Sir Wm., O.M., F.R.S., 7, Kensington Park Gardens, Notting Hill, W., Analytical Chemist.
1896. Crosby, Thos., Llanelly Steelworks, Llanelly, South Wales, Metallurgist.
- O.M. Crosfield, A. L., 46, Bidston Road, Oxtou, Birkenhead; (Journals) c/o Prof. B. Moore, Biochemical Dept., The University, Liverpool, Analytical Chemist and Assayer.
1896. Crosfield, Capt. G. R., Lodge Lane, Warrington Soap Manufacturer.
1917. Crosland, Charles K., c/o L. B. Holliday and Co., Huddersfield, Chemical Manufacturer.
1908. Crosland, Percy F., Century Dye Works, Elland, Yorks, Technical Chemist.
1884. Cross, C. F., F.R.S., 4, New Court, Lincoln's Inn, London, W.C., Analytical Chemist.
1917. Cross, Samuel M., Levinstein Ltd., Blackley, Manchester, Research Chemist.
1917. Cross, Lt.-Col. Sir Wm. C., Bart., 44, Queen's Gate Gardens, London, S.W., Chemical Manufacturer.
1894. Crossley, Prof. Arthur W., F.R.S., King's College, Strand, and (Jnks.) 46, Lindfield Gardens, Hampstead, N.W., Professor of Chemistry.
1915. Crossley, Henry, 105, Edenfield Road, Rochdale, Engine Packing Maker.
1904. Crossley, T. Linsey, c/o J. T. Donald & Co., 43, Scott Street, Toronto, Canada, Technical Chemist.
1908. Croston, Henry, Marcus Hook, Pa., U.S.A., Foreman.
1894. Crow, Henry W., Hart's Lane, North Street, Barking, E., Tar Distiller.
1915. Crowley, Thomas, 13, Cliff on Road, Devizes Road, Salisbury, Gas Engineer and Chemist.
1883. Crowther, Horace W., The Beeches, West Bromwich, Technical Chemist.
1906. Crowther, R. E., Westwood, Langford Road, Heaton Chapel, near Stockport, Chemist.
1912. Cruikshanks, Dr. Geo. S., Royal Technical College, Glasgow, Chemist.
1916. Cruse, Henry, 6, Crumpsall Green, Manchester, Engineer.
1906. Cruser, Dr. Fred. Van D., c/o The Diamond Match Co., Oswego, N.Y., U.S.A., Chemical Engineer.
1892. Cullen, Wm., c/o British South African Explosives Co., Ltd., 612, Salisbury House, Finsbury Circus, London, E.C., Chemist.
1903. Cullen, W. H., The Castner-Kellner Alkali Co., Ltd., Wallsend-on-Tyne, Engineer.
1897. Culmann, Dr. J., c/o G. Siegle Co., Rosebank, Staten Is., N.Y., U.S.A., Chemist and Colourist.
1883. Cumming, James, jun., Chemical Works, Yarraville, Melbourne, Vic., Australia, Chemical and Fertiliser Manufacturer.
1912. Cumming, Wm. F., c/o Cumming, Smith, and Co. Proprietary, Ltd., Yarraville, Victoria, Australia, Manufacturing Chemist.
1916. Cumming, Dr. A. C., 2, Relugas Road, Edinburgh, Chemist.
1916. Cumming, Wm. M., 26, Osborne Road, Birkby, Huddersfield, Works Chemist (British Dyes, Ltd.).
1907. Cunningham, James E., Minas Peña del Hierro, Provincia de Huelva, Spain, Analytical Chemist.
1915. Cunningham, Thos. R., 33, Mentz Apartment, Niagara Falls, N.Y., U.S.A., Chemist.
- O.M. Curphey, W. S., 87, Canfield Gardens, South Hampstead, N.W., Chief Alkali Works Inspector.
1916. Curran, E. A., 27, St. Jean Baptiste Street, Montreal, Canada, Manufacturing Chemist.
1916. Currier, Richard J., P.O. Box 178, Fulton, N.Y., U.S.A., Chemist and Colourist.
1898. Curtis, Marvin, 108, Front Street, San Francisco, Cal., U.S.A., Wine Chemist.
1903. Cushing, Robt. P., c/o Cattaraugus Tanning Co., Olean, N.Y., U.S.A., Chemist.

1902. Cutbush, Chas. G., 59, Byne Road, Sydenham, Kent, Electrical Engineer.
1899. Cutler, Fred. F., 166, Essex Street, Boston, Mass., U.S.A., Publisher.
1913. Cutts, H. Cyril, Brooklyn, Private Road, Sherwood, Nottingham, Embroidery Manufacturer.
1904. Cutts, Henry E., Grand View Terrace, Tenally, New Jersey, U.S.A., Technical Chemist.

D

1911. Dager, Herman J., 278, Jarvis Street, Toronto Canada, Dominion Food Inspector.
1897. Dajns, Herbert H., c/o J. E. Ferguson, 2, Union Court, London, E.C., Analytical Chemist.
1915. Daley, Samuel F., H. Fitzwarren Street, Seedley, Manchester, Works Chemist.
1884. Daniell, Louis C., Royal Standard Brewery, Tamworth, New South Wales, Brewer.
1904. Danker, Dan. J., 73, Dean Road, Brookline, Mass., U.S.A., Dyestuff and Chemical Merchant.
1903. Dannenbaum, Dr. H., c/o National Ammonia Co., Frankford, Philadelphia, Pa., U.S.A., Secretary and Treasurer.
1885. Darby, Jno. H., Howard Chambers, 155, Norfolk Street, Sheffield, Ironmaster.
1916. Dargie, Andrew, 140, Perth Road, Dundee, City Analyst.
1916. Darzens, Prof. Georges A., 22, Avenue Ledru-Rollin, Paris, France, Professor of Chemistry.
1916. Das, Dr. Durga C., Barabazar, P.O. Midnapore, Bengal, India, Medical Practitioner.
1916. Dayer, B. F., 32, Churchgate Street, Fort, Bombay, India, Chemical Engineer.
1917. Davey, David R., 38, Harvey Road, Hornsey, London, N., Analytical and Research Chemist.
1911. David, Edward J., 249, Wood Avenue, Tottenville, Staten Is., N.Y., U.S.A., Chemist and Assayer.
1900. Davidson, Alex., St. Helen's, Biggar, Analytical Chemist.
1917. Davidson, Alfred N., 17, Highbury, Newcastle-on-Tyne, Commercial Manager.
1899. Davidson, Charles, 24, Hamilton Drive, Cambuslang, Glasgow, Analytical Chemist.
1901. Davidson, G. M., Chicago and N.W. Railroad Shops, P.O. Station E., Chicago, Ill., U.S.A., Chemist.
1883. Davidson, J. E., 40, Percy Gardens, Tynemouth, Chemical Manufacturer.
1891. Davidson, Richard, 272, Strathmartine Road, Dundee.
- O.M. Davidson, R. Holden, c/o United Alkali Co., Ltd., Ammonia Soda Works, Fleetwood, Works Manager.
1911. Davidson, Thos. A., 53, Galpins Road, Thornton Heath, Surrey, Chemist and Varnish Expert.
1905. Davidson, Dr. Wm. B., c/o British Dyes Ltd., Huddersfield, Chemical Engineer.
1906. Davies, Harry R., 80, Prince Street, Jamaica Plain, Mass., U.S.A., Chemist.
1898. Davies, Herbert E., The Laboratory, 28, Chapel Street, Liverpool, Analytical Chemist.
1907. Davies, James, 12, Harefield Road, Brockley, London, S.E., Scientific Apparatus Maker.
1911. Davies, Jas. H., c/o Lever Bros., Ltd., Royal Liver Building, Liverpool, Chemist.
1896. Davies, Llewellyn J., 103, Bute Road, Cardiff, Analytical and Consulting Chemist.
1886. Davies, M. L., Standard Chemical Iron and Lumber Co., Toronto, Canada, General Manager.
1897. Davies, Saml. H., c/o Rowntree and Co., Ltd., The Cocoa Works, York, Research Chemist.
1908. Davies, T. H., c/o John Cox and Co.'s Successors, Stillhouse Lane, Bedminster, Bristol, Tanner.
- O.M. Davis, A. R., 12, Heaton Moor Road, Stockport, Analytical Chemist.
1901. Davis, Bernard F., 35, Aldermay Road, Bromley, Kent, Metallurgical Engineer.
1902. Davis, Charles B., c/o National Brewers' Academy, 402, West 23rd Street, New York City, U.S.A., Technical Chemist.

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1914. Davis, Eric, N., 68, Bowrons Avenue, Wembley, N.W., Technical Journalist. On Active Service; retain Journals.
1908. Davis, G. Keville, 265, Strand, London, W.C., Chemical Engineer.
1897. Davis, Wm. A., Agricultural Research Institute, Pusa, Bihar, India, Chemist.
1911. Davis, Wm. C., c/o The British Cyanide Co., Ltd., Popes Lane, Oldbury, Worcestershire, Chemist.
1900. Daw, Fred W., Duffryn House, Ebbw Vale, Mon., Metallurgical Chemist.
1916. Dawe, Alfred E., H.M. Stationery Office, London, S.W., Assistant Examiner of Paper.
- O.M. Dawson, C. A., 32, Elm Hall Drive, Mossley Hill, Liverpool, Technical Chemist.
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1916. Dawson, J. A. M., Inland Revenue Laboratory, 249, Hastings Street East, Vancouver, B.C., Canada, Analyst-in-Charge.
1915. Dawson, Reginald D., Chemical Dept., Southern Outfall Works, Crossness, Abbey Wood, Kent, Chemist.
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1901. Day, Dr. David T., 715, 19th Street N.W., Washington, D.C., U.S.A., Geologist.
1913. Day, Frank E., c/o Condensed Milk Co. of Ireland, Lansdowne, Limerick, Ireland, Analytical Chemist.
1912. Day, G. A. C., Casilla No. 417, Lima, Peru (*via* New York), Oil Mill Manager.
- O.M. Deacon, H. Wade, 8, Ullet Road, Liverpool; and (Jnls.) c/o C. E. Tyers, 186, Derby Road, Farnworth, Widnes, Alkali Manufacturer.
1911. Dean, Arthur L., College of Hawaii, Honolulu, H.I., U.S.A., Assistant Prof. of Industrial Chemistry.
1892. Deaville, B., Beech Avenue, Nottingham, Manufacturing Chemist.
1899. De Castro, J. Paul. *See* Castro, J. Paul de.
1902. De Cew, J. A., 903, McGill Building, Montreal, Canada, Chemical Engineer.
1900. Deerr, Noel F., 28, Fort Greene Place, Brooklyn, N.Y., U.S.A., Analytical Chemist.
1902. Deghucé, Dr. Jos. A., 39, West 38th Street, New York City, U.S.A., Chemist.
1911. Dehn, Dr. Frank B., Broad Sanctuary Chambers, Westminster, S.W., Chemist and Patent Agent.
1908. Delafield, Dr. F. H., Winnington, Northwich, Cheshire, Chemical Manufacturer.
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1909. De Laire, Edgar, 129, Quai de Moulineaux, Issy, Seine, France, Industrial.
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1916. Dellow, John, 11, Hardwick Grove, West Bridgford, Nottingham, Perfumery-Chemist.
1908. Dellschaft, Dr. F. H. *See* Delafield.
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1888. Dempsey, Geo. C., 165, Market Street, Lowell, Mass., U.S.A., Chemist.
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1908. Dennis, Martin, 859, Summer Avenue, Newark, N.J. U.S.A., Manufacturing Chemist.
1907. Dennison, Henry S., c/o Dennison Manufacturing Co., Framingham, Mass., U.S.A., Manufacturer.
1898. Dent, Dr. Frankland, Government Analyst's Dept., Singapore, Straits Settlements, Government Analyst.
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1912. Depierres, Gaston, The Indestructible Paint Co., King's House, King Street, Cheapside, London, E.C., Managing Director.
1911. Derry, Albert Victor, 301, Glossop Road, Sheffield, Gas Engineer.
1913. Desch, Dr. Cecil H., Metallurgical Dept., The University, Glasgow, Lecturer.
1912. Dettmann, A. H., Stuart Street, Longueville, Sydney, N.S.W., Leather Manufacturer.
1914. Detwiler, Jas. G., c/o The Texas Co., Port Arthur, Texas, U.S.A., Chemist.
1916. Devereux, Percy S., Keeling and Walker, Ltd., Stoke-on-Trent, Chemist and Manager.
1898. Dewar, Alex. H., c/o The Linoleum Manufacturing Co., Staines, Middlesex, Chemist.
- O.M. Dewar, Sir J., F.R.S., 21, Albemarle Street, London, W., Professor of Chemistry and Physics.
1889. Dewey, Fred. P., 832, Varnum Street, N.W., Washington, D.C., U.S.A., Metallurgist.
1904. Dewhurst, J. A., Imperial Chambers, Halifax, Yorks, Analyst.
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1904. Dickenson-Gair, C. J. *See* under Gair.
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1902. Dixon, Wm. A., Reiby Chambers, Reiby Lane, Circular Quay, Sydney, N.S.W., Australia, Public Analyst and Assayer.
1909. Dixon, W. P., c/o Bryant and May, Ltd., Fairfield Works, Bow, London, E., Match Manufacturer.
1892. Dobb, Thos., c/o J. T. Dobb and Son, West Bar, Sheffield, Pharmaceutical Chemist.
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1889. Dodd, W. Ralph, Burton Grange, Goff's Oak, near Cheshunt, Chemical Works Manager.
1913. Dodds, Herbert H., c/o Kynoch, Ltd., Umbogintwini, Natal, Explosives Chemist.
1917. Dodds, James M., c/o Bristol Box and Printing Co., Ltd., Greenway Bush Lane, Bristol, Works Manager.
1906. Dodds, Thos., c/o Reckitt and Sons, Ltd., and (Journals) 7, The Oval, Garden Village, Hull, Works Manager and Chemist.
1900. Dodge, Dr. Francis D., 69, Avenue A., Bayonne, N.J., U.S.A., Chemist.
1897. Doerflinger, Wm. F., Rosebank, Staten Island, N.Y., U.S.A., Research Chemist.
1897. Dohme, Dr. Alf. R. L., Messrs. Sharp and Dohme, Baltimore, Md., U.S.A., Manufacturing Chemist.
1905. Dolan, H., Westbourne, Belvoir Road, Lower Walton, Warrington, Chemist.
1914. Donald, James R., c/o Imperial Ministry of Munitions, Transportation Building, Ottawa, Canada, Chemical Engineer.
1903. Donald, Dr. Jas. T., 318, Lagachetière Street West, Montreal, Canada, Consulting Chemist.
1900. Donald, Wm. Bridgefield Park, Bergen Co., N.J., U.S.A., Assayer and Chemist.
1917. Donald, William E., Vista Alegre 3, Minas de Rio Tinto, S. Spain, Chemical Engineer. Retain Journals.
1913. Donaldson, Richard, 63, Waverley Gardens, Crossmyloof, Glasgow, Assistant Manager.
1902. Donaldson, Thos., Beecheroff, Ardrossan Road, Saltcoats, Scotland, Analytical Chemist.
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1886. Doolittle, Orrin S., 388, Palisade Avenue, Yonkers, N.Y., U.S.A., Chemist.
1905. Doolittle, Roscoe E., 109, Hillside Avenue, Glen Ridge, N.J., U.S.A., Chemist.
1890. Dore, Jas., Copper Works, High Street, Bromley-by-Bow, E., Distiller's Engineer.
1911. Dorce, Dr. Charles, 56, Albany Mansions, Battersea Park, London, S.W., Head of Chemistry Department, Borough Polytechnic.
1896. Doremus, Dr. Clas. A., 55, West 53rd Street, New York City, U.S.A., Professor of Chemistry.
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1917. Dougal, John W., 38, Royal Park Terrace, Edinburgh, Chemist.
1911. Dougall, Jas. S. N., 305, Manufacturers' Street, Montreal, Canada, Varnish Manufacturer.
1915. Dougall, George, Royd House, Watkney Lane, Heckmondwike, Yorks, Gas Engineer.
1897. Douglas, Geo., Farfield Hall, Addingham, Yorks, Dyer.
1915. Douglas, John, Reed Street, Cliff-at-Ilco, Kent, Explosives Chemist.
1894. Douglas, Loudon M., Douglas Wharf, Putney, S.W., Chemical Manufacturer.
1909. Douglas, Robt. P., Prudential Buildings, Nelson Square, Bolton, Consulting Chemist.
1884. Douglas, William, Gratton House, Berkhamsted, Herts., Chemical Engineer.
1900. Doulton, H. Lewis, Royal Doulton Potteries, Lambeth, S.E., Potter.
1900. Dow, Allan W., 131 E. 23rd Street, New York, U.S.A., Chemical Engineer.
1898. Dow, Herbert H., c/o The Dow Chemical Co., Midland, Mich., U.S.A., Manufacturing Chemist.
1908. Dow, John W., 564, Park Avenue West, Mansfield, Ohio, U.S.A., Manufacturing Chemist.
1905. Dowbiggin, James, Craiglands, Albert Park, Lancaster, Chemist.
1915. Downing, James, jr., 17, Hallswelle Road, Golder's Green, London, N.W.
1912. Doxey, Carl W., c/o Dinting Vale Printworks, Dinting, near Manchester, Printworks Chemist.
1901. Doxrød, Christian, Technical School, Christiania, Norway, Professor of Chemical Technology.
1907. Doyle, B. W., 245, Lindell Avenue, Leominster, Mass., U.S.A., Manufacturer.
1902. Drake, Bryant S., 5830, Colby Street, Oakland, Cal., U.S.A., Chemist.
1911. Drake, Joseph W. D., Three Mills Distillery, Bromley-by-Bow, London, E., Distillery Brewer.
1914. Drew, John M., Lower House, Burnley, Lancashire, Calico Printer.
1906. Drew, W. Newton, Raincliffe, Ecclesfield, near Sheffield, Chemical Manufacturer.
1896. Drewsen, Dr. Viggo B., 5, Beckman Street, New York City, U.S.A., Wood Pulp and Paper Expert.
- O.M. Dreyfus, Dr. C., Claremont, Fallowfield, Manchester. Retired Dye Manufacturer.
1904. Dreyfus, Dr. L. A., Maple Avenue, Rosebank, S.I., N.Y., U.S.A., Chemist.
1893. Dreyfus, S., Thorncliffe Villa, Windmill Lane, Denton, near Manchester, Chemist.
1899. Dreyfus, Dr. Wm., 57, East 96th Street, New York City, U.S.A., Chemist.
1917. Drummond Alan A. I., Fairhaven Mansions, Lower Hill, S.E., Research Chemist.
1898. Drummond, Dr. Isaac W., 436, West 22nd Street, New York City, U.S.A., Chemist.
1910. Drury, Chas. Dru, Hendon Gas Works, Sunderland, Gas Engineer.
1899. Ducas, B. P., 25-27, South William Street, New York City, U.S.A., Chemical and Dyestuff Importer.
1909. Duchemin, René P., 6, Rno Chanoinesse, Paris IV., France, Chemical Engineer.
1897. Duckham, Alex., Phoenix Wharf, West Ferry Road, Millwall, E., and (Journals) 130, St. James's Court, Buckingham Gate, S.W., Chemical Manufacturer.
1915. Duckham, Sir Arthur M., K.C.B., Palace Chambers, Westminster, S.W., Engineer.
1917. Duckworth, Charles W., 747, Ashton New Road, Clayton, Manchester, Director and Secretary.
1905. Duckworth, Harry S., Garner Printworks, Garnerville, Rockland Co., N.Y., U.S.A., Printworks Superintendent.
1913. Duff, Alex. R., 211, Fern Avenue, Toronto, Canada, Rubber Chemist.
1899. Duff, Wm. S., Merrie Lands, Westbury Road, Buckhurst Hill, Essex, Manufacturing Chemist.
1901. Dufy, Lawrence, 92, Tom Lane, Nether Green, Sheffield, Analytical Chemist.
1905. Duggan, Edw. J., c/o Brewer and Co., 95, William Street, New York City, U.S.A., Vice-President.
- O.M. Duggan, T. R., 52, East 41st Street, New York City, U.S.A., Analytical Chemist.
1916. Duke, J. A. H., The Dell, Sutton, Surrey, Edible Oil Manufacturer.
1888. Dukes, T. William, Box 10, Vrijheid, South Africa, Merchant.
1906. Duncalfe, Roger, Forge Mills, Bestwood Colliery, Nottingham, Glue Manufacturer.
1889. Duncan, Arthur W., c/o J. Woolley, Sons and Co., Ltd., Victoria Bridge, Manchester, Analytical Chemist.
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1909. Duncan, Jas., c/o Steel Bros. and Co., Ltd., 6, Fenchurch Avenue, London, E.C., Merchant.
1915. Duncan, J. Gibson, 67, Waverley Gardens, Crossmyloof, Glasgow, Works Chemist.
1906. Dunford, Jno. H., Trent Side Bone Works, Nottingham, Managing Director.
1915. Dunglison, B., c/o Messrs. Blair, Campbell and McLean, Woodville Street, Govan, Glasgow, Chemical Engineer.

1912. Dunkelsbühler, F. S., 63, Brook Street, Grosvenor Square, London, W., Technical Chemist.
1905. Dunnlop, Harry, 231, St. Vincent Street, Glasgow, Chemist.
- O.M. Dunn, Dr. J. T., 10, Dean Street, Newcastle-on-Tyne, Consulting Chemist.
1915. Dunningham, Dr. Alfred C., c/o Electro-Bleach and By-Products Ltd., Middlewich, Cheshire, Technical Chemist.
1901. Dunsford, Geo., Laboratory, Wigan Coal and Iron Co., Ltd., Wigan, Analytical Chemist.
1907. Dunstan, Dr. A. E., "Meadhurst," Feltham Hill, Sunbury-on-Thames. Head of Chemical Department (Technical College), East Ham.
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1905. Durfee, Winthrop C., 516, Atlantic Avenue, Boston, Mass., U.S.A., Manufacturing Chemist.
1897. Durkee, Frank W., Tuft's College, Medford, Mass., U.S.A., Professor of Chemistry.
1911. Durkin, Jos. A., British Chemical Co., Ltd., Trenton, Ont., Canada, Chemical Superintendent.
1907. Durrans, Thos. H. (Journals to c/o Professor W. H. Perkin, F.R.S., Chemical Laboratories, South Park Road, Oxford), Chemist.
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1912. Dyche-Teague, F. C., 258, Gloucester Terrace, Hyde Park, London, W., Analytical Chemist and Bacteriologist.
1916. Dyer, Alfred (Journals to 7, Grisedale Avenue, Birkby, Huddersfield), Analytical and Consulting Chemist. On Active Service (Inns of Court O.T.C.).
- O.M. Dyer, Dr. B., 17, Great Tower Street, London, E.C., Analytical and Consulting Chemist.
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- O.M. Dyson, C. E., Flint, North Wales.
1902. Dyson, George W., 24, Clarkehouse Road, Sheffield, Analyst.
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1909. Eberlin, Leon W., 360, Lake View Park, Rochester, N.Y., U.S.A., Chemist.
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1909. Edge, J. Harold, c/o Wm. Edge and Sons, "Dolly" Blue Works, Bolton, Lancashire, Technical Chemist.
1902. Edison, Thos. Alva, Edison Laboratory, Orange, N.J., U.S.A., Inventor and Manufacturer.
1917. Edmondson, John S., Blaydon Manure and Alkali Co., Ltd., Blaydon-on-Tyne, Works Chemist.
1916. Edon-Brown, Herbert, c/o Nitrogen Products and Carbide Company, Ltd., Dagenham Dock, Essex, Chemical Engineer.
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1909. Everette, Dr. W. E., 3512, South 11th Street, Tacoma, Wash., U.S.A., Consulting Chemical Engineer.
1904. Everitt, Walter, Norwood Wharf, Southall, Middlesex, Analyst.
1912. Evers, Norman, c/o Allen and Hanbury's, Ltd., Bethnal Green, London, E., Analytical Chemist.
1907. Eves, Archie, P., 762, East Buchtel Avenue, Akron, Ohio, U.S.A., Chemist.
1894. Ewan, Dr. Thos., c/o Cassel Cyanide Co., Shuna Street, Maryhill, Glasgow, Chemist.
1905. Eynon, Lewis, 41, Champion Road, Upminster, Essex, Chief Chemist (London Beetroot Sugar Association).
- F
1902. Faill, Jas., 52, Robertson Street, Glasgow, Technical Chemist.
1902. Fairchild, Benj. T., P.O. Box 1120, New York City, U.S.A., Manufacturing Chemist.
1910. Fairclough, Lt.-Col. Brereton, Quarry House, Hill Cliffe, Warrington, Cheshire, Miller.
1911. Fairfield, Thos. J., c/o W. T. Glover and Co., Trafford Park, Manchester, Analytical Chemist.
1903. Fairhall, E. J., Lindfield, Windmill Lane, Southall, Middlesex, Chemist.
- O.M. Fairley, T., 17, East Parade, Leeds, Analytical Chemist.
1901. Fairlie, Jas., Camelon Chemical Works, Falkirk, Manufacturing Chemist.
1917. Falconer, James H., 1848, Venables Street, Vancouver, B.C., Canada, Manufacturer.
1911. Farey, F. O., 905, McGill Building, Montreal, P.Q., Canada, Chemist.
1910. Farr, Harry, Free Library, Cardiff, Librarian.
- O.M. Farrant, N., c/o J. Nicholson and Sons, Ltd., Chemical Works, Hunslet, Leeds, Chemist.
1913. Farrar, Stanley C., 50, Holly Road, Handsworth, Birmingham, Chemical Technologist.
1897. Farrell, Frank James, Shanrahan, Beeches, Suffolk, Artificial Silk Manufacturer. (Journals to c/o Grout & Co., Ltd., Textile Manufacturers, Great Yarmouth.)
- O.M. Farrington, T., 4, Waterloo Place, Cork, Ireland, Chemical Engineer.
1909. Fath, Dr. Arthur, Société Italienne de la Viscose, Vinaria-Reale, Prov. Torino, Italy, Chemical Engineer.
1917. Faust, Thos. A., London, Ontario, Canada, Analytical-Manufacturing Chemist.
1903. Fawsitt, Prof. Chas. E., The University, Sydney, N.S.W., Australia, Prof. of Chemistry.
1914. Fearnley, C. A., 2, Alcester Terrace, Shepherd's Lane, Leeds (Journals to c/o Messrs. Brotherton & Co., Ltd., Holmes Street, Chemical Works, Dewsbury Road, Leeds), Technical Chemist.
1903. Feilmann, Dr. M. E., See Fyleman, Dr. M. E.
1913. Feldenheimer, Wm., 20, Holborn Viaduct, London, E.C. Clay Merchant.
1909. Fell, Wm. M. W., 27, Clarendon Road, Garston, Liverpool, Chemist.
1905. Felton, Herbert L., 516, East Second Street, South Boston, Mass., U.S.A., Distiller.
1900. Ferguson, Prof. Geo. A., 121, West 42nd Street, New York City, U.S.A., Professor of Analytical Chemistry.
1914. Ferguson, Jas., "Mountside," Prestwich Park South, Manchester, Technical Chemist.
1917. Ferguson, John G., Box 195, Stettler, Alta. Canada, Teacher of Chemistry.
1902. Fergusson, Donald M., c/o Acadia Sugar Refining Co., Halifax, N.S., Canada, Analytical Chemist.
1883. Fergusson, H., Prince Regent's Wharf, Silvertown, E., Technical Chemist.
1916. Ferns, John F., 61, Withington Road, Whalley Range, Manchester, Technical Chemist.
1893. Fiebing, John H., 238, Reed Street, Milwaukee, Wis., U.S.A., Leather Trade Chemist.

1911. Field, Allan J., c/o G. Siegle Co., Rosebank, Staten Island, N.Y., U.S.A., Analytical Chemist.
1917. Field, Chas. H., 52, Lee Park, Blackheath, S.E., Analytical Chemist.
1885. Field, E. W., Brewer.
1917. Field, Fredk. C., City Hall, Calgary, Alberta, Canada, Analytical Chemist.
1915. Field, G. H., "Holmwood," Dolgarrog, Tal-y-Cafu, N. Wales, Chief Chemist.
1887. Field, S. S., 41, Kidbrook Park Road, Blackheath, S.E., Manufacturing Chemist.
1891. Field, Wm. Eddington, Martin Street, Elsternwick, Melbourne, Victoria, Analytical Chemist.
1907. Finch, Archibald M., Vitriol and Chemical Works, Cattedown, Plymouth, Chemical Manufacturer.
1917. Finch, Wm. J., 9, Stokes Croft, Bristol, Works Manager.
1910. Findlater, James, c/o Price's Patent Candle Co., Ltd., Bromborough Pool, near Birkenhead, Chief Chemist.
1916. Findlater, R. H., c/o Broxburn Oil Co., Ltd., Broxburn, West Lothian, Chemist.
1899. Findland, John J., Kaslo, B.C., Canada, Analytical Chemist.
1911. Fink, F. W., 420, Riverside Drive, New York City, U.S.A., Manufacturing Chemist.
1904. Finn, Cornelius P., Coke Ovens, etc., Departments, Hemsworth Collieries, Fitzwilliam, near Wakefield, Coke Ovens Manager.
1903. Fish, Chas. C. R., 439, Boylston Street, Boston, Mass., U.S.A., Chemist.
1911. Fish, Charles W., c/o The Turner Paper Mill Co., Ltd., Rawcliffe Bridge, S.O., Yorks, Chemist and Paper Technologist.
1917. Fisher, Alfred, 19, Richmond Hill, Langley Green, near Birmingham, Technical Chemist.
1900. Fisher, Henry, 16, East 96th Street, New York City, U.S.A., Teacher of Chemistry.
1916. Fisher, John M., 701, Broadway East, Vancouver, B.C., Canada, Pharmacist.
1915. Fisher, L. E., The Laboratory, Messrs. Ardel, Ltd., Barby Road, Selby, Yorks, Works Chemist.
1917. Fisk, Alan E., 11, Balfour Road, Ilford, London, E., Works Chemist.
1895. Fison, John, Messrs. Jas. Fison and Sons, Thetford, Norfolk, Chemical Manufacturer.
1904. Fitch, A. J., 67, Branstone Road, Burton-on-Trent, Brewer's Chemist.
1916. FitzPatrick, G. D., 33, Church Road, Moseley, Birmingham, Analytical Chemist.
1917. Fleck, Dr. Alexr., c/o Messrs. Castner Kellner Alkali Co., Ltd., Wallsend-on-Tyne, Research Chemist.
1913. Fleming, M. D., c/o S. Fleming & Co., 31, Robertson Street, Glasgow (Journals to Plantation Albion, Berbice, British Guiana), Analyst.
1893. Fletcher, E. Morley, 30, Grosvenor Place, Newcastle-on-Tyne, Alkali Works Inspector.
- O.M. Fletcher, F. W., c/o Fletcher, Fletcher, and Co., Ltd., Holloway, N., Manufacturing Chemist.
1891. Fletcher, R. Jaques, North Geelong, Victoria, Australia, Manufacturing Chemist.
1904. Fletcher, Wm. E., 1104, Rodney Street, Wilmington, Del., U.S.A., Chemist.
1912. Flürscheim, Dr. Bernhard J., Rushmoor, Fleet, Hampshire, Research Chemist.
1899. Focht, Louis, 12, Atterbury Avenue, Trenton, N.J., U.S.A., Civil Engineer.
1890. Foden, Alfred, Fairholme, Mossley Hill Road, Grassendale, Liverpool, Metallurgical Chemist.
1900. Foersterling, Dr. H., c/o Roessler Hasslacher Chem. Co., Perth Amboy, N.J., U.S.A., Chemist.
1916. Foley, Nelson T., c/o Leders and Nucoline, Ltd., Hammersmith, W. (Journals to Lynceot, Monkham's Drive, Woodford, Essex), Assistant Manager and Chemist.
1895. Forbes, Paul R. (Retain Journals), Chemist and Assayer.
1893. Ford, J. B., jun., Michigan Alkali Co., Wyandotte, Mich., U.S.A., Secretary and Treasurer.
1889. Ford, John S., Abbey Brewery, Edinburgh, Analyst.
1914. Ford, Joseph James, c/o Skinner and Holdford, Ltd., Waleswood Collieries, Waleswood, near Sheffield, Analytical Chemist.
1915. Ford, Jos. J., 84, Normandy Avenue, High Barnet, Herts., Agent.
1916. Foreman, Thos. Y., 100, Chamber Street, Newcastle-on-Tyne, Analytical Chemist.
1904. Forrest, Chas. N., Technical Dept., Barber Asphalt Paving Co., Maurer, N.J., U.S.A., Chemist.
1890. Forrester, A. M., c/o Richmond Guano Co., Richmond, Va., U.S.A., Analytical Chemist.
1905. Forrester, H. A., Hill View, Dances Road, Rusholme, Manchester, Chemical Works Manager.
1909. Forshaw, Arthur, c/o John Wright and Co., Ltd., Essex Works, Aston, Birmingham, Works Chemist.
1902. Forstall, Alf. E., 84, William Street, New York City, U.S.A., Consulting Gas Engineer.
1916. Forster, E. L. C., Inland Revenue Laboratory, Postal Station "B," Winnipeg, Canada, Analyst.
1902. Forster, Ferdinand E. P., c/o Messrs. Bass and Co., 19, Guild Street, and (Jnls.) The River House, Burton-on-Trent, Brewer's Chemist.
1907. Forster, Francis, Edgewood, Woodville Road, New Barnet, Lead Manufacturer.
1889. Forster, Joseph F., 17, Hilpot Lane, London, E.C., Chemical Merchant.
1899. Forster, Dr. M. O., F.R.S., Queen Anne's Mansions, St. James's Park, London, S.W., Chemist.
1884. Forster, Sir Ralph C., Bart., c/o Messrs. Beasler, Waechter, and Co., Salisbury House, Finsbury Circus, London, E.C., Chemical Merchant.
1915. Forster, Dr. R. B., c/o Levinstein, Ltd., Blackley, Manchester, Chemist.
1884. Forth, Henry, Stoke Lacy, Marple, Cheshire, Drysalter.
1907. Forward, Charles C., Dept. of Inland Revenue Lab., 50, Bedford Road, Halifax, N.S., Canada, Chemist.
1906. Foster, Robt. K., Church Street, Middle Brighton, Melbourne, Victoria, Pharmaceutical Chemist.
- O.M. Foster, R. Le Neve, Fulshaw Cottage, Wilmslow, Cheshire, Manufacturing Chemist.
1888. Foster, Wm., St. Martin's Terrace, Newton Park, Leeds, Manufacturing Chemist.
1916. Foster, Wm. A. J., South Hall, Farningham, Kent, Paper Manufacturer.
1891. Fowler, Dr. Gilbert J., Indian Institute of Science, Bangalore, India, and (Journals) Frankland Laboratory, Chem. Dept., Victoria University, Manchester, Prof. of Applied Chemistry.
1912. Fox, Charles P., 401, South 3rd Street, Miamisburg, Ohio, U.S.A., Chemist.
1913. Fox, Edward Carey, 27, Scarth Road, Toronto, Canada, Pork Packer.
1917. Fox, Frank, "Varuna," Victoria Road, Grappenhall, Cheshire, Departmental Manager.
1898. Fox, John, 10, Clarendon Road, Eccles, Lancs., Analyst.
1911. Fox, Dr. John J., 6, Alkham Road, Stamford Hill, N.; all communications to c/o Government Lab., 13, Clement's Inn Passage, Strand, W.C., Government Analyst.
- O.M. Fox, T., jun., c/o Fox Bros. and Co., Ltd., Wellington, Somerset, Wool Manufacturer.
1916. Foxwell, G. E., 70, Steade Road, Sharrow, Sheffield, Works Manager and Chemist.
1905. France, Edward W., Philadelphia Textile School, Broad and Pine Streets, Philadelphia, Pa., U.S.A., Director.
1917. Francis, Francis, The University, Bristol, Professor of Chemistry.
- O.M. Francis, G. Bult, The British Drug Houses, Ltd., 22-30, Graham Street, City Road, London, N., Wholesale Druggist.
- O.M. Francis, W. H., 11, Bramham Gardens, South Kensington, London, S.W., Wholesale Druggist.
1894. Frank, Jerome W., 29, Broadway, New York City, U.S.A., Chemist.

1886. Frankenburg, Isidor, Greengate Rubber Works, Salford, Manchester, India-rubber Manufacturer.
1895. Frankforter, Dr. G. B., University of Minnesota, Minneapolis, Minn., U.S.A., Prof. of Chemistry.
- O.M. Frankland, H., Stroonshalh, The Crescent, Louthorpe, Middlesbrough, Analytical Chemist.
- O.M. Frankland, Prof. P. F., F.R.S., The University, Edgbaston, Birmingham, Professor of Chemistry.
1916. Franks, C. F., 10, Woodville Road, Blackheath, S.E., Civil Engineer.
1901. Frasch, Hans A., 52, Broadway, New York City, U.S.A., Manager.
1910. Fraser, Arthur, Casilla 1464, Valparaiso, Chile, Analyst.
1917. Fraser, John, 11, Northumberland Road, Redlands, Bristol, Chemist and Soap Works Manager.
1891. Fraser, L. McG., Engineering Works, Dagenham, Essex, Chemical Engineer.
1902. Frederick, Geo. E., jun., 169, Columbia Heights, Brooklyn, N.Y., U.S.A., Chemical Merchant.
1916. Frenay, John L., The Works, Leagrave Road, Luton, Beds, Straw Dyer and Bleacher.
1900. French, Thos., P.O. Box 324, Nelson, B.C., Canada, Chemist.
1911. French, Wm., Wheatfield, Dallas Road, Lancaster, Manager and Secretary.
1903. Frerichs, Dr. F. W., 4320, Washington Boulevard, St. Louis, Mo., U.S.A., Manufacturing Chemist.
1913. Frew, John, Box 1, Johannesburg, South Africa, Chemist.
1907. Freytag, Henry, 35 and 37, Dickinson Street, Manchester, Chemical Merchant.
1886. Fries, Dr. Harold H., 92 Reade Street, New York City, U.S.A., Chemical Manufacturer.
1915. Frosst, Charles E., 259, Metcalfe Avenue, Westmount, P.Q., Canada, Manufacturing Chemist.
1916. Frost, F. A., c/o South Metropolitan Gas Co., and 144, Fekham Park Road, London, S.E., Sub-Manager (Chemical Works).
1884. Frost, Joe, Rocky Mount, Somerset Road, Huddersfield, Manufacturing Chemist.
- O.M. Fryer, Dr. A. C., 13, Eaton Crescent, Clifton, Bristol, Alkali Works Inspector.
1904. Fryer, P. J., 12, Pembury Road, Tonbridge, Kent, Analyst.
1889. Fuerst, Jos. F. See Forster, Jos. F.
1917. Fuerst, Jules, 17, Philpot Lane, London, E.C., Chemical Merchant.
1895. Fuerst, W. F., 87, Nassau Street, New York City, U.S.A., Chemical Merchant.
1913. Fulks, Elbridge B., American Tar Products Co., 208, South La Salle Street, Chicago, Ill., U.S.A., Vice-President.
1894. Fuller, Chas. J. P., 603, Chorley New Road, Horwich, near Bolton, Analytical Chemist.
1902. Fuller, Henry C., Institute of Industrial Research, Washington, D.C., U.S.A., Analytical Chemist.
- O.M. Fuller, Wm., Vanbrugh Cottage, Maze Hill, S.E., Chemist.
1916. Fulton, Chas. W., Rubber Tar Ltd., Bishopbriggs, Glasgow, Chemical Manufacturer.
1909. Fulweiler, W. H., 1706, North Broad Street, Philadelphia, Pa., U.S.A., Engineer.
1903. Fyelman, Dr. M. E., Kilmorna, Egmont Road, Sutton, Surrey, Chemist.
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1915. Gaby, F. A., Hydro-Electric Power Commission of Ontario, 150, University Avenue, Toronto, Canada, Chief Engineer.
1913. Gage, Roscoe M., 206, Rosalind Place, Toledo, Ohio, U.S.A., Chemical Engineer.
1906. Gagnebin, Chas. L., 140, Oliver Street, Boaton, Mass., U.S.A., Dyestuff Merchant.
1907. Gaines, Richard H., 49, Lafayette Street, New York City, U.S.A., Chemist (Board of Water Supply).
1912. Gajjar, M. J., Girgaum Chemical Laboratory, Sandhurst Road, Bombay, India, Consulting Chemist.
1890. Gajjar, Prof. T. K., Girgaum Chemical Laboratory, Sandhurst Road, Bombay, India, Consulting Chemist.
1912. Gale, Lieut. R. C., Mancot Royal, near Hawarden, Flintshire, Technical Chemist.
1884. Gall, Henry, 2, Rue Blanche, Paris, France, Technical Chemist.
1905. Gall, J. B., c/o Callender's Cable and Construction Co., Belvedere, Kent, Chemist.
1911. Gallagher, Jas. L., c/o Lever Bros. Ltd., Sydney N.S.W., Australia, Analytical Chemist.
1897. Galletly, J. C., No. 1, Staff Quarters, Eastriggs, Dornock, by Annan, Rubber Chemist.
1901. Gallivan, Dr. Frank B., 113, Third Street, South Boston, Mass., U.S.A., Chemist.
1903. Gallum, Albert F., 1000, North Water Street, Milwaukee, Wis., U.S.A., Tanner.
1901. Gallup, W. Arthur, Arnold Printworks, North Adams, Mass., U.S.A., Printer.
1901. Galpin, Harry T., 57, West 57th Street, New York City, U.S.A., Chemist.
1891. Galt, Hugh Allen, Columbia Chemical Co., Barberton, Ohio, U.S.A., Works Manager.
1894. Gane, Eustace H., 91, Filton Street, New York City, U.S.A., Pharmaceutical Chemist.
1901. Gansser, Dr. A., Albnang, 164, Basle, Switzerland, Chemical Engineer.
1916. Gant, Thos. H., 4, Victory Avenue, I.L.M. Factory, Gretna, Dumfriesshire, Explosives Chemist.
1911. Garbutt, C. Durlham, "Oakwood," 44, Long Lane, Garston, Liverpool, Analytical Chemist.
1910. Gardner, Arthur L., 126, West Chestnut Street, Wakefield, Mass., U.S.A., Chemical Engineer.
1907. Gardner, Edward, The Tryst, Bigwood Road, Meadway, Hendon, N.W., Metallurgical Chemist.
1909. Gardner, Henry A., 19th and B Streets N.W., Washington, D.C., U.S.A.
1891. Gardner, Prof. Walter M., Technical College, Bradford, Director of Chemical and Dyeing Departments.
1897. Garfield, Jos., Bank House, Apperley Bridge, near Bradford, Civil Engineer.
1910. Garland, Charles S., 57 Garratt Lane, Wandsworth, S.W., Chemist and Works Manager.
1911. Garner, John H., Sewage Works, Deighton, Huddersfield, Chemist.
1917. Garnett, Henry J., "Heathdene," Shoreham Road, Oxford, Kent, Chemist.
1915. Garrett, Dr. C. Scott, I.L.M. Factory, Bideford, Devon, Chemist.
1890. Garrett, Col. F. C., 27, Fern Avenue, Jesmond, Newcastle-on-Tyne, Teacher of Science.
1906. Garroway, Major John, 58, Buchanan Street, Glasgow, Chemist.
1908. Garson, Jas. W., c/o Lewis Berger and Sons, Ltd., Homerton, N.E., Managing Director.
- O.M. Garton, Sir Richard, Messrs. Hill, Garton, and Co., Southampton Wharf, Battersea, S.W., Glucose Manufacturer.
1886. Gascoyne, Dr. W. J., 27, South Gay Street, Baltimore, Md., U.S.A., Analytical Chemist.
- O.M. Gaskell, Holbrook, Erindale, Frodsham, Cheshire, Alkali Manufacturer.
1902. Gaskell, Holbrook, jun., Hillcroft, Church Road, Woolton, near Liverpool, Engineer.
1915. Ga'celiff, John, jun., 3, St. Andrew's Street, Rugby, Works Chemist.
1908. Gatehouse, Frank B., "Maristowe," Butts Green Road, Hornchurch, Romford, Chemist and Technical Journalist.
1912. Gates, Alfred E., c/o Messrs. T. Lyo and Sons, Luton, Beds, Works Chemist.
- O.M. Gathral, Geo., Beechwood, Sherbourne Road, Acocks Green, near Birmingham.
1906. Gaunt, Percy, Macclesfield Corporation Sewage Works, Prestbury, near Macclesfield, Chemist.
1917. Geary, Samuel T. T., Ellesmere, Littlemoor Hill, Smethwick, Works Chemist.
1912. Gee, Wm. J., 48, Kingsmead Road, Tulse Hill, London, S.W., Chemical Engineer.

1891. Geisler, Dr. Jos. F., New York Mercantile Exchange Building, 6, Harrison Street, New York City, U.S.A., Consulting Chemist.
1901. Gemmell, G. H., 4, Lindsay Place, George IV Bridge, Edinburgh, Analytical Chemist.
1901. Gent, Percy W., Trentholme, Misterton, near Gainsboro', Chemist.
1897. Gent, Wm. T., Springfield, Misterton, near Gainsboro', Metallurgical Chemist.
1912. Georgeson, George, Stephen Court, 77-79, Elizabeth Street, Sydney, N.S.W., Manager of Oil Companies.
1913. Gepp, Herbert W., c/o Amalgamated Zinc (De Bavay's), Ltd., Broken Hill, N.S.W., Australia, General Manager.
1906. Gerkensmeyer, Henry H., 207, Mississippi Avenue, Joliet, Ill., U.S.A., Chemist.
1912. Ghislain, Raoul, Jefe de Fabricacion, Soc. Anon. des Fours a Coke Semet-Solvay du Nueva Montaña Compania 22, 2^a Izqda, Santander, Spain, Chemical Engineer.
1916. Ghose, A., c/o Mica Mining and Timber Co., and P.O., Ganwan, Dt. Hazaribagh, Prov. Behar, India, General Manager.
1911. Gibbings, W. Alan, P.O. Box Sannomiya 174, Kobe, Japan, Works Manager and Chemist.
1903. Gibbings, Wm., Woodside, Halebank, Widnes, Works Manager.
1910. Gibbins, Roland B., 18, Wheeley's Lane, Birmingham, Chemical Manufacturer.
1902. Gibbon, Edw., Belvedere, Park Road, Clydach, R.S.O., Glam., Works Chemist.
1915. Gibbon, John, The British Explosives Syndicate, Ltd., Factory, Pitsea, Essex, Chemist.
1904. Gibbs, A. E., c/o Pennsylvania Salt Manufacturing Co., Widener Building, Philadelphia, Pa., U.S.A., Manufacturing Chemist.
1913. Gibbs, Victor G., c/o Wm. Pearson, Ltd., Clough Road, Hull, Works Manager.
- O.M. Gibbs, Wm. P., 1, Dartmouth Park Avenue, London, N.W., Analytical Chemist.
1916. Gibson Prof. Charles S., The University Chemical Laboratory, Cambridge, Assistant to the Professor of Chemistry.
- O.M. Gibson, J. M., c/o Buckley Brick and Tile Co., Buckley, via Chester, Brick and Tile Manufacturer.
1905. Gibson, John, 360-366, Collins Street, Melbourne, Vic., Australia, Concrete Manufacturer.
1913. Gibson, R. M., 58, Chester Road, Buckley, via Chester, Clay Goods Manufacturer.
1905. Gibson, Wm. F., c/o Turner Bros. Asbestos Co., Ltd., Rochdale, Lancs., Works Chemist.
1914. Gidden, W. T., Woodside, Abbey Road, Smethwick, near Birmingham, Technical Chemist.
1916. Gifford, E. C., c/o British Dyes, Ltd., Turnbridge Works, Huddersfield, Technical Chemist.
1899. Gifford, Wm. E., 54, Austin Street, Newark, N.J., U.S.A., Chemist.
1892. Gilbard, J. Francis H., 245, Dalston Lane, Hackney, N.E., Analytical Chemist.
1905. Gilbertson, Isaac H., 33, Broad Street, Rhodes, near Middleton, Lancs., Calico Printer.
1903. Gilby, Joseph W., 11, Westfield Grove, Wakefield, Yorks, Works Chemist.
- O.M. Gilchrist, Percy Carlyle, F.R.S., Reform Club, Pall Mall, London, S.W., Metallurgist.
1884. Gilchrist, Peter S., Charlotte, N.C., U.S.A., Chemical Engineer.
900. Gildersleeve, W. H., Johnson City, Tenn., U.S.A., Chemist.
- O.M. Giles, W. B., The Grange, Leyton, Essex, Chemical Manufacturer.
1915. Giles, W. H., The Grange, Leyton, Essex, Manufacturing Chemist.
1886. Gill, Dr. Ang. H., Chemical Department, Massachusetts Institute of Technology, Cambridge, Mass., U.S.A., Professor of Technical Analysis.
1913. Gill, Harold W., Magadi Soda Co., Lake Magadi, British East Africa, Chief Resident Chemist.
1915. Gill, Hubert A., 55-56, Chancery Lane, London, W.C., Chartered Patent Agent.
1909. Gill, John H., 18, Fourth Avenue, Sherwood Rise, Nottingham, Soapworks Chemist.
1901. Gili, Wm. S., c/o Farquhar and Gill, North of Scotland Colour Works, Aberdeen, Paint and Varnish Manufacturer.
1901. Gilles, Wm. S., The Cottage, Bocking, near Braintree, Essex, Technical Chemist.
1917. Gilliam, Charles, Curtis and Harvey Explosives Works, Dartford, Kent, Chemist.
1888. Gillman, Gustave, 296 Avenida Sete Setembro, Petropolis, via Rio de Janeiro, Brazil, Civil Engineer.
1917. Gilmour, Dr. Robert, 40, Ulsterville Avenue, Belfast, Research Chemist.
1891. Gimmingham, Edw. A., Croyland, Clapton Common, N., Technical Electrician.
1906. Girtin, Thomas, H. L. Raphael's Refinery, 48, Thomas Street, Burdett Road, London, E., Bullion Refiner.
1903. Giadding, Thos. S., 181, Front Street, New York City, U.S.A., Analytical Chemist.
1906. Glass, A. Melville, "Copley Dene," Park Avenue, Hampstead, N.W., Patent Agent.
1894. Glen, Chas., Glengowan Printworks, Caldercruix, Scotland, Calico Printer.
1884. Glendinning, H., Winnington House, Northwich, Cheshire, Technical Chemist.
1917. Glossop, Arthur A., Lee Green, Cliffe-at-Hoo, Kent, Chemist.
1896. Glover, H., 6445, Emlen Street, Germantown, Philadelphia, Pa., U.S.A., Chemical Works Superintendent.
- O.M. Glover, William, Albareda 27, Seville, Spain, Technical Chemist.
1911. Gmach, Ludwig T., Kew Bridge Label Works, Waldeck Road, Chiswick, W., Manufacturer.
1916. Godber, Geo. E., 86, Wellington Street, New Whittington, near Chesterfield, Chemist (Tar Products).
1911. Goetheius, John M., c/o General Chemical Co., 25, Broad Street, New York City, U.S.A., Sales Manager.
1915. Goffin, Armand, Compagnie Commerciale du Nord, 126, Rue de Provence, Paris, Director.
1915. Golding, Geo., "Haverthwaite," Litherland Park, Liverpool, Analytical Chemist.
- O.M. Goldschmidt, Dr. S. A., 11, Broadway, New York City, U.S.A., President (Columbia Chemical Works).
1895. Goldsmith, Byron B., 19, East 74th Street, New York City, U.S.A., Vice-President (American Lead Pencil Co.).
1899. Goldsmith, Dr. Jno. N., 67, Chancery Lane, London, W.C., Chemist.
1914. Goldsmith, L. D., 31, Colvestone Crescent, West Hackney, N.E., Research Chemist.
1916. Goldstein, W., c/o The Asiatic Petroleum Co., Ltd., Portishead, Somerset, Works Chemist.
1906. Goodall, Wm. Leslie, Finboro' Road, Stowmarket, Suffolk, Works Chemist.
1909. Goodban, Leonard, 43, Addison Gardens, Kensington, London, W., Works Chemist.
1912. Gooderham, J. Leys, 49, Wellington Street East, Toronto, Canada, Chemist.
1904. Gooding, E. Claude, Willow House, Washford, Somerset, Chemist. On active service.
1913. Goodman, Alexander, c/o Lever Bros., Ltd., Sunlight Wharf, Upper Thames Street, London, E.C., Manager.
1915. Goodman, V. E., c/o Waterlow and Sons, Ltd., 68-70, Worship Street, Finsbury, E.C., Manager of Cheque Department.
1898. Goodrich, Chas. C., 60, Broadway, New York City, U.S.A., Rubber Manufacturer.
1884. Goodwin, C. C., Racefield, St. Margaret's Road, Altrincham, Cheshire, Soapmaker.
1909. Goodwin, Capt. Camillo J., 60, Mark Lane, London, E.C., Chemical Engineer.

1913. Goodwin, H. W., c/o Charles Case and Sons, Westbury, Wilts, Analytical Chemist.
1903. Goodwin, Major Leo F., 46, Earl Street, Kingston, Ontario, Canada, Professor of Phys. Chemistry and Engineering.
1894. Goodwin, Dr. W. L., Library Dept., Gordon Hall, School of Mining, Kingston, Canada, Professor of Chemistry.
- O.M. Goppelsroeder, Prof. Dr. F., Leimenstrasse 51, Basel, Switzerland, Professor of Chemistry.
1884. Gordon, J. G., Queen Anne's Mansions, Westminster, S.W., Steel Manufacturer.
1904. Gotthelf, August H., Hastings-on-Hudson, N.Y., U.S.A., Chemist.
1914. Gotts, H. S., Corrison Works, Carnwarth Road, Fulham, S.W., Sugar Manufacturer.
1917. Gould clock, Wm. B. O'Brien, 46, Groslands Park, Barrow-in-Furness, Metallurgist.
1890. Goulding, The Right Hon. Sir Wm. J., Bart., c/o W. and H. M. Goulding, Ltd., Alexandra Road, East Wall, Dublin, Manure Manufacturer.
1917. Gower, Owen L., 20, Talbot Road, South Tottenham, N., Purchasing Agent and Manager.
- O.M. Gowland, Prof. W., F.R.S., 13, Russell Road, Kensington, W., Professor of Metallurgy (Royal School of Mines).
1890. Grabfield, Dr. J. P., c/o Morris and Co., Chemical Laboratory, Union Stock Yards, Chicago, Ill., U.S.A., Chemist.
1916. Grace, Claude S., 36, Harvard Road, Gunnersbury, W., Analytical Chemist.
1906. Graesser, Norman H., Chemical Works, Ruabon, N. Wales, Manufacturing Chemist.
1917. Grageroff, I., c/o Canadian Explosives, Ltd., Transportation Building, Room 82, Montreal, Canada, Chemical Engineer.
- O.M. Graham, C. C., Oriel House, Scarborough, Yorks, Technical Chemist.
1917. Graham, Charles W., 13, Prust Avenue, Toronto, Canada, Chemist.
1913. Graham, Jos. I., Chemical Laboratory, Bentley Colliery, Doncaster, Chemist.
1883. Grandage, H., c/o S. Smethurst and Sons, Ltd., Woolfold Dye and Bleach Works, Bury, Lancashire, Dyer.
1897. Granger, Dr. J. Darnell, c/o The Chiswick Polish Co., of Australia, Ltd., 338-356, Mitchell Road, Alexandria, N.S.W., Australia, Analytical Chemist.
1905. Grant, Alexander, 15, Hermitage Drive, Edinburgh, Baker.
1917. Grant, George, 56, Balmoral Avenue, Cathcart, Glasgow, Analytical Chemist.
1916. Grant, Robert, Microbiological Laboratory, Department of Public Health, Sydney, N.S.W., Bacteriologist.
1916. Grant, Wm., c/o Illinois Steel Co., Gary Works, Gary, Ind., U.S.A. (all comms. to 566, Maryland Street, Gary, Ind., U.S.A.), Chemist.
1896. Graves, Geo. H., 219, West 81st Street, New York City, U.S.A., Manufacturing Chemist.
1896. Graves, Walter G., 1950, East 90th Street, Cleveland, Ohio, U.S.A., Chemist.
1914. Gray, George, 3, Victoria Drive, Rock Ferry, Cheshire, Technical Chemist.
1884. Gray, G. Watson, 8, Inner Temple, Dale Street, Liverpool, Consulting Chemist and Assayer.
1911. Gray, Dr. G. W., The Midland Refining Co., El Dorado, Kansas, U.S.A., Chairman, Manufacturing Committee.
1910. Gray, H. Le Breton, c/o Eastman Kodak Co., Rochester, N.Y., U.S.A., Superintendent, Film Department.
1904. Gray, Jas., P.O. Box 5254, Johannesburg, Transvaal, Chemist.
1886. Gray, John, 3, Victoria Drive, Rock Ferry, near Birkenhead, Technical Chemist.
1901. Gray, J. Campbell, The Cottage, Strines, near Stockport, Printworks Chemist.
1916. Gray, Leslie R., 10, Palin Street, Hyson Green, Nottingham, Technical Chemist (Gerard Bros., Ltd.).
1896. Gray, Prof. Thos., Royal Technical College, Glasgow, Professor of Technical Chemistry.
1916. Gray, Thomas H., 52, Burford Road, Nottingham, Works Chemist (Gerard Bros., Ltd.).
1905. Gray, W. B., Messrs. Lever Bros., Durban, Natal, South Africa, Analytical Chemist.
1903. Gray, Wm. S., 76, William Street, New York City, U.S.A., Chemical Merchant.
1909. Greeff, R. H., Thames House, Queen Street Place, London, E.C., and (Jnls.) 80, Maiden Lane, New York City, U.S.A., Chemical Merchant.
1894. Greeff, R. W., Thames House, Queen Street Place, London, E.C., and (Jnls.) Elm Bank, Bromley, Kent, Chemical Merchant.
- O.M. Green, Prof. Arthur G., F.R.S., Municipal School of Technology, Whitworth Street, Manchester, (Journals to Holloway Clough, Arthog Road, Hale, Cheshire), Professor of Chemistry.
1907. Green, Clarence, c/o Nicholson's Raincoat Co., Beaumont Works, St. Albans, Herts, Chemist.
1906. Green, Ernest, 98, Cheadle Road, Cheadle Hulme, Cheshire, Science Teacher.
- O.M. Green, H., Hayle Mill, Maidstone, Paper Manufacturer.
- O.M. Green, L., Lower Tovil, Maidstone, Paper Manufacturer.
1908. Green, Dr. W. Heber, Chemical Laboratory, The University, Melbourne, Victoria, Lecturer in Chemistry.
- O.M. Greenaway, A. J., The Orchard, Chertsey, Surrey, Sub-Editor of Chemical Society's Journal.
1915. Greene, F. A., 7, Alexandra Mansions, West End Lane, London, N.W., Consulting Engineer.
1909. Greenhough, George D., 21, Mincing Lane, London, E.C., Chemical Broker.
1913. Greenough, Thomas R., Beechwood, Leigh, Lancashire, Analytical Chemist.
1917. Greenwood, Dr. Harold C., 10, University Mansions, Putney, S.W., Research Chemist.
1907. Greenwood, Herbert W., c/o Backhouse and Coppock, Ltd., Sutton Mill, Macclesfield, Metallurgical Chemist.
- O.M. Greenwood, Holmes, Regent House, Hartmann Street, Accrington, Technical Chemist.
1907. Gregory, Joshua C., 3, Oak Villas, Bradford, Yorks, Analytical and Consulting Chemist.
1915. Greville, Henry, 57, Hamilton Square, Birkenhead, Research Chemist.
1890. Griffin, John R., Kenble Street, Kingsway, London, W.C., Chemical Apparatus Maker.
1886. Griffin, Martin L., c/o Oxford Paper Co., Rumford, Maine, U.S.A., Manager of Chemical and Electro-Chemical Department.
1912. Griffiths, Clement S., Central Queensland Meat Export Co., Ltd., Lake's Creek, Rockhampton, Queensland, Chemist.
1909. Griffiths, E., 136, George Street N., Sydney, N.S.W., Australia, Chemist.
1917. Griffiths, Hugh, c/o Bruce, Ward & Co., 41, Castle Street, Liverpool, Technical Chemist.
1902. Griffiths, Manfred E., Caizley House, Temple Road, Stowmarket, Suffolk, Explosives Chemist.
1916. Grigioni, J. L., c/o Antony Gibbs & Co., Antofagasta, Chile, South America, Consulting Chemical Engineer.
1912. Grinké-Drayton, Norman, Royal Mint Refinery, 19, Royal Mint Street, London, E., Metallurgist.
1917. Grimshaw, Harold B., 27, Wingfield Street, Gorse Hill, Manchester, Works Chemist.
1902. Grimwade, W. Russell, 335-343, Spencer Street, West Melbourne, Vic., Australia, Manufacturing Chemist.
1900. Grimwood, Robt. G., 43, Leaside Avenue, Muswell Hill, N., Analytical Chemist.
1905. Grip, August E., 495, Columbia Street, Brooklyn, N.Y., U.S.A., Chemical Engineer.
1888. Gripper, Harold, Great Central Railway, Gorton, Manchester, Analytical Chemist.

1916. Grisley, Geo. C., 51, Henry Road, West Bridgford, Nottingham, Chemical Engineer.
1909. Grist, John M., c/o Curtis's and Harvey, Ltd., Explosives Works, Cliffe-at-Hoo, Kent, Explosives Chemist.
1906. Groenewoud, Sidney H., 12, Alexandra Road, Birmingham, Analytical Chemist.
- O.M. Grossmann, Dr. J., 157, Plymouth Grove, Manchester, Consulting Chemist and Chemical Engineer.
1896. Grosvenor, Dr. W. M., jun., Chemists' Building, 50, East 41st Street, New York City, U.S.A., Consulting Chemical Engineer.
1917. Grounds, Arthur, 10, Handfield Road, Waterloo, Liverpool, Chemist in Charge.
1909. Grove, Daniel, "Carmington," Canonbury Grove, Dulwich Hill, N.S.W., Australia; Diamond Buyer and Mine Owner.
- O.M. Groves, C. E., F.R.S., 352, Kennington Road, London, S.E., Chemist (Thames Conservancy).
1907. Groves, J. Stuart, c/o E. I. du Pont de Nemours Powder Co., City Point, Va., U.S.A., Chemist.
1899. Gudemann, Dr. E., 903, Postal Telegraph Building, Chicago, Ill., U.S.A., Chemist.
1915. Guelpa di Luigi, G., 41, Corso Dante, Turin, Italy, Manufacturer and Engineer.
1899. Guild, Frank N., University of Arizona, Tucson, Arizona, U.S.A., Professor of Chemistry.
1916. Guillaume, F. J., 736, Tower Building, Liverpool, Chemical Engineer.
1909. Gulliek, Wm. A., Government Printing Office, Sydney, N.S.W., Government Printer.
1906. Gulline, Percy, c/o Columbia Textile Co., Lowell, Mass., U.S.A., Agent.
1903. Gunn, Gilbert, Eastern Chemical Co., Ltd., Dharair, Bombay, Paper Mill Chemist.
1900. Gunther, Chas. E., Third Floor, Thames House, Queen Street Place, London, E.C., Merchant.
1910. Günther, C. M., Condong Mill, Tweed River, N.S.W., Sugar Chemist.
1903. Guthrie, Alan, The Leather Trades School, Washermupet, Royapuram, Madras, India, Leather Chemist.
1901. Guthrie, John M., 199, Ferry Road, Leith, Scotland, Analytical Chemist.
1909. Guttman, Camillo J. See Goodwin, C. J.
1903. Guttman, Dr. L. F. See Goodwin, Major Leo F.
1912. Guy, Wm. W., Melbourne House, Rowlands Gill, co. Durham, Analytical Chemist.
1916. Gwyer, Dr. A. G. C., c/o British Aluminium Co., Ltd., Research Laboratory, Warrington, Metallurgical Chemist.
1913. Gytton, Walter J., British Standard Cement Works, Rainham, Kent, Chemist.
- H**
1904. Hacking, D. H., Enfield Soap Works, Clayton-le-Moors, near Accrington, Soap Manufacturer.
1887. Hadfield, Sir Robert A., Bart., F.R.S., 22, Carlton House Terrace, London, S.W., Steel Founder.
1904. Hadley, Geo., 10, Waterfall Lane, Blackheath, Staffs, Spelter Works Manager.
1887. Haig, Robert, Dollarfield, Dollar, Scotland, Chemical Engineer.
1915. Haigh, Alfred, c/o Britains Ltd., Cheddleton Paper Mills, near Leek, Staffs., Paper Manufacturer.
1904. Haigh, B. Wilson, By-Product Coke Oven Dept., Barnsley Main Colliery, Barnsley, Yorks, Chemical Engineer.
1896. Haigh, De Lagnel, 381, Fourth Avenue, New York City, U.S.A., Chemist.
1915. Haigh, Sam, 89, Johnson Avenue, Winthrop, Mass., U.S.A., Dyer and Chemist.
1888. Hailes, A. J. de, 15, Red Lion Square, London, W.C., Analytical Chemist.
1910. Hailstone, Harold J., 44, Cordley Street, West Bromwich, Works Chemist.
- O.M. Hake, C. Napier, Jnls. to c/o Dr. A. W. Hake, Medical School, Caxton Street, Westminster, S.W., Chemical Adviser.
1903. Halbert, Thos., c/o British South African Explosives Co., Modderfontein, Transvaal, Chemist.
1888. Hale, Edw. P., Park End, Minthorpe, Westmorland, Analytical Chemist.
1917. Haley, George A., 42, Lansdowne Road, West Didsbury, Manchester, Technical Chemist.
1898. Hall, Clarence A., Pelham Court, Germantown, Philadelphia, Pa., U.S.A., Chemist.
1917. Hall, Edwin A., 55, Somerville Road, Waterloo, Liverpool, Analytical Chemist.
1909. Hall, Harold, Chem. Laby., Loco. Dept., S.E. & C Rly., Ashford, Kent, Analyst.
1916. Hall, John H., Departure Bay, B.C., Canada, Superintendent High Explosives Works.
1912. Hall, Robert H., Weardale Tar Works, Spennymoor, Co. Durham, Chemical Works Manager.
1896. Hall, Capt. S. Godfrey, East London Soap Works, Bow, E., Soap Maker.
1914. Hall, William A., Hall Motor Fuel, Ltd., Wilson's Wharf, Angel Road, Edmonton, N., Chemical Engineer.
1886. Haller, Geo., Sussex House, 52, Leadenhall Street, London, E.C., Chemical Merchant.
1893. Haller, H. Loft, 26, Scale Lane, Hull, Analytical Chemist.
1912. Hallday, McDonald, 6, Oficina Carmen Bajo, Iquique, Chile, Analytical Chemist.
1895. Halliwell, Edw., c/o Ribble Joint Committee, 2, Stanley Place, Preston, Chief Inspector.
1892. Hamaguchi, Gihei, Maedachō, Choshi Chibaken, Japan, Soy Manufacturer.
1897. Hamby, Fred J., Buckingham, Quebec, Canada, Chemist.
1901. Hambuechen, Carl, 4, Pennsylvania Avenue, Belleville, Ill., U.S.A., Secretary (American Carbon and Battery Co.).
1915. Hamilton, David, 31, Newlands Road, Newlands, Glasgow, Analytical Chemist.
1911. Hamilton, David J., Locksley, Helensburgh, Dumbartonshire, Oil Refiner and Paint Manufacturer.
1904. Hamilton, Edward H., c/o The Consolidated Mining and Smelting Co. of Canada, Ltd., Trail, B.C., Canada, Metallurgist and Engineer.
1912. Hamilton, James, 9, Esplanade Avenue, Whitley Bay, Northumberland, Analytical Chemist.
1917. Hamilton, James H., 707, Yorkshire Building, Vancouver, B.C., Canada, Technical Journalist.
1884. Hamilton, Robert, Glengarnock Chemical Co., Ltd., Glengarnock, Ayrshire, Works Manager.
1892. Hamilton, Robt., Jnl. to c/o Walter Scott, Ltd., Leeds Steel Works, Leeds, Analytical Chemist.
1917. Hamilton, Robt., junr., 24, Old Side, Workington, Analytical Chemist.
1898. Hammersley, W. Stanley, Rue Champbertrand, Sens (Yonne), France, Tanner.
- O.M. Hammill, M. J., The Gables, St. Helens, Alkali Manufacturer.
1917. Hampson, Harry, c/o Levinstein Ltd., Blackley, Manchester, Works Chemist.
1905. Hancock, Thos. J., Chemist. Retain Journal's.
1900. Hancock, Walter C., 10, Upper Chadwell Street, Myddelton Square, London, E.C., Chemist.
1896. Hand, Daniel, 30, Mount Pleasant Avenue, Newark, N.J., U.S.A., Chemist.
1888. Hanks, Abbot A., 630, Sacramento Street, San Francisco, Cal., U.S.A., Assayer.
1916. Hannay, Jas. R., Knowmill House, Entwistle, near Bolton, Printworks Manager.
1905. Hanson, H. Norman, The Oaks, Huddersfield Road, Brighouse, Yorks, Research Assistant.
1908. Hanson, W. G., c/o United States Glue Co., Milwaukee, Wis., U.S.A.
1909. Harbord, F. W., 16, Victoria Street, Westminster, S.W., Consulting Metallurgist.
1905. Harcourt, Prof. R., Ontario Agricultural College, Guelph, Ont., Canada, Professor of Chemistry.
1904. Hard, Dr. James M. B., 422, Gravier Street, New Orleans, La., U.S.A., Chemist and Pathologist.

1901. Harcastle, G. Fred., 307, East Park Road, Leicester, Teacher of Science and Technology.
1894. Harden, Dr. Arthur, F.R.S., 5, Cambridge Gardens, Marlborough Road, Richmond, Surrey, Lecturer in Chemistry.
1910. Hardie, Thos., Newcastle and Gateshead Gas Co., Tyneside Road, Newcastle-on-Tyne, Gas Engineer.
1915. Harding, Cpl. Gilbert (on Active Service, Journals to 47, Buttermarket Street, Warrington), Chemist.
1912. Hardwick, Walter A. N., 26, West Kensington Mansions, London, W., Chemist.
1900. Hardwick, W. Roscoe, 13, Batavia Buildings, Hackins Hey, Liverpool, Chemist.
1905. Hardy, Chas. H., 16, Westbourne Avenue, Hull, Chemist.
1913. Harger, Dr. John, Grange Hollies, Gateacre, Liverpool (Journals to Chemical Labv., University College, Gower Street, London, W.C.).
1914. Hargreaves, C. H., Hilton, Court Hill, Banstead, Surrey, Analyst.
1906. Hargreaves, F., c/o Brimsdown Lead Co., Ltd., Brimsdown, Middlesex, Chemist.
1916. Hargreaves, Harry, 137, Whalley Road, Acerington, Lanes, and Corporation Electricity Works, Chemist.
- O.M. Hargreaves, Jno., Widnes, Alkali Manufacturer.
1904. Harker, Dr. George, Dept. of Organic Chemistry, The University, Sydney, N.S.W., Australia, Chemist.
1909. Harland, Robert M., 37, Lombard Street, London, E.C., Analytical Chemist and Assayer.
1893. Harlock, E. B., Newton House, Middlewich, Chemical Manufacturer.
1916. Harlow, L. C., Agricultural College, Truro, Nova Scotia, Chemist.
1905. Harper, Dr. Henry W., University of Texas, 2216, Rio Grande Street Austin, Texas, U.S.A., Professor of Chemistry.
1912. Harper, J. G., Kynochtown, Stanford le Hope, Essex, Managing Chemist.
1913. Harper, William, 3, Gindera Cottages, Montrose, Scotland (Journals to c/o Lever Bros. (Japan) Ltd., Sannomiya, P.O. Kobe, Japan), Works Chemist.
1912. Harran, Dr. Edward B., Abbey Field, Sandbach, Cheshire, Chemist.
1885. Harris, Booth, jun., "Diconwyn," Woodford Green, Essex, Soap Maker.
1897. Harris, Fred. W., 20, Trongate, Glasgow, Public Analyst.
1915. Harris, John, "York House," 8, Main Road, Handsworth, Sheffield, Metallurgist.
1906. Harris, Jonathan W., c/o Western Electric Co., 463, West Street, New York City, U.S.A., Chemist.
1914. Harris, Joseph H., 994, Danforth Avenue, Toronto, Canada, Superintendent.
1907. Harris, Thos. E., c/o The Union Acid Co., 17, Cooper Street, Manchester, Chemical Merchant.
1906. Harris, Wm. G., jun., 35, Fraser Avenue, Toronto, Canada, Metallurgist.
1916. Harrison, Charles, 137, Avondale Square, Old Kent Road, S.E., Lecturer.
1905. Harrison, E. F., Langholm, Edgar Road, South Croydon, Analytical Chemist.
1883. Harrison, G. Herbert, Hagley, Stourbridge, Firebrick Maker.
1892. Harrison, Prof. John B., C.M.G., Government Laboratory, Georgetown, British Guiana, Government Analyst.
1907. Harrison, W., 28, Delfh Lane, Hyde Park, Leeds, and (Juls.) Fuel Dept., The University, Leeds, Technical Investigator.
1896. Hart, Bertram, Oakfield Cottage, Stamford Road, Bowdon, Cheshire, Analyst.
1886. Hart, Bertram H., Rosslyn, High Street, Sidcup, Kent, Analytical Chemist.
- O.M. Hart, Dr. E., Gayley Hall, Lafayette College, Easton, Pa., U.S.A., Professor of Chemistry.
1890. Hart, H. W., Garth, Clifton Drive, Lytham, Lancashire, Analytical Chemist.
1916. Hart, Samuel H., Monnt Ngwibi, via Vryheid, Natal, Technical Chemist and Works Manager.
1897. Hart, Wm. Beamont, Manchester Laboratory, 8, Exchange Street, Manchester, Consulting Chemist.
1908. Hartley, Bernard C., 56, Wood View, Manningham, Bradford, Analytical Chemist.
1912. Hartley, Harold, c/o The Richmond Gas Stove and Meter Co., Ltd., Warrington, Research Chemist.
1883. Hartley, Joseph, 73, East Road, Stockport Road, Longsight, Manchester, Technical Chemist.
1912. Hartley, Thos., 64, Westleat Road, Swindon, Wilts., Teacher of Technical Chemistry.
1905. Hartshorne, Wm. D., Arlington Mills, Methuen, Mass., U.S.A., Agent.
1901. Hartwell, S. Warren, 825, Papinosa Avenue, Easton, Pa., U.S.A., Chemist.
1917. Harvey, Arthur, 12, Chaldon Road, Fulham, London, S.W., Analytical Chemist.
1908. Harvey, Arthur J., 18, Shochbury Road, East Ham, E., Chemist.
1885. Harvey, Ernest W., 36, Arthur Road, Wimbledon Park, London, S.W., Engineer.
1899. Harvey, Thos. F., 5, Park Hill Road, Chingford, Essex, Analyst (Drug Co.).
1916. Harwood, H. E., Royal College of Science, South Kensington, S.W., Teacher of Chemistry.
1906. Haskell, Walter F., 234, Bridge Street, Westbrook, Maine, U.S.A., Textile Chemist and Colourist.
1900. Haslwanter, Chas., 447, Spruce Street, Richmond Hill, Long Is., N.Y., U.S.A., Analytical Chemist.
1897. Hasslacher, Jacob, P.O. Box 1999, New York City, U.S.A., President, Roessler-Hasslacher Chemical Co.
1916. Hastings, John Wm., 284, Paisley Road West, Glasgow, Chemist.
1903. Hatschek, Emil, c/o S. Bornett and Co., Ltd., 19, St. Dunstan's Hill, London, E.C., Engineer.
1887. Hatton, Wm. P., c/o W. R. Hatton and Sons, Wormwood Scrubbs, W., Starch Works Manager.
1915. Hattori, T., c/o Institute of Science, Taipei, Formosa, Japan, Chemical Expert.
1906. Hattrick, John M., c/o Board of Agriculture, Food Production Department, 72, Victoria Street, Westminster, S.W., Potash Agent.
1916. Haunton, Alfred, 41, Junction Road, Romford, Essex, Technical Chemist.
1906. Havercroft, Arthur E., Glenholme, Westbourne Road, Hornsea, Yorks, Chemist.
1916. Haviland, Edwin, Maxa Ltd., 43, Cannon Street, London, E.C., Manager.
1899. Hawdon, H. S., Cleadon, near Sunderland, Chemical Works Manager.
1895. Hawker, E. W., Gladstone Chambers, Adelaide, South Australia, Metallurgist.
1910. Hawkes, Cornelius A., "Eastnor," Tuffley Crescent, Gloucester, Analytical Chemist.
1902. Hawkins, Clement C., c/o The Texas Co., Port Neches, Texas, U.S.A., Chemist.
1897. Hawkins, Ernest M., Watling Chambers, Canterbury, Analytical Chemist.
1905. Hawkins, Henry, Moyola Villa, Lansdown, Limerick, Ireland, Gas Engineer.
1887. Hawliczek, Dr. Josef E., c/o United Alkali Co., Ltd., Intelligence Dept., Widnes Consulting Technical Chemist.
1899. Haworth, Dr. Edw., Beaconsbury, Weston Road, Runcorn, Cheshire, Chemist.
1910. Haworth, John, Sewage Disposal Works, Wincobank, Sheffield, Chemist and Sewage Works Superintendent.
1916. Haworth, Dr. W. N., Scores Villa West, St. Andrews, Scotland, Reader and Lecturer in Chemistry.
1904. Hawthorn, J. H., Municipal Technical School, Leicester, Head Master.
1915. Hay, Alex. H., Essex Wharf, Narrow Street, Limehouse, E., Caramel Manufacturer.
1914. Hay, George S., "Westbrook," 30A, Marriott Road, Tollington Park, London, N., Analytical Chemist.

1915. Hay, William, 121, St. Vincent Street, Glasgow, Secretary.
1909. Haydon, James R., Laboratory, 30, Norfolk Street, Liverpool, Works Manager and Chemist.
1916. Hayhurst, W., "Woodlands," Accrington, Technical Chemist.
1894. Haynes, David O., 3, Park Place, New York City, U.S.A., Proprietor, "Pharmaceutical Era."
1902. Hays, B. F., c/o E. R. Squibb and Sons, 80, Beekman Street, New York City, U.S.A., Pharmaceutical Chemist.
1906. Hayworth, W. P., 24, Tower Road, Dartford, Kent, Chemist.
1905. Hazard, Fred R., P.O. Box 2, Syracuse, N.Y., U.S.A., President (Solvay Process Co.).
1903. Hazen, Chas. R., 258, Prince Albert Avenue, Westmount, Quebec, Canada, Chemist.
1894. Heal, Carlton B., Hill Crest, Runcorn, Cheshire, Tanner.
1912. Healey, E., jun., St. Mary's Mills, Leicester, India-rubber Manufacturer.
1905. Heathcote, Henry L., c/o Rudge-Whitworth, Ltd., Coventry, Research Chemist.
1917. Heaven, George S., Templemead, Albany Road, Coventry, Engineer Chemist.
1905. Heberlein, Dr. Edw., c/o H. T. Enthoven and Sons, Ltd., 247, Rotherhithe Street, London, S.E., Works Manager.
1889. Hecht, Jos. L., c/o French and Hecht, Davenport, Iowa, U.S.A., Analytical Chemist.
1900. Heckman, J. Conrad, Larkin Soap Manufacturing Co., Seneca Street, Buffalo, N.Y., U.S.A., Chemist.
1914. Hector, Alex. B., c/o Burroughs, Wellcome and Co., 481, Kent Street, Sydney, N.S.W., Australia, Manager.
1912. Hedley, Dr. Edgar P., c/o Mrs. Alenby, Fernbank, 61, Derby Road, Borrowash, near Derby, Chemist.
- O.M. Hehner, Otto, 11, Billiter Square, London, E.C., Analytical and Consulting Chemist.
1914. Heinemann, Dr. A., The D.R. Syndicate, Ltd., Ryders Green, West Bromwich, Research Chemist.
1887. Hellier, E. A., Avonside Varnish Works, St. Philip's Marsh, Bristol, Varnish Manufacturer.
1885. Hellon, Dr. R., 40, New Lowther Street, Whitehaven, Analytical and Consulting Chemist.
1903. Helps, D. H., c/o Reading Gas Co., King's Road Works, Reading, Engineer and Manager.
1898. Hemingway, Frank C. R., 1, Broadway, New York City, and (Jnls.) 6, East Union Avenue, Bound Brook, N.J., U.S.A., Chemical Manufacturer.
1883. Hemingway, H., 9, Albemarle Mansions, Heath Drive, Hampstead, N.W., Chemical Manufacturer.
1903. Hemstreet, George P., Hastings-on-Hudson, N.Y., U.S.A., Mechanical Engineer.
1910. Henderson, Ernest G., c/o Canadian Salt Co., Ltd., Windsor, Ont., Canada, Vice-President and Manager.
1883. Henderson, Prof. G. G., F.R.S., Royal Technical College, Glasgow, Professor of Chemistry.
1902. Henderson, Dr. Jas. A. Russell, 21, Irlain Road, Sale, Cheshire, Professor of Chemistry and Physics.
1894. Henderson, Norman M., Broxburn Lodge, Broxburn, Scotland, Oil Works Manager.
1915. Henderson, T. A., 140, Keewatin Avenue, Toronto, Canada, Chemical Works Manager.
- O.M. Henderson, W. F., Moorfield, Claremont Gardens, Newcastle-on-Tyne.
1893. Hendrick, Prof. Jas., Marischal College, Aberdeen, Professor of Agriculture.
1906. Henius, Dr. Max, 1135-1147, Fullerton Avenue, Chicago, Ill., U.S.A., Secretary, Brewers' School.
1912. Henley, Andrew T., Lady's Well Brewery, Cork, Ireland, Technical Chemist.
1904. Henley, Hon. F. R., 49, Montagu Square, London, W., Brewer's Chemist.
1905. Henning, Albert, c/o Hedley and Co., 92, Harrow Road, Leytonstone, N.E., Chemical Manufacturer.
1906. Henning, C. I. B., c/o E. I. du Pont de Nemours Powder Co., Experimental Station, P.O. Henry Clay, Del., U.S.A., Chemist.
1914. Henshaw, D. M., c/o W. C. Holmes and Co., Ltd., Whitestone Ironworks, Huddersfield, Chemical Engineer.
1894. Henshaw, Sam., Glenthorpe, Wolstanton, Stoke-on-Trent, Chemical Works Manager.
1916. Heon, Alfred A., c/o Vancouver Milling and Grain Co., Ltd., 236, Smythe Street, Vancouver, B.C., Canada, Chemist.
1910. Hepburn, Edward, Priory Works, Dartford, Kent, Tanner.
1888. Hepworth-Collins, W., Junior Constitutional Club, Piccadilly, W., Civil Engineer.
1917. Herbert, Alfred E., 21, Fitzwilliam Street West, Huddersfield, Works Chemist.
1914. Herdsman, Frank, 144, Wellington Street, Glasgow, Consulting Chemist and Metallurgist.
1906. Herig, Harry W., c/o General Chemical Co., Hudson River Works, Edgewater, N.J., U.S.A., Chemist.
1897. Heriot, T. H. P., Royal Technical College, Glasgow, Lecturer on Sugar Manufacture.
1916. Heritage, C. C., 452, Auburn Avenue, Buffalo, N.Y., U.S.A., Assist. Manager.
- O.M. Herman, W. D., Holm Lea, Rainhill, Lancashire, Glass Works Chemist.
1917. Heron, Harold, 110, Fenchurch Street, London, E.C., Analytical and Consulting Chemist.
1903. Herreshoff, J. B. F., 620, West End Avenue, New York City, U.S.A., Chemical Engineer.
1887. Herriot, Wm. Scott, Clarewood, Thorntonhall, Lanarkshire, Mechanical Engineer.
- O.M. Herrmann, R. W., 59, Mark Lane, London, E.C., Chemical Merchant.
1891. Hersam, Ernest A., University of California, Berkeley, Cal., U.S.A., Associate Professor of Metallurgy.
1898. Hersey, Dr. Milton L., P.O. Box 1036, Montreal, Canada, Consulting Chemist.
1906. Herty, Prof. Chas. H., 35, East 41st Street, New York City, U.S.A., Professor of Chemistry.
1916. Hess, Julius, c/o Adolph Hess and Bro., Ltd., Oil Works, Kirkstall Road, Leeds, Oil Distiller and Refiner.
1891. Hetherington, Dr. Albert E., Ammonia Soda Works, Fleetwood, Lancashire, Analytical Chemist.
1910. Hewitt, Arthur, c/o Consumers' Gas Co., 19, Toronto Street, Toronto, Canada, General Manager.
1896. Hewitt, Dr. J. Theo., F.R.S., Clifford House, Bedford, Middlesex, Lecturer.
1890. Hewlett, John C., 40-42, Charlotte Street, Great Eastern Street, London, E.C., Manufacturing Chemist.
1907. Hewson, Geo. W., Grasmere, Field Terrace, Jarrow-on-Tyne, Analytical Chemist.
1893. Hey, Harry, 2, Ash Terrace, Saville Town, Dewsbury, Dyer.
1894. Heyl, G. Edward, 61-62, Lincoln's Inn Fields, London, W.C., Chemical and Electrical Engineer.
1906. Heys, Charles H., Toronto Arcade, Toronto, Canada, Consulting Chemist.
1915. Hibbert, Gilbert S., Buckton Vale Print Works, Stalybridge, Cheshire, Printworks Manager.
1906. Hicking, Sir W. Norton, Bart., Queen's Road Works, Nottingham, Lace Dresser.
1906. Hickman, T. Moore, Oakleigh, Tettenhall Wood, Wolverhampton, Analyst.
1897. Hicks, Edwin F., 4837, Fairmount Avenue, Philadelphia, Pa., U.S.A., Chemical Engineer.
- O.M. Higgin, W. H., c/o C. J. Schofield, Ltd., Alkali Works, Clayton, Manchester, Chemical Manufacturer.
1913. Higgins, A. Howard, Estrella, Hale Lane, Mill Hill, London, N.W. (Journals to c/o Minerals Separation Ltd., 62, London Wall, E.C.), Metallurgist.
1915. Higgins, C. A., c/o G. M. Norman, Hercules Powder Co., Du Pont Building, Wilmington, Del., U.S.A., Works Chemist.
1886. Higgins, C. L., 41, Knowsley Road, Cressington Park, Liverpool, Manufacturing Chemist.
1908. Higgins, S. H., Lunceary Bleachfield, Perth, Chemist and Asst. Manager.

1909. Higson, Frank, 52, Chapel Street, Salford, Manchester, Analytical Chemist.
- 1909 Higuchi, Ken-ichi, Central Laboratory, South Manchuria Railway Co., Dairen, Manchuria, Chemical Engineer.
1917. Hinkins, George H., 28, Hornby Road, Old Trafford, Manchester, Chemical Engineer.
1911. Hidditch, T. P., Birchdene, Cross Lane, Grappenhall, Warrington, Research Chemist.
1903. Hill, Chas. Alex., c/o British Drug Houses, Ltd., 22-30, Graham Street, City Road, N., Chemist.
1917. Hill, Edgar, 36, Mysore Road, Clapham Common, S.W., Chemist.
1916. Hill, George Norman, c/o Imperial Varnish and Colour Co., 8/20, Morse Street, Toronto, Canada, Chemist.
1897. Hill Dr. Herbert M., 20, West Eagle Street, Buffalo, N.Y., U.S.A., City Chemist.
1907. Hill, James A., 8, Highfield Crescent, Rock Ferry, Cheshire, Technical Chemist.
1908. Hill, J. H. F., Ministry of Munitions, Dept. of Explosives Supply, Acid Section, Queen Anne's Chambers, Westminster, London, S.W., Superintendent, Coke and By-Product Plant.
1916. Hill, Jas. W., Box 218, Banff, Alberta, Canada, Industrial Chemist.
- O.M. Hill, J. K., 13, Osborne Place, Ibrox, Glasgow, Manufacturing Chemist.
1915. Hill, J. Rutherford, 36, York Place, Edinburgh, Pharmaceutical Chemist.
1892. Hill, Sydney, c/o Blundell, Spence, and Co., Ltd., Hull, Analytical Chemist.
1903. Hill, W. Basil, Foss Islands Tannery, York, Tanner.
1894. Hills, Harold F., Commercial Gas Works, Stepney, London, E., Analytical Chemist.
- O.M. Hills, W., Oxford Works, Tower Bridge Road, London, S.E., Pharmaceutical Chemist.
1899. Hinchley, J. W., 55, Redcliffe Road, London, S.W., Chemical Engineer.
1904. Hinchley, J. F., 550, East 7th Street, Brooklyn, N.Y., U.S.A., Chemical Engineer.
- O.M. Hindle, J. H., 8, Cobham Street, Accrington, Dyeworks Manager.
1916. Hindley, Edward, jun., The Poplars, Barnton, near Northwich, Cheshire, Phosphate Manufacturer.
1909. Hinks, Edward, 16, Southwark Street, London, S.E., Analyst.
1899. Hinks, Percy J., Danger Building Dept., Royal Laboratory, Woolwich Arsenal, S.E., Chemist.
1891. Hinman, Bertrand C., Coventry House, South Place, Finsbury, London, E.C., Metallurgical Chemist.
1909. Hirsch, Fritz, 44, Rothwell Road, Gosforth, Newcastle-on-Tyne, Analytical Chemist.
1914. Hirst, A. Norman, Box 1141, Durban, South Africa, Consulting Chemist.
1895. Hirst, H. Reginald, c/o Geo. H. Hirst and Co., Ltd., Victoria Mills, Savell Town, Dewsbury, Works Chemist.
1907. Hirt, Wilhelm B., c/o Cumming, Smith, and Co., Ltd., Yarra Junction, Vic., Australia, Analytical Chemist.
1916. Hiscock, W. G., c/o New Explosives Co., Ltd., Stowmarket, Suffolk, Works Chemist.
1896. Hislop, Geo. R., (Journals) Gas Works, (Communications) Greenhill House, Underwood Road, Paisley, Gas Engineer and Manager.
1915. Hitch, E. F., Equitable Powder Manufacturing Co., East Alton, Ill., U.S.A., Chemist.
1913. Hitchcock, Thos. J., 28, Albany Road, Manor Park, Essex, Technical Chemist.
1915. Hitchins, A. B., Research Laboratory, Anseo Co., Binghamton, New York, U.S.A., Research Chemist.
1917. Hitchman, Fredk. G., 50, Cranmer Street, Nottingham, Analytical Chemist (Boots Pure Drug Co.).
1906. Hobsbaum, I. B., c/o Messrs. Anthony Gibbs & Sons, 22, Bishopsgate, London, E.C., Analytical Chemist.
1905. Hobson, Alfred, Dantzic Brewery, Imperial Street, Regent Street, Leeds, Brewer and Wine Manufacturer.
1916. Hockin, Daniel, 796, Beatty Street, Vancouver, B.C., Canada, Wholesale Druggist.
1894. Hodger, Andrew, "Wilford," 16, Clifton Road, Heaton Moor, near Stockport, Printworks Chemist.
1913. Hodgetts, E. A. Brayley, 36, Elvaston Place, Queen's Gate, S.W.
1915. Hodgkinson, S. E., 5, Taylor Street, Heaton Park; Manchester, Works Analyst.
- O.M. Hodgkinson, Dr. W. R., 89, Shooter's Hill Road, Blackheath, S.E., Professor of Chemistry.
1913. Hodgson, Cyril V., 57, St. George's Avenue, Southlands, Wolstanton, Stoke-on-Trent, Works Chemist.
1917. Hodgson, Joseph P., 1573, Main Street, Vancouver, B.C., Canada, Chemical Manufacturer.
1897. Hodgson, Matthew, The Murrrough, Wicklow, Ireland, Technical Chemist.
1890. Hodgson, Wm., 66, Deansgate, Manchester, Oil and Colour Broker.
1910. Hodsman, Henry J., Dept. of Fuel and Coal Gas Industries, The University, Leeds, Chemist.
1917. Hodson, Thos., c/o Levinstein, Ltd., Blackley, Manchester, Works Chemist.
1906. Hogarth, Julius W., H.M. Guncotton Factory, Colnbrook, near Staines, Middlesex, Demonstrator of Chemistry.
1886. Hogben, W., 71, Leamington Terrace, Edinburgh, Celluloid Works Manager.
1916. Hogg, Charles, 8, Cadogan Street, Glasgow, Chemical Broker.
1917. Hogg, Stuart, c/o Chas. Butters & Co., Ltd., 54, New Broad Street, E.C., Director.
1905. Holcroft, Harold, Parkdale, Wolverhampton, Iron-founder.
1916. Holden, Geo. E., 29, Durnford Street, Middleton, Lanes, Dyeworks Chemist.
1887. Holden, G. H., Manchester Oxide Co., Ltd., Canal Street, Miles Plating, Manchester, Chemist.
1904. Holden, Norman N., c/o Hardman and Holden, Ltd., Miles Plating, Manchester, Manufacturing Chemist.
1916. Holdredge, Leigh I., c/o Hilton Trading Co., 136, Liberty Street, New York City, U.S.A., Chemical Engineer.
1902. Holdsworth, Ernest T., "Holme Dene," Crossley Hall, Bradford, Dyer.
1885. Holgate, T. E., 173, Hollins Grove, Darwen, Lancashire, Metallurgist.
- O.M. Holland, Philip, 22, Taviton Street, Gordon Square, London, W.C., Analytical Chemist.
1892. Holland, Philip H., 546, Sherbrooke Street West, Montreal, Canada, Merchant.
1915. Hollings, Harold, 1, Northwood Road, Forest Hill, S.E., Technical Chemist.
1896. Hollings, J. Spencer, Brymbo, North Wales, Works Manager.
1917. Hollingsworth, C., "Brooklyn," Broomfield Road, Chadwell Heath, Essex, Analytical Chemist.
1909. Hollingsworth, David V., Birchenwood Collieries, Kidsgrove, Stoke-on-Trent, Gas Analyst.
1917. Hollins, Cecil, 43, Stapleton Road, Balham, London, S.W., Chemist.
1903. Hollinshead, Peter, The Beeches, Weston Road, Runcorn, Cheshire, Chemist.
1900. Hollinshead, Dr. Warren H., 1606, Belcourt Avenue, Nashville, Tenn., U.S.A., Teacher of Chemistry.
1904. Holloway, E. G., c/o Jas. S. Kirk and Co., 360, North Water Street, Chicago, Ill., U.S.A., Chemist.
1890. Holloway, G. T., 9-13, Emmett Street, Limehouse, London, E., Chemist and Metallurgist.
1916. Holmes, C. E., 64, Harrington Road, Workington, Chemist.
1883. Holmes, Ellwood, Wyncote, Jesmond Park East Newcastle-on-Tyne, Colour Manufacturer.
- O.M. Holmes, F. G., Thames Tar Works, Lower Road, Northfleet, Kent, Tar and Ammonia Distiller

1914. Holroyd, Thomas A., c/o Levinstein, Ltd., Blackley, Manchester, Colour Chemist.
1913. Holt, Dr. Alfred, Dowsefield, Allerton, Liverpool, University Reader in Physical Chemistry.
1900. Holthouse, Harold B., 106, Radcliffe Road, West Bridgford, Nottingham, Chemist.
1902. Holton, Alf. L., Chemical Dept., Gas Works, Bradford Road, Manchester, Chemist.
1892. Holton, E. C., 601, Canal Road, N.W., Cleveland, Ohio, U.S.A., Chemist.
1893. Holzapfel, Max, c/o Holzapfels, Ltd., Felling-on-Tyne, Manufacturer.
1916. Home, James, 17/19, St. Therese Street, Montreal, Canada, Paper Maker.
1893. Homfray, D., c/o The Hard Chemical Co., Santa Julia, Mexico City, Analytical Chemist.
1909. Hook, Russell W., 8, Holton Street, West Medford, Mass., U.S.A.
1904. Hooker, A. H., c/o Hooker Electrochemical Co., Niagara Falls, N.Y., U.S.A., Manufacturing Chemist.
- O.M. Hooper, E. Grant, 16, Royal Avenue, Sloane Square, London, S.W., Analytical Chemist.
1889. Hooper, Ernest F., Pilgrim House, Pilgrim Street, Newcastle-on-Tyne (Journals to "The Hill," Stroud, Glos.), Technical Chemist.
1888. Hope, Jas., The Knoll, Lenzie, near Glasgow, and (Journals) The Nickel Co., Kirkintilloch, by Glasgow, Nickel Works Manager.
1904. Hopewell, Fredk., 8, Place Youville, Montreal, Canada, Manager.
1892. Hopkins, Erastus, 21, Arnold Park, Rochester, N.Y., U.S.A., Consulting Chemical Engineer.
1915. Hopkins, E. M., c/o Thos. Jackson, Chemical Works, Clayton, Manchester, Manager and Chemist.
1905. Hoppstedt, A. W., Perry and Mississippi Streets, Buffalo, N.Y., U.S.A., Chemist.
1895. Horne, Dr. W. D., 175, Park Avenue, Yonkers, N.Y., U.S.A., Consulting Chemist.
1904. Hornsey, J. W., 233, Broadway, New York City, U.S.A., and (Journals) Summit, N.J., U.S.A., Chemical Engineer.
1913. Horrocks, Herbert, 147, Wegman Parkway, Jersey City, N.J., U.S.A., Chemist.
1914. Horrocks, John M., "Maywood," Osborne Road, Levenshulme, Manchester, Tar Distiller and Manufacturing Chemist.
1900. Horsfall, John, 4, Grange Avenue, Rawtenstall, Manchester, Analytical and Consulting Chemist.
1917. Horsfall, Ronald S., c/o Levinstein, Ltd., Blackley, Manchester, Chemist.
1901. Horton, Edw., jun., Rothamsted Experimental Station, Harpenden, Herts, Chemist.
1916. Hose, Dr. Chas., The Lodge, Botesdale, Diss; (Jnls.) H.M. Factory, King's Lynn, Norfolk, Acetone Manufacturer.
1906. Hoseason, Jas. H., Sun Buildings, 2, Bridge Street, Manchester, Chemical Manufacturer.
1916. Hoskin, H. E., 35, Vallance Road, Alexandra Park, London, N., Works Manager and Chemist.
1916. Hoskins, Arthur A., Rainham, Kent, Explosives Chemist.
1890. Hoskins, A. Percy, "Clonlec," Rosetta Park, Belfast, Ireland, Analytical Chemist.
1899. Hoskins, Wm., 2009, Harris Trust Building, 111, West Monroe Street, Chicago, Ill., U.S.A., Chemist.
1914. Hough, Alex. T., 188, Boulevard de Charente, Paris XXc.
1917. Hough, Ralph, 2, Bridge Street, and Journals to "Newlands," Wilbraham Road, Alexandra Park, Manchester, Manufacturing Chemist.
1911. Hough, Samuel, Q10 West, Greta, Scotland, Analytical Chemist.
1899. Houlder, Bertram E., 50, Lady Margaret Road, Southall, Middlesex, Chemist.
1915. Houston, R. H., 46, Elm Park Road, London, S.W., General Manager (Aluminium Mills).
- O.M. Howard, A. G. Burnt House, Chigwell, Essex, Chemical Manufacturer.
1901. Howard, Bernard F., Firbank, Loughton, Essex, Chemist.
1887. Howard, D. Lloyd, Uphall Works, Ilford, Essex, Chemical Manufacturer.
1915. Howard, Dr. G. S., Lock Box 204, Carleton Place, Ontario, Canada, Research Chemist.
1898. Howard, Henry, 36, Amory Street, Brookline, Mass., U.S.A., Chemical Engineer.
1902. Howard, Nelson A., c/o General Chemical Co. of California, 705, Royal Insurance Building, San Francisco, Cal., U.S.A., General Manager.
1915. Howard, O. McG., Paint, Oil and Drug Review, 212, West Washington Street, Chicago, Ill., U.S.A., President and Journalist.
1913. Howard, Tom, 320, Wellington Road, Heaton Chapel, Stockport, Cheshire, Chemist.
1916. Howden, Robert, 12, Wolveleigh Terrace, Gosforth, near Newcastle-on-Tyne, Analytical Chemist.
1906. Howe, Chester A., 135, Oliver Street, Boston, Mass., U.S.A., Dyestuff Merchant.
1916. Howe, Harrison E., 137, McGill Street, Montreal, Canada, Chemical Engineer.
1903. Howe, Jas. Lewis, Washington and Lee University, Lexington, Va., U.S.A., Professor of Chemistry.
1912. Howe, Dr. Percy R., 536, Pleasant Street, Belmont, Mass., U.S.A., Dentist.
1904. Howell, Walter L., Room 314, Custom House, New Orleans, La., U.S.A., Chemist.
1916. Howie, William, 4, Porter Street, Ibrox, Glasgow, Works Chemist.
1899. Howles, Fred., c/o McDougall Bros., 66-68, Port Street, Manchester, Chemist.
1889. Howorth, F. Wise, 10, New Court, Lincoln's Inn, W.C., Technical Chemist and Chartered Patent Agent.
1907. Howroyd, Richard R., c/o Calder Mersey Extract Co., Ltd., Ditton, near Widnes, Chemist.
1914. Howson, Herbert G., c/o Kynoch, Ltd., Umbogintwini, Natal, Analytical Chemist.
1906. Hoyler, Fritz, 93, Market Street, Perth Amboy, N.J., U.S.A., Chemist.
1896. Hoyte, Percy S., Gas Works, Coxside, Plymouth, Gas Engineer.
1916. Hubbard, R. S., Harrison Bros., and Co., Inc., 3500, Grays Ferry Road, Philadelphia, Pa., U.S.A., Chemical Manufacturer.
1909. Hudson, Baker, Public Library, Middlesbrough, Librarian.
1899. Hudson, Dr. Edw. J., c/o Pioneer Iron Co., Marquette, Mich., U.S.A., Chemist.
1916. Hudson, G. Fred., Cawood Villa, Barnes Road, Castleford, Yorks, Works Manager.
1915. Hudson, G. Inglis, "Gudvangen," Arden Street, Coogee, Sydney, N.S.W., Australia, Manufacturing Chemist.
1914. Hudson, Norman S.W., No. 1, Staff House, Eastriggs, Dornock, Annan, Chemist.
1905. Hudson, O. F., Royal School of Mines, South Kensington, London, S.W., Lecturer on Metallurgy.
1900. Huebner, Julius, Linden, Cheadle Hulme, Cheshire, Director of Dyeing and Papermaking Departments (Municipal School of Technology).
1917. Huether, Davis J., c/o Dunlop Tyre and Rubber Goods Co., Booth Avenue, Toronto, Canada, Foreman.
1916. Huggins, A. F., "Cartref," Cromford Road, West Bridgford, Nottingham, Analytical Chemist.
- O.M. Hughes, J., 79, Mark Lane, London, E.C., Agricultural Chemist.
1917. Hulbert, Percy G., 3, Station Parade, Balham, S.W., Chemist.
1915. Hulme, Chas., Gas Works, Uxbridge, Middlesex, Gas Engineer.
1906. Hulme, Robert B., 1162, Union Avenue, Memphis, Tenn., U.S.A., Chemical Engineer and Manager.
1909. Hultman, G. H., St. Paulsgatan 31, Stockholm, Sweden, Chemical Engineer.
1905. Hulton, H. F. E., 15, Oak Hill Court, Putney S.W., Chemist.
1893. Humphrey, Chas., Homewood, Hartford, Cheshire, Alkali Works Manager.

1916. Humphrey, Wm. A., Seaton Lodge, Southbury Road, Enfield, Lead Products Works Manager.
1916. Humphrey, Edith E., 4, Cumberland Park, Acton, W., Works Chemist.
1902. Humphrey, Richard L., 1001, Harrison Building, Philadelphia, Pa., U.S.A., Civil Engineer.
1903. Humphreys, A. C., 165, Broadway, New York City, and (Jnls.) Stevens Inst. of Technology, Hoboken, N.J., U.S.A., Engineer.
1908. Humphries, Albert E., Coxes Lock Mill, Weybridge, Surrey, Flour Miller.
1912. Humphries, Herbert B. P., 14, Old Queen Street, Westminster, London, S.W., Consulting Chemist.
- O.M. Humphrys, N. H., 5, Wyndham Road, Salisbury, Wilts., Gas Engineer.
1900. Hunt, Arthur V., 5, The Wind, Lower Bebbington, Cheshire, Analytical Chemist.
- O.M. Hunt, Chas., 17, Victoria Street, Westminster, London, S.W., Civil Engineer.
1883. Hunt, J. S., Appleton, Widnes.
1903. Hunt, P. C. Holmes, 360, Collins Street, Melbourne, Vic., Australia, Gas Engineer.
- O.M. Hunt, W., Hampton House, Wood Green, Wodnesbury, Staffs., Chemical Manufacturer.
1893. Hunter, Prof. Matthew, Rangoon College, Rangoon, Burmah, Professor of Chemistry.
1902. Huntly, Geo. N., 14, Old Queen Street, Westminster, S.W., Analytical and Consulting Chemist.
1904. Hurren, F. H., c/o The Rover Co., Ltd., Coventry, Analytical Chemist.
1894. Hurry, E. H., Llanover, Churt, Farnham, Surrey, Mechanical Engineer.
1912. Hutchin, C. D., c/o Messrs. Meredith and Drew, Ltd., High Street, Shadwell, London, E., Biscuit Manufacturer.
1915. Hutchinson, Alfred, Manesty, Saltburn-by-the-Sea, General Manager, Skinningrove Iron Co.
- O.M. Hutchinson, T. J., Aden House, Manchester Road, Bury, Analytical and Consulting Chemist.
1909. Hutchison, Chas. F., Eastman Kodak Co., Kodak Park, Rochester, N.Y., U.S.A., Photographic Emulsion Maker.
- O.M. Huxley, Jas. H., c/o Vickers, Son, and Maxim, Ltd., River Don Works, Sheffield, Metallurgical Chemist.
1906. Huyett, Miles C., 1005, Morgan Building, Buffalo, N.Y., U.S.A., Mechanical Engineer.
1897. Hyams, Godfrey M., 312, Sears Building, Boston, Mass., U.S.A., Mines Manager.
1902. Hyde, Austin T., Box 98, Rumford Falls, Maine, U.S.A., Chemical Engineer.
1897. Hyde, B. T. Babbitt, 11, Broadway, New York City, U.S.A., Soap Manufacturer.
1899. Hyde, Fred. S., 215, Schermerhorn Street, Brooklyn, N.Y., U.S.A., Research Chemist.
1899. Hyde, Wm. Grantley, Garden Wharf, Church Road, Battersea S.W., Assayer.
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1900. Ichioka, Dr. Tajiro, 19, Maruyama, Shinmachi, Hongo, Tokyo, Japan, Chemist (Imperial Japanese Navy).
1906. Iddings, Richard P., Arlington Mills, Lawrence, Mass., U.S.A., Chemist.
1885. Idris, T. H. W., 120, Pratt Street, Camden Town, N.W., Mineral Water Manufacturer.
1913. Illingworth, S. R., c/o Gas Lighting Improvement Co., Ltd., Pacific Wharf, West Ham, E., Works Chemist. On active service.
1909. Imison, C. S., The Cottage, Runcorn, Cheshire, Chemist, United Alkali Co.
1900. Imrie, John, 30, Osgathorpe Road, Sheffield, Producer Gas and By-Products Plant Manager.
1900. Ingalls, Walter R., "Engineering and Mining Journal," 10th Avenue at 36th Street, New York City, U.S.A., Mining Engineer and Metallurgist.
1889. Ingle, Dr. Harry, 26, Bond Street, Leeds, Organic Chemist.
1909. Ingleby, G. W., c/o John L. Seaton and Co., Ltd., Sculcoates, Hull, Director.
1916. Inglis, George P., 37, Stratford Road, West Bridgford, Nottingham, Works Chemist (Boots Pure Drug Co., Ltd.).
1906. Inglis, Dr. Jno. K. H., University of Otago, Dunedin, New Zealand, Professor of Chemistry.
1916. Inglis, Robert, c/o Lever Bros. (Japan), Ltd., P.O. Box, 174, Kobe, Japan, Chemist.
1912. Inglis, Robert J. C., "Rosedale," Airdrie, Lanarkshire, Analytical Chemist.
1911. Innes, Dr. Alfred G., H.M. Factory, Gretna, Technical Chemist.
1909. Innes, R. Faraday, c/o The British Chrome Tanning Co., St. Andrew's Tannery, Northampton, Chemist.
1903. Innes, Dr. Wm. Ross, 121, Norton Way, Letchworth, Herts, Chemist.
1910. Irvine, Prof. J. C., Chemical Research Laboratory, The University, St. Andrews, Scotland, Professor of Chemistry.
1884. Irving, J. M., 17A, Dickinson Street, Cooper Street, Manchester, Chemical Merchant.
1911. Irwin, George C., c/o S. H. Johnson and Co., Ltd., Carpenter's Road, Stratford, E., Manager (Engineering Works).
- O.M. Irwin, W., Derwent Lodge, Cockermouth, Analytical Chemist.
1901. Isakovics, Alois von, Synflour Scientific Laboratories, Monticello, N.Y., U.S.A., Manufacturing Chemist.
1915. Isherwood, Dr. Percy C. C., c/o W. J. Bush & Co., Ltd., Hackney, N.E., and (Journals) Moss Cottage, Bushey Heath, Herts, Chief Chemist.
1900. Ittner, Dr. Martin H., c/o Colgate and Co., Jersey City, N.J., U.S.A., Soap and Essential Oil Chemist.
1912. Ivatt, Albert, The Engadine, Histon, Cambridge, Chemist (Foods).
- J
1890. Jackman, E. J., 60, Belgrave Road, Ilford, Essex, Technical Chemist.
1904. Jackson, Ernest W., Godrevy, Saltburn, Yorks, Analytical Chemist.
1991. Jackson, F., Smedley Bridge Works, Cheetham, near Manchester, Bleacher and Dyer.
1883. Jackson, Frederick, 44, Chapel Street, Salford, Manchester, Laboratory Furnisher.
1886. Jackson, John, 98, Dobbie's Loan, Glasgow, Lubricant Manufacturer.
1901. Jackson, Percy G., c/o National Boiler and General Insurance Co., St. Mary's Parsonage, Manchester, Chemist.
1916. Jackson, R. S., c/o Kemp and Co., Ltd., Manufacturing Chemists, Bombay, India, Pharmacist and Analyst.
1890. Jackson, Saml., 3, Buckingham Gardens, Perambore Barracks, Madras, India, Analytical Chemist.
1902. Jackson, Samuel, c/o Wm. Metcalf, Ltd., Church, near Acerington, Director (Tar Distillery).
1898. Jackson, Thos., 31, Brownsville Road, Heaton Moor, near Stockport, Chemical Manufacturer.
1900. Jackson, Dr. W. Hatchett, Radcliffe Library, University Museum, Oxford, Librarian and Science Tutor (Keble College).
1899. Jackson, W. Morton, c/o British Oxygen Co., Ltd., Great Marlborough Street, Manchester, Manager.
- O.M. Jackson, W. P., Saxilby, near Lincoln, Chemical Works Manager.
1915. Jacobs, Lionel L., Algoma Steel Corporation, Ltd., Sault Ste. Marie, Ontario, Canada, Superintendent Coke Plant.
1900. Jacoby, Arcll H., c/o National Aniline and Chemical Co., 100, William Street, New York City, U.S.A., Chemist.
1886. Jago, Wm., 17, Wilbury Avenue, Hove, Sussex, Barrister-at-Law.

1833. James, E. T., British Alizarin Co., Ltd., Silvertown, Victoria Docks, E., Secretary.
1916. James, Fredk. O., c/o Lever Bros., Ltd., H.C.B. Dept., Liver Buildings, Liverpool, Chemist.
1916. James, Geoffrey M., 515, Stewart Avenue, Ithaca, New York, U.S.A., Chemical Engineer.
1915. James, Hugh W., South Metropolitan Gas Co., Tar Works, Ordnance Wharf, East Greenwich, S.E., Technical Chemist.
1905. James, Oscar S., 6, Leuty Avenue, Toronto, Canada, Analytical Chemist.
1916. Jaques, Harry J., 11, Moreton Avenue, Stretford, Manchester, Chemist.
1914. Jaques, John, 66, Grove Road, Wanstead, N.E., Rubber Technologist.
1890. Jarman, Geo. S., Dalton Lodge, Huddersfield, Wool Extractor.
- O.M. Jarmay, G., Hartford Lodge, Hartford, Cheshire, Alkali Manufacturer.
1911. Jarrom, Harry G., 14, Goodwyn Avenue, Mill Hill, Middlesex, Managing Director (Gallenkamp and Co.).
1900. Jarvie, Jas., Ferndale, Kenmure Avenue, Bishopbriggs, Scotland, Chemist.
1914. Jaubert, Dr. G. F., 155, Boulevard Malesherbes, Paris, France, Technical Journalist.
1910. Jayne, David W., c/o Barrett Manufacturing Co., 17, Battery Place, New York City, U.S.A. Journals to c/o A. G. Peterkin, jun., The Barrett Co., Bridesburg Station, Philadelphia, Pa., U.S.A. Manager.
1913. Jeans, Harold, 165, Strand, London, W.C., Metallurgist.
1892. Jenkin, W. A., 12, Bella Vista, Minas de Rio Tinto, Provincia de Huelva, Spain, Metallurgical Chemist.
1905. Jenkins, Chas. D., 1384, Commonwealth Avenue, Allston, Mass., U.S.A., Chemist.
1894. Jenkins, John H. B., Laboratory, G.E.R. Works, Stratford, E., Analytical Chemist.
1912. Jenkins, Leslie C. W., 26, Ulundi Road, Blackheath, S.E., Chemist (Wood Dyeing).
1912. Jenkins, Rees, 53, Shaftesbury Road, Ravenscourt Park, W., Analytical Chemist.
1916. Jenkinson, Stanley N., Edinburgh and Leith Flint Glass Co., Norton Park, Edinburgh, Glass Manufacturer.
1905. Jennison, Jas., Mount Nod, London Road, Greenhithe, Kent, Chemist.
1904. Jepson, John Elliott, c/o Star Paper Mill Co., Ltd., Feniscowles, near Blackburn, Chemist.
1899. Jerdan, Dr. David S., Temora, Colinton, Midlothian, Chemist (Gelatin Works).
1890. Jessop, Louis V., St. Bede's, Bushwood, Leytonstone, Essex, Chemist.
1904. Jewson, F. T., Earlith, near St. Ives, Hunts, Chemist.
1896. Job, Robt., 649, Roslyn Avenue, Westmount, Quebec, Canada, Analytical Chemist.
1886. Johnson, A. E., 24, Parkdale, Wolverhampton, Analytical Chemist.
1908. Johnson, Arthur, 7, Carlton Road, Bolton Road, Pendleton, Manchester, Chemist.
1904. Johnson, Cedric, Winnington Park, Northwich, Cheshire, Chemical Engineer.
1891. Johnson, Edmond E., c/o Adcocks, Drayton Park Works, Highbury, N., Chemical Engineer.
1904. Johnson, Dr. F. M. G., 286, Peel Street, Montreal, Canada, Chemist.
1904. Johnson, G. B., 7, Church Street, Liverpool, Wholesale Chemist.
1907. Johnson, H. Finnis, c/o Borax Consolidated, Ltd., 16, Eastcheap, London, E.C., Sales Manager.
1900. Johnson, John, c/o John Johnson and Co., 37th Street and Second Avenue, Brooklyn, N.Y., U.S.A., Chemical Engineer.
1913. Johnson, J. Carroll, on active service, Chemist.
- O.M. Johnson, J. E. J., 133, Earlham Grove, Forest Gate, E., Manufacturing Chemist.
1900. Johnson, John W. Haigh, West Riding Rivers Board, Wakefield, Yorks, Analytical Chemist.
1906. Johnson, Oliver L., c/o The Aspinook Co., Jewett City, Conn., U.S.A., Dye Works Manager.
1904. Johnson, S. Hearon, 7, Church Street, Liverpool Wholesale Chemist.
1916. Johnson, Walter L., c/o Bell Bros., Ltd., Middlesbrough, Iron Master.
1895. Johnston, Alex. R., 18, Percy Street, Ibrox, Glasgow, Analytical Chemist.
1906. Johnston, A. McA., Box 108, Germiston, Transvaal, Metallurgical Chemist.
1894. Johnston, G. Lawson. *See* Lawson-Johnston, G.
1904. Johnston, J. H., 8, Leopold Road, Wimbledon, S.W., Chemist and Bacteriologist.
1904. Johnston, Thos. J., 1, Brunswick Street, Edinburgh, Chemist.
1890. Johnston, Wm. A., The S. S. White Dental Manufacturing Co., Prince Bay, N.Y., U.S.A., Dental Enamel Manufacturer.
1894. Johnston, W. E. Lawson. *See* Lawson-Johnston, W. E.
1910. Johnstone, E. J., Park Place, Watertown, New York, U.S.A., Consulting Engineer and Industrial Chemist.
- O.M. Johnstone, Jas., Shawfield Works, Rutherglen, Glasgow, Technical Chemist.
1905. Johnstone, J. Swanston, Natal Distilleries Co., Bond Street, Durban, Natal, Distiller.
1903. Johnstone, S. J., "Rousdon," Clifford Road, New Barnet, Herts, Research Chemist.
1907. Jolliffe, Ernest H., Central Technical School, Toronto, Canada, Works Chemist.
1905. Jolliffe, Frank, 51, Vancouver Road, Forest Hill, S.E., Chemist.
1917. Jollyman, Frederic W., c/o The Imperial Tobacco Co., Ltd., Bodminster, Bristol, Analyst.
1904. Jones, Arthur B., 981, Central Avenue, Plainfield, N.J., U.S.A., Superintendent.
1913. Jones, B. Vaughan, P.O. Box 27 Petersburg, Va., U.S.A., Chemist and Manufacturer.
1912. Jones, Charles, Bearpark, Brancepeth Colliery, Durham, Coke Plant Manager.
1908. Jones, D. Trevor, 44, Ardrossan Road, Saltcoats, Ayrshire, Works Chemist.
1911. Jones, Edgar D., 157 Wakehurst Road, Clapham Common, S.W., Analytical Chemist.
1912. Jones, E. Gabriel, City Analyst's Laboratory, Ashton Street, Liverpool, Assistant Public Analyst for Liverpool.
1910. Jones, E. Protheroe, The Golden Horseshoe Estates Co., Salisbury House, London Wall, London, E.C., Secretary.
1902. Jones, E. Strangways, Sulphide Corporation, Ltd., Cockle Creek, N.S.W., Australia, Metallurgical Chemist.
1909. Jones, E. Willis, 22, Coleshill Terrace, Llanelli, South Wales, Chemical Manufacturer.
- O.M. Jones, E. W. T., 10, Victoria Street, Wolverhampton Analytical Chemist.
1897. Jones, Fred. W., 35, Addiscombe Road, Croydon, Technical Chemist.
1896. Jones, G. Cecil, 41, London Road, Forest Hill, S.E., Consulting Chemist.
1905. Jones, Harold, Villa Nova de Lima, Minas Geraes, Brazil, Analyst and Assayer.
1893. Jones, Herbert. *See* Sefton-Jones, H.
1910. Jones, Herbert J., 81, Ham Park Road, Stratford, E., Chemist.
1910. Jones, Ivor R., 54, Atlantic Chambers, Manchester, Chemical Merchant.
1905. Jones, J. E. Staey, Hearsall Works, Coventry, Consulting Chemist and Technical Metallurgist.
1904. Jones, J. Shirley, Moscow, Idaho, U.S.A., Chemist.
1894. Jones, M. W., Stonebeck, Brislington, Bristol, Manager (Oil and Colour Works).
1917. Jones, Richard O., 57, Browning Avenue, Rockferry, Cheshire, Research Chemist (Lever Bros., Ltd.).

- O.M. Jones, Walter Norris, Lancashire Metal Works, Widnes, Technical Chemist.
1915. Jones, W. B., 366, Washington Street, New York City, U.S.A., Research Chemist.
1903. Jones, Wm. App, c/o Boston Artificial Leather Co., 200, Fifth Avenue, New York City, U.S.A., Chemist.
1905. Jones, W. Ellis, 80, Arundel Avenue, Liverpool, Sugar Refiner.
1908. Joselin, Percy H., 81, Bennerley Road, New Wandsworth, S.W., Chemist.
1905. Joseph A. F., 296, Willesden Lane, N.W., Lecturer on Chemistry.
1900. Josephson, Edgar, c/o Pantasote Leather Co., Passaic, N.J., U.S.A.
1891. Joslin, Omar T., 3223, Spring Grove Avenue, Cincinnati, Ohio, U.S.A., Chemical Engineer.
1887. Jölet, Dr. C. H., 238, East 2nd Avenue, Roselle, N.J., U.S.A., Technical Chemist.
1904. Jowett, Dr. H. A. D., Phoenix Mills, Dartford, Kent, Research Chemist.
1903. Joyce, Clarence M., 145, Walnut Street, Leominster, Mass., U.S.A., Consulting Chemist (Nitro-cellulose).
1916. Joyce, Sydney R., c/o Curtis's and Harvey, Ltd., Cliff-at-Hoo, Kent, Analytical Chemist.
- O.M. Justice, Philip M., 55-56, Chancery Lane, London, W.C., Patent Agent.
- K
1896. Kalbfleisch, Franklin H., 31, Union Square West, New York City, U.S.A., Chemical Manufacturer.
1908. Kaliski, Dr. Maximilian S., 116, Broad Street, New York City, U.S.A., Technical Chemist.
1916. Katz, Israel, c/o Sulzberger and Sons Co., Union Stockyards, Chicago, Ill., U.S.A., Chief Chemist.
1901. Kauder, Dr. E. c/o Merck and Co., Rahway, N.J., U.S.A., Chemist.
1892. Kaufmann, Dr. Herbert M., c/o Mutual Chemical Co., Jersey City, N.J., U.S.A., Chemist.
1904. Kaus, Dr. Emil, 96, High Street, Perth Amboy, N.J., U.S.A., Chemist.
1915. Kawakami Kaichi, c/o Sumitomo Electric Wire and Cable Works, Osaka, Japan, Chemical Engineer.
1885. Kawakita, Prof. Michitada, Imperial Engineering College, Tokio, Japan, Professor of Applied Chemistry.
1912. Kay, Jas. H., Fair Fields, Dundee Lane, Ramsbottom, Lancashire, Soap Manufacturer.
- O.M. Kay, Wm. E., 349, The Cliff, Broughton Park, Manchester, Printworks Chemist.
1910. Kaye, Henry R., c/o Cuming, Smith, and Co., Port Melbourne, Vic., Australia, Analytical Chemist.
1904. Kaye, Thos., 26, Rose Crescent, Perth, Scotland, Analytical Chemist.
1884. Keane, Dr. Charles A., Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C., Principal.
- O.M. Kearns, H. W., Boothroyd, Brooklands, near Manchester, Dyer.
1897. Kearns, Jno. S., Cowpe Mills, Waterfoot, near Manchester, Chemist and Dyer.
1915. Keary, Harold E., The Glen, Stanford le Hope, Essex.
1908. Keen, Dr. Jas. L., 7, King Street, Chapside, London, E.C., Consulting Chemical Engineer.
1911. Keenan, Thomas J., 117, East 24th Street, New York City, U.S.A., Paper Chemist.
1915. Keetland, C. G., c/o The Standard Chemical Iron and Lumber Co., 524, St. Ambrose Street, Montreal, Canada, Montreal Manager.
1908. Keith, Jas. W., c/o Parry and Co., Ranipettai, North Arcot Dt., Madras Presidency, India, Analytical Chemist.
1915. Keller, D. Rayment, 20, Carey Place, Watford, Herts, Works Chemist.
1907. Keller, Dr. Edward, 365, W. 56th Street, New York City, U.S.A., Chemist and Metallurgist.
1905. Keller, Robt. J., 89, Barclay Street, New York City, U.S.A., Dyestuff and Chemical Merchant.
1885. Kellner, Dr. Wm., 135, Victoria Road, Old Charlton, S.E., Chemist to War Department.
1908. Kellogg, H. W., c/o National Electrolytic Co., Niagara Falls, N.Y., U.S.A., General Manager.
1916. Kelly, Wm., c/o Canadian Explosives Ltd., Room 807, Transportation Building, Montreal, Canada, President's Assistant.
1916. Kempson, J. F., Crow Lees, Thorpe Road, Norwich, Chemical Manufacturer.
1907. Kendall, G. F., Chemical Works, Stratford-on-Avon, Chemical Manufacturer.
1912. Kennedy, Carl D., c/o General Rubber Co., Kisaran Asahan, Sumatra, D.E.I., Chemist.
1916. Kennedy, J. R., 21, Crown Park Road, Toronto, Canada, Perfumer.
1916. Kenner, Capt. James, A.P.O. 4 (Shops), B.E.F., Chemist.
1912. Kent, Raymond W., East Palistine, Ohio, U.S.A., Chemist.
1914. Kenyon, James, U.K. Chemical Products, Ltd., Sutton Oak Works, St. Helens, Analytical Chemist.
1903. Kenyon, Percy S., Park House, Cheadle Hulme, Cheshire, Drysalter.
1889. Kenyon, Thos., The Shrubbery, Hilton Park, Prestwich, near Manchester, Manufacturing Chemist.
1915. Kerfoot, Thos., Pole Bank Hall, Gee Cross, Cheshire, Manufacturing Chemist.
1899. Kern, Walter P., c/o General Chemical Co., 1642, Halle Street, Laurel Hill, Boro' of Queens, N.Y., U.S.A., Chemist.
1916. Kernick, Fred S., c/o Kernick and Sons, Ltd., Old Rink Building, Moira Terrace, Cardiff (Journals to 192, Newport Road, Cardiff), Laboratory Manager.
1915. Kernot, Dr. J. C., Furze Hill, Augustus Road, Wimbledon Park, S.W., Doctor of Chemistry.
1906. Kerr, Charles H., c/o American Optical Co., Southbridge, Mass., U.S.A., Director of Research Laboratory.
1912. Kerr, R. Vaughan, Saboaria Seixas Irmaos y Ca., Parahyba, Brazil, Technical Chemist.
1890. Kerr, Saml. T., 516, North Delaware Avenue, Philadelphia, Pa., U.S.A., Salt Manufacturer.
1897. Kerr, Wm. M., 1421, Chestnut Street, Philadelphia, Pa., U.S.A., Manufacturing Chemist.
1896. Kershaw, Jno. B. C., 9, Grosvenor Road, Colwyn Bay, N. Wales, Analytical Chemist.
1915. Kertland, Chas. G., The Standard Chemical and Lumber Co., 524, St. Ambrose Street, Montreal, Canada, Local Manager.
1903. Kesava-Menon, A., Government Soap Works, Calicut, Madras, India, Chemist.
1902. Kessler, Henry W., 1640, East 115th Street, Cleveland, Ohio, U.S.A., Manufacturing Chemist.
1893. Kestner, Paul, 16, Rue de Chabrol, Paris, France, Chemist.
1900. Kewley, Jas., The Refinery, Portishead, near Bristol, Oil Refinery Manager.
1890. Keys, W. H., Hall End Works, West Bromwich, Oil and Chemical Manufacturer.
1900. Kilgore, Berj. W., North Carolina Dept. of Agriculture, Raleigh, N.C., U.S.A., Chemist.
1901. Kilmer, Fred. B., c/o Messrs. Johnson and Johnson, New Brunswick, N.J., U.S.A., Chemical Manufacturer.
- O.M. Kitch, Prof. E., Komaba, Haslemere, Surrey, Professor of Chemistry.
- O.M. King, A. J., Elleray, Windermere, Bleacher and Finisher.
1917. King, Albert P., 98, Foxley Road, Purley, Chemical Manufacturer.
1907. King, C. A., c/o The Farnley Iron Co., Farnley, near Leeds, Technical Chemist.
1913. King, Edward W., New Liverpool Rubber Works, Walton, Liverpool, Analytical Chemist.
1915. King, George, 25, Whitmore Road, Small Heath, Birmingham, Research Chemist.

1911. King, Harold, Welcme Research Laboratories, King Street, Snow Hill, E.C., Chemist.
- O.M. King, J. Falconer, 43, Stirling Road, Edinburgh, Consulting Chemist.
1910. King, John, Summerville Gardens, Latchford, Warrington, Lancashire, Works Manager.
1913. King, Dr. Robert C., Aptekarsky Prospect Sa, Petrograd, Russia, Chemist.
1895. King, Sidney J., "Blenheim," Union Road, Surrey Hills, Melbourne, Victoria, Australia, Analytical Chemist.
- O.M. King, Walter R., "Torville," The Cliffs, Southend-on-Sea, Chemical Manufacturer.
1905. King, Warren C., 72, Front Street, New York City U.S.A., President, Independent Chemical Co.
1916. King, Wm. E., 24, Tantallon Road, Balham, S.W., Research Chemist.
1917. King, William W., "Double Trees," The Ridgway, Sutton, Surrey, Chemical Manufacturer.
1896. Kingdon, G. Holman, c/o Joseph Crosfield and Sons, Ltd., Warrington, Technical Chemist.
1908. Kingsbury, Percy C., German-American Stoneware Works, 50, Church Street, New York City, U.S.A., Chief Engineer.
1883. Kingsford, T. P., Oswego, N.Y., U.S.A., Starch Manufacturer.
- O.M. Kingzett, C. T., "Maplin," Frinton on Sea, Essex, and (Journals) Sanitas Co. Ltd., Locksley Street, Limehouse, E., Chemical Manufacturer.
1906. Kinnersley, H. W., "Ingleside," Abbey Park, Keynsham, Somerset, Chemist and Manufacturer.
1897. Kipping, Dr. F. Stanley, F.R.S., University College, Nottingham, Prof. of Chemistry.
1914. Kirby, William, 50, Mayhill Road, Charlton, Kent, Chemist.
1916. Kirkcaldie, J. C., The Laboratory, Bo'ness Distillery, Bo'ness, Scotland, Analytical and Consulting Chemist.
1908. Kirkhope, T. Bertram, Sandbank, Gwithian, Hayle, Cornwall, Explosives Works Chemist.
1905. Kirkland, John, 2, Cranworth Gardens, Brixton Road, S.W., Technical Instructor.
1900. Kirkpatrick, Prof. S. F., Kensington Avenue, Kingston, Ont., Canada, Professor of Metallurgy.
1913. Kirsebom, Gustave, Readingsgade 11, Christiania, Norway, Metallurgical Engineer.
1911. Kiretein, H. C. See Bingham, H. C.
1902. Kitchen, Wm. J., Port Melbourne North, Vic., Australia, Soap and Candle Manufacturer.
1883. Kitto, B., 26, Lancaster Road, Finsbury Park, London, N., Analytical Chemist.
1900. Kittredge, H. G., c/o The Kay and Ess Co., Dayton, Ohio, U.S.A., Chemist.
1908. Klaber, Wm., c/o Castle Kid Co., Camden, N.J., U.S.A., Chemist.
1900. Kleber, Dr. Clemens, Clifton Chemical Laboratory, Passaic, N.J., U.S.A., Director.
1911. Klein, C. A., Brimsdown Avenue, Enfield Highway, Middlesex, Works Chemist.
1909. Klemm, W. F. E., 58 Woodlands Road, Aigburth, Liverpool, Chemist.
1908. Klien, Dr. J. L. See Keen, Dr. J. L.
1903. Kline, Clarence M., 429, Arch Street, Philadelphia, Pa., U.S.A., Wholesale Druggist.
1889. Klipstein, A., Messrs. A. Klipstein and Co., 644-654, Greenwich Street, New York City, U.S.A., Chemical Manufacturer.
1902. Klipstein, Ernest C., 93, Prospect Street, East Orange, N.J., U.S.A., Chemical Merchant.
1916. Klotz, J. R. N., c/o The Newport Hydro Carbon Co., 32, Liberty Street, New York City, U.S.A., Chemist.
1913. Klotz, W. C., Canadian Ammonia Co., Ltd., Toronto, Canada, Chemist.
1891. Knaggs, Alfred B., c/o Dr. Knaggs, Oak House, New North Road, Huddersfield, Technical Chemist in Dyeworks. Retain Journals.
1911. Knapp, Arthur W., c/o Cadbury Bros., Ltd., Bourneville, near Birmingham, Research Chemist.
1911. Knapp, Harry P., c/o Talbot Dyewood and Chemical Co., 38-44, Middle Street, Lowell, Mass., U.S.A., Chemical Manufacturer.
1916. Knapp, Lionel F., Hertcombe, Kingston Hill, Surrey, Chemist.
1892. Knecht, Dr. E., Beech Mount, Marple, Cheshire, Professor of Tinctorial Chemistry.
1904. Kniffen, Frederick, Holly Oak, Del., U.S.A., Chemist.
1887. Knight, A. H., 51, Highfield Street, Liverpool, Assayer.
1903. Knight, Harley F., 14, Old Queen Street, Westminster, S.W., Analyst.
1887. Knights, J. West, 67, Tenison Road, Cambridge, Analytical Chemist.
1885. Knipier, F., "Strathberg," Greensborough, near Melbourne, Victoria, Starch Manufacturer.
1907. Knoedler, E. L., c/o Welsbach Co., Gloucester City, N.J., U.S.A., Factory Foreman.
1910. Knott, E. Anthony F., The Priestman Collieries, Ltd., Ottovale Coke Works, Blaydon-on-Tyne, Works Chemist.
1904. Knowles, W. R., The Hollies, Wood Green, Wednesbury, Chemical Works Manager.
1886. Knox, E. W., Colonial Sugar Refining Co., Sydney, N.S.W.; Sugar Manufacturer and Refiner.
1906. Knudsen, Kristian H., 96, Maiden Lane, New York City, U.S.A., Chemist.
1904. Koch, J. A., Bluff and Pride Streets, Pittsburg, Pa., U.S.A., Chemist.
1911. Kochs, A. Victor. See Derry, A. V.
1904. Koebig, Dr. J., 934, Union Oil Building, Los Angeles, Cal., U.S.A., Consulting Chemical Engineer.
1909. Kockkoek, Lt. P. R., No. 2, Special Co., R.E., B.E.F., France. Retain Journals.
1915. Koenig, W. A., 1802, North Smallwood Street, Baltimore, Md., U.S.A., Chemist.
1916. Koetz, Metty, c/o L. Borne, Limoilon, Canada, Chemist.
1884. Kohn, Dr. Charles A. See Keane, Dr. Charles A.
1902. Kohnstamm, Lothar S., 87, Park Place, New York City, U.S.A., Chemist.
1915. Kondakow, Prof. I., Prudowaja, 74, Jurjew, Livland, Russia, Director of Pharmaceutical Institute.
1913. Kondo, K., 136, Yoyogi, Tokyo, Japan, Chemical Engineer.
1894. Krause, Dr. Albert H., 1444, West 98th Street, Cleveland, Ohio, U.S.A., Chemist (Grasselli) Chemical Co.).
1898. Krebs, H. J., 806, Franklin Street, Wilmington, Del., U.S.A., Manufacturing Chemist.
1915. Kübler, Ernest, c/o The West Indies Chemical Works, Ltd., 1, Brazennose Street, Manchester, Dyeworks Chemist.
1916. Krobot, S., 220, Broadway, New York City, U.S.A., Chemical Engineer.
1917. Kulp, Samuel R., 414, N. 5th Street Allentown, Pa., U.S.A., Chemist.
1904. Kunz, Dr. George F., c/o Tiffany and Co., 409, 5th Avenue, New York City, U.S.A., Gem Expert.
1905. Kurt, Franklin T., 553, Boylston Street, Boston, Mass., U.S.A., Professor of Chemistry, B.Y.M.C.A.
1916. Kutsuki, Viscount Tsumasada, Kwayaku-Kenkusho, Itabashi, Tokyo, Japan, Lt. Col.
1900. Kuttroff, Fred., 128, Duane Street, New York City, U.S.A., Merchant.
- O.M. Kynaston, J. W., 3, Oak Terrace, Beech Street, Liverpool, Chemical Engineer.

L

1906. Lacell, Harold G., Liderley, Lansdowne Road, Finchley, N., Chemist.
1890. Lacey, E. C., St. Julian's Lodge, St. Julian's Farm Road, West Norwood, Manufacturing Chemist.
1903. Lachman, Dr. Arthur, Corner The Alameda and Newhall Street, San Jose, Cal., U.S.A., Chemical Engineer.
115. Lacy, Edwin, c/o Harland and Wolff, Ltd., Queen's Island, Belfast, Engineering Works Chemist.

1913. Laib, Walter, Rittman, Wayne Co., Ohio, U.S.A., Chemist (Ohio Salt Co.).
- O.M. Lake, G., jun., Lee Mount, Glossop, Derbyshire, Analytical Chemist.
1907. Lake, Henry B., The Manbré Saccharine Co., Fulham Palace Road, Hammersmith, W., Manager.
1900. Lamar, Wm. R., 8502, Ferriss Street, Woodhaven, New York City, U.S.A., Chemical Manufacturer.
1898. Lamb, Morris Chas., Leathersellers' Technical College, 176, Tower Bridge Road, London, S.E., Chemist.
1912. Lancaster, Harry C., 39, Ladbroke Grove, Kensington, W., Managing Director.
1907. Lancaster, Harry M., Laboratory, Provincial Board of Health, 5, Queen's Park, Toronto, Canada, Chemist.
1916. Land, Henry S., c/o Hardman and Holden, Ltd., Tar Distillers, Manchester: (J.) 7, Amos Street, Church Lane, Moston, Manchester, Works Chemist.
1914. Lander, Dr. G. D., Royal Veterinary College, Camden Town, London, N.W., Consulting Chemist.
1910. Landrum, R. D., c/o The Harshaw, Fuller and Goodwin Co., Electric Building, Cleveland, Ohio, U.S.A., Chemical Engineer.
1910. Lane, J. Henry, 3, Arbour Square, Stepney, London, E., Analytical and Consulting Chemist.
1903. Lane, Nathaniel J., U.S. Laboratory, 641, Washington Street, New York City, U.S.A., Chemist.
1915. Lane-Hall, 2nd Lieut. R., 4, Lloyds Avenue, London, E.C. (Journals to 2nd Northamptonshire Regt., R.E.F., France), Chemical Merchant.
1893. Lang, Dr. Wm. R., University of Toronto, Canada, Professor of Chemistry.
1892. Langer, Dr. Carl, Bucklebury Place, Woolhampton, Berks, Analytical Chemist.
1914. Langlands, S. H. B., Glasgow Corporation Lighting Dept., 20, Trongate, Glasgow, Chief Inspector of Lighting.
1897. Langmuir, Arthur C., c/o Marx and Rawolle, 9, Van Brunt Street, Brooklyn, N.Y., U.S.A., Factory Manager.
1902. Langmuir, F. Leighton, 288, Bloor Street West, Toronto, Canada, Chemist.
1898. Langstaff, Wm., 35, Orchard Street, Elizabeth, N.J., U.S.A., Chemist.
1915. Langton, H. M., The Universal Oil Co., Ltd., Kynochtown, Stanford-le-Hope, Essex, Research Chemist.
1916. Lankshear, F. R., 63, Birchfield Road, Rusholme, Manchester, Works Manager.
1900. Lant, Herbert, "Ivy Bank," Wath-on-Dearne, near Rotherham, Yorks, Chemist and Manager.
1909. Lantsberry, Fred. C. A. H., Birmingham Small Arms Co., and (Journals) 63, Walford Road, Sparkbrook, Birmingham, Metallurgical Chemist.
1906. Lantz, Lieut. Alfred, 139, Rue La Fayette, Paris, France, Chemical and Colour Manufacturer.
1914. Laplante-Courville, H., 399, Viger Avenue, Montreal, Canada, Lecturer.
1915. Lapworth, Prof. Arthur, F.R.S., The University, Manchester, Professor of Organic Chemistry.
1903. Larter, Alfred T., 5, Rookfield Avenue, Muswell Hill, N., Chemist.
1904. Lasher, F. G., 104, Grove Street, Brooklyn, N.Y., U.S.A., Chemist.
1884. Latham, Baldwin, Parliament Mansions, Victoria Street, Westminster, S.W., Civil Engineer.
1889. Latham, J. J., Mill House, Bold, Widnes, Chemical Works Manager.
1907. Lathwood, Arthur, c/o Borax Consolidated, Ltd., 16, Eastecheap, London, E.C., and (Jnls.) The Briars, Maidstone Road, Bounds Green, N., Chemist.
1914. Lander, Dr. Alex., College of Agriculture, 13, George Square, Edinburgh, Lecturer in Chemistry.
1914. Laurie, Dr. A. P., Heriot Watt College, Chambers Street, Edinburgh, Principal.
1909. Law, (Lt.) Douglas J., Trent Bridge Leather Works, Nottingham, Chemist.
1915. Law, Dr. H. Drake, Castle Fields, Rastrick, Brighouse, Yorks, Chemist.
1913. Law, John A., c/o Barry, Ostlere, and Shepherd, Ltd., Forth Works, Kirkcaldy, Scotland, Lino-leum Works Director.
- O.M. Lawrence, Jas., c/o Arch. Hamilton, 70, Glassford Street, Glasgow, Explosives Manufacturer.
1916. Lawrence, Jas. C., 16, Glencairn Drive, Pollok-shields, Glasgow, Chemical Plant Manufacturers.
1911. Lawrence, Wm. A., Manorville, Long Island, N.Y., U.S.A., Director.
1916. Lawrenson, Thos., Plas Newydd, Croxton Lane, Middlewich, Cheshire, Manufacturing Chemist.
1916. Lawson, John, 49, Melton Road, West Bridgford Notts, Pharmaceutical Chemist.
1904. Lawson, Jos. H. S., Rodney Street Works, Oldham Road, Manchester, Salesman.
1891. Lawson-Johnston, G., (Journals) 29, Portman Square, W., and 152, Old Street, E.C., Vice-Chairman of Bovril, Ltd.
1894. Lawson-Johnston, W. E., c/o Bovril, Ltd., 152, Old Street, London, E.C., Director.
1916. Layton, W. T., 313, Friern Road, Dulwich, S.E., Editor, South Met. Gas Co.'s Journal.
1907. Leach, Dr. F. P., "Lynden," Frodsham, Cheshire, Research Chemist.
1908. Leake, Percy C., Prospect House, Ferryhill Village, co. Durham, Tar Works Manager.
1898. Lean, Geo., 3, Park Quadrant, Glasgow, Chemist.
- O.M. Leather, Major J. Walter, 3rd Garrison Batta., Cheshire Regt., Ramsey, Isle of Man, Retain Journals, Government Chemist.
1893. Le Boutilier, Clement, c/o Taylor Iron and Steel Co., High Bridge, N.J., U.S.A., Chemist.
1904. Le Chatelier, Prof. H., 75, Rue Notre Dame des Champs, Paris, France, Professor (l'Ecole des Mines).
1896. Leecombe, W. G., Cambridge Works, Knott Mill, Manchester, Engineer.
1896. Lederle, Dr. E. J., Stamford, Conn., U.S.A., Chemist.
1892. Ledoff, Prof. A., Technological Institute, Kharkoff, Russia, Professor of Chemistry.
1895. Ledoux, Dr. Albert R., 99, John Street, New York City, U.S.A., Chemist.
1903. Ledoux, Aug. D., 15, William Street, New York City, U.S.A., Importer of Pyrites.
1915. Ledoux, P., Société Minière Métallurgique de Peniarroya, 12, Place Vendôme, Paris, Director-General.
1915. Ledwidge, Jos. G., Municipal Technical School, Drogheda, Ireland, Analytical Chemist.
1905. Lee, Ashton, Lawrence, Mass., U.S.A., Manufacturing Chemist.
1905. Lee, Frank W., Lawrence, Mass., U.S.A., Manufacturing Chemist.
1905. Lee, John C., Wellesley, Mass., U.S.A., Assistant Engineer (American Telegraph and Telephone Co.).
1898. Lee, Jno. L., Woodfield, Lytham, Lancashire, Dyer and Bleacher.
1885. Lee, S. Wright, 6-10, Whitechapel, Liverpool, Wholesale Druggist.
1906. Lee, William, 28, Sherard Gardens, Eltham, Kent, Works Chemist.
1915. Leech, Ben., 77, Pownall Street, Macclesfield, Consulting Chemist.
1916. Leech, Herbert L., Craig Royston, Gonrock Road, Eltham, Kent, Director and Works Manager.
1912. Lees, Arnold, West View, Town Street, Beeston, Leeds, Analytical Chemist.
1915. Leese, Ernest, c/o Wilson's Portland Cement Co., Ltd., Warkworth, Auckland, New Zealand, Works Chemist.
1914. Legg, Bertram, Minas de Rio Tinto, Prov. Huelva, Spain, Chemist and Assayer.
1915. Leggett, T. S. L., 35, Sufton Street, Birkby, Huddersfield, Chemist.

1907. Lehmann, Dr. Adolf L. F. University of Alberta, Strathcona, Alberta, Canada, Professor of Chemistry.
1888. Leigh, Cecil, Birmingham Metal and Munition Co., Adderley Park Rolling Mills, Birmingham, Technical Chemist.
1902. Leighton, A. E., Commonwealth Cordite Factory, Maribyrnong, Victoria, Australia, Analytical Chemist.
1916. Leighton, E. W., "Karachi," Empress Avenue, Woodford Green, Essex, Metallurgist.
1894. Leitch, Jno. W., Milnsbridge Chemical Works, near Huddersfield, Aniline Dye Manufacturer.
1904. Le Maistre, Fred. J., Ridley Park, Pa., U.S.A., Research Chemist.
1898. Leman, Wm. T., P.O. Box 747, Chicago, Ill., U.S.A., Oil and Asphalt Agent.
1883. Lennard, F., c/o Forbes, Abbott, and Lennard, Ltd., Chemical Works, Shorham, Sussex, Chemical Manufacturer.
1917. Lentz, C. E., 1235 Lincolnway W., South Bend, Indiana, U.S.A., Glue Engineer.
1884. Leonard, Wm. J., 1, Lindfield Gardens, Hampstead, N.W., Naphtha Distiller.
1904. Lesley, R. W., 604, Pennsylvania Building, Philadelphia, Pa., U.S.A., Cement Manufacturer.
1917. Leslie, Eugene H., Research Lab., General Petroleum Corporation, 3800, Santa Fe Avenue, Los Angeles, Cal., U.S.A., Chief Chemist.
1907. Leslie, Dr. Fred. A., 79, Post Avenue, New York City, U.S.A., Chemist.
1904. Lessing, Dr. Rudolf, Southampton House, 317, High Holborn, London, W.C., Consulting Chemist.
1912. Lessner, C., Carril, Spain, Metallurgical Chemist.
1892. Lester, J. H., The Laboratory, 56, Oxford Street, Manchester, Analytical Chemist.
1899. Le Sneur, Major Henry R., Chemical Laboratory, St. Thomas' Hospital, London, S.E., Lecturer.
1909. Lever, W. Hulme, Heathfield, Bebington, Cheshire, Soap Manufacturer.
1891. Leverhulme, Rt. Hon. Lord, Thornton House, Thornton Hough, Cheshire, Soap Manufacturer.
1901. Levett, Walter, Holmdands, Stanford-le-Hope; and (Journals) Mines Safety Explosives Co., Stanford-le-Hope, Essex, Factory Manager.
1915. Levey, Alfred E., 18, Roxburgh Avenue, Higher Trannura, Cheshire, Works Chemist.
1903. Levi, Dr. Louis E., 781, Sherman Boulevard, Milwaukee, Wis., U.S.A., Chemist.
1912. Levin, Isaac H., P.O. Box 562, Dayton, Ohio, U.S.A., Chemist.
1906. Levinstein, Edgar, 74, India Street, Boston, Mass., U.S.A., Chemical Manufacturer.
1901. Levinstein, Dr. Herbert, c/o Levinstein, Ltd., Blackley, near Manchester, Chemist.
1917. Levy, Frank, No. 3 Staff Hostel, Eastgriggs, Annan, Dumfries, Chemical Engineer.
1909. Levy, Louis S., 80, Maiden Lane, New York City, U.S.A., Editor "American Perfumer."
1916. Levy, Stanley I., 9, Parkhurst Road, Holloway, N., Chemist.
1901. Levy-Mond, Dr. Albert. See Mond, Dr. Albert L.
1898. Lewin, H. James, Royal Clarence Yard, Gosport, Hants, Analytical Chemist.
1914. Lewis, C. Preston, 223, Brixton Hill, London, S.W., Technical Chemist.
1896. Lewis, Daniel C., c/o Millville Manufacturing Co., Millville, N.J., U.S.A., Dye Works Chemist.
1904. Lewis, Edw. W., c/o J. G. Ingram and Sons, London India Rubber Works, Hackney Wick, N.E., Chemist.
1909. Lewis, Reginald J., Govt. Explosives Office, 423, Flinders Lane, Melbourne, Australia, Chemist.
1900. Lewis, Dr. S. Judd, The Laboratories, Staple Inn Buildings, High Holborn, London, W.C., Analytical Chemist.
1914. Lewis, Prof. W. C. McC., Muspratt Laboratory, The University, Liverpool, Professor of Physical Chemistry.
1913. Lewkowitsch, Mrs. K. J., The Lewkowitsch Laboratories, 71, Priory Road, West Hampstead, N.W.
1907. Leyson, Lewis T., Penseynor, near Neath, S. Wales, Analytical Chemist.
1916. Licence, A. B. C., 150, Springbank Road, Hither Green, S.E., Director and Chemist (Dye Manufacturing Co.).
1901. Lichtenstein, Alf. F., c/o Geisenheimer and Co., P.O. Box 994, New York City, U.S.A., Chemist.
1913. Lichtenstein, L. M., Royal Albert and Victoria Docks Chemical Works, Silvertown, London, E., Manufacturing Chemist.
1917. Lidstone, Frank M., 37, Powell Street, Derby, Analytical Chemist.
1916. Liebert, Dr. Martin, c/o Spencer Chapman and Messel, Ltd., 36, Mark Lane, E.C., Chemical Manufacturer.
- O.M. Liebmann, Dr. A., The Whim, Weybridge, Surrey, Consulting Chemist.
- O.M. Lightfoot, T. E., Fernleigh, Accrington, Calico Printer's Chemist.
1905. Liley, Thos. A., 46, Westover Road, Bramley, Leeds, Chemist.
1898. Lilly, Josiah K., c/o Eli Lilly and Co., Indianapolis, Ind., U.S.A., Manufacturing Pharmacist.
1904. Lindemann, Ottocar, 53, Victoria Street, Westminster, S.W., Managing Director (Korting Bros., Ltd.).
1908. Lindfield, James H., c/o Messrs. Martineau, King Edward Street, Whitechapel, E., Technical Chemist.
1897. Lindsay, Robt., Transvaal G.M. Estates, Ltd., Pilgrim's Rest, Lydenburg, Transvaal, Chemist.
1911. Line, Chas. A., 39, Beaufort Road, Edgbaston, Birmingham, Technologist.
1890. Ling, Arthur R., Laboratory, 74, Great Tower Street, London, E.C., Consulting Chemist.
1896. Lishman, Geo. P., Lambton Coke Works, Fence Houses, Co. Durham, Colliery Chemist.
1905. Little, Arthur D., 93, Broad Street, Boston, Mass., U.S.A., Consulting Chemist.
1916. Littler, Robert P., United Alkali Co., Ltd., Netham, Works, Bristol, Chemist.
- O.M. Littlejohn, Jas., c/o Littlejohn and Whitby, P.O. Box 849, Johannesburg, Transvaal, Analytical Chemist.
1916. Littlewood, Ernest A., 6, Monart Road, Blackley, Manchester, Works Chemist.
1904. Livermore, W. D., Washington Mill, Lawrence Mass., U.S.A., Chemist.
1886. Liversedge, A. J., 63, Northampton Road, Croydon, Mechanical Engineer.
1914. Liversedge, John A., The Whangarei Freezing Works, Restah, New Zealand, Assistant Lead Mill Manager.
- O.M. Liversedge, Prof. A., F.R.S., Field Head, Coombe Warren, Kingston, Surrey, Professor of Chemistry.
1883. Livingston, W. J., 30, Fountayne Road, Stoke Newington Common, London, N., Analytical Chemist.
1903. Llewellyn, Ivor P., 149, Moorland Road, Stockport, Chemist.
1907. Llewellyn, W. B., Park House, Westbourne Park, Urmoston, nr. Manchester, Chemist.
1909. Lloyd, Edward, "Kings Pylon," Cavendish Road, Bowdon, Cheshire, Chemical Engineer.
1904. Lloyd, Leonard B., Whitehall Street, Yarraville, Victoria, Australia, Cannier.
1907. Lloyd, Dr. Lorenzo L., Technical College, Bradford, Yorks, Lecturer in Chemistry.
1916. Lloyd, Prof. Stewart J., University, Alabama, U.S.A., Professor of Chemistry.
1900. Lloyd, Thos. H., 7, Beacon Hill Road, Newark-on-Trent, Analyst.
1916. Lloyd-Wilky, W. S., Invicta Mills, Pew Common Lane, London, E., Charcoal Manufacturer.

1914. Lockett, William T., School of Technology, Manchester, Research Chemist.
1915. Lockie, J. R., Ascog, Meikleriggs, Paisley, Scotland, Analytical Chemist.
1916. Lockwood, Jos. H., 3, Ridge Road, Winchmore Hill, London, N., Analytical Chemist.
1888. Lodge, Edw., 35, Scale Hill, Cowcliffe, Huddersfield, Chemist and Dyer.
1917. Lodge, George, Levinstein Ltd., Blackley, Manchester, Research Chemist.
1916. Lodge, Wm. C., c/o Canadian Inspection Co., 603, Canadian Express Building, Montreal, Canada, Chemist.
1907. Lomax, E. Lawson, c/o Anglo-Persian Oil Co., Ltd., Gresham House, 24 Old Broad Street, London, E.C., Chemist.
1901. Long, Eugene J., c/o E. O'Callaghan and Son, City Tannery, Limerick, Ireland, Tanner.
1909. Long, George M., Cudahy, Wis., U.S.A., Glue Maker.
1898. Longstaff, Dr. J. P., Broadway Chambers, Westminster, London, S.W., Journals to "Arcadia," Squirrels Heath, Romford, General Secretary.
1890. Lord, F. J., Winmarleigh, Southbourne, Bournemouth, Hants, Analytical Chemist.
1896. Lord, Jno. Lloyd, Wellington Cement Works, Elton, Bury, Lancs, Chemist and Manager.
- O.M. Lorenz, H., 7 and 8, Idol Lane, London, E.C., Chemical Merchant.
1917. Lorimer, John W., c/o Curtis's and Harvey, Dartford, Kent, Analytical Chemist.
1905. Loring, Lindsley, 40, Central Street, Boston, Mass., U.S.A., Vice-President (Cochrane Chemical Co.).
1909. Lorieberg, C., c/o R. W. Greeff and Co., Thames House, Queen Street Place, London, E.C., Chemical Merchant.
1916. Lothbury, Philip A., 3a, Kingdon Road, West Hampstead, London, N.W., Managing Director, Dye Manufacturing Co.
- O.M. Lott, F. E., The Laboratory, Bridge Chambers, Burton-on-Trent, Consulting Brewing Chemist.
1894. Louis, Prof. Henry, Armstrong College, Newcastle-on-Tyne, Professor of Mining.
- O.M. Love, Dr. E. G., 124, East 15th Street, New York City, U.S.A., Analytical Chemist.
- O.M. Lovibond, T. W., West Jesmond House, Newcastle-on-Tyne, Brewer.
1913. Low, Frank S., 52, N. Pearl Street, Buffalo, New York, U.S.A., Chemical Engineer.
1900. Low, Prof. Wilson H., Cudahy Packing Co., South Omaha, Neb., U.S.A., Chemist.
1911. Lowcock, J. Harold, 39, Wickham Way, Park Langley, Beckenham, Kent, Chemist.
1913. Lowe, Austin, 39, Chelverton Road, Putney, S.W., Research Chemist.
1887. Lowe, Clement W., Thorneyholme, Knutsford, Cheshire, Manufacturing Chemist.
- O.M. Lowe, W. F., 18, Hough Green, Chester, Analytical Chemist.
1906. Lawson, Wm., The University, Leeds, Chemical Lecturer.
1917. Loynes, Walter C., 308, Dudley Road, Birmingham, Analytical Chemist and Assayer.
1895. Lucas, Ah., Laborstories, Public Works Ministry Gardens, Cairo, Egypt, Analyst.
1892. Lucas, Bernard R., Winnington Park, Northwich, Cheshire, Alkali Works Manager.
- O.M. Luek, A. Courtenay, San Martin 475, Buenos Aires, Argentina, Explosives Chemist.
1913. Luey, Arthur J., c/o Turner & Co., 6, Dale Street, Liverpool, Consulting Engineer.
1916. Luff, B. D. W., 85, Ashley Terrace, Edinburgh Technical Chemist.
1915. Lumley, Edgar P., 37, General Graham Street, Chester Road, Sunderland, Chemist.
1900. Lummus, Walter E., 39, Bassett Street, Lynn, Mass., U.S.A., Manager.
1903. Lumsden, Alex. A., Forth Chemical Works, Bo'ness, Scotland, Technical Chemist.
1910. Lumsden, William W., 39, Caledonia Road, Saltcoats, Scotland.
1888. Lund, Jas., 142, Hawthorne Street, Malden, Mass., U.S.A., Ammonia Works Manager.
1915. Lund, W. Jackson, "Penryn," Temple Road, Stowmarket, Suffolk, Chemist.
1888. Lundholm, Carl O., 220, Winchester House, Old Broad Street, London, E.C., Explosives Works Manager.
- O.M. Lunge, Dr. G., Carmenstrasse 37, Zürich, Switzerland, Professor of Chemistry.
1885. Lupton, Sydney, 102, Park Street, Grosvenor Square, London, W.
1884. Luthy, Otto, Haekensack, N.J., U.S.A., Analytical Chemist.
1903. Lye, Ernest B., Legrave Hall, near Luton, Beds, Straw Plait Dyer and Bleacher.
1885. Lye, W. T., Legrave Hall, near Luton, Beds, Straw Dyer.
1915. Lyle, C. E. Leonard, 21, Mineing Lane, London, E.C., Sugar Refiner.
1884. Lyle, James, 23, Mainsfield Road, Ilford, Sugar Refiner.
1916. Lyman, Arthur, c/o Lyman's Ltd., 344, St. Paul Street West, Montreal, Canada, Wholesale Druggist.
1896. Lymn, Arthur H., 40, Westminster Palace Gardens, S.W., Consulting Chemical and Gas Engineer.
1899. Lynn, R. Rankine, 8, Windsor Quadrant, Kelvin-side, Glasgow, Chemical Engineer.
1906. Lyons, Robert H., c/o Canadian Explosives, Ltd., Beloeil Station, Quebec, Canada, Chemist.
- O.M. Lytle, A. M., North of Ireland Chemical Co., Ltd., 34, Victoria Street, Belfast, Ireland, Chemical Manufacturer.

1908. Maas, Milton A., 92, William Street, New York City, U.S.A., Manufacturing Chemist.
1911. Mabbitt, Alan T., 3, Wallwood Road, Leytonstone Essex, Analytical Chemist.
1887. Mabery, Prof. Chas. F., Case School of Applied Science, Cleveland, Ohio, U.S.A., Professor of Chemistry.
1891. Macadam, Herbert E., Dalkeith, Glengall Road, Woodford Green, Essex, Manure Works Manager.
1894. Macadam, Stevenson, 55, York Place, Edinburgh, Analytical Chemist.
1912. McAfee, Dr. A. M., c/o The Gulf Refining Co., Port Arthur, Texas, U.S.A., Chemist.
1917. McAlley, James, "Noreot," Church Lane, Whitefield, nr. Manchester, General Manager.
1894. McAlley, Robt., Bankside, Falkirk, Scotland, Paint Works Manager.
1892. Macara, Thos., jun., 20, Denton Road, Stroud Green, N., Chemist.
1912. McArlly, T. P., Mount Lyell Mining and Railway Co., Queenstown, Tasmania, Chemist and Assayer.
1917. McArthur, Donald N., Chemistry Dept., West of Scotland Agricultural College, 6, Blythswood Square, Glasgow, Research Chemist.
1887. McArthur, James B., Price's Patent Candle Co., Limited, Belmont Works, Battersea, S.W., Chemist.
- O.M. McArthur, J. S., Loch Lomond Radium Works, Balloch, Dumbartonshire, Consulting Chemist and Metallurgist.
1901. Macarthur, Jno. S., 15, St. John's Road, Pollokshields, Glasgow, Paint and Varnish Manufacturer.
1892. McArthur, Thos., 711, Tower Building, Water Street, Liverpool, Drysalter and Drywood Extractor.
1917. Macaulay, James R., 2378, Hutchinson Street, Outremont, Quebec, Canada, Chemist.
1912. Macaulay, John W., Evermonde, 10, Holmlands, Monkseaton, Northumberland, Metallurgical Chemist.
1898. MacCallum, D. A., 389, Central Chambers, 93, Hope Street, Glasgow, Chemist.
- O.M. MacCallum, Sir J. M., M.P., Southdene, Paisley, Scotland, Soap Manufacturer.

1914. McCarthy, Robt. A., Bertram Street, Mortlake, Sydney, N.S.W., Australia, Gas Chemist.
1917. McCauley, John J., "Sunnyholme," Fairfield Road, Latchford, W., Warrington, Technical Chemist.
1905. McCaw, Lt.-Col. W. D., Library, Surgeon General's Office, Washington, D.C., U.S.A., Officer, Medical Department, U.S. Army.
1915. McCleak, G. E., Curhar Crescent, Station Road, Cliffe, Kent, Explosives Chemist.
1905. McCleary, Wm., 61, Station Road, Pendlebury, near Manchester, Finisher.
1910. McColl, A. L., 60, Addingham Road, Mossley Hill, Liverpool, Chemist.
1913. McCrady, McH., 9, St. James Street, Montreal, Canada, Chemist and Bacteriologist.
1897. McCrae, Dr. John, Government Laboratories, P.O. Box 1080, Johannesburg, Transvaal, Government Analyst.
1898. McCreath, Wm. D., Quantock Vale Cider Works, North Petherton, Bridgewater, Cider Manufacturer.
1900. McCulloch, John, Glencee, Lostock Gralam, near Northwich, Cheshire, Chemical Engineer.
1911. McCulloch, Norman G., Rhodes Works, Rhodes, Manchester, Chemist and Calico Printer.
1903. McCully, R. E. J., c/o The Indian Cement Co., Porbandar, Kathiawar, India, Analytical Chemist.
1916. McDermott, F. A., c/o Corby Co., Station K., Washington, D.C., U.S.A., Research Chemist.
1910. Macdonald, Alexander, Netherlea, Matilda Road, Pollokshields, Glasgow, Manufacturing Chemist.
1912. Macdonald, Allan D., "Belgrano," Milngavie, near Glasgow, Manufacturing Chemist.
- O.M. Macdonald, Andrew, 72, Great Clyde Street, Glasgow.
1912. McDonald, Donald, 95, Clarence Gate Gardens, Regent's Park, London, N.W., Analytical Chemist.
1897. MacDonald, G. W., Whitefriars, Rochester, Kent Chief Explosives Research Chemist (Curtis's and Harvey, Ltd.).
1910. Macdonald, Major J. L. A., 13, Howard Place, St. Andrews, Fife, Scotland.
- O.M. MacDonald, J. W., c/o Henry Tate and Sons, Ltd., Thames Sugar Refinery, Silvertown, E., Analytical Chemist.
- O.M. McDonald, T. McG., Wahlabo Estate, St. Vincent, West Indies, Sugar Chemist.
1916. MacDougall, A. J., Toronto Power Co., 12, Adelaide Street East, Toronto, Canada, Mechanical Engineer.
1890. McDougall, J. T., St. Lawrence, Isle of Wight, Manufacturing Chemist.
1906. McDowall, Wm., Oficina Santa Isabel, Tocopilla, Chile, Analytical Chemist.
1889. MacEwan, Peter, 64, Southwood Lane, Highgate, N., Editor of "Chemist and Druggist."
1901. McEwen, Duncan C., c/o Chosen Gold Mines, Ltd., Kok-Kang-Kol Mine, Chung-An, Korea, Metallurgical Chemist.
1917. McEwen, Gordon C., c/o Imperial Varnish and Colour Co., Ltd., Morse Street, Toronto, Canada, Chemist.
1914. McFadyen, F. H., Batavia Rubber Company, Batavia, N.Y., U.S.A., Chemist.
1902. McFarland, Alan R., c/o Solvay Process Co., Syracuse, N.Y., U.S.A., Alkali Works Manager.
1916. Macfarlane, C. W. C., 116, Forth Street, Pollokshields, Glasgow, Analytical Chemist.
1910. McFarlane, John, 6, Gordon Terrace, Shettleston, Glasgow, Metallurgist.
1893. McGhie, T. Burns, c/o Dr. Goodall, 1, Annandale Road, East Greenwich, S.E., Metallurgist.
1904. McGill, Dr. A., 317, Queen Street, Ottawa, Canada, Analytical Chemist.
1899. McGillivray, Wm. A., c/o Swansea Safety Fuse Factory, Pipe House Wharf, Swansea, Works Manager.
1887. McGlashan, John, Post Office, Tolodi Balapur, Dist. Chanda, C.P., India, Technical Chemist.
1917. MacGregor, Jas., c/o E. Scott and Co., Ltd., 19, Waterloo Street, Glasgow, Joint Managing Director.
1896. Mellhiney, Dr. Parker C., 50, East 41st Street, New York City, U.S.A., Chemist.
- O.M. Mellowaine, Alf. W., Stoneferry, Hull, Oil Manufacturer.
- O.M. McIndoe, G. D., Ness Street, Invercargill, New Zealand, Public Analyst and Consulting Chemist.
1917. MacInnes, Ronald, 17, Shrewsbury Road, New Southgate, London, N., Departmental Manager.
1903. MacIntire, Benj. Gould, c/o du Pont Powder Co., Georgetown, S.C., U.S.A., Chemist.
1916. McIntosh, J. G., 9, Parsonage Street, Cubitt Town, E., Technical Chemist.
1909. McIntyre, George D., 536, Notre Dame de Grace Avenue, Montreal, Canada, Technical Chemist.
1916. Mack, G. A., 19, Havergal Street, Runcorn, Cheshire, Works Chemist.
1910. Mackay, Angus, Laboratory, Wellpark Brewery, Glasgow, Brewer's Chemist.
1911. Mackay, F., Oficina Agua Santa, Negreiros, Iquique, Chile, Analytical Chemist.
1912. McKechnie, Alex., Chad Hill Cottage, Edgbaston, Birmingham, Copper Smelter.
1904. MacKeehnie, R. D., c/o British Aluminium Co., Ltd., Larne Harbour, co. Antrim, Ireland, Chemical Engineer.
1917. McKee, Ralph H., 187, Bergen Avenue, Ridgefield Park, N.J., U.S.A., Research Chemist.
1887. McKellar, W. G., c/o United Alkali Co., Ltd., St. Rollox Works, Glasgow, Technical Chemist.
1899. McKenzie, Alex. H., 17, North Street, North Adams, Mass., U.S.A., Colour Mixer.
1909. Mackenzie, Kenneth G., c/o The Texas Co., 17, Battery Place, New York, U.S.A., Chemist.
1917. McKenzie, Tom M., c/o Anglo Mexican Petroleum Co., Ltd., Finsbury Court, Finsbury Pavement, E.C., Chemist.
1893. McKerrow, C. A., 50, Great Russell Street, W.C.; and (Journals) c/o Mitchells, Ashworth and Co., 23-24, Old Bailey, London, E.C., Consulting Chemist.
1893. McKesson, John, 91, Fulton Street, New York City, U.S.A., Manufacturing Chemist.
1891. Mackey, W. McD., Victoria Chambers, Leeds, Analytical Chemist.
1916. Mackie, Wm., c/o Mrs. French, 219, Sydenham Road, Sydenham, London, S.E., Ironworks Chemist.
1912. McKillop, G. F., Oilworks, Broxburn, West Lothian, Scotland, Works Chemist.
1890. McKillop, Jno., c/o W. Muller, 69A, Great Queen Street, Kingsway, W.C., Metallurgist.
1902. McKim, Wm., 37, Fairview Street, Yonkers, N.Y., U.S.A., Colour Maker.
1915. MacKusick, M. H., The Rubber Regenerating Co., Ltd., Westinghouse Road, Trafford Park, Manchester, Managing Director.
1916. MacLachlan, H. F., Hillcrest Oil Co., Ltd.; and (Journals) Woodend, Styal, Cheshire, Managing Director.
1908. McLaren, Alex., c/o W. P. Hartley, Aintree, Liverpool, Analytical Chemist.
1908. McLaren, Alex. W., Ramsden Dock, Barrow-in-Furness, Analytical Chemist.
1916. McLaren, Geo., 146, Dukes Avenue, Muswell Hill, N., Analytical Chemist.
1898. McLaurin, Robt., Homesteads, Cambusbarron, Stirling, Chemist.
1916. MacLean, Dr. A. R. M., 369, Mance Street, Montreal, Canada, Chemist.
1905. McLellan, Basil G., c/o Rowntree and Co., Ltd., The Cocoa Works, York, Technical Chemist.
1908. Macleod, Alex., Mount Pleasant, Old Kilpatrick, Dumbartonshire, Analytical Chemist.
1914. MacLeod, Fred. L., 694, Duke Street, Glasgow, Chemical Manufacturer.
1892. Macleod, Jas., Clairmont, 54, Albert Drive, Pollokshields, Glasgow, Manager.

1912. McMaster, Prof. Le Roy, Washington University, St. Louis, Mo., U.S.A., Assoc. Prof. of Chemistry.
1904. McMullen, Alan, Saint James' Gate, Dublin, Ireland, Brewer.
1895. McMurtry, G. C., Templemore, Richmond, Nelson, New Zealand, Manager.
- O.M. Macnab, W., 10, Cromwell Crescent, London, S.W., Analytical Chemist.
1907. McNaughton, Wm. G., Port Edwards, Wis., U.S.A., Chemist.
1908. McQueen, James, jun., No. 3, Staff Quarters, Dornock, Dumfriesshire, Chemical Manufacturer.
1912. McRae, J. A., 184, University Avenue, Kingston, Ont., Canada, Research Chemist.
1914. McTavish, D. D., 626, Roslyn Avenue, Westmount, Quebec, Canada, General Manager (Canadian Carbide Co.).
1909. McWhirter, James, c/o Wm. Beardmore and Co., Laboratory, Parkhead Forge, Glasgow, Metallurgical Chemist.
1910. Madge, Norman, 406, West Fifth Avenue, Roselle, N.J., U.S.A., Chemist.
1912. Main, Hugh, Almondaie, Buckingham Road, South Woodford, Essex, Analytical Chemist.
1898. Main, Wm., Piermont, N.Y., U.S.A., Chemist.
1915. Maitland, Prof. W., Robert Gordon's Technical College, Aberdeen, Professor of Chemistry.
1905. Major, Ernest, c/o Major Bros. and Co., Johnstone's Bay, Balmain, Sydney, N.S.W., Paint and Chemical Manufacturer.
- O.M. Major, J. Lewis, Sculcoates, Hull, Tar Distiller and Chemical Manufacturer.
1910. Male, C. E., c/o Bankoku Toryo Seizosho, P.O. Box No. 141, Kobe, Japan, Chemist.
1886. Mallinckrodt, Edw., Mallinckrodt Chemical Works, St. Louis, Mo., U.S.A., Manufacturing Chemist.
1916. Malpas, A. E., "Inglebrook," Flint, North Wales, Manager (Perchlorate Works).
1915. Manahan, E. H., Marris Avenue, and Elm Road, Mountain Lakes, N.J., U.S.A., Manager (J. C. Wiarda and Co.).
1912. Manley, Chas. E., 8, Wilmington Gardens, Barking, Essex, Paint and Colour Works Manager.
1917. Manley, John W., "Woodbury," New Barnet, Herts, Electrical Engineer.
1893. Mann, Harold H., Agricultural College, Poona, Bombay, India, Research Chemist.
1899. Mann, Jas. S., 19, Stoford Road, Upton Manor, Essex, Analyst.
1891. Mann, John C., 33, Nicholls Street, West Bromwich, Staffs, Chemist.
1914. Mann, Wilfred G., 37, Parliament Street, Westminster, S.W., Chemical Engineer.
1914. Mann, William, Messrs. Mann and Cook, 27, St. Mary Axe, London, E.C., Oil and Chemical Merchant.
1892. Mansbridge, Wm., 4, Norwich Road, Wavetree, Liverpool, Chemist.
1915. Mansfield, John F., 433, Beverley Road, Hull, Manufacturer of Oils and Fats.
1916. Marcan, A., Sapatum Road, Bangkok, Siam, Chief Assayer, Royal Siamese Mint.
1883. Markel, Dr. K. E., 20, Queen's Gate Terrace, South Kensington, S.W., Technical Chemist.
1916. Marks, H. P., 3, Cranley Mansions, Muswell Hill, N., Analytical Chemist.
1905. Marland, Percy, Kempfield House, Knottingley, Yorks, Technical Chemist.
1905. Marlatt, Wilbur T., Oakville, Ont., Canada, Leather Manufacturer.
1914. Marples, Morris E., 20A, Belvedere Road, Upper Norwood, London, S.E., Chemist.
1916. Marriott, A. W., 21, Tennyson Street, Nottingham, Analytical Chemist.
1904. Marris, H. C., 68, Schlüsselsburg Prospekt, Petrograd, Russia, Analytical Chemist.
1901. Marsden, Dr. Fred., Technical Institute, Madura, South India, Chemist.
1906. Marsden, Oliver, Manor Road Mill, Victoria Road, Leeds, Cashier.
- O.M. Marsh, J. T., Ammonia Soda Works, Fleetwood, Lancashire, Chemist.
1883. Marsh, W., Union Alkali Co., Soho Works, Ancoats, Manchester, Chemical Manufacturer.
1895. Marshall, Arthur, Waverley Cottage, Naini Tal, India, Chief Chemical Examiner.
1895. Marshall, Francis G., 56, Bewick Road, Gateshead, Technical Chemist.
1908. Marshall, John, Cudbear Street, Hunslet, Leeds, Dyeware Manufacturer.
1917. Marshall, Joseph, 11, George Road, West Bridgford, Nottingham, Research Chemist (Boots Pure Drug Co.).
1913. Marshall, Philip W., c/o The Fred. Crane Chemical Co., Armoury Close, Bordesley Green, Birmingham, Lacquer Manufacturer (retired).
1917. Marshall, Reginald E., No. 29 Black, Gaitlebridge, Greta, Works Chemist.
1883. Marshall, Wm., Laboratory, Ladybrook Road, Cheadle Hulme, Cheshire, Dyer.
1884. Marshall, Wm., 9, Castello Avenue, Putney Park, S.W., Analytical Chemist.
1904. Marston, John P., 247, Atlantic Avenue, Boston, Mass., U.S.A., Merchant.
1894. Martin, Alex. M., Hillview, Twechar by Glasgow, Analytical Chemist.
1895. Martin, Chas. H., 50, Longmead Road, Claremont, Pendleton, Manchester, Oil and Soap Works Manager.
1913. Martin, Edwin J., c/o Jas. Martin and Sons, Luton, Beds, Bleacher and Dyer.
1911. Martin, Dr. G., Co-operative Wholesale Society, Ltd., Research Dept., 109, Corporation Street, Manchester, Science Teacher and Industrial Chemist.
1916. Martin, Sam W., "Wood Grange," Station Road, Brimington, Chemical Works Manager.
1917. Martin, Thomas, 18, Winifred Road, Urmston, Manchester, Works Chemist.
1916. Martin, V. M., 68, Upper Thames Street, London, E.C., Fur Skin Dyer and Dresser.
1916. Martin, Dr. Wm., c/o Brady and Martin, Ltd., Northumberland Road, Newcastle-on-Tyne.
1899. Martin, Wm. E., 111, Bellevue Road, Durban, Natal, South Africa, Chemist.
1887. Martineau, Sydney, Streatham Grove, Norwood, S.E., Sugar Chemist.
1894. Martyn, T. Graham, Box 5, Maraishburg, Transvaal, South Africa, Metallurgist.
1909. Marx, Robert J., 133-139, Finsbury Pavement, London, E.C., Engineer.
1904. Mason, Dr. Edward D., 32, Vernon Road, Edgbaston, Birmingham, Scientific Apparatus Dealer.
1911. Mason, Francis A., c/o Murphy and Lonsdale, 4, Queen Square, Leeds, Analytical Chemist.
1915. Mason, Dr. Fredk. A., 21, Queen Square, London, W.C., Demonstrator in Chemistry.
1906. Mason, Dr. Frederic S., 90, Beckman Street, New York City, U.S.A., Manufacturing Chemist.
1887. Mason, J. Francis, Eynsham Hall, Witney, Oxon.
1914. Mason, William O. S., Bankside, Meopham, near Gravesend, Kent, Analytical Chemist.
1915. Masse, René, 12, Rue de Clichy, Paris, France, President (Gas Society).
- O.M. Masson, Prof. D. Orme, University of Melbourne, Victoria, Australia, Professor of Chemistry.
1908. Masson, R. Duncan, c/o Messrs. R. Silcock and Sons, Stanley Hall, Union Street, Liverpool, Analytical Chemist.
1902. Masujima, Prof. Bunjiro, c/o K. Takebe, 16, Gizenbocho, Azabuku, Tokyo, Japan, Prof. of Applied Chemistry.
1910. Matchet, Andrew S., 13, Bute Gardens, Muirend, Cathcart, Glasgow, Analytical Chemist.
1911. Mather, Hubert, Lonsdale Terrace, Whitefield, Lancashire, Chemist.
1900. Mather, Wm., c/o The Standard Chemical Iron and Lumber Co., Montreal, Canada, Chemist.
1907. Matheson, A. Greville E., 9, Mossband, Greta, near Carlisle, Engineer.

1890. Matheson, W. J., c/o Cassella Color Co., 182, Front Street, New York City, U.S.A., Chemical Merchant.
1901. Mathew, W. E. B. de Vere, "Dinham," Hillside Gardens, Wallington, Surrey, Analytical Chemist.
1898. Mathewson, E. P., Royal Bank Building, 8, King Street East, Toronto, Canada, Metallurgist.
1888. Mátos, Dr. Louis J., (Comms.) 103, North 19th Street, East Orange, N.J., and (Jnls.) c/o Cassella Color Co., 182-4, Front Street, New York City, U.S.A., Chemist.
1896. Matsui, G., 10, Nishikatomachi, Hongo, Tokyo, Japan, Chemical Engineer.
1912. Matthewman, Fred. P., Analyst's Office, L.B. and S.C. Railway Co., Brighton, Chief Chemist.
- O.M. Matthews, Chas. G., 31, Stapenhill Road, Burton-on-Trent, Brewing Chemist.
1907. Matthews, Dr. F. E., Aberdeen House, Flat No. 1, 211, Adelaide Road, Swiss Cottage, N.W., Technical Research Chemist.
1899. Matthews, Dr. J. Merritt, 50, East 41st Street, New York City, U.S.A., Professor of Chemistry and Dyeing.
1903. Maxim, Hudson, 698, St. Mark's Avenue, Brooklyn, N.Y., U.S.A., Chemist and Mechanical Engineer.
1916. Maxted, Dr. Edw. B., 63, Highgate Road, Walsall, Staffs, Chemist.
1894. Maxwell, Jno., Solway Chemical Works, Silloth, Cumberland, Chemical Manure Manufacturer.
1903. Maxwell, Orin P., c/o West Virginia Pulp and Paper Co., Luke, Md., U.S.A., Chemist.
1911. May, Clarence E., 520, South Park Avenue, Bloomington, Ind., U.S.A.
1914. May, Dr. Percy, 126, Cazenove Road, Stamford Hill, London, N., Chemist.
1884. Mayenfeld, Dr. E. von Salis. See Salis-Mayenfeld, Dr. E. von.
1903. Mayer, Andrew, jun., 8210, Ridge Boulevard, Brooklyn, N.Y., U.S.A., Chemist.
1896. Mayfield, A. S., Oakdene, Newland Park, Hull, Analyst.
1892. Mayfield, H. B., Normanhurst, Mundy Street, Heanor, near Nottingham, Dyer.
1885. Mayhew, E. W. A., Library, Technical College, Perth, Western Australia, Manufacturing Chemist.
1916. Mayo, Chas. R., 155, Dashwood House, New Broad Street, E.C., Consulting Engineer.
1909. Meanwell, Chas. W., 15, Woodlands Crescent, Muswell Hill Road, London, N., Analytical Chemist.
1916. Meek, R. H., 1331, Salisbury Drive, Vancouver, B.C., Canada, Chief Dairy and Food Inspector.
1896. Meggitt, Loxley, c/o Co-operative Wholesale Society, Ltd., Irlam, near Manchester, Analytical Chemist.
1901. Meier, Dr. Franz, c/o Society of Chemical Industry in Basle, Basle, Switzerland, Chemist.
1888. Meikle, John, S., Melrose Street, Great Western Road, Glasgow, Journalist.
1915. Meister, Fred J., Laboratory, Distillers' Co., Ltd., Menstrie, Scotland, Analytical Chemist.
1902. Mecher, Arthur C., 58, Bowen Street, Newton Centre, Mass., U.S.A., Research Chemist.
1912. Melling, S. E., Bank House, The Cliff, Higher Broughton, Manchester, Analytical Chemist.
- O.M. Mellon, W. W., Woodlands, Blackrock, Co. Dublin, Ireland, Manufacturing Chemist.
1910. Mellor, Dr. Joseph W., Sandon House, Regent Street, Stoke-on-Trent, Ceramic Chemist.
1917. Melvin, Geo. M. A., c/o Australian Explosives and Chemical Co., Ltd., 135, William Street, Melbourne, Australia, General Manager.
1915. Mendonça, M. S. de, 100, Rua S. Julião, Lisbon, Portugal, Chemist.
1912. Mennell, Harold, 41, Wolverton Road, Stony-Stratford, Bucks, Analytical Chemist.
1893. Mensching, Dr. C., Journals to Mersey Chemical Works, Bromborough Port, Birkenhead, Chemist.
1915. Menzies, R. C., c/o A. Beake Roberts & Co., Ltd., Carpenters Road, Stratford, E., Chemist.
1892. Mercer, C. A., 34, Camomile Street, London, E.C., Chemical Apparatus Maker.
1905. Merck, George, Merck and Co., 45, Park Place, New York City, U.S.A., Manufacturing Chemist.
1916. Merreywether, J. E., 27, Agnes Street Meadows, Nottingham, Analytical Chemist.
1899. Merrill, Frank H., 2420, Ocean View Avenue, Los Angeles, Cal., U.S.A., Factory Superintendent.
1906. Merrils, Fred. J., 25, Figtree Lane, Sheffield, Analytical Chemist.
1909. Merriman, C. E. B., 74, Trent Boulevard, West Bridgford, Nottingham, Technical Chemist.
1909. Merriman, H. J., 214, Victoria Park Road, South Hackney, N.E., Research Chemist.
1905. Merrin, A. C., 194-200, Bishopsgate, London, E.C., Assistant Editor and Analyst.
1904. Merry, Jno. B., 74, Park Hill Road, Harborne, Birmingham, Metallurgical Chemist.
1903. Mersan, Ferdinand de, Fairfield, Chestnut Avenue, Boston Spa, Yorks, Chemist.
1905. Merz, Eugene, Newark, N.J., U.S.A., Superintendent, Heller and Merz Co.
1897. Meslans, Prof. M., 6, Rue de Navarin, Paris, France, Professor of Chemistry.
- O.M. Messel, Dr. R., F.R.S., 147, Victoria Street, London, S.W., Chemical Manufacturer.
1899. Metcalf, Howard F., Farr Alpaca Co., Holyoke, Mass., U.S.A.
1886. Metcalf, Jno., Moorfield Chemical Works, Altham, near Acerington, Tar Distiller.
1908. Metcalfe, Ernest D., Messrs. Curtis's and Harvey, Ltd., Cannon Street House, London, E.C., Secretary.
1906. Methley, Bernard, Ferndale, Moorgate, Rotherham, Yorks, Engineering Chemist.
1898. Metz, Herman A., P.O. Box 753, New York City, U.S.A., Chemical Merchant.
1917. Metzger, F. J., 120, Broadway, New York City, U.S.A., Professor of Chemical Engineering.
1900. Mewborne, Robt. G., c/o Kentucky Tobacco Products Co., Louisville, Ky., U.S.A., Chemist.
1907. Meyer, Dr. Erwin, c/o Morgan and Wright, Detroit, Mich., U.S.A., Chemist.
1902. Meyrick, L. J., 137, City Road, Birmingham, Assistant Analyst.
1915. Miall, Dr. S., 28, Belsize Grove, Hampstead, N.W., Chairman of the Grimsdown Lead Co.
1912. Michie, Arthur C., The Wallsend Laboratories, Wallsend-on-Tyne, Technical Chemist.
1909. Michie, John L., c/o Peter Scott and Co., Limited, Buccleuch Street, Hawick, Scotland.
1907. Micklethwait, Miss Frances M. G., 17, St. Mary's Terrace, Paddington, W., Chemist.
1916. Middleditch, B., Hillside, Peterborough Hill, Harrow, Chemistry Master.
1911. Middlemass, Alphonso, 59, Promenade, Portobello, Midlothian, Works Chemist.
1904. Mighill, Dr. Thos. A., 37, Wareham Street, Boston, Mass., U.S.A., Chemist.
1896. Miles, G. Wellington, jun., Room 214, 88, Broad Street, Boston, Mass., U.S.A., Analytical Chemist.
1889. Milestone, W. C., 45, Heathfield Road, Wandsworth Common, S.W., Chemical Works Manager.
1916. Millar, A. Falconer, 28, Victoria Street, London, S.W., Chemical Engineer.
1916. Millar, E. T., Douglas House, Birmingham Road, West Bromwich, Chemist.
1899. Millar, Jas. H., P.O. Box 4975, Johannesburg, Transvaal, Manufacturing and Analytical Chemist.
1909. Millar, Jas. Hill, Chief Chemist's Laboratory, St. James' Gate Brewery, Dublin, Chemist.
1883. Miller, Dr. A. K., Kilvert's Buildings, Withy Grove, Manchester, Analytical Chemist.
- O.M. Miller, E. V., Sugar Works, Chelsea, Auckland, New Zealand, Sugar Works Chemist.
1914. Miller, Eric J., Carnub Club, Perambur Barracks, Madras, India, Chemist.
1917. Miller, Frank, 21, Ossington Villas, Sherwood Street, Nottingham, Works Chemist (Boots Pure Drug. Co.).

1889. Miller, Geo., Thornlea, Beaconsfield Road, Farnworth, Widnes, Technical Chemist.
1893. Miller, Dr. Harry E., 305, Palm Avenue, Oakland, Cal., U.S.A., Chemist.
1894. Miller, Dr. John A., 44-45, Lewis Block, Buffalo, N.Y., U.S.A., Consulting Chemist, to State of N.Y.
1888. Miller, J. Hopkins, 86, North Frederick Street, Glasgow, Dyeworks Chemist.
1889. Miller, Jno. Poynter, Sandilands Chemical Works Aberdeen, Technical Chemist.
1901. Miller, Stuart B., c/o Du Pont Powder Co., High Explosives Operating Dept., Wilmington, Del., U.S.A., Chemical Engineer.
1916. Miller-Jones, T., Invieta Mills, Bow Common Lane, London, E., Manufacturing Chemist.
1901. Miller, Dr. W. Lash, 50, St. Alban Street, Toronto, Canada, Associate Professor of Physical Chemistry.
1884. Miller, W. M., Caledonia Estate, Prov. Wellesley, Penang, S.S., Sugar Chemist.
1902. Milligan, R. E., New York Continental Jewell Filtration Co., 15, Broad Street, New York City, U.S.A., Chemical Engineer.
- O.M. Mills, Prof. E. J., F.R.S., 64, Twyford Avenue, West Acton, W., Emeritus Professor of Technical Chemistry and Consulting Chemist.
1916. Mills, Frederick Peter, Colliery Rescue Station, 854, Scotswood Road, Newcastle-on-Tyne, Mining Engineer.
1904. Mills, Dr. J. E., University of South Carolina, Columbia, S.C., U.S.A., Analytical and Consulting Chemist.
1916. Mills, Willie G., "Sylvan," Bramford, near Ipswich, Suffolk, Works Manager.
1905. Mills, Wm. Henry, 120, Broadway, New York City, U.S.A., Merchant.
1916. Mills, Dr. Wm. S., Research Dept., Levinstein, Ltd., Blackley, Manchester, Research Chemist.
1915. Milne, John, 1, St. Mary's Place, Inverurie, Aberdeenshire, Merchant.
1905. Milne, Thomas, c/o The Gas Light and Coke Co., Ltd., Finsbury Court, Finsbury Pavement, London, E.C., Chemical Products Salesman.
1916. Milner, David W., Well Close Place, Lofthouse, Wakefield, Works Chemist.
1903. Milnes, Cresswell, The Cedars, Holborough, near Rochester, Cement Works Manager.
1887. Milnes, Edmund, Seedfield, Bury, Lancashire, Dyeing Extract Maker.
1902. Milnes, Ernest E., Park Print Works, Halifax, Yorks, Chemist.
1909. Mindeff, Chas., c/o American Smelting and Refining Co., Maurer, N.J., U.S.A., Chemist.
1895. Miner, Harlan S., c/o Welsbach Light Co., Gloucester City, N.J., U.S.A., Technical Chemist.
1916. Mingaye, J. C. H., Chemical Laboratory, Dept of Mines; (Journals) Campbell Street, Parramatta, N.S.W., Australia, Chemist and Assayer.
1915. Misell, D., c/o R. Lane-Hall and Co., 4, Lloyds' Avenue, London, E.C., Chemical Merchant.
1895. Mitchell, Chas. A., c/o Beanfoy and Co., South Lambeth Road, S.W., Analyst.
1898. Mitchell, G. D. H., 309, North Fullerton Avenue, Montclair, N.J., U.S.A., Chemist.
1917. Mitchell, Percy, Hillside, Wheatthampstead, Herts, Works Chemist.
1917. Mitchley, John W., A4, Staff Quarters, Easttriggs, Annan, N.B., Chemical Engineer.
1904. Mitsugi, R., c/o Tokyo Gas Co., Kanda, Tokyo, Japan, Chemist.
- O.M. Mitting, E. Kennard, 38, Harold Road, Norwood, S.E., Technical Chemist.
1909. Miyoshi, K., Osaka Gas Works, Iwasakicho, Nishiku, Osaka, Japan, Engineer.
1905. Modi, Dr. E. M., Meher Buildings, Tardeo, Bombay, India, Manufacturing and Analytical Chemist.
1917. Mody, Frederick W., 12, Park Avenue, Long-sight, Manchester, Works Chemist.
1910. Moe, Carl, The Pine Tree Inn, Bogalusa, La., U.S.A., Chemist.
1906. Moe, Eldor H., Box 266, Salt Lake City, Utah, U.S.A., Chemist.
1914. Moffitt, Francis A., 72, Hawley Street, Binghamton, N.Y., U.S.A., Chemist.
- O.M. Mohr, Dr. B., 69A, Parliament Hill, Hampstead, N.W., Consulting Chemist and Metallurgist.
1894. Mole, Herbert B., Royal Albert Brewery, Queen's Road, Reading, Brewer.
1901. Mond, Dr. Albert L., c/o Hubers and Mond, 19, Southampton Buildings, Chancery Lane, London, W.C., Chemical Engineer.
1899. Mond, Emile S., 22, Hyde Park Square, London, W., Technical Chemist.
1891. Mond, Dr. Robt. L., Cembe Park, near Sevenoaks, Kent, Chemist.
1906. Monier-Williams, G. W., 32, St. Leonard's Terrace, Chelsea, S.W.
1908. Monk, Chas. W., 102, Bloomfield Road, Plumstead, Kent, Chemist.
1909. Monk, Reginald Hill, 388, Grosvenor Avenue, Westmount, P.Q., Canada, Chemical Engineer.
1916. Montgomerie, J. A., Maryfield, Central Avenue, Cambuslang, Chemist.
1890. Moodie, Wm. E., Alexandria Works, Alexandria, Scotland, Analytical Chemist.
1905. Moody, Dr. Gerald T., Lorne House, North Dulwich, S.E., Barrister-at-Law.
1898. Moody, Dr. Herbert R., College of the City of New York, and (Journals) 330, Convent Avenue, New York City, U.S.A., Professor of Chemistry.
1903. Mooney, F. Morgan, 118, Pembroke Road, Dublin, Chemical Manure Manufacturer.
1902. Mooney, Luke, Box 435, Woodbridge, N.J., U.S.A.,
1887. Moore, Chas. C., 33, Clarendon Road, Garston, Liverpool, Chemist.
1901. Moore, Dr. Chas. W., c/o Crosfield and Sons, Ltd., Laboratory, Warrington, Chemist.
1907. Moore, Ernest P., 34, Jackson Street East, Hamilton, Ont., Canada, Chemist.
1911. Moore, 2nd Lieut. Ernest W., 3rd Battalion Middlesex Regt., Salonika E.F., Analytical Chemist. On Active Service; retain Journals.
1902. Moore, Fred., Canadian Explosives, Ltd., Victoria, B.C., Canada, Manufacturing Chemist.
1906. Moore, F. H., Messrs. G. H. Ogston and Moore, 87-89, Aldgate, London, E., Analytical Chemist.
1892. Moore, Dr. Geo. D., 201, Salisbury Street, Worcester, Mass., U.S.A., Professor of Chemistry.
1914. Moore, Harold, c/o Mirreles, Bickerton, and Day, Hazel Grove, Stockport, Chemist.
1916. Moore, Jos. H., Main Street, Randalstown, co. Antrim, Ireland, Textile Chemist and Cloth Bleacher.
1912. Moore, Joseph W., Kinderton House, Runcorn, Works Chemist.
1914. Moore, Lawrence, Stoneywood, 22, Welbeck Street, Wakefield, Dyer.
1905. Moore, Leslie R., 14, Elm Street, Concord, Mass., U.S.A., Chemist.
1899. Moore, Quintin, jun., Garrowbank House, Riddrie, Glasgow, Works Manager.
1885. Moore, R. T., 142, St. Vincent Street, Glasgow, Mining Engineer.
1899. Moore, Dr. Russell W., 121, Madison Avenue, New York City, U.S.A.; and Journals to University Library, Princeton, N.J., U.S.A., Chemist.
1890. Moore, Thos., 3, Tamworth Road, Sutton Coldfield, Birmingham, Analytical Chemist.
1917. Moore Tom S., Hillside, Egham, Surrey, Professor of Chemistry.
1910. Moorhouse, Samuel, 48, Oakworth Street, Blackley, Manchester, Secretary and Oil Specialist.
1903. Moran, Geo. A., 98, Massachusetts Avenue, North Andover, Mass., U.S.A., Chemist.
1916. Mordecai, W. E., 1, Craig-yr-Hesg, Berw Road, Pontypridd, Glem, Technical Chemist.
1902. More, Andrew, "Ellesmere," King's Road, Walton-on-Thames, Analytical Chemist.

1908. Morfev, Harold, c/o The Mitchell Main Colliery Co., Ltd., Wombwell, near Barnsley, Yorks, Manager of By-Products Works.
1901. Morgan, Dr. Gilbert T., F.R.S., City and Guilds Technical College, Leonard Street, Finsbury, E.C., Professor of Chemistry.
1912. Morgan, Sidney, Petaling Estate, Selangor, Federated Malay States, Analytical Chemist.
1906. Morgan, Thos., c/o R. H. Morgan and Co., Ltd., Custom House Buildings, Liverpool, Manufacturing Chemist.
1898. Morgan, T. M., 370, Wood Avenue, Westmount, Quebec, Canada, Cement Works Manager.
1916. Morgan, Trevor O., c/o Messrs. Levinstein, Ltd., Blackley, Manchester, Analytical Chemist.
- O.M. Moritz, Dr. E. R., 45, Great Tower Street, London, E.C., Brewing Chemist.
1885. Morley, Dr. H. Forster, 5, Lyndhurst Road, Hampstead, N.W., Professor of Chemistry.
1902. Morrell, Dr. R. S., Messrs. Mander Bros., Colour and Varnish Works, Wolverhampton, Chemist.
1884. Morrice, Jas. A., 1, Prince's Terrace, Dowanhill, Glasgow, Starch and Gum Manufacturer.
1906. Morris, A. H., 152, Chorley New Road, Bolton, Lanes, Brewer.
1898. Morris, Edgar F., Holly Bank, Roby, near Liverpool, Research Chemist.
1897. Morris, Harry, The Hall, Hexthorpe, Doncaster, Chemical Merchant.
1890. Morris, Herbert N., Alpha Works, Denton, near Manchester, Technical Chemist.
1903. Morris, Wm. J., 33, Prince Alfred Road, Wavertree, Liverpool, Chemist.
1911. Morrison, G. R., Oficina Reducto, Santa Catalina, Iquique, Chile, Chemist.
1910. Morrison, J. A. S., S. Esteourt Avenue, Headingley, Leeds, Leather Chemist.
1904. Morson, Thos. D., 14, Elm Street, Gray's Inn Road, London, W.C., Chemist.
1906. Morson, T. Pierre, 14, Elm Street, Gray's Inn Road, London, W.C., Chemical Manufacturer.
1916. Morton, Allan, 167, Trent Boulevard, West Bridgford, Nottingham, Technical Chemist.
1907. Morton, George A., "Silverbirch," Station Road, Wylde Green, Birmingham, Chemist and Works Manager.
1917. Morton, James, Dentonhill Works, Carlisle, Textile Manufacturer.
1897. Morton, Jno., North Road, St. Helens, Lancashire, Analytical Chemist.
1902. Mosbaugh, F. R., c/o Anglo-Canadian Leather Co., Huntsville, Ont., Canada, Chemist.
1911. Mosenthal, E. Macqueron de, 9, Rue Neuve, Versailles, France, Chemist.
1915. Moss, Gerald L., 13, Barkly Grove, Beeston, Leeds; Chemical Engineer.
1894. Moszczenski, John B., 216, Ovington Avenue, Brooklyn, N.Y., U.S.A., Consulting Chemist.
1897. Motion, Jno., c/o The Joseph Dixon Crucible Co., Jersey City, N.J., U.S.A., Assistant Superintendent.
1887. Moul, Frank, Aldersgate Chemical Works, Southall, Technical Chemist.
1898. Moulton, Prof. Chas. W., Vassar College, Poughkeepsie, N.Y., U.S.A., Professor of Chemistry.
1905. Moulton, Rt. Hon. Lord, K.C.B., G.B.E., F.R.S., 57, Onslow Square, London, S.W.
1915. Moulton, P. P., 49, The Mall, Faversham, Kent, Explosives Chemist.
1892. Mount, Edw., Oaklands, Aughton, near Ormskirk, Assistant Secretary (United Alkali Company).
1905. Mrazsek, F. M., 31, West Cromwell Road, London, S.W., Consulting Chemist.
1890. Muir, Jas. Stanley, 23, Lilybank Gardens, Glasgow, Chemist.
1896. Mundy, Lionel, 27, Merton Road, Kensington, W., Importer of Unfermented Wines.
1914. Munn, W. F., 518, Main Street, East Orange, N.J., U.S.A., Chemist.
1887. Munroe, Prof. Chas. E., George Washington University, Washington, D.C., U.S.A., Professor of Chemistry and Dean.
1900. Munton, Fred. T., c/o The Salt Union, Ltd., Engineer's Office, Winsford, Cheshire, Analytical Chemist.
1904. Murdoch, Alexander, Garden Suburb, Westerton, near Glasgow, Analytical Chemist.
1917. Murdoch, David S., 28, Craigpark Drive, Dennistoun, Glasgow, Analytical Chemist.
1886. Murdoch, R. H. M., Norwood, Saltecoats, Ayrshire, Explosives Chemist.
1899. Murphy, Albert J., 3 and 4, Queen Square, Leeds, Brewer's Chemist.
1901. Murray, Benjamin L., c/o Merck and Co., Rahway, N.J., U.S.A., Chemist.
1903. Murray, Chas. B., 467, Perry Payne Building, Cleveland, Ohio, U.S.A., Chemist.
1914. Murray, John E., c/o Emerson Drug Co., 64, Spadina Avenue, Toronto, Canada, Laboratory Superintendent.
1898. Murray, Rd., c/o Brotherton and Co., Ltd., Ammonia Works, Holmes Street, Leeds, Analyst.
1908. Murray, Captain Thos. J., O.C. 71st Sanitary Section, B.E.F., Lecturer on Chemistry.
1916. Murray-Salamon, W. H., Ferry Road, Rainham, Essex, Chemical Manufacturer.
1905. Murrill, Dr. Paul L., Room 86, Chemists' Building 50, East 41st Street, New York, U.S.A., Superintendent.
- O.M. Muspratt, Dr. E. K., Seaforth Hall, near Liverpool, Alkali Manufacturer.
1894. Muspratt, Max, The Grange, Fulwood Park, Liverpool, Technical Chemist.
- O.M. Muspratt, S. K., Alkali Manufacturer.
1907. Musso, Louis A., Box 956, G.P.O., Sydney, N.S.W., Australia, Technical Chemist.
1911. Myers, Ernest M., "Greycourt," Harpfield, Stoke-on-Trent, Coke Oven Manager and Chemist.
1917. Myers, Francis W., c/o W. J. Bush & Co., Ltd., Ash Grove, Hackney, N.E., Works Chemist.
1917. Myers, Jos. W., 4, Balmoral Gardens, Monkseaton, Northumberland, Analytical Chemist.
1891. Myers, Dr. Wm. S., 25, Madison Avenue, New York City, U.S.A., Director.

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1913. Nagase, Denzo, c/o Japan Dyestuff Manufacturing Co., Ltd., Osaka, Japan, Engineer.
1917. Nagelvoort, Adriaan, 52, East 41st Street, New York City, U.S.A., Chemist.
1908. Nagle, J. C., c/o Nicholls, Nagle and Co., Ltd., Trafford Park, Manchester, Glucose and Starch Manufacturer.
1913. Nair, Valliyil G., Société Cotonnière du Tonkin, Nam-Dinh, Tonkin, French Indo-China, Chemist and Colourist.
1897. Nairn, Sir Michael, Bart., Dysart House, Fife, Linoleum Manufacturer.
1909. Nakai, S., Miike Colliery Office, Omuta-machi, Chikugo, Japan, Engineer.
1903. Nakayama, T., Kihō, near Fusan, Korea, Chemist.
1893. Napier, John W., Gas Works, Alloa, Scotland, Manager and Chemist.
1904. Napper, Sidney S., c/o S. Courtauld and Co., Ltd., Foleshill Road, Coventry, Chemist.
1897. Nash, L. Myddleton, Westlands, Princess Road, Finsbury Park, N., Industrial Chemist.
1910. Nash, N. C., Treleven, Darling Street, Balmain East, Sydney, N.S.W., Works Chemist.
1908. Nasmith, M. E., Curtis Bay Chemical Co., Curtis Bay, Md., U.S.A., Chemist.
1900. Nathan, Col. Sir Frederic L., 37, Cornwall Gardens, South Kensington, S.W.
1917. Naughton, Wm. J. S., Levinstein Ltd., Blackley, Manchester, Research Chemist.

1916. Naylor, J. H., Braemore, Flinn Lane, Frodsham, Cheshire, Explosives Works Manager.
- O.M. Naylor, W. A. H., The British Drug Houses, Ltd., 22-30, Graham Street, City Road, London, N., Manufacturing Chemist.
1909. Neal, C. S., Acme White Lead and Colour Works, Detroit, Mich., U.S.A., Manager.
1899. Neate, Percy J., 49, Frogna, Hampstead, N.W., Director of Cement Co.
1916. Neaverson, Lewis, Clough Edge, Halifax Old Road, Huddersfield, Teacher of Dyeing.
1905. Neff, Robert W., 22, India Square, Boston, Mass., U.S.A., Chemical Manufacturer.
1906. Neil, Dr. Archibald A., c/o Brunner, Mond, and Co., Ltd., Caxton House, Westminster, S.W., Chemical Engineer.
1890. Neill, Geo. D., 78, Drumfrah Road, Greenock, Sugar Refiner.
1898. Neilson, Alex. McG., Umbilo, Durban, Natal, Analytical Chemist.
1911. Neilson, R. G., c/o Anglo-Persian Oil Co., Ltd., Abadan, Persian Gulf (via Bombay), Assistant Works Manager.
1902. Neish, Dr. Arthur C., Columbia University, New York City, U.S.A., Chemist.
1911. Nello, Vincent, Baldwin's Hill, Loughton, Essex, Artists' Colour Manufacturer.
1917. Nelson, Colin McG., Casa Pirita, Minas de Rio Tinto, Huelva, Spain, Metallurgist.
1916. Nelson, Sir E. Montague, K.C.M.G., Emseote Mills, Warwick, Gelatine Manufacturer.
1916. Nelson, Percy S., 153, Holly Road, St. Albans, Christchurch, New Zealand, Assistant Chemist.
1913. Nesbitt, Cosby T., 18, Montrose Road, Sheffield, Metallurgical Chemist.
1906. Nestell, Raymond J., c/o Western Precipitation Co., 1016, West Ninth Street, Los Angeles, Cal., U.S.A., Analytical Chemist.
1902. Neumann, Dr. Edgar D. M., Chemical Supply Co., Barking Gas Works, Abbey Road, Barking, E.
- O.M. Newall, F. S., Washington Station R.S.O., Co. Durham, Chemical Manufacturer.
1905. Newall, Jos., Hill Cliffe, Heath Road, Runcorn, Cheshire, Chemist.
1889. Newberry, Spencer B., 818, Engineers' Building, Cleveland, Ohio, U.S.A., Manager.
- O.M. Newlands, W. P. R., 10, Criclado Avenue, Streatham Hill, S.W., Sugar Chemist.
1914. Newman, Alex. R., C.E.R.A. (Temp.), H.M.S. Erebus, c/o G.P.O., London, Chemical Engineer.
- O.M. Newton, Jno., Verney Road, Rotherhithe New Road, London, S.E., Manure Manufacturer.
1912. Newton, Leonard O., Sefnol Ltd., Westcombe Hill, Greenwich, S.E., Analytical Chemist.
1901. Nibelius, Axel W. T., The Engineers' Club, 32, West 40th Street, New York City, U.S.A., Chemist.
1916. Nicholl, George, 15, Prince's Road, Heaton Moor, Stockport, Director, Claus & Co., Ltd.
1915. Nicholls, H. V., c/o G. and C. Hoskins, Ltd., Eskbank Iron and Steel Works, Lithgow, N.S.W., Australia, Chemist.
1904. Nichols, C. W., 25, Broad Street, New York City, U.S.A., Manufacturing Chemist.
1905. Nichols, E. Remington, 25, Broad Street, New York City, U.S.A., Treasurer (Nichols Chemical Co.).
1888. Nichols, Dr. Wm. H., 25, Broad Street, New York City, U.S.A., Chemical Manufacturer.
1905. Nichols, W. H., jun., 25, Broad Street, New York City, U.S.A., Chemical Manufacturer.
1916. Nicholson, Frank, The Brewery, Castle Street, Sunderland, Brewery Director.
1904. Nicholson, Wilfred E., Hunstet Chemical Works, Leeds, Chemical Manufacturer.
1897. Nicholson, Wm. J., Ardeer, Stevenston, Ayrshire, Chemist.
1917. Nicol, James, "Sunny Lawn," 25, Montague Road, Wimbledon, London, S.W., Chemist.
1903. Nicoll, Frank, c/o Messrs. F. Steiner and Co. Ltd., Church Works, Church, Lanes, Chemist.
1905. Nieghorn, Albert, 120, Mill Street, Toronto, Canada, Agent.
1900. Nield, J. H., c/o General Chemical Co., Edgewater, N.J., U.S.A., Superintendent.
1916. Nightingale, Ernest, 20, Swain Street, Hyde, Cheshire, Works Chemist.
- O.M. Nimmo, Jas., 35, Whitworth Road, South Norwood, S.E., Analytical Chemist.
1907. Nims, H. E., c/o The Fiberloid Co., Indian Orchard, Mass., U.S.A., Chemist.
1916. Nisbet, Edward T., Lambton and Hetton Collieries, Ltd., Cathedral Buildings, Dean Street, Newcastle-on-Tyne, Secretary.
1885. Nishigawa, T., 5, Hikawa Cho, Akasaka, Tokyo, Japan, Works Director and Chemical Engineer.
1898. Nishikawa, Dr. T., Dept. of Applied Chemistry, Kyushu Imp. University, Fukuoka, Japan, Prof. of Applied Chemistry.
1916. Nivling, Walter A., 185, Devonshire Street, Boston, Mass., U.S.A., Sales Manager.
- O.M. Noetting, Prof. Dr. E., Cengiopresso, Savona, Italy, Professor of Chemistry.
1917. Nordin, Chas., c/o Russian-American India Rubber Co., Treugolnik, Petrograd, Russia, Works Chemist.
- O.M. Norman, Sir Frederick J., Lyndhurst, Higher Runcorn, Cheshire, Chemical Manufacturer.
1892. Norman, J. T., 23, Leadonhall Street, London, E.C., Consulting Chemist.
1913. Norman, T. Stanley, Lyndhurst, Runcorn, Cheshire, Chemical Manager.
1890. Norman-Bott, Dr. Wm., 64, Victoria Street, Westminster, London, S.W., Consulting Chemist.
1915. Norris, Edward W., c/o Levinstein, Ltd., Blackley, Manchester, Works Chemist.
1902. North, Barker, 33, Ashgrove, Great Horton Road, Bradford, Assistant Professor of Chemistry.
1915. Northing, H. C., Reenmore, Arklow, co. Wicklow, Ireland, Technical Chemist.
1916. Northwood, T. G., 22, Claremont Road, Woodsmoor, Stockport, Works Chemist.
1905. Norton, Arthur L., 100, William Street, New York City, U.S.A., Dyestuff Merchant.
- O.M. Norton, Dr. S. A., 363, East Town Street, Columbus, Ohio, U.S.A., Professor of Chemistry (Ohio State University).
1911. Norton, Samuel J., Craigie Bank, 15, Merrylyce Road, Newlands, Glasgow, Engineer.
1887. Norton, Dr. T. H., c/o Wm. Bryce, 54, Lothian Street, Edinburgh, U.S. Consul.
1899. Noyes, Henry, 499-501, Bourke Street, Melbourne, Victoria, Australia, Engineer.
1901. Noyes, Prof. Wm. A., University of Illinois, Urbana, Ill., U.S.A., Editor (J. Amer. Chem. Society).
1917. Nutter-Smith, Arthur, 47, North Road, West Bridgford, Nottingham, Works Chemist (Boots Pure Drug Co.).

O

1910. Oakden, W. E., 11, Lonsdale Road, Barnes, S.W., Director of Research Laboratory.
1905. Oakes, F. J., jun., 141, Milk Street, Boston, Mass., U.S.A., Secretary, Oakes Manufacturing Co.
1904. Oberländer, Dr. Otto, 29, Queen Street, London, E.C., Research and Consulting Chemist.
1904. O'Brien, Claude H., c/o Central Cane Price Board, Dept. of Agriculture, Brisbane, North Queensland, Supervising Chemist.
1900. O'Brien, Frederick, Pineleigh, Saltford, near Bristol, Analytical Chemist.
1905. Oburg, W. F., 148, State Street, Boston, Mass., U.S.A., Assistant Treasurer (Merrimac Chem. Co.).
1917. O'Callaghan, Jas. P., c/o United Water Softeners, Ltd., Imperial House, Kingsway, London, W.C. (Journals to 36, Tyrwhitt Road, Brockley, London, S.E.), Analytical Chemist.
1908. O'Day, John, 15, Custom House Street, Boston, Mass., U.S.A., Dyestuff and Chemical Merchant.

1888. Oddy, Robert W., Abbey Street, Toad Lane, Rochdale, Chemist.
1908. Ogilvie, Jas. P., 2, St. Dunstan's Hill, E.C., Analytical Chemist.
1901. Ogston, Alex. G., Heathpark, near Aberdeen, Soap Manufacturer.
1903. Ohlenschläger, J. G., jun., Shanghai House, Botolph Lane, London, E.C., Chemical Merchant.
1905. Ohliger, Willard, c/o F. Stearns and Co., Detroit, Mich., U.S.A., Chemist.
1907. Oke, Alfred W., 32, Denmark Villas, Hove, Sussex, Solicitor.
1884. Oliver, F., 31, Horsley Hill Road, Westoe, South Shields, Analytical Chemist.
1910. Oliver, Willie, Wilton Villa, 4, St. Mary's Avenue, Carlton Grange, Batley, Yorks, Works Chemist; retain Journals.
1888. Oliver, Wm. Letts, 251, Vernon Street, Oakland, Cal., U.S.A., Mining Engineer.
1914. Olle, Arch. D., "Kareema," Charlotte Street, Ashfield, N.S.W., Australia, Electro-therapeutist.
1904. Olney, Prof. L. A., 118, Riverside Street, Lowell, Mass., U.S.A., Professor of Chemistry and Dyeing.
1916. Olssen-Seffer, R., 1, Royal Exchange Place, Calcutta, India, Nitrate Agent.
1902. O'Neill, Chas., c/o Bleachers' Association, Ltd., 4, Norfolk Street, Manchester, Chemist and Colourist.
1905. Ormandy, Dr. W. R., Imperial House, Kingsway, London, W.C., Consulting Chemist.
1898. Ormerod, Dr. Ernest, 62, Dale Street, Liverpool, Consulting and Analytical Chemist.
1894. Ormerod, John, Globe Leather Works, Castleton, Manchester, Tanner and Currier.
1913. Ormsby, Irwin, "Caleula," Allison Road, Randwick, New South Wales, Australia, Factory Assistant.
1917. Orr, Donald J. W., c/o Messrs. Orr's Zinc White, Ltd., Widnes, Lancs., Chemical Manufacturer.
- O.M. Orr, J. B., Crossacres, Woolton, Liverpool, Chemical Manufacturer.
1907. Ortvad, Niels C., c/o Hiram Walker and Sons, Ltd., Walkerville, Ont., Canada, Chemist and Fermentologist.
1900. Osbourne, Jno. P., "Bowsden," Prescott Road, St. Ann's, St. Helens, Lancs., Analytical Chemist.
1900. O'Shaughnessy, Francis R., 42, Temple Street, Birmingham, Consulting Chemist.
1885. O'Shea, Prof. L. T., Dept. of Applied Science St. George's Square, Sheffield, Professor of Applied Chemistry (University of Sheffield).
1912. Osius, George, Canadian Ammonia Co., Ltd., Foot of Meldrum Street, Detroit, Mich., U.S.A., Secretary and Treasurer.
1883. O'Sullivan, J., High Bank, Burton-on-Trent, Brewing Chemist.
1912. Oswald, Jacob, c/o Messrs. Fels and Co., 73rd Street and Woodland Avenue, Philadelphia, Pa., U.S.A., Soap Works Technical Manager.
1898. Oushkoff, John P., Warwarka 5, Moscow, Russia, Chemical Manufacturer.
1906. Oxley, Horace F., Ashfield, Helsby, Cheshire, Chemist.
1908. Oxley, John C., Oakwell House, Heckmondwike, Aniline Colour Merchant.
1886. Pagès, Albert, 34, Boulevard Henri IV., Paris, Technical Chemist.
1916. Pallister, Chas. (on Active Service; retain Journal). Metallurgical Chemist.
1906. Palm, Otto G., 41, Colborne Street, Toronto, Canada, President (Atteaux Dye and Chemical Co.).
1917. Palmberg, Dr. Bertil, Kaipainen, Finland.
1917. Palmén, Baron, Dr. J. O., Boulevardsgatan 30, Helsingfors, Finland, Research Chemist.
1903. Palmenberg, O. W., 59, Church Street, New York City, U.S.A., Consulting Chemist and Fuel Engineer.
1916. Palmer, Chas. W., Heaton House, Wilmslow Road, Withington, Manchester, Chemist.
1902. Palmer, Fred. G., c/o Curtis's and Harvey, Cliffe, Kent, Chemist and Gunetteon Superintendent.
1887. Palmer, T. Chalkley, c/o American Dyewood Co., Chester, Pa., U.S.A., Manufacturing Chemist.
1887. Palmer, Thos. C., c/o W. J. Fraser and Co., Ltd., Dagenham, Essex, Engineer.
1907. Palmer, Wm. J., 25, Beech Hill Road, Eltham, Kent, Analytical Chemist.
1915. Pandya, Prof. Kantilal, Bag Mazaffar Khan, Agra, India, Professor of Chemistry.
1911. Paniker, Ramni, Vidrio 10, Barcelona, Spain, Leather Trades Chemist.
1915. Pansky, Dr. A., c/o Williamson and Corder, Ltd., Low Walker, Newcastle-on-Tyne, Chemical Engineer.
1917. Parker, Dr. Albert, The University, Edmund Street, Birmingham, Lecturer in Chemistry.
1891. Parker, Edw., Laburnum House, Rushford Avenue, Levenshulme, Manchester, and (Jnls.) 142, Manchester Road, Denton, Manchester, Analytical Chemist.
1894. Parker, Dr. J. Gordon, Leathersellers' Technical College, 176, Tower Bridge Road, London, S.E., Principal.
1897. Parker, Prof. Matthew A., University of Manitoba, Winnipeg, Canada, Professor of Chemistry.
1915. Parker, R. G., 63, Gondar Gardens, Hampstead, N.W., Chemist.
1901. Parker, Richard H., 147, Seymour Avenue, Newark, N.J., U.S.A., Analytical Chemist.
1894. Parker, Thos. J., 100, William Street, New York City; and (Journals) Bayonne, N.J., U.S.A., Chemical Works Manager.
1903. Parker, Wm. B., 1, Murray Road, Rugby, Chief Chemist (British Thomson-Houston Co., Ltd.).
1901. Parkes, Albert E., 43, Whitehorse Street, Stepney, E., Analytical Chemist.
1915. Parrish, Percy, c/o South Metropolitan Gas Co., East Greenwich, S.E., Chemical Works Manager.
1898. Parrish, Saml., 80, Grange Avenue, Chapeltown Road, Leeds, Teacher of Chemistry.
1916. Parsons, C. H., Prior Park, and Journals to Castle Soap Works, Ashby de la Zouch, Soap Manufacturer.
1914. Pascoe, Charles F., The Thomas Davidson Manufacturing Co., Ltd., Montreal, Canada, Metallurgist.
1909. Passmore, Dr. Francis W., 81, Queen Victoria Street, London, E.C., Consulting Chemist.
1897. Patchett, Col. Jas., Oakworth, Hadley, Wellington, Salop, Ironmaster.
1884. Paterson, John, 24, Bank Street, Carlisle, Mechanical Engineer.
1916. Paton, John D., 25, Market Street, Manchester, Engineer and Technologist.
1901. Patterson, Chas. A., 1007, Broome Street, Wilmington, Del., U.S.A., Analytical Chemist.
- O.M. Patterson, Geo., Elm Lodge, 8, The Grove, Isleworth, W., Technical Chemist.
1893. Patterson, Harry J., Collage Park, Prince George's Co., Md., U.S.A., Agricultural Chemist.
1902. Patterson, Wm. Hamilton, 30, Lightwoods Hill, Warley, Birmingham, Technical Chemist.
1917. Patterson, Wm. S., 85, Abbey Road, Barrow-in-Furness, Analytical Chemist.

- O.M. Pattison, Jas., Drimmonona, Kilmacoolm, N.B., Chemical Merchant.
1889. Pattison, Percy J., St. Budeaux, Devonshire Road, Hornechurch, Essex, Technical Chemist.
1909. Patton, H. G., c/o Fred Rueping Leather Co., Fond du Lac, Wis., U.S.A., Chemist.
1908. Paul, David M., c/o Clayton Aniline Co., Ltd., Clayton, Manchester, Chemist.
1891. Paul, Jas. H., 11, Glenluce Road, Blackheath, S.E., Analytical Chemist.
1900. Paul, Dr. L. Gordon, Market Hall Chambers, King Street, Huddersfield, Consulting Chemist.
1916. Payman, William, Home Office Experimental Station, Eskmeads, Cumberland, Chemist.
1904. Payne, A. G. C., 6, Bradford Place, Penarth, near Cardiff, Chemist.
- O.M. Payne, J. B., 13, Mosley Street, Newcastle-on-Tyne, Manufacturing Chemist.
1912. Peachey, S. J., 5, Yew Tree Road, Davenport, Stockport, Lecturer in Chemistry.
1894. Pearce, Jas. Stanley, Priest's Mere, Tadworth, Surrey, Chemical Manufacturer.
1897. Pearce, Richard, 6, Beach Lawn, Waterloo, Liverpool, Metallurgist.
1916. Pearce, Robert J., 318, LaGauchetiere Street West, Montreal, Canada, Analytical Chemist.
1883. Pearce, Sir W., M.P., 14, Park Crescent, Portland Place, W., Chemical Manufacturer.
1903. Pearcey, A. C., 43, Marlborough Mansions, Finchley Road, London, N.W., Director, Explosives Co.
1915. Pearson, Geo. E., c/o Burroughs, Wellcome and Co., Snow Hill Buildings, London, E.C., Chemist and General Manager.
1917. Pearson, Herbert, 4, Leinster Gardens, Runcorn, Cheshire, Technical Chemist.
1915. Pearson, Stanley, 21, Kingsway, Coventry, Works Chemist.
1904. Pease, Fred N., P.O. Box 503, Altoona, Pa., U.S.A., Chemist.
1898. Peck, Dr. Ernest L., High Lawn, Bromborough, Cheshire, Chemist.
- O.M. Pedler, Sir Alexander, C.I.E., F.R.S., 28, Stanhope Gardens, Queen's Gate, London, S.W., Director of Public Instruction (retired).
1906. Peile, Henry, Milburn House, Newcastle-on-Tyne, Colliery Owner.
1897. Pellaw, Chas. E., 111, East 78th Street, New York City, U.S.A., Adjunct Professor of Chemistry.
1904. Pelly, Russell George, 3, Wingate Road, Hammer-smith, W., Analytical Chemist.
1915. Pemberton, W. G., c/o F. Reddaway and Co., Ltd., Pendleton, Manchester (Journals to 49, Acresfield road, Pendleton, Manchester), Rubber Works Chemist.
1914. Penfold, A. R., 34, Alt Street, Ashfield, Sydney, N.S.W., Australia, Research Chemist.
1896. Penney, Mulgrave D., 11, High Street, Hull, Analytical Chemist.
1890. Pennock, J. D., c/o Solvay Process Co., Syracuse, N.Y., U.S.A., Technical Chemist.
1885. Pentecest, S. J., Lenton Works, Nottingham, Lace Dresser.
1892. Peplow, D. H. T., Underriver House, Sevenoaks, Kent.
1885. Perkin, A. G., F.R.S., Grosvenor Lodge, Grosvenor Road, Leeds, Technical Chemist.
1898. Perkin, Dr. F. Mollwo, 59, New Oxford Street, London, W.C.
1887. Perkin, Dr. W. H., F.R.S., 5, Charlbury Road, Oxford, Professor of Chemistry.
1916. Perkins, M., 29, Whites View, Manningham, Bradford, Technical Chemist.
1917. Perkins, Stephen E., Jas. Pascall, Ltd., Furzedown Works, Streatham Lane, Mitcham, Confectioners' Manager.
1901. Perry, Chas. M., Greene, Kent County, R.I., U.S.A., Bleach and Dyeworks Chemist.
1887. Perry, David, 1, Albert Drive, Pollokshields, Glasgow, and (Journals) Forth and Clyde Chemical Works, Nitshill, near Glasgow, Manufacturing Chemist.
1917. Perry, Guy A., Lincoln House, Percy Street, Fartown, Huddersfield, Chemist.
1895. Perry, Jos. H., 276, Highland Street, Worcester, Mass., U.S.A., Teacher of Chemistry.
1903. Perry, M. J. T., Australian Drug Co., O'Connell Street, Sydney, N.S.W., Australia, Manufacturing Chemist.
1903. Perry, Robt. Swain, 31, Union Square West, New York City, U.S.A.
1911. Perry, R. W., c/o Gunn's, Ltd., Toronto, Canada, Superintendent and Chief Analyst.
1916. Perry, W. S., 65, Grafton Street, Mile End, E., Technical Chemist.
1917. Peter, Alfred M., Kentucky Agricultural Experiment Station, Lexington, Kentucky, U.S.A., Chief Chemist.
1897. Peter, D. A. H., 2508, Broadway, New York City, U.S.A., Chemist.
1908. Peters, John M., c/o National Lead Co., 111, Broadway, New York City, U.S.A., White Lead Manufacturer.
1909. Petrie, A. Swanston, c/o Gibson, Rosslyn, 154, Vicarage Road, Langley, Birmingham, Analytical Chemist.
1903. Petrie, Dr. Jas. M., The University, Sydney, N.S.W., Australia, Chemist.
1906. Pettee, Chas. L. W., c/o Hartford Laboratory Co., Hartford, Conn., U.S.A., Chemist.
1916. Pettersen, M. G., 2, Elm Grove, Hyde, Cheshire, Chief Chemist.
1892. Pettigrew, Robert, c/o Mersey and Irwell Joint Committee, 44, Mosley Street, Manchester, Electro-Chemist.
1902. Pettitt, Alf., c/o Chestnut Ridge Brick Co., 7, West 45th Street, New York City, N.Y., U.S.A., Chemist.
1917. Pezzani, Henri M., c/o National Bank of South Africa, Ltd., Circus Place, London Wall, E.C., Sugar Chemist.
1916. Philbert, Pierre, French Commission of Munitions, Empire House, Kingsway, London, W.C., Leather Manufacturer.
1888. Philip, Arnold, Admiralty Chemist's Dept., H.M. Dockyard, Portsmouth, Electro-Metallurgist and Electrical Engineer.
1908. Philip, Prof. James C., Imperial College of Science and Technology, South Kensington, S.W., Professor of Physical Chemistry.
1903. Philipp, Herbert, 178, Market Street, Perth Amboy, N.J., U.S.A., Chemist and Electrochemical Engineer.
1917. Phillips, Ernest George, "Southfield," Wollaton Street, Nottingham, Electrical Engineer (Boots Pure Drug Co.).
1912. Phillips, G. A., Laboratory, The Powell Duffryn Co., Aberdare, Mon., Chemist.
1917. Phillips, George W., 52, Lendenhall Street, London, E.C., Chemical Merchant.
- O.M. Phillips, Harecourt, Court Chambers, Mawdsley Street, Bolton, Analytical Chemist.
1911. Phillips, Henry A., Royal Gunpowder Factory, Waltham Abbey, Essex, Chemist.
1917. Phillips, John T., 52, Cloncurry Street, Fulham Palace Road, Fulham, London, S.W., Chemist.
1910. Phillips, Prof. Percy P., Thomason College, Rurki, United Provinces, India, Professor of Chemistry.
1915. Phillips, Richard, St. Gatien, Warbreck Moor, Aintree, Liverpool, Chemist.
1895. Phillips, S. Chas., 47, Cannon Street, London, E.C., Chemical Engineer.
1911. Phillips, Major William E., Retain Journals.
1896. Phillips, Wm. H., 100, Milton Avenue, East Ham, E., Soap Works Chemist.
1917. Phipps, Ernest Wm., c/o Mardon, Son and Hall, Printers, Temple Gate, Bristol, Deputy Printers, Manager.
1911. Philpotts, Wilfred C., 35, Sandford Avenue, Toronto, Canada, Gasworks Chemist.
1894. Picard, Hugh F. K., 44, London Wall, London, E.C., Metallurgist.
1905. Piekard, Greenleaf W., 59, Dalton Road, Newton Center, Mass., U.S.A., Electrical Engineer.

1914. Pickard, Joseph A., 21, Rosemont Road, Acton, W., Consulting Metallurgical Chemist.
1902. Pickard, Dr. R. H., Billinge View, Blackburn, Teacher and Analyst.
1914. Pickering, Walter J., Central Laboratory, City Gasworks, Nchells, Birmingham, Works Chemist.
1914. Pickles, R. H., Prussiate Works, Droylsden, near Manchester, Chemical Manufacturer.
1915. Pickles, R. W., P. 13 W., Gretna, N.B., Pharmacist.
1915. Pickup, Edgar H., 348, Great Clowes Street, Higher Broughton, Manchester, Calico Printer.
1904. Pierce, Jas. B., jun., Lock Box 932, Charleston, W. Va., U.S.A., Chief Chemist (Rollin Chemical Co.).
1915. Pilkington, A. C., Briar's Hey, Rainhill, Lanes, Glass Manufacturer.
1888. Pilkington, G., The Conservative Club, Broad Street, Bury, Lancashire, Analytical Chemist.
1893. Pilley, Thos. W., 33, Grove Hill Road, Denmark Hill, S.E., Analytical Chemist.
1894. Pilling, John E., 229, Hornby Road, Blackpool, Chemist.
1906. Pincott, Emile S., 222, St. James' Street, Montreal, Canada, Manager (Nichols Chemical Co. of Canada, Ltd.).
1914. Pinkerton, Corporal Andrew, 196250, Sect. 77, N. Coy., 4th Batt., Spec. Brigade, R.E., G.H.Q., B.E.F., France (Journals to 59, Mount Preston, Leeds), Analytical Chemist.
1910. Pinnock, Douglas R., c/o The Nucoa Butter Co., 4th Street and Avenue A, Bayonne, N.J., U.S.A., Chemist.
1905. Pinnock, H. T., 11, Fountain Road, Edgbaston, Birmingham, Chemist.
1896. Piper, Walter E., Boston Rubber Shoe Co., Malden, Mass., U.S.A., Chemist.
1916. Pirrie, Noble W., Imperial Munitions Board, Union Bank Building, Ottawa, Ont., Canada, Technical Chemist.
1907. Pitman, Brig.-Gen. John, 167, Berkeley Avenue, Orange, N.J., U.S.A., U.S. Army (retired).
1902. Pittard, Jno., West Ham Chemical Works, West Ham, E., Chemical Manufacturer.
1884. Pittuck, F. W., 19, Stratford Grove, Heaton, Newcastle-on-Tyne, Technical Chemist.
1909. Piutti, Prof. Dr. Arnaldo, Instituto Chimico-farmaceutico, R. Universita, Napoli, Italy, Director.
1899. Pizey, Jas. H., 38, Lewisham Road, Highgate Road, London, N.W., Chemist.
1915. Platt, J. H., c/o Major & Co., Ltd., Hull, Technical Chemist.
1894. Platten, Frank, c/o Elliot's Metal Co., Selly Oak Works, near Birmingham, Metallurgical Chemist.
1890. Platts, Jno. C., 547, Notre Dame, St. Lambert, Montreal, Canada, Metallurgical Chemist.
1914. Plews, George, jun., 65, Keswick Road, St. Helens, Lanes., Chemist.
1907. Poetschke, Paul, c/o L. D. Caulk Co., Milford, Del., U.S.A., Chemist.
1915. Polack, W. G., Beacon Mount, Highlands Road, Runcorn, Cheshire, Alkali Works Manager.
1901. Pollard, Wm., Oakfield, Hitchio, Herts., Chemist (retired).
1904. Pollitt, Major G. P., D.S.O., H.Q. Special Companies, R.E., B.E.F., France.
1902. Pollitt, Jas. C. T., Sharrow, The Lickey, near Bromsgrove, Worcestershire (Journals to A. A. Pollitt, Karl Cottage, Stanley Road, Knutsford) Managing Chemist.
1883. Pollock, A., Kirkland, Bonhill, Dumbartonshire, Dyeworks Manager.
1890. Pomeroy, Dr. Chas. T., 459, High Street, Newark, N.J., U.S.A., Ink Manufacturer.
1916. Pomphrey, John, c/o Sapon Ltd., and 39, Leeds Old Road, Bradford, Manager Textile Department.
1909. Pond, Dr. Francis J., Stevens Institute of Technology, Hoboken, N.J., U.S.A., Professor of Chemistry.
1896. Pond, Prof. G. G., State College, Centre Co., Pa., U.S.A., Professor of Chemistry.
- O.M. Pond, J. A., 99, Queen Street, Auckland, New Zealand, Analytical Chemist.
1914. Pondal, Prof. M. Leguizamon, 726, Str. Mexico, Buenos Aires, Argentina, Doctor of Chemistry.
1906. Pont, A. Felix du, Box 31, Wilmington, Del., U.S.A., Explosives Manufacturer.
1895. Pont, Pierre S. du, c/o Dr. C. L. Reese, E. I. du Pont de Nemours Powder Co., Wilmington, Del., U.S.A., Explosives Manufacturer.
1912. Pope, Chester H., 34, Brookfield Road, Winthrop, Mass., U.S.A., Ink Manufacturer.
1899. Pope, Thos. H., 31, Cecil Street, Hillhead, Glasgow, Chemist and Lecturer on Brewing.
1900. Pope, Prof. W. J., F.R.S., University Chemical Laboratory, and (Journals) Holmesdale, Brooklands Avenue, Cambridge, Professor of Chemistry.
1917. Popham, Fredk. J. W., 71, Kennington Avenue, Bishopston, Bristol, Technical Chemist.
1912. Porritt, B. D., c/o North British Rubber Co., Ltd., Castle Mills, Edinburgh, Chief Chemist.
1911. Porteous, Jas. W., c/o Bolckow, Vaughan, and Co., Ltd., Grange Hill, Bishop Auckland, Co. Durham, Chemist and Coke Oven Manager.
1902. Porter, J. Edw., P.O. Box 785, Syracuse, N.Y., U.S.A., Chemist.
1915. Potter, Alfred, 16, Nelson Street, Lower Broughton, Manchester, Rubber Works Chemist.
1884. Potter, Chas. E., Love Lane Sugar Refinery, Liverpool, Sugar Works Chemist.
1888. Potter, Chas. J., Heaton Hall, Newcastle-on-Tyne, Cement Manufacturer.
- O.M. Potter, E. P., Chemical Works, Little Lever, near Bolton, Alkali Manufacturer.
1915. Potter, F. M., H.M. Factory, Penrhyn-Deudraeth, N. Wales, Chemist.
1915. Potter, H. V., 98, Bradford Street, Birmingham, Manager and Chief Chemist.
1910. Potts, Harold E., c/o W. P. Thompson and Co., 6, Lord Street, Liverpool, Patent Agent.
1915. Poulenc, Camille, 122, Boulevard St. Germain, Paris, France, Chemical Manufacturer.
1915. Powell, Alar R., 150, Capel Road, Forest Gate, Essex, Analytical Chemist.
1916. Powell, Arthur D., 152, Robin Hood Chase, Nottingham, Analytical Chemist.
1900. Powell, Harry J., 125, Thurlow Park Road, Dulwich, S.E., Glass Manufacturer.
1897. Power, Dr. Fred. B., Bureau of Chemistry, U.S. Dept. of Agriculture, Washington, D.C., U.S.A. Research Chemist.
1902. Powney, Wm. E. F., 35, Priory Avenue, Hornsey, N., Analytical Chemist.
1912. Prasad, Prof. H., Government College, Ajmer, India, Professor of Science.
1897. Prentice, Dr. Bertram, Royal Technical Institute, Salford, Lecturer on Chemistry.
1902. Prentice, Dr. David, Teesholme, Walton New Road, Lower Walton, near Warrington, Chemist.
1903. Prentice, Jas., Cossipore Sugar Works, Cossipore, Calcutta, India, Chemist.
1911. Prescott, Alfred, 63, Corporation Street, Manchester, Chemical Agent.
1900. Prescott, Prof. Saml. C., 585, Boylston Street, Boston, Mass., U.S.A., Prof. of Ind. Biology.
1916. Preston, Ernest, 105, Barker's Pool, Sheffield, Pharmaceutical Chemist and Laboratory Furnisher.
1905. Preston, Jas. F., 403, Andover Street, Lowell, Mass., U.S.A., Manufacturing Chemist.
- O.M. Price, Arthur F., 503, Market Street, San Francisco, Cal., U.S.A., Analytical Chemist.
1905. Price, Lieut. T. Slater, (R.N.V.R.), R.N.A.S. Factory, Stirling Chemical Works, Canning Road, Stratford, E. (Journals to The Technical School, Birmingham), Lecturer on Chemistry.
1904. Prichard, Norman B., 40, Quebec Street, Sherbrooke, Quebec, Canada, Superintendent.

1905. Priest, Geo. Wesley, 1018, West 10th Street, Wilmington, Del., U.S.A., General Manager.
1915. Priestley, Donald. [Address unknown.] Works Chemist.
1916. Priestley, J. W., Grove Mills, Halifax, Woollen Manufacturer.
1899. Prinsen-Geerligns, H. C., Wanningstraat 17, Amsterdam, Holland, Director of Sugar Cane Experimental Station.
1917. Pritchard, David A., "The Gables," Farnworth, Widnes, Departmental Manager.
1912. Prittie, Frank H., Southern Pacific Railway Laboratory, Sacramento, Cal., U.S.A., Assistant Chemist.
1896. Prochazka, Dr. Geo. A., c/o Central Dyestuff and Chemical Co., Newark, N.J., U.S.A., Colour Manufacturer.
- O.M. Procter, Prof. H. R., The Grange, Ilkley; and (Jnls.) The University, Leeds, Emeritus Professor of Tanning.
1884. Procter, J. W., Skeldergate Bridge, York, Manure Manufacturer.
1890. Procter, Miss Ann J., Free Library, Widnes, Librarian.
- O.M. Proctor, C., 118, Grosvenor Road, London, S.W., Analytical Chemist.
1916. Pryor, J. C., 4160, Sherbrooke Street West (Flat 31), Montreal, Canada, Metallurgist and Chemist.
1917. Pugh, Frank H., 2, Cotham Street, Walworth, London, S.E., Student.
1905. Pugh, John V., Guiting House, Allesley, near Coventry, Works Director (Rudge-Whitworth, Ltd.).
1916. Pugh, Ralph J., London Chemical Works, Ltd., Southall, Middlesex (Journals to 99, Lonsdale Road, Barnes, S.W.), Director.
1899. Pullar, Edmund, Keirfield, Bridge of Allan, Scotland, Manufacturer.
- O.M. Pullar, R. D., Pullar's Dyeworks, Perth, Scotland, Dyer.
1913. Pulsifer, Lanson V., c/o Messrs. Valentine and Co., 364, Manhattan Avenue, Brooklyn, N.Y., U.S.A., Chemist.
1902. Puntan, H. H. C., 10, London Chambers, Durban, Natal, Public Analyst.
1913. Purves, G. Thomson, Coke Ovens Dept., Auchen-geich Colliery, Chryston, Scotland, Manager.
1905. Pyman, Dr. Frank Lee, Southwood, Pinner, Chemist.

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1903. Queeny, Jno. F., Monsanto Chemical Works, 1800, South 2nd Street, St. Louis, Mo., U.S.A., Chemical Manufacturer.
1903. Queneau, Augustin L. J., The Chloride Syndicate, Ltd., The Quay, Wallsend-on-Tyne, Metal-lurgical Engineer.
1887. Quibell, Oliver, Shalem Lodge, Newark-on-Trent, Manure Manufacturer.
1902. Quinan, Kenneth B., Cape Explosives Works, Somerset West, C.C., South Africa, and (sub-scriptions) c/o Cape Explosives Works, Ltd., 15, St. Swithin's Lane, E.C., Superintendent.

R

1917. Rabinovitch, Dr. L., 6, Belsize Road, Hampstead, N.W., Electro-Chemical Engineer.
1911. Rae, Joseph, City Hall, Ottawa, Canada, City Bacteriologist.
1915. Radcliffe, L. Guy, 929, Chester Road, Stretford, Manchester, Chemist.
1917. Radford, Samuel C., 13, Belmont Road, Luton, Works Chemist.
1900. Radley, Ernest G., 49, Ernest Street, West Norwood, S.E.
1902. Ramsay, A. Alexander, Laboratory, Department of Agriculture, 136, George Street, Sydney, N.S.W., Australia, Assistant Chemist.

1916. Ramsay, Thos., 101, West George Street, Glasgow, Chemical Exporter.
1885. Ramsay, W., c/o Cammell, Laird, and Co., Ltd., Birkenhead Ironworks, Birkenhead, Chemist and Assayer.
1911. Ramsay, Wm. G., Beecherof, Hazlemere, Bucks., Research Chemist.
1913. Ramsbottom, Dr. J. E., 98, Peabody Road, South Farnborough, Hants, Chemist.
1906. Ranck, Samuel H., Ryerson Public Library Building, Grand Rapids, Mich., U.S.A., Librarian.
1909. Randall, George, Severn Bank Tannery, Worcester, Tanner.
1916. Randall, Jas., Low Mill, Ulverston, Lancs, Tanner.
1910. Ranken, Charles, 19, Stockton Road, Sunderland, Analytical and Consulting Chemist.
1901. Ransom, Francis, The Chilterns, Hitchin, Herts., Manufacturing Pharmaceutical Chemist.
1905. Ransom, H. B., 70, Beulah Hill, Upper Norwood, Consulting Engineer.
1898. Rasehen, Dr. Julius, The Highlands, Runcorn, Cheshire, Consulting Chemist (United Alkali Co.).
1915. Rashid, Dr. S. A., "Dar-ul-Fazl," Gujrat, Punjab, India, Pharmacist.
1908. Rassow, Prof. Dr. Berthold (address unknown), General Secretary.
1893. Ratcliff, Frank D., Stourbank House, Stourport, Vinegar Brewer.
1904. Ratcliffe, C. F., c/o Brotherton and Co., Ltd., City Chambers, Leeds, Tar Distiller.
1914. Ratcliffe, Henry, Leeds Phosphate Works, Ltd., Midland Road, Hunslet, Leeds, Chemist.
1916. Ratcliffe, Norman, 16, Park Street, Clydach, near Swansea, Analyst.
1898. Ratcliffe, Walter, c/o Carter and Wright, Hexagon Works, Pollon Lane, Halifax, Analytical Chemist.
1917. Ratcliffe, Wm. A., c/o Jas. Ratcliffe and Sons, Ltd., Hillgate Works, Stockport, Candle and Soap Maker.
1901. Rawlins, Herbert J. L., The Crossways, Rainhill, Lancashire, Managing Director.
1903. Rawolle, Frederick C., c/o Marx and Rawolle, 100, William Street, New York City, U.S.A., Chemist.
- O.M. Rawson, Chris., 22, Cumberland Street, Manchester, Consulting Chemist.
1909. Rayner, Arthur B., 45, Gilpin Avenue, East Sheen, Surrey, Chemical Broker.
1912. Rayner, Edgar A., 72, Annan Road, Gretna, near Carlisle, Analytical Chemist.
1915. Razzaek, Syed A., c/o S. A. Razzaek and Co., Charkaman, Hyderabad, Deccan, South India, Pharmaceutical Chemist.
1895. Read, E. J., c/o Pretoria Portland Cement Co., Ltd., P.O. Box 405, Pretoria, South Africa, Analyst.
1917. Read, Fredk. Wm., The Laboratory (W. D. & H. O. Wills), East Street, Bedminster, Bristol, Analytical Chemist.
1914. Read, Harold M., The Briers, North Park Avenue, Roundhay, Leeds, Manufacturing Chemist.
1913. Read, Prof. John, The University, Sydney, N.S.W., Australia, Prof. of Organic Chemistry.
1890. Reade, Thos., 118, Tettenhall Road, Wolverhampton, Manufacturing Chemist.
1908. Reavell, J. Arthur, 28, Oakwood Avenue, Becken-ham, Kent, Engineer.
1902. Redfern, C. G., 15, South Street, Finsbury, London, E.C., Patent Agent.
1915. Redfield, C. S., P.O. Box 502, Trenton, N.J., U.S.A., Rubber Chemist.
1915. Redman, L. V., Redmanol Chemical Products Co., 636, West 22nd Street, Chicago, Ill., U.S.A., Chemical Manufacturer.
1916. Redmayne, Leonard, c/o The British Engineering Co. of Russia and Siberia, Ltd., Central House, Kingsway, London, W.C., Engineer and Manager.
1914. Redpath, G. C., 10, Dean Street, Newcastle-on-Tyne, Analytical Chemist.
- O.M. Redwood, Sir Boverton, Bart., 4, Bishopsgate, London, E.C., Petroleum Expert.

1887. Redwood, Robt., 4, Bishopsgate, London, E.C., Secretary.
1886. Rée, Dr. A., 15, Mauldeth Road, Withington, Manchester, Aniline Dye Manufacturer.
1916. Reed, Arthur S., c/o J. and H. S. Pattinson, 10, Dean Street, Newcastle-on-Tyne, Analytical Chemist.
1902. Reed, Herbert C., 227-229, Fulton Street, New York City, U.S.A., Cons. Tanning Chemist.
1916. Reed, John Y., c/o Hoyle, Robson, Burnett & Co., Ltd., Bill-Quay-on-Tyne, Analytical Chemist and Works Manager.
1906. Reed, William, c/o London County and Westminster Bank, 52, East India Dock Road, Limehouse, E., Works Manager.
1893. Reekie, J. A., Buckton Grange, Stalybridge, Calico Printer's Colour Mixer.
1883. Reeks, T. H., 106, Queen Victoria Street, London, E.C., Analytical and Consulting Chemist.
1906. Rees, Walter J., Department of Applied Science, The University, Sheffield, Glass Works Chemist.
1900. Reese, Dr. Chas. L., Eastern Laboratory, P.O. Box 424, Chester, Pa., U.S.A., Chemist.
1915. Reeve, H. T., American Optical Co., Southbridge, Mass., U.S.A., Metallurgist.
1917. Reeves, Bartow V., The Horse Head Inn, Palmerton, Pa., U.S.A., Assistant Chief of Spelter Dept.
1916. Reeves, George, c/o British Dyes, Ltd., Dalton Works, Huddersfield, Works Chemist.
1913. Regan, Colston J., 14, Penerley Road, Catford, S.E., Analytical Chemist.
1916. Reid, Alexander F., 3, Dalmarnock Road, Glasgow, Chemist.
1897. Reid, Andrew, c/o L. and J. McLellan, 65, Port Dundas Road, Glasgow, Chemist.
1916. Reid, C. A., c/o Mauri Bros., and Thompson, 123, Castlereagh Street, Sydney, N.S.W., Technical Chemist.
1909. Reid, David E., Kodak Park, Rochester, N.Y., U.S.A., Chemist.
1906. Reid, James, Caldererux Mills, by Airdrie, Scotland, Chemist.
1905. Reid, Dr John H., Westgarth, Eccles Road, Formby, Lanes, Chemist.
1907. Reid, Robert, Agencia de Tharsis, Huelva, Spain, Analytical Chemist.
1896. Reid, Robt., Oil Mills, Horbury Bridge, near Wakefield, Chemist.
- O.M. Reid, Walter F., Fieldside, Addlestone, Surrey, Technical Chemist.
1893. Reid, Wm., jun., Bombay Dyeworks, Dadur, Bombay, India, Dyer.
1904. Reinherz, Otto. *See* Reynard, Otto.
1898. Reitmeyer, Robt. E. D., c/o Messrs. Reitmeyer, Calburn and Kindersley, Ltd., 2, Marlborough Gate, Bayswater Road, London, W., Chemical Merchant.
1916. Relyea, P. J., Dept. of Explosives Supplies, Ministry of Munitions, Storey's Gate, Westminster, S.W., Chemical Engineer.
1904. Remington, Prof. Joseph P., 1832, Pine Street, Philadelphia, Pa., U.S.A., Author, U.S. Pharmacopoeia.
1903. Remsen, Professor Ira, Johns Hopkins University, Baltimore, Md., U.S.A., Professor of Chemistry.
1911. Renaud, Paul, 8, Rue Nouvelle, Paris (9^e), France, Consulting Engineer.
- O.M. Rennie, Dr. E. H., University of Adelaide, South Australia, Professor of Chemistry.
1911. Rentschler, Mahlon J., Willoughby, Ohio, U.S.A., Chemist.
1901. Renwick, Frank F., Sunny Side, Weald Road, Brentwood, Essex, Chemist (Photographic Works).
1907. Reoch, Robert A. S., Pacific Mills Printworks, Laurence, Mass., U.S.A., Printworks Superintendent.
1894. Rettie, Dr. Theodore, 12, Ann Street, Edinburgh, Metallurgical Chemist.
1915. Reuschle, Wm. C., 471, Summer Avenue, Newark, N.J., U.S.A., Manufacturing Chemist.
1905. Revis, Cecil, 5, Carlton Villas, Station Road, Barnes, S.W., Chemist.
1904. Reynard, Otto, 3, Selborne Villas, Manningham, Bradford, Yorks, Chemist.
1916. Reynolds, Clayton W., Canadian Inspection and Testing Labs., Ltd., Montreal, Canada, Manufacturing Chemist.
- O.M. Reynolds, Dr. J. Emerson, F.R.S., 3, Inverness Gardens, Kensington, W., Professor of Chemistry.
1912. Reynolds, Wm. Colebrook, "Wharfedale," Upminster, Essex, Manufacturing Chemist.
1913. Rhead, T. F. Eric, Central Laboratory, Neehells Gas Works, Birmingham, Research Chemist.
1908. Rhoads, J. Edgar, 2211, Shallcross Avenue, Wilmington, Del., U.S.A., Leather Chemist.
1892. Rhodes, P. J., Bridge House, Church, Acerington, Dye and Print Works Manager.
1889. Richards, Edgar, 60, Ayrault Street, Newport, R.I., U.S.A., Analytical Chemist.
1888. Richardson, Dr. Clifford, Room 1615, Woolworth Building, 233, Broadway, New York City, U.S.A., Chemical Engineer.
1884. Richardson, F. W., County Analyst's Office, Bradford, Yorkshire, Analytical Chemist.
1900. Richardson, Jno. H., 29, Westbury Road, Henleaze, Bristol, Manager.
1891. Richardson, Walter W., Aldingham, Park View Crescent, Roundhay, Leeds, Manufacturing Chemist.
1903. Richardson, Wm., Linfield, Wood Lane, Headingley, Leeds, Drysalter.
1894. Richardson, Wm. H., Newsky Thread Mills, Malaja, Bolotnaja, Petrograd, Russia, Textile Chemist.
1898. Richmond, Jno. R., "Maisonette," Park Drive, Trentham, Staffs, Alkali Works Manager.
1884. Rideal, Dr. Samuel, Laboratory, 28, Victoria Street, Westminster, S.W., Consulting Chemist.
1916. Rider, Douglas, H.M. Factory, West Gorton Chemical Works, Manchester, Works Manager.
1905. Ridge, H. M., The Ridge Roasting Furnace and Engineering Co., 2, Great Winchester Street, London, E.C., Mining Engineer.
- O.M. Ridsdale, C. H., Laboratory, 3, Wilson Street, Middlesbrough, Analytical Chemist.
1899. Riederer, Emil J., Forcite Works, Landing, N.J., U.S.A., Superintendent.
1902. Riederer, Dr. Herman S., 2124, South Compton Avenue, St. Louis, Mo., U.S.A., Chemist.
1916. Rigg, Geo. F., 154, Titford Road, Langley, near Birmingham, Metallurgical Chemist.
1907. Rigg, Gilbert, c/o Associated Smelters Proprietary, Ltd., Collins House, Melbourne, Australia, Chemist.
1892. Riker, Jno. J., 19, Cedar Street, New York City, U.S.A., Merchant.
1913. Riley, George, Effra Works, South Lambeth Road, London, S.W., Chemical Engineer.
1915. Riley, Lt.-Col. J. J., 400, St. James Street, Montreal, Canada, Explosives Manufacturer.
1905. Riley, Louis J. E., 8, Newton Road, London, W., Chemist.
1912. Riley, Walter A., 100, King Street, Norwich, Brewer.
1899. Rink, Arnold, 11, Bridgewater Street, Barbican, London, E.C., Tannin Extract Manufacturer.
1889. Rintoul, Wm., "Lauriston," Ardrossan, Ayrshire, Explosives Chemist.
1901. Ripley, Philip F., 7, Abbott Street, Andover, Mass., U.S.A., Chemist.
1914. Ritchie, P. B., Box 894 G.P.O., Sydney, N.S.W., Australia, Manufacturer.
1916. Roast, Harold J., c/o The James Robertson Co., Ltd., 142, William Street, Montreal, Canada, Analyst.
1915. Roberts, Alfred A., Carlton House, Yate, Glos., Director, Strontia Works.
1907. Roberts, Chester, Swarthmore College, Swarthmore, Pa., U.S.A., Superintendent.

- O.M. Roberts, F. G. Adair, Oak Hill Lodge, Hampstead, N.W., and Jnls. to Madane Brook, c/o Messrs. A. Boake, Roberts and Co., Ltd., Carpenters' Road, Stratford, E., Chemical Manufacturer.
1916. Roberts, Frederick, Broad Oak Printworks, Broad Oak, near Acreington, Calico Printworks Manager.
1901. Roberts, H. E. U., c/o British Explosives Synd., Pitsea, Essex, Chemist.
1911. Roberts, H. W., H.M. Factory, Queensferry, near Chester, Chemist.
1916. Roberts, Joseph G., c/o Shanks and Co., Ltd., Tubal Works, Barrhead, Glasgow, Chemist.
1917. Roberts, Oswald, Chemical Dept., Inspection Dept., Royal Arsenal, Woolwich, Analytical Chemist.
1902. Roberts, Wm. H., City Analyst's Laboratory, Ashton Street, Liverpool, Analytical Chemist.
1891. Robertson, Alex. A., Riversdale, Cressington Park, Liverpool, Technical Chemist.
1916. Robertson, Arthur F., c/o National Drug and Chemical Co., Montreal, Canada (Journals to 9, Seymour Avenue, Montreal), Chemical Engineer.
1910. Robertson, Charles, c/o Messrs. S. Allsopp and Sons, Ltd., Burton-on-Trent, Brewer.
1915. Robertson, G. S., East Anglian Institute of Agriculture, Chelmsford, Essex, Agricultural Chemist.
1900. Robertson, Jas., Barneraig, South Medrox, by Glenboig, Scotland, Analytical Chemist.
1910. Robertson, Dr. Joseph G., 19, Broomhill Terrace, Partick, Glasgow, Manufacturer.
1391. Robertson, Dr. Robt., Research Dept., Royal Arsenal, Woolwich; and (Journals) 29, Charlton Road, Blackheath, S.E., Research Chemist.
1916. Robertson, W. O., The Bungalow, Redbridge, Hants., Chemist.
1910. Robertson, William, 21, Worfield Street, Battersea Park, S.W., Research Chemist.
1913. Robins, Edmund A., c/o Messrs. Kodak, Ltd., Wealdstone, Middlesex, Assistant Works Manager.
1913. Robinson, C. Stanley, H.M. Factory, Queen's Ferry, near Chester, Works Chemist.
1897. Robinson, Clarence J., 708, Jewett Avenue, West New Brighton, N.Y., U.S.A., Chemist.
1916. Robinson, Frederick, "The Hollies," Mile End, Stockport, Cheshire, Brewing Chemist.
1902. Robinson, Hy., Fishwick, Culeth Chemical Works, Newton Heath, Manchester, Manufacturing Chemist.
- O.M. Robinson, H. H., 42, Penyvern Road, Earl's Court, S.W., Analytical Chemist.
1907. Robinson, Herbert W., Robinson Bros., Ltd., Ryders Green, West Bromwich, Staffordshire, Tar Distiller.
1913. Robinson, I. H., 7, West Road, Northumberland Park, London, N., Technical Chemist.
1911. Robinson, Jas. H., 22, Park Parade, Whitley Bay, Northumberland, Analytical Chemist.
- O.M. Robinson, Jos., Farnworth, Widnes, Chemical Manufacturer.
1915. Robinson, Prof. R., Organic Chemistry Dept., The University, Liverpool, Professor of Organic Chemistry.
1916. Robinson, Robert, 36, Ripon Gardens, Newcastle-on-Tyne, Scientific Instrument Maker.
1887. Robinson, Thomas, (Journals) 401, West Street, Glasgow; and (communications), The Villa, Nitschill, Chemical Works Manager.
1902. Robitschek, Carl, 200, Worth Street, New York City, U.S.A., Scientific Brewer.
1915. Robson, J. C., 16, View Park Drive, Burnside, Glasgow, Chemist.
1915. Rocha, João, Villa Nova de Lima, Minas Gerais, Brazil, Assayer and Chemist.
1884. Rodger, Edw., 1, Clairmont Gardens, Glasgow, W.
1904. Rodger, Robert, Government Laboratory, Clement's Inn Passage, Strand, London, W.C., Chemist.
1909. Rody, Franz A., 601, West Maple Street, Johnson City, Tenn., U.S.A., Chemist.
1903. Roelofsen, Dr. J. A., c/o Coal Distillation Co., Middlesbrough, Yorks, Works Manager.
1910. Roessler, Dr. F., 89, High Street, Perth Amboy, N.J., U.S.A., Chemist.
1905. Rogers, Dr. Allen, Pratt Institute, Brooklyn, N.Y., U.S.A., Research Chemist.
1915. Rogers, Dr. F. M., c/o Standard Oil Co., Whiting, Ind., U.S.A., Chemist.
1900. Rogers, Geo. J., 32, Chudleigh Road, Brockley, S.E., Chemist.
1908. Rogers, Harry V., Ilkeston Laundry, Ilkeston, Derbyshire, Engineer.
1909. Rogers, Herbert, c/o James Lyne Hancock, Ltd., 266, Goswell Road, London, E.C., Rubber Works Chemist.
1915. Rogers, J. E., "Quarry Bank," Hawthorn Road, Bootle, Liverpool, Chemist.
1899. Rogers, John, c/o Nobel's Explosives Co., Ltd., Nobel House, Glasgow, Chemist.
1898. Roller, H. C., 493, Central Avenue, Newark, N.J., U.S.A., Superintendent.
1899. Rollin, Chas., Bylton, East Jarrow-on-Tyne, Chemical Manufacturer.
1909. Rollin, Hugh, 1558, Kanawha St., Charleston, West Va., U.S.A., Chemical Manufacturer.
- O.M. Rollin, J.C., 1, St. Nicholas Buildings, Newcastle-on-Tyne, Chemical Manufacturer.
1907. Rolph, George M., c/o California and Hawaiian Sugar Refining Co., Crockett, Cal., U.S.A., Sugar Refiner.
1905. Romanes, J. W., c/o Lothian Chemical Co., Ltd., 3, Broughton Road, Edinburgh, Chemical Engineer.
1904. Rose, Jno., Wicken House, Stretton, near Warrington, Technical Chemist.
1901. Rose, Jno. Leonard, 14, St. Vincent Road, Westcliff-on-Sea, Chemist.
1916. Rosebrugh, R. M., 120, Circle Road, Berkeley Park, Syracuse, N.Y., U.S.A., Chemical Engineer.
1897. Rosengarten, Dr. Geo. D., P.O. Box 1625, Philadelphia, Pa., U.S.A., Manufacturing Chemist.
1913. Rosenplauter, Carlos B., Seaholme, Galton Road, Westcliff-on-Sea, Petroleum Technologist.
1916. Rosenstamm, B., King Street, Perth, Western Australia, Tanner.
1893. Ross, Arthur, 1, Glengall Road, Old Kent Road, London, S.E., Analytical Chemist.
1917. Ross, John D. McB., Chemistry Dept., Imperial College of Science, S. Kensington, London, S.W., Research Chemist.
1900. Ross, Raymond, Public Analyst's Office, Burnley, Lancashire, Analytical Chemist.
1910. Ross, Thos. M., Burmah Oil Co., Yenangyat, via Myingyan, Up. Burmah, Analytical Chemist.
1910. Rossati, Guido, 226, Lafayette Street, New York City, U.S.A., Agricultural Chemist.
1911. Rossi, Dr. Carlo, 29, Via Leopardi, Milan, Italy, Electro-chemist.
1906. Rossi, Louis M., c/o General Bakelite Co., Perth Amboy, N.J., U.S.A., Works Manager.
1913. Rossini, Jas. L., 6, Firpark Terrace, Dennistoun, Glasgow, Oil Works Manager.
1906. Rossiter, E. C., Brougham, West Hagley, Worcestershire, Chemical Engineer.
1888. Rothwell, C. F. Seymour, Photographic Works, Mobberley, Cheshire, Chemist.
- O.M. Rottenburg, Dr. Paul, 55, West Regent Street, Glasgow, Chemical Merchant.
1903. Rouse, Wm., The Knowe, Carlibar Road, Barrhead, by Glasgow, Chemist.
1906. Rowell, Herbert W., Brooklands, Palinge Road, Roehdale, Analytical Chemist.
- O.M. Rowland, W. L., 2815, Gray's Ferry Road, Philadelphia, Pa., U.S.A., Chemist.
1904. Rowley, Ernest W., Chemical Laboratory, C.M.E. Department, North Eastern Railway, Darlington, Analytical Chemist.
1908. Rowley, Frank, 8, Tulnell Park Road, London, N., Metallurgist.
1901. Rowley, Walter Eugene, c/o National Aniline and Chemical Co., 100, William Street, New York City, U.S.A., Chemist.

1904. Rowling, S. R., 1, Beechwood, Kendal, Westmoreland, Chemist.
1913. Rowse, Walter W., 39, Oliver Street, Boston, Mass., U.S.A., Representative of Cassella Color Co.
1915. Roy, Dr. Charles S., 4, Farnley Road, Chingford, Essex, Chemist.
1896. Royal-Dawson, H., 155 Bradford Road, Huddersfield, Chemist.
1898. Royle, Chas. L., Hacienda Cartavio, Trujillo, Peru, Sugar Chemist.
1913. Rubinstein, I. H., *See* Robinson, I. H.
1916. Ruck, Edwin, 19, Bryn Road, Swansea, Works Manager.
1902. Rucker, Dr. Hermann von, The Windsor, Anderson Place, Buffalo, N.Y., U.S.A., Chemist.
1896. Ruddock, Fred. G., Corporation Street, Warrington, Analytical Chemist.
1895. Rudge, Alfred, United Alkali Co., Ltd., Allhusen Works, Gateshead-on-Tyne, Analytical Chemist.
1911. Rudnick, Paul, c/o Armaour and Co., Union Stock Yards, Chicago, Ill., U.S.A., Chemist.
1908. Rudolf, Prof. Norman S., Post Box 12A, Royal Automobile Club, London, S.W., Professor of Applied Chemistry.
1909. Rudolf, Dr. G., 52, Cranley Gardens, Muswell Hill, N., Manufacturing Chemist.
1884. Ruffie, Jno., Musley, Ware, Herts, Consulting Chemist and Electrician.
1898. Ruhl, Louis, c/o Roessler and Hasslacher Chemical Co., 100, William Street, and (Inls.) Box 0101, New York City, U.S.A., Chemical Merchant.
1909. Ruiloba, J. A., c/o U.S. Steel Corporation, 71, Broadway, New York City, U.S.A., Engineer.
1910. Rule, Dr. Alexander, H.M. Factory, Dean Forest, Coleford, Gloucester, Technical Manager.
1915. Rule, Dr. H. G., Chemistry Department, The University, Edinburgh, Lecturer on Chemistry.
- O.M. Rumble, C., 169, Gleneldon Road, Streatham, S.W., Chemist.
1899. Rumbold, Wm. R., Electro-metallurgist.
1913. Rumi, Dr. Tomás J., Salta 947, Buenos Aires, Argentina, Chemist.
1911. Runekles, A. R., c/o Brotherton and Co., Ltd., Lonsdale Dock, Workington, Cumberland, Technical Chemist.
1903. Runyan, Elmer G., Hutchins Building, Washington, D.C., U.S.A., Chemist and Gas Inspector.
1899. Rushby, Wm., Oakview, Batley, Yorks, Analyst.
1906. Russell, David, Rothes, Markinch, Fife, Scotland, Paper Maker.
1912. Russell, George H., c/o Michaelis, Hallenstein, and Co. Propy., Ltd., Footscray, Vic., Australia, Leather Trades Chemist.
1913. Russell, Stanley, Savonnerie Sunlight, Olten, Switzerland, Works Manager.
1912. Russell, Thomas F., 131, Steade Road, Sheffield, Analytical Chemist.
1910. Russell, William, 88, Peel House Lane, Widnes; Jnls. to c/o United Alkali Co., Pilkington-Sullivan Works, Widnes, Lancashire, Chemist.
1905. Ruttan, Prof. R. F., Medical Faculty, McGill University, Montreal, Canada, Professor of Chemistry.
1909. Ryall, W. E., 29, Darfield Avenue, Leeds, Soapworks Chemist.
1905. Ryan, Prof. F. G., c/o Parke, Davis, and Co., Detroit, Mich., U.S.A., Manufacturing Chemist.
1884. Sadtler, Dr. S. P., 210, South 13th Street, Philadelphia, Pa., U.S.A., Consulting Chemist.
1896. Sadtler, Dr. S. S., 219, South 13th Street, Philadelphia, Pa., U.S.A., Analytical and Consulting Chemist.
1897. Sage, C. Edward, 10, London Street, London, E.C., Consulting Chemist.
1902. Sahm, Louis N., c/o The Heller and Merz Co., 505, Hudson Street, New York City, U.S.A., Chemist.
1884. Salamon, A. Gordon, 1, Fenchurch Avenue, London, E.C., Consulting Chemist.
1911. Salamon, Maurice S., 79, Mark Lane, London, E.C., Consulting Analyst.
1884. Salis-Mayenfeld, Dr. E. von, 24, South Allen Street, Albany, N.Y., U.S.A., Technical Chemist.
1916. Salway, Arthur H., 59, Cavendish Drive, Rock Ferry, Cheshire, Research Chemist.
1907. Samuel, Marcus R. A., c/o Compania General de Tabacos Filipinas, 37, Fenchurch Street, London, E.C., Merchant.
- O.M. Samuel, W. Cobden, 66, Croxted Road, West Dulwich, S.E., Analytical Chemist.
1896. Samuelson, Francis A. E., Sir B. Samuelson and Co., Ltd., Middlesbrough, Ironmaster.
1916. Sanburn, J. C., Strathmore Paper Co., Mitrineague, Mass., U.S.A., Chemist.
1904. Sand, Dr. Henry J. S., Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C., Lecturer and Demonstrator.
1910. Sandeman, Archibald, Ruchill Oil Works, Glasgow, Chemist.
1906. Sanders, J. McConnell, Cia Mexicana de Petrole, "El Aguila, S.A.," Tampico, Mexico, Analytical and Consulting Chemist.
1915. Sanders, W. W., Factory Library, Goodyear Tire and Rubber Co., Akron, Ohio, U.S.A., Chemist.
1895. Sanderson, John, c/o B. S. Cohen, Ltd., Neasden Lane, London, N.W., Chemist.
1890. Saniter, E. H., Stratford Villa, Moorgate, Rotherham, Analytical Chemist.
1916. Sankey, Harold, 2, Latham Road, Southport, Soap Manufacturer.
1901. Sargent, Dr. Geo. W., c/o Crucible Steel Co. of America, Oliver Building, Pittsburgh, Pa., U.S.A., Chemist and Metallurgist.
1910. Sargent, R. N., St. Albans, W. Va., U.S.A., Chemical Engineer.
1911. Sauer, J. N. A., Joh Verhulststraat 43, Amsterdam, Holland, Sugar Chemist.
1903. Saunders, Lewis E., 123, Buffalo Avenue, Niagara Falls, N.Y., U.S.A., Electro-Chemical Engineer.
1896. Saunders, Walter M., 20, Dewey Street, Olneyville, R.I., U.S.A., Analytical Chemist.
1911. Saville, W. B., 35, North Side, Clapham Common, S.W., Analytical Chemist.
1895. Sawers, Wm. D., "Woodend," Giffnock, Scotland, Chemist.
1907. Saxe, Joel B., c/o Milton Hersey Co., Ltd., P.O. Box, 1086, Montreal; Journals to c/o Milton Hersey Co., Ltd., 257, Portage Avenue, Winnipeg, Man., Canada, Chemist.
1898. Saxe, Sigmund, 111, West 78th Street, New York City, U.S.A., Manufacturing Chemist.
1890. Sayers, Jos. J., c/o H.M. Factory, Pembrey, South Wales, Explosives Chemist.
1915. Seafe, Captain R. C., Stockton Chemical Co., Stockton-on-Tees, Works Chemist.
1917. Seard, Frederic L., West India Committee, 15, Seething Lane, E.C., Consulting Chemist (Sugar).
1913. Scarfe, H. Crespin, "Chikato," Willifield Way, Hendon, N.W., Public Officer.
1899. Schaak, Dr. Milton J., 719, Victoria Street, Corona, Cal., U.S.A., Chemist.
- O.M. Schack-Sommer, Dr. G., 87, Victoria Street, London, S.W., Sugar Refiner.
1898. Schad, Dr. Philipp, *see* Shaud, Dr. Philip.
1910. Schaefer, Dr. George L., New York Quinine and Chemical Works, 105, North 11th Street, Brooklyn, N.Y., U.S.A., Chemist and Technical Manager.

1912. Schapiro, Hugo H. B., Wadsworth, Ohio, U.S.A., Chemist.
1917. Scharff, Godfrey E., 144, Warwick Road, Carlisle, Chemical Engineer.
1908. Schatzmann, Dr. Paul, Isleben bei Fluelen, Switzerland, Chemist.
1903. Scheidel, Dr. Aug., c/o Commonwealth Portland Cement Co., 4, O'Connell Street, Sydney, N.S.W., Australia, Managing Director.
1886. Schellhaas, Henry Alf., Thornhill, Beech Road, Hartford, Northwich, Mechanical Engineer.
1894. Schidrowitz, Dr. P., 57, Chancery Lane, London, W.C., Research Chemist.
1902. Schlegel, Jno. Wm., New York Sugar Refinery, Long Island City, N.Y., U.S.A., Chemist.
1893. Schleicher, Francis J., 38, West Tenth Street, Long Island City, N.Y., U.S.A., Technical Chemist.
1901. Schlichting, Emil, 402 West 23rd Street, New York, City, U.S.A., Chemist.
1907. Schmitt, Charles A., The Carter's Ink Co., Cambridge "C," Boston, Mass., U.S.A., Chemist.
1904. Schniewind, Heinrich, jun., 149, Madison Avenue, New York City, U.S.A., Vice-President and Treasurer.
1904. Schoeller, Dr. Walter R., 57, York Street, Baker Street, London, W., Metallurgical and Research Chemist.
1902. Schofield, Prof. Jas. A., The University, Sydney, N.S.W., Australia, Lecturer in Chemistry.
1917. Schofield, Wilfred, 40, Grange Road, Leigh-on-Sea, Essex, Analytical Chemist.
1908. Schofield, Fred., c/o Burgess, Ledward and Co., Ltd., Dychouse Department, Walkden, Manchester, Works Chemist.
- O.M. Scholefield, H. E., Edgehill Chemical Works, Liverpool, Chemical Manufacturer.
1917. Schotz, Dr. S. P., 30, Russell Square, London, W.C., Chemist.
1906. Schroeder, C.M.E., 235 Wood Street, Rutherford, N.J., U.S.A., Analytical Chemist.
1895. Schroeder, E. August, c/o Church and Dwight Co., 1416, Willis Avenue, Syracuse, N.Y., U.S.A., Chemist.
1901. Schultz, Wm., 31, Gerry Avenue, Elmhurst, Long Island, N.Y., U.S.A., Chemist.
1907. Schwamm, Chas. A., c/o Antoine Chiris, 20, Platt Street, New York City, U.S.A., Chemist.
1889. Schweich, Emilo. See Mond, Emilo S.
1894. Schweitzer, Dr. H., Riverside Mansions, corner 113th Street and Riverside Avenue, New York City, U.S.A., Chemical Expert.
1906. Schwerin, Lorenz R., c/o Casein Co. of America, Bainbridge, N.Y., U.S.A., Vice-President.
1917. Secker, Arthur R., Portland Road, Bowdon, Cheshire, Engineer Director.
1917. Sechter, Wm. L., A4, Staff Quarters, Eastriggs Township, Annan, Analytical Chemist.
1891. Scott, Andrew L., Royal Gunpowder Factory, Waltham Abbey, Essex, Analytical Chemist.
1916. Scott, Ernest Kilburn, 51, Poplar Avenue, Edgbaston, Birmingham, Journals to Farningham, Kent, Electrochem. Engineer.
1912. Scott, Harold M., c/o R. Clay, Ltd., The Demmings, Cheadle, Cheshire, Works Chemist.
1898. Scott, Jas., Cawnpore Woollen Mills, Cawnpore, India, Chemist.
1894. Scott, Jno. Gillespie, Annislea, Clermiston Road, Corstorphine, Edinburgh, Analytical Chemist.
1912. Scott, Jno. William, 576, Church Street, Toronto, Canada.
1916. Scott, Robert, c/o Miss Cornell, 19, Ipswich Road, Stowmarket, Suffolk, Chemist.
1907. Scott, Wm. F., c/o Madison Woollen Co., Madison, Maine, U.S.A., Manager.
1904. Scoville, Wilbur L., c/o Parke, Davis, and Co., Detroit, Mich., U.S.A., Analytical Chemist.
1915. Scragg, Harold, c/o Locke, Blackett and Co., Ltd., St. Anthony's, Newcastle-on-Tyne, Analytical Chemist.
- O.M. Seudder, F., Mersey and Irwell Joint Committee, 44, Mosley Street, Manchester, Chemist.
1917. Seaber, Wm. M., National Explosives Works, Hayle, Cornwall, Chemist.
1889. Searl, Albert, 7, Palmeira Avenue, Westcliff-on-Sea, Technical Chemist.
1898. Searle, Alfred B., The White Building, Fitzalan Square, Sheffield, Consulting Chemist.
1915. Seaton, Cecil, 69, Vicarage Road, Smethwick, Birmingham, Technical Chemist.
1905. Seeker, A. F., 160, Midwood Street, Brooklyn, N.Y., U.S.A., Food Analyst.
1896. Seldner, Rudolph, 383, St. John's Place, Brooklyn, N.Y., U.S.A., Manufacturing Chemist.
1904. Seligman, Dr. Richard, Point Pleasant, Putney Bridge Road, Wandsworth, S.W., Chemist.
1908. Sellen, Elijah, Gasworks Laboratory, M.L.H. & P. Co., Elm Station, Montreal, Canada, Chemist.
1905. Sellers, Geo. E., Hopton Lane, Mirfield, near Huddersfield, Aniline Colour Maker.
1915. Sellers, R. A., 194, Goodshaw Lane, Crawshawbooth, Manchester, Print and Dye Works Chemist.
1898. Sen, Kavaraj Nagendra Nath, 18, Lower Chitpur Road, Calcutta, India, Physician and Chemist.
1910. Sen, Prof. Rajendra Nath, Engineering College, Sibpur, Bengal, India, Professor of Tinctorial Chemistry.
1916. Seward, Horace J., 84t, Cathedral Street, Montreal, Canada, Manufacturer.
1905. Sewell, B. F. Brooke, P.O. Box 1334, Washington, D.C., U.S.A., Chemical Engineer.
1896. Seyler, Clarence A., Public Analyst's Office, Nelson Terrace, Swansea, Chemist and Assayer.
1907. Seymour, Tom G., Kilton, Northway, Wavertree, Liverpool, Analytical Chemist.
1903. Shacklady, T. G., Hope Point, Cliffe at Hoo, Kent, Technical Chemist.
1906. Shah, Prof. S. J., Dhanasutar's Street, Ahmedabad, India, Consulting Chemist.
1916. Shankland, George A., Park Dale, Peveril Drive, Nottingham, Chemical Manufacturer. Journals to c/o Sam. Meggitt and Sons, Ltd., Sutton-in-Ashfield, Notts.
1892. Shanks, Arch., 5, Green Lodge Terrace, Greenhead, Glasgow, Chemist.
1908. Shanks, John, Dalmeny Park, Barrhead near Glasgow, Sanitary Engineer.
1908. Shard, Dr. Philip, The Gables, Hartford, Cheshire, Manufacturing Chemist.
1916. Sharp, F. L., 4, Rushworth Avenue, West Bridgford, Nottingham; Journals to c/o Sam Meggitt & Sons, Ltd., Sutton in Ashfield Notts.
1916. Sharpe, Frederick H., Reba Villa, Rowlands Gill, co. Durham, Chemist.
1901. Sharples, G. H., 253, Onslow Drive, Glasgow, Works Chemist.
1905. Sharples, Philip P., 90, Porter Place, Montclair, N.J., U.S.A., President (Nat'l. Coal Tar Co.).
1884. Sharples, Stephen P., 22, Concord Avenue, Cambridge, Mass., U.S.A., Analytical Chemist.
1911. Shaverock, Charles W., 35, Great St. Helen's, E.C., Cement Manufacturer.
1900. Sharwood, Dr. Wm. J., c/o Homestake Mining Co., Lead, South Dakota, U.S.A., Metallurgical Chemist.
1900. Shattuck, A. F., c/o Solvay Process Co., Detroit, Mich., U.S.A., Chemist.
1915. Shaw, John H., Public Library, Bury, Lancashire, Librarian.
1913. Shaw, T. W. A., "Springfield," Dee View Road, Heswall, Cheshire, Process Manager.
1912. Shearman, Cecil H., The Tees Bone Mills, Thornaby-on-Tees, Managing Director.
1904. Shedden, Frank, 25, Middleborough Road, Coventry, Science Master.
1903. Sheldon, Dr. N. L., Cordite Factory, Aruvankadu, Nilgiri Hills, India, Works Manager.
1912. Shelley, F. E., Apothecaries' Hall, Blackfriars, London, E.C., Analytical Chemist.

1912. Shelley, Wm. E., 20, Mount Street, Manchester, Engineer.
1911. Shelton, James, Government Laboratories, Singapore, S.S., Chemist.
1913. Shengle, J. C., c/o Major Bros., Ltd., Kiangsu Chemical Works, Shanghai, China, General Manager.
1892. Shenton, Jas. P., 37, Torbay Road, Chorlton-cum-Hardy, near Manchester, Analytical Chemist.
1916. Shenton, Joseph C., c/o Newcastle Alloy Co., Ltd., Rowlands Gill, co. Durham, Metallurgical Chemist.
1906. Shepard, Jas. H., Experiment Station, Brookings, S. Dakota, U.S.A., Agricultural Chemist.
1907. Shephard, Fred. G., Hetland Cottage, Ruthwell, Dumfriesshire, Chemist. Ret'n Journ ls
1904. Shephard, A. B., Copenhagen Oil Mills, Limehouse, London, E., Analytical Chemist.
1917. Shepherd, Harry, 17, Maudsley Street, Bury, Lancs, Works Chemist.
1893. Shepherd, H. H. B., 8, The Park, Sidenup, Kent, Chemist.
1898. Shepherd, Reginald des F., Central Laboratory, Rhodes, Manchester, Printworks Chemist.
1909. Shephard, Stephen W., c/o Eastern Chemical Co., Ltd., Rowles Hill, Dharavi, Bombay, India, Works Manager.
1899. Shero, John E., c/o Aluminium Co. of America, Niagara Falls, N.Y., U.S.A., Chemist.
1893. Shields, Dr. John, Minas de Rio Tinto, Prov. de Huelva, Spain, Chemist.
1896. Shimomura, Prof. K. Shinkarasumaru, Kojinguchi, Kyoto, Japan. Professor of Chemistry.
1905. Shoffstall, Arthur S., 153, Henderson Avenue, New Brighton, Staten Is., N.Y., U.S.A., Chemist.
1899. Sholes, Chas. E., 80, Maiden Lane, New York City, U.S.A., Chemical Agent.
1900. Shonk, Albert, 9, Lambton Road, Cottenham Park, Wimbledon, Analytical Chemist.
1897. Shores, Dr. Jeff. H., Kingsway, Frodsham, Cheshire, Chemist.
1904. Short, Andrew, 23, Hotspur Street, Tynemouth, Northumberland, Works Chemist.
1902. Shoubridge, Sydney Y., Gasworks, Lower Sydenham, S.E., Gas Engineer.
1901. Shukoff, Dr. Alexis A., Borowaja No. 86, Petrograd, Russia, Technical Chemist.
1915. Shulman, Harry, 21, Tredegar Square, Bow, E., Analytical Chemist.
1916. Shulman, Isaac, 75, Reginald Terrace, Chapeltown, Leeds, Yorks, Colour Chemist.
1890. Shutt, Frank T., Central Experimental Farm, Ottawa, Canada, Agricultural Chemist.
1906. Shuttleworth, E. B., 220, Sherbourne Street, Toronto, Canada, Chemist.
1901. Siau, Raymond L., Springfield Brewery, Wolverhampton, Research Chemist.
1902. Sibley, Samuel E., c/o Mauri Bros. and Thomson Ltd., 123, Castlereagh Street, Sydney, N.S.W., Australia, Technical Chemist.
1912. Siddons-Wilson, S., 4, Northfield Road, East Ham, E., Analytical Chemist.
1915. Siderfin, N. E., c/o The Gas Light and Coke Co., Tar and Liquor Works, Beckton, E., Works Chemist.
1902. Siebold, Alfred, c/o Lactose Ltd., Hibernia Works, Tipperary, Ireland, Technical Chemist.
1901. Silberrad, Dr. Oswald, Sunny Croft, Buckhurst Hill, Essex, Research Chemist.
1912. Sillars, Daniel, The Laboratory, Bolekow, Vaughan, and Co., Ltd., South Bank, S.O., Yorks, Metallurgical Chemist.
1892. Silvester, Harry, 78, Holyhead Road, Handsworth, Birmingham, Analytical and Consulting Chemist.
1901. Sim, Wilfrid A., c/o Wm. Sim and Sons, 40, Jane Street, Leith, Scotland, Colour Manufacturer.
1911. Simmons, Thos. A., "Shaugh," 6 Albert Road, Caversham, Reading, Technical Chemist.
1903. Simmons, Wm. H., Oakleigh, Stoke Newington Common, N., Analytical Chemist.
1898. Simon, Dr. A., 80, Bishopsgate, London, E.C., Chemical Engineer.
1905. Simons, Albert J., Pontianak, Dutch West Borneo, vii Singapore, Engineer.
1902. Simonson, Wm., 126, West 9th Street, Cincinnati, Ohio, U.S.A., Chemist.
1905. Simpson, Henry, 26, Austen Avenue, Sherwood Rise, Nottingham, Works Chemical Assistant.
- O.M. Simpson, W.S., Wyndcroft, Old Park Road, Enfield, N., Analytical Chemist.
1900. Sims, W. Edgar, Colinswell House, Burntisland, Fifeshire, Manager (British Aluminium Co.)
1894. Sinclair, Dr. W., 250, Ferry Road, Leith, Scotland, Chemist.
1890. Sindall, R. W., 2, Oxford Court, Cannon Street, London, E.C., Paper Chemist.
1911. Singh, Shersingh W., N.W. Railway, Beas, Punjab, India, Engineer.
1899. Singmaster, J. Arthur, 10, Millard Avenue, Bronxville Terrace, Yonkers, New York, U.S.A., Chemist.
1901. Sinnatt, Frank S., 321, Great Clowes Street, Higher Broughton, Manchester, Demonstrator of Chemistry.
1916. Sisson, Geo., Junr., Elvaston Road, Hexham, Consulting Chemist.
1917. Sissons, Harold H., c/o Sissons Bros., and Co., Ltd., Hull, Varnish, etc., Manufacturer.
1914. Sjöhlahl, H.A., c/o The Chatfield Manufacturing Co., Station P., Cincinnati, Ohio, U.S.A., Chemist.
1912. Skellon, Herbert, Newlands, Water Street, Leyland, near Preston, Chemist.
1894. Skelton, John R., c/o Norwich Crape Co. (1856), Ltd., St. Augustine's, Norwich, Managing Director.
1897. Skertchly, W. P., "Kenwyn," Station Road, Barrowash, near Derby, Analytical Chemist.
1891. Skilton, C. F. E., c/o Beamish and Crawford, Ltd., Cork, Ireland, Brewer.
1901. Skinner, Hervey J., 71, West Chestnut Street, Wakefield, Mass., U.S.A., Chemist.
1908. Skinner, Wm., 38, Sanchiehall Street, Glasgow, Analytical Chemist.
1917. Skipp, Ralph W., 10, Clarendon Road, Leeds, Student of Technical Chemistry.
1904. Skirrow, Dr. F. W., Macdonald Chemistry Building, McGill University, Montreal, Canada, Assistant Professor of Chemistry.
1911. Skjold, E., Erith Oil Works, Erith, Kent, Technical Manager and Chemist.
1904. Skowronski, S., c/o Raritan Copper Works, Perth Amboy, N.J., U.S.A., Chemist.
1891. Skurray, Thos., The Brewery, 40, Ock Street, Abingdon, Berks, Brewer.
1917. Slack, Harry, 59, Great Egerton Street, Stockport, Chemist.
1917. Slann, Alfred E. L., 31, Ranelagh Gardens, Stamford Brook Avenue, London, W., Works Chemist.
1904. Slater, Dr. Arthur, 174, Ashby Road, Burton-on-Trent, Lecturer and Demonstrator.
1912. Slattery, F. J., 31, Morningson Avenue, Cranbrook Park, Ilford, E., Analytical Chemist.
1906. Sleeper, Robt. R., 112, Charles Street, Lowell, Mass., U.S.A., Instructor in Dyeing.
1916. Sloan, Alexander, P.O. Box 410, Cumberland, Md., U.S.A., Manufacturing Chemist.
1895. Slocum, Dr. Frank L., 401, South Linden Avenue, E.E., Pittsburg, Pa., U.S.A., Chemist.
1913. Slusser, Holland B., c/o Hodgman Rubber Co., Tuckahoe, N.Y., U.S.A., Chief Chemist.
1898. Small, Fritz H., 38, Berwick Street, Worcester, Mass., U.S.A., Chemist.
1915. Smalley, Oliver, 7, Wentworth Place, Newcastle-on-Tyne, Metallurgist.
1904. Smart, Bertram J., Testing Branch, Dept. of Public Works, Sydney, N.S.W., Australia, Chemist.
- O.M. Smetham, A., 16, Brunswick Street, Liverpool, Analytical Chemist.
1916. Smith, Albert E., c/o New Bedford and Agawam Finishing Co., East Warcham, Mass., U.S.A., Bleaching Agent.

1905. Smith, Prof. Albert W., Case Library, Cleveland, Ohio, U.S.A., Professor of Chemistry.
1916. Smith, Alfred, Excelsior Works, Clayton, Manchester, Chemical Manufacturer.
1898. Smith, Alf. B., Ryecroft, Glossop, Derbyshire, Bleacher and Dyers' Manager.
1897. Smith, Allan, 30, Fountainhall Road, Edinburgh, Chemist.
1914. Smith, Andrew, c/o Leech, Neal, and Co., Ltd., Spondon, Derby, Colour Manufacturer.
1896. Smith, Andrew T., c/o Castner-Kellner Alkali Co., Ltd., 257, Royal Liver Building, Liverpool, General Manager.
1905. Smith, Arthur, Town End Chemical Works, Bramley, Leeds, Chemical Manufacturer.
1912. Smith, 2nd Lieut. Arthur R., O.W.A., B.E.F. (Journals c/o Professor H. L. Smith, 17, Bloomsbury Square, W.C.), Chemist.
1916. Smith, Claude, Barnburgh, Carmel, Grange-over-Sands, Lancs, Chemist.
1893. Smith, Edgar B., c/o Dominion Tar and Chemical Co., Ltd., Box 415, Sault Saint Marie, Ontario, Canada, Manager.
1913. Smith, Edward C., 18, Constance Street, and c/o Canadian National Carbon Co., 99, Paton Road, Toronto, Canada, Superintendent.
1906. Smith, E. A. Cappelen, c/o M. Guggenheim's Sons, 120, Broadway, New York City, U.S.A., Metallurgical Engineer.
1895. Smith, Dr. E. Ellsworth, Suite 80, Chemists' Building, 50, East 41st Street, New York City, U.S.A., Consulting Physiological Chemist.
1892. Smith, Ernest A., The Assay Office, Leopold Street, Sheffield, Assayer.
1911. Smith, E. Woodhouse, Central Laboratory, City Gasworks, Neebells, Birmingham, Chief Chemist.
1891. Smith, Francis P., 131-133, East 23rd Street, New York City, U.S.A., Chemist.
1907. Smith, Frank Morse, 81, Fulton Street, New York City, U.S.A., Chemical Merchant.
1908. Smith, George A., 1433, President Street, Brooklyn, N.Y., U.S.A., Chemist (Printing Ink).
1907. Smith, George D., 247, Atlantic Avenue, Boston, Mass., U.S.A., Salesman.
1916. Smith, Harold P., 5, North View, Whickham, Works Chemist.
1890. Smith, Harry E., 105, Mamaroneck Avenue, White Plains, N.Y., U.S.A., Analytical Chemist.
1904. Smith, Henry, 83, Brownlow Road, Horwich, Bolton-le-Moors, Lancs, Analytical Chemist.
1902. Smith, Hy. Geo., Technological Museum, Harris Street, Ultimo, Sydney, N.S.W., Australia, Assistant Curator and Chemist.
- O.M. Smith, Henry R., 1, Aubert Park, Highbury, London, N., Analytical Chemist.
1915. Smith, Herbert, "Rose Bank," Old Chester Road, Woodhey, Rock Ferry, Cheshire, Works Chemist.
1905. Smith, H. Melville, Ammunition Works, Abbey Wood, Kent, Engineer.
1901. Smith, H. Procter, Highfield, Shotton Lane, Shotton, Flintshire, Metallurgical Chemist.
1905. Smith, Hugh Duntord, 7 and 9, The Side, Newcastle-on-Tyne, Analytical Chemist.
1906. Smith, Irwin J., 21, Lyon Avenue, Menands, Albany Co., N.Y., U.S.A., Salesman.
- O.M. Smith, Jas., Ash Grove House, Radcliffe, Manchester.
1897. Smith, James, Sunnyside, Groes Road, Cressington, near Liverpool, Analytical Chemist.
1903. Smith, James, "Lyndhurst," Frodsham, and (Jnls.) Ditton Copper Works, Widnes, Metallurgist.
1907. Smith, Jas. C., c/o Edward Ripley and Son, Ltd., Bowling Dyeworks, Bradford, Dyer.
1893. Smith, Jas. F., Central Laboratories, Gas Works, Neebells, Birmingham, Analytical Chemist.
1901. Smith, J. Cruickshank, King's House, King Street, London, E.C., Technical Chemist.
1888. Smith, J. Tertius, Richmond House, Plaistow, Essex, Technical Chemist.
- O.M. Smith, Jno. W., 7, Brookfield Street, Roslindale, Boston, Mass., U.S.A., Analytical Chemist.
1890. Smith, J. Wm., 1615, West Genesee Street, Syracuse, N.Y., U.S.A., Alkali Works Manager.
1916. Smith, Julian C., c/o Shawinigan Water and Power Co., 611, Power Building, Montreal, Canada, Chief Engineer.
1911. Smith, N. Garrett, Heathside, Treville Street, Rochampton, S.W., Analytical Chemist.
1898. Smith, R. F. Wood, 90, Lower Thames Street, London, E.C., Consulting Chemist. On Active Service.
1890. Smith, Dr. R. Greig, Linnean Society's House, Elizabeth Bay, Sydney, N.S.W., Bacteriologist and Chemist.
1890. Smith, Robert Watson, c/o The New Transvaal Chemical Co., Ltd., Delmore, Transvaal, South Africa, Chemical Works Manager.
1916. Smith, Samuel G., Tattenhall Road Works, near Chester, Fat, Glue, and Manure Manufacturer.
1914. Smith, Stanley, The Ammonia Soda Co., Ltd., Lostock Gralam, near Northwich, Chemist.
1907. Smith, Thorn, 49, West Larned Street, Detroit, Mich., U.S.A., Chemist.
1910. Smith, Vincent, J., 107, Swinderby Road, Wembley, Middlesex, Technical Chemist.
1903. Smith, Dr. Warren R., Lewis Institute, Chicago, Ill., U.S.A., Teacher.
- O.M. Smith, Watson, 34, Upper Park Road, Haverstock Hill, N.W., Retired Editor and Chemist.
1908. Smith, Dr. Watson, jun., Cape Explosives Works, Somerset West, C.C., South Africa, Chemist.
- O.M. Smith, Wilfred, 182, West Street, Glasgow, Chemical Manufacturer.
1910. Smith, W. C., c/o The Anchor Cable Co., Leigh, Lancashire, Analytical Chemist.
1909. Smith, Wm. G., 23, Wickham Way, Park Langley, Beckenham, Kent, Chemical Merchant.
1916. Smith, Wm. Stanley, Tattenhall Road Works, near Chester, Fat, Glue, and Manure Manufacturer.
- O.M. Smithells, (Lt.-Col.) A., F.R.S., G.H.Q. Home Forces, Horse Guards, London, S.W., Professor of Chemistry.
1902. Smoot, Albert M., 99, John Street, New York City, U.S.A., Analytical Chemist.
1909. Smoot, Chas. C. III., c/o C. C. Smoot and Sons Co., North Wilkesboro', N.C., U.S.A., Tanning Chemist.
1888. Snape, Dr. H. Lloyd, Balholm, Lathom Road, Southport, Director of Education for Lancashire.
1908. Snell, Professor John F., Macdonald College P.O., Prov. Quebec, Canada, Professor of Chemistry.
1915. Snowber, John L., 3671, Broadway, New York City, U.S.A., Manufacturing Chemist.
1896. Snowden, J., Messrs. Snowden, Sons and Co., Millwall, E., Chemical and Oil Manufacturer.
1894. Soane, Chas. E., 31, Mattison Road, Hornsey, N., Analyst.
1903. Sohlman, Ragnar, Bofors, Sweden, Manager (A. B. Bofors Nobelkrut).
1894. Sohn, Chas. E. See Soane, Chas. E.
1906. Solomon, M., Birmingham Carbon Works, Witton, Birmingham, Manager.
1916. Solomon, Simon, 22, Sainfoin Road, Upper Tooting, S.W., Works Chemist and Manager.
1914. Somerville, C. Winthorpe, South Metropolitan Gas Company, East Greenwich, S.E., Works Chemist.
1884. Sommer, Adolph, Corner 1st and Binney Streets East, Cambridge, Boston, Mass., U.S.A., Pharmaceutical Chemist.
1907. Sonsthagen, Asbjörn, 35, Drayton Grove, W., Ealing, London, W., Engineer, Chocolate Trade.
1912. Sorley, Jas., Novara, Mount Vernon, Glasgow, Analytical Chemist.
1904. Southall, A. W., Lower Priory, Birmingham, Manufacturing Chemist.
1904. Southarden, F., 11, Gordon Road, Exeter, Teacher of Chemistry.
1890. Sowerby, Thos. H., Canal Soap Works, Verney Road, Rotherhithe, S.E., Soap Manufacturer.
1887. Spackman, Chas., Rosehaugh, Clitheroe, Lancashire Portland Cement Manufacturer.

1910. Spackman, Henry S., 2211, Chestnut Street, Philadelphia, Pa., U.S.A., President of Engineering Co.
1904. Sparre, Fin, c/o E. I. du Pont de Nemours and Co. Room 250, du Pont Building, Wilmington, Del., U.S.A., Director.
1913. Speedy, Alan, 81, Burges Road, East Ham, E.6, Technical Chemist.
1904. Speiden, C. C., 46, Cliff Street, New York City, U.S.A., Chemical Merchant.
1905. Speight, W. E., Haeken Sewage Works, Great Lever, Bolton. Chemist.
1911. Spence, Dr. David, Norwalk, Conn., U.S.A., Research Chemist.
1900. Spence, Howard, Journals to Manchester Alum Works, Manchester, Chemical Manufacturer.
1883. Spence, Jno. W., Tiviot Colour Works, Manchester Road, Stockport, Drysalter.
1903. Spencer, A. Gordon, 4076, Tupper Street, Westmount, P.Q., Canada, Chemist.
1917. Spencer, Edward J., 212, Hulme Hall Lane, Miles Platting, Manchester, Chemical Engineer.
1903. Spichmann, Dr. P. E., c/o The Institute of Chemistry, 30, Russell Square, London, W.C., Chemist.
1906. Spiera, Dr. V. G., c/o Inchiostroificio-Veneto, Treviso, Italy, Chemist.
1889. Spies, Adolph, 21, Broadwater Down, Tunbridge Wells, Chemical Merchant.
1885. Spiller, A., 20, Holly Avenue, Newcastle-on-Tyne, Electrician.
- O.M. Spiller, J., 2, St. Mary's Road, Canonbury, London, N., Consulting Chemist.
1914. Spilman, G. H., 3, Park Place, Maze Hill, London, S.E., Works Chemist.
1896. Spoor, J. L., Rede Court, Rochester, Kent, Portland Cement Manufacturer.
- O.M. Squire P. W., 413, Oxford Street, London, W., Pharmaceutical Chemist.
1916. Srivastava, J. P., Department of Industries for United Provinces, Cawnpore, India, Technical Chemist.
- O.M. Stahl, Dr. K. F., 57th Street and A. V. Ry., Pittsburgh, Pa., U.S.A., Consulting Chemist.
1912. Stancourt, Fred., 24, Walbrook, London, E.C., Chemical Manufacturer.
1904. Standfast, Jno. T., Prince Regent's Wharf, Silver-town, E., Chemist.
1917. Stanhill, David B., Research Dept., Levinstein, Ltd., Blackley, Manchester, Chemist.
1897. Stannard, Dr. Oscar J., c/o Twite and Stannard, 65, London Wall, E.C., Consulting Metallurgist.
1888. Stantial, Frank G., c/o Cochrane Chemical Co., Everett, Mass., U.S.A., Technical Chemist.
1885. Staples, H. J., The Old Hall, Spondon, Derby, Colour Manufacturer.
- O.M. Stark, J. F., Rosedale, Bromborough, Cheshire, Works Manager.
1917. Starnes, Arthur H., c/o Pirie's Photographic Paper Co., Ltd., Waterton Works, Aberdeenshire, Manager.
1916. Starrels, Joel, 250, Front Street, New York City, U.S.A., Chemical Engineer.
1896. Statham, Neel, c/o West Virginia Pulp and Paper Co., 200, Fifth Avenue, New York City, U.S.A., Engineer.
1907. Stand, Joseph E., c/o W. W. Lawrence and Co., West Carson Street, S.S., Pittsburgh, Pa., U.S.A., Chemist.
1904. Stauffer, W., 64, Oberwilerstrasse, Basle, Switzerland, Chemical Works Manager.
1895. Stead, J. Christopher, 57, Chancery Lane, London, W.C., Technical Chemist.
- O.M. Stead, Dr. J. E., F.R.S., 11, Queen's Terrace, Middlesbrough-on-Tees, Analytical Chemist.
1915. Steedman, Geo., Annickburn, Irvine, Ayrshire, Chemical Manufacturer.
1896. Steel, Fred. W., c/o General Chemical Co., Ltd., Auburn, Sydney, Australia, Works Manager.
- O.M. Steel, Thos., Colonial Sugar Refining Co., O'Connell Street, Sydney, N.S.W., Australia, Sugar Chemist.
1914. Steele, George Francis, c/o Canadian Export Paper Co., Ltd., Sun Life Building, Dominion Square, Montreal, Canada, Paper Manufacturer.
1915. Steger, Prof. Alph. M.A.A., Bibliotheek van het Schiekundig Laboratorium der Technische Hoogeschool, Delft, Holland, Chemical Technologist.
1912. Steiner, Bernard C., Enoch Pratt Free Library, Baltimore, Md., U.S.A., Librarian.
1897. Steinhart, Dr. Oscar J., See Stannard, Dr. Oscar J.
1912. Steinhoff, Fred., See Stancourt, Fred.
1887. Stenhouse, T., 166, Drake Street, Rochdale, Analytical Chemist.
1908. Stenhouse, Thos., jun., Chemical Laboratory, H.M. Dockyard, Portsmouth, Analytical Chemist.
1904. Stephen, A. E., 67, Castlereagh Street, Sydney, N.S.W., Australia, Analytical Chemist.
1917. Stephens, Albert J., c/o John Stephens, Son and Co., Ltd., Gloucester, Jam and Vinegar Manufacturer.
1911. Stephens, C. E., Messrs. Stephens Bros. & Co., 2, Bury Court, St. Mary Axe, E.C., Chemical Merchant.
1884. Stephens, H. Chas., Avenue House, Finchley, N., Ink Manufacturer.
1892. Stephens, M. E., 57-60, Aldersgate Street, London, E.C., Ink Manufacturer.
1917. Stephens, Thos. E., c/o The Russian American Indian Rubber Co., Treugolnik, Petrograd, Russia, Chemist and Manager.
1909. Stephenson, Henry H., 52, Commercial Road, Hayle, Cornwall, Technical Chemist.
1909. Stephenson, Herbert F., 8, The Park, Mitcham, Surrey, Analytical Chemist.
1889. Stern, Arthur L., 148, High Street, Burton-on-Trent, Brewing Chemist.
1912. Sterne, Edward T., Imperial Munitions Board, Beloeil Station, Quebec, Canada, Chemist.
- O.M. Steuart, D. R., Osborne Cottage, Broxburn, West Lothian, Oilworks Chemist.
1903. Steven, A. B., Royal Technical College, Glasgow, Lecturer on Dyeing.
1914. Steven, George, 23, Denstone Road, Pendleton, Manchester, Pharmaceutical Chemist.
1907. Steven, Michael M., c/o The Murree Brewery Co., Ltd., Rawalpindi, Punjab, India, Analytical Chemist.
1899. Stevenot, G. A., 280, Baltic Street, Brooklyn, N.Y., U.S.A., Chemist.
1902. Stevens, Dr. Hy. P., Laboratory, 15, Borough, London Bridge, S.E., Consulting Chemist.
1894. Stevens, Jno. H., c/o Librarian, The Celluloid Co., 3, Westcott Street, Newark, N.J., U.S.A., Manufacturing Chemist.
1908. Stevens, J. Venn, 30, Linthorpe Road, Stamford Hill, London, N., Analytical Chemist.
1916. Stevens, Victor G., 6, Kingland, Jesmond, Newcastle-on-Tyne, Metallurgist.
1917. Stevenson, Alex. W., 5, Chiswick Street, Carlisle, Chemist.
1917. Stevensen, Arnold, 4, Porchester Gardens, London, W., Chemist.
1916. Stevenson, C. E., Inglis Green House, Slateford, Midlothian, Dyer and Manufacturer.
1917. Stevenson, Capt. R., Inspector Ordnance Machinery, A.O.D. O i/c Heavy Mobile Workshop, A.P.O. S 14, Third Army, France, Consulting Engineer.
- O.M. Stevenson, W., Standard Works, 95A, Southwark Street, London, S.E., Chemical Manufacturer.
1913. Steward, H. Bernard, Rose Hill House, Coseley, near Bilston, Staffs, Enamel Chemist.
1912. Stewart, Allan E., 136, Bedford Road, Toronto, Canada, Chemist.
1901. Stewart, David B. D., Aberdeen Comb Works, Hutcheon Street, Aberdeen, Managing Director.
1903. Stewart, Jas., "The Gas World," 8, Bouverie Street, Fleet Street, London, E.C., Editor.
1909. Stewart, Jeffrey, c/o E. F. Drew Inc., McKean and Swanson Streets, Philadelphia, Pa., U.S.A., Works Manager.
1890. Stewart, Robt., 46, Westbourne Road, Luton, Chemical Works Manager.

1916. Stewart, Robert P., 402 Lakeview Aven., Jamestown, N.Y., U.S.A., Dyer, Empire Worsted Mills.
1915. Stewart, R. P., Carricklea, Kirkintilloch, Scotland, Analytical and Manufacturing Chemist.
- O.M. Stewart, S., c/o Michael Nairn and Co., Ltd., Kirkealdy, Fife, Technical Chemist.
1906. Stickland, Oliver W., c/o The New Explosives Co., Ltd., Stowmarket, Suffolk, Chemist.
1904. Stieglitz, Dr. Julius, University of Chicago, Chicago, Ill., U.S.A., Associate Professor of Chemistry.
1904. Stiff, John T., 37, Grasmere Road, Handsworth, Birmingham, Works Chemist.
1903. Stillwell, Albert G., 76½, Pine Street, New York City, U.S.A., Chemist.
1917. Stobart, James W., 37, Cicada Road, Wandsworth Common, S.W., Chemist.
1916. Stobart, Wm. R., Etherley Lodge, Bishop Auckland, Managing Director, H. Stobart and Co., Ltd.
1914. Stock, Cyril J. H., 9, Houndgate, Darlington, Analytical Chemist.
1900. Stockdale, Edgar, c/o R. Dewhurst and Co., Ltd., Printworks, Batley, Yorks, Colour Mixer.
1888. Stockdale, Wm., Rosebank Printworks, Ramabottom, near Manchester, Calico Printer.
1887. Stocks, H. B., 33, Prenton Park Road, Birkenhead, Cheshire, Analytical Chemist.
1916. Stockton-Abbott, Lyle, 300, Willow Avenue, River Edge, N.J., U.S.A., Chemical Engineer.
1903. Stoddard, Jesse D., 674, Woodward Avenue, Detroit, Mich., U.S.A.
1899. Stokes, Alf. W., Laboratory, Town Hall, Paddington Green, W., Public Analyst.
1910. Stokes, Colonel Edward S., 18, Ben Boyd Road, Neutral Bay, Sydney, N.S.W., Australia, Medical Officer.
1900. Stone, Geo. C., c/o New Jersey Zinc Co., 55, Wall Street, New York City, U.S.A., Engineer.
1899. Stone, I. F., 100, William Street, New York City, U.S.A., Chemical Merchant.
- O.M. Storey, I. H., Haverheskas, Lancaster, Chemical Manufacturer.
1914. Storie, George B., 62, Vineyard Hill Road, Wimbledon, S.W., Works Manager.
1902. Storr, Bertram V., 26, The Square, Garden Suburb, Ilford, Essex, Chemist.
1914. Stott, Augustus P., 165, City Road, N., Manager.
1909. Strachan, Jas. T., c/o The Canada Paper Co., Ltd., Windsor Mills, P.Q., Canada, Technical Chemist.
1916. Strafford, Norman, 95, Tonbridge Street, Leeds, Chemist.
1917. Street, Brooks K. G., 10, Tutton Grove, Withington, Manchester, Analytical Chemist.
1903. Strickler, Emerson H., c/o General Chemical Co., 25, Broad Street, New York City, U.S.A., Chemist.
1909. Strivens, Percy R., 20, Cartmel Road, St. Annes-on-Sea, Lancs, Analytical Chemist.
1916. Stuart, A. T., Toronto Power Co., 12, Adelaide Street East, Toronto, Canada, Chemical Engineer.
1896. Stuart, Harry T. R., High Bank, Walshaw, Bury, Lancs, Manager.
- O.M. Stuart, T. W., 7, Livingston Drive, Sefton Park, Liverpool, Alkali Works Manager.
1896. Stubbs, Augustus J., Castellon de la Plana, Spain.
1903. Sturrock, Major G. C., R.A., 6, Esplanade East, Calcutta, Deputy Director of Ordnance Factories, India.
1908. Suart, Arthur B., c/o Johnson and Sons' Smelting Works, Ltd., Paul Street, Finsbury, London, E.C., Bullion Refiner.
1895. Sudborough, Dr. J. J., Indian Institute of Science, Bangalore, India, Lecturer in Chemistry.
1916. Sullivan, E. C., Corning Glass Works, Corning, N.Y., U.S.A., Chemist.
1889. Sulman, H. L., 44, London Wall, London, E.C., Chemist and Metallurgist.
1910. Sulzer, Albert F., 16, Beverly Street, Rochester, N.Y., U.S.A., Chemical Engineer.
1907. Sundar-Ram, Minakshi, c/o Parry and Co., Ranipettai, N. Arcot, Madras, India, Agricultural Chemist.
1912. Sutchliffe, J. A. L., c/o Price's Co., Ltd., Belvedere, Kent, Analytical Chemist.
1906. Sutermeister, Edwin, c/o S. D. Warren and Co., Cumberland Mills, Westbrook, Maine, U.S.A., Chemist.
1884. Sutherland, D. A., 26, Victoria Street, Westminster, S.W., and (Jnls.) Fairfield Lodge, Twickenham, Consulting Technical Chemist.
1909. Sutherland, Daniel M., Ashgrove, Sunbury Common, Middlesex, Works Manager.
1894. Sutherland, Geo., Ladyton Croft, Bonhill, Scotland, Chemist.
1887. Sutherland, Jas., c/o British Aluminium Co., Ltd., Larne Harbour, Co. Antrim, Ireland, Chemist.
1906. Sutherland, John, Vril Lodge, Larne Harbour, Co. Antrim, Ireland, Chemical Engineer.
1916. Sutherst, Dr. W. F., Technical Chemist. Retain Journals.
1886. Sutton, F. Napier, 21, Lydford Road, Cricklewood, N.W., Alkali Works Inspector.
1900. Sutton, W. Lincoln, Redwell Street, Norwich, Public Analyst.
1917. Swallow, Albert V., St. Helens Cable and Rubber Co., Ltd., Warrington, Works Chemist.
1913. Swan, J. Waldron, "Purleighs," The Downs, Luton, Beds., Gas Works Chemist.
1917. Swann, Herbert, 47, Upper Wickham Lane, Welling, Kent, Chemist.
1905. Swenarton, W. Hastings, 2, Rector Street, New York City, U.S.A., Patent Lawyer.
1904. Swindells, Seth, Liverpool Road, Kidsgrove, Stoke-on-Trent, Chemist.
1912. Swinden, Dr. Thos., 12, Nether Edge Road, Sheffield, Metallurgist.
1912. Sykes, Charles D., Ivy House, Langley, near Birmingham, Chemical Works Manager.
1902. Sylow, Paul, New Farm Sugar Refinery, Brisbane, Queensland, Analytical Chemist.
1906. Symes, Langford P., Belfast Freezing Works, Christchurch, New Zealand, Chemist.
1906. Symonds, Abram E., Wick Lane Colour Works, Old Ford Road, Bow, E., Colour Manufacturer.
1910. Szilagyi, L. F., 39, Belsize Avenue, London, N.W., Consulting Engineer.

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1895. Taber, G. H., 18th floor, Frick Building Annex, Pittsburg, Pa., U.S.A., General Manager (Gulf Refining Co.).
1915. Taberner, E., H.M. Factory, Greta, N.B., Technical Chemist.
1914. Tack, Howarth K., Acid Plant, La Refineria, El Aguila S.A., Minatitlan, Vera Cruz, Mexico, Chemical Engineer.
1910. Tainsh, Peter, 36, Green Lawn, Rock Ferry, Cheshire, Technical Chemist.
1915. Tait, J. W., Blackford, Salteats, Ayrshire, Chemist.
1909. Tait, Walter Scott, Innellan, Behington, Cheshire, Works Manager.
- O.M. Takamatsu, T., 13, Nishikatamachi, Hongo, Tokyo, Japan, Analytical Chemist.
- O.M. Takamine, Dr. Jokichi, Takamine Laboratory, Inc., Clifton, N.J., U.S.A., Engineer.
1915. Tallantyre, S. B., H.M. Factory, Chance and Hunt, Ltd., Site B, Oldbury, near Birmingham, Technical Chemist.
1912. Talley, Herbert, c/o Hercules Powder Co., Wilmington, Del., U.S.A., General Manager.
1910. Tanahashi, Dr. T., 1, Yariyacho, Kyobashiku, Tokyo, Japan, Manufacturing Chemist. [Nippon Chem. Industry Co.]
1898. Tanaka, Keishin, Matsuba Hotel, Kudansaka, Uye, Tokyo, Japan, Chemist.
1915. Tangye, Albert W., Thorn, Hartford, Cheshire, Chemical Works Manager (Brunner, Mond & Co.).

1900. Tankard, Arnold R., 67, Ferens Avenue, Cottingham Road, Hull, Analytical Chemist.
1911. Tarver, Percy, 2095, East 36th Street, Cleveland, Ohio, U.S.A., Chemist.
- O.M. Tate, F. H., Winterghyll, Caldys Road, West Kirkby, Analytical and Technical Chemist.
- O.M. Tatlock, R. R., 156, Bath Street, Glasgow, Consulting Chemist.
1902. Tatters, Hugh Lee, 21, Park Road, Hebburn-on-Tyne, Analytical Chemist.
1906. Tattersfield, Frederick, Stortholme, Framlingham, Suffolk, Analyst.
1905. Taveau, René de Mortemer, Experimental Station, E. I. du Pont de Nemours Power Co., Wilmington, Del., U.S.A. (Journals to P.O. Box 244, Wilmington, Del., U.S.A.), Chemist.
1903. Taylor, Alvin M., c/o General Chemical Co., Hege-
wisch, Ill., U.S.A., Chemist.
1917. Taylor, Arthur, "The Woodlands," Langley,
Macclesfield, Technical Chemist.
1902. Taylor, Arthur, P., 12, Willington Street East,
Toronto, Canada, Soap Manufacturer.
1886. Taylor, G. Crosland, Crane House, Crane Wharf,
Chester, Electrical Engineer.
1894. Taylor, G. Midgley, Caxton House, Westminster,
S.W., Analytical Chemist.
- O.M. Taylor, H. E., 1, Alexandra Park Gardens, Glasgow,
Lead Works Manager.
1917. Taylor, Henry F., Holly House, 299, Eccles New
Road, Salford, Works Chemist.
1883. Taylor, Jas., "Cartref," Brierley Street, Mosman,
N.S.W., Australia, Government Metallurgist.
1898. Taylor, Jas. M., Tynevale, Groes Road, Cressington,
Liverpool, Analytical Chemist.
1888. Taylor, J. Scott, North London Colour Works,
Spring Place, Kentish Town, N.W., Technical
Chemist.
1896. Taylor, Martin, Abbotsmead, St. Albans, Herts,
Chemical Works Manager.
1901. Taylor, Sidney H., 63, Wolstenholme Road,
Sharrow, Sheffield, Works Chemist.
1898. Taylor, Walter, 475, Grosvenor Place, Limefield,
Bury, Lancs, Technical Chemist.
1915. Taylor, W. Ivan, c/o Kynoch, Ltd., Umbogintwini,
Natal, Chemical Works Manager.
1905. Taylor, Wm. H., 36, Glenhouse Road, Eltham Park,
Kent, Chemist.
1916. Tcherniac, Dr. Jos., 49, Palace Road, Streatham
Hill, S.W., Consulting Chemist.
1887. Teanby, G. W. A., Elvin Lodge, East Dereham,
Norfolk, Analytical Chemist.
1899. Teas, Wm. Holmes, Marion, Va., U.S.A., Chemist.
- O.M. Teed, Dr. F. L., Chem. Lab., 9, Mincing Lane,
London, E.C., Analytical Chemist.
1905. Teeple, Dr. J. E., 50, East 41st Street, New York
City, U.S.A., Director.
1915. Tefit, H. Delano, 75, Chelsea Avenue, Toronto,
Canada, Chemist.
1904. Teller, George L., 31, North State Street, Chicago,
Ill., U.S.A., Chemist.
1906. Tempny, Dr. Harold A., Department of Agriculture,
Reduit, Mauritius, Analyst.
1916. Templeman, W. H., 53, Fountain Street, Hull,
Chemist and Barrister-at-Law.
1884. Tennant, Jas., Fairlie, Ayrshire, Lead and Colour
Manufacturer.
1896. Tennille, Geo. F., c/o Southern Cotton Oil Co.,
206, Bay Street East, Savannah, Ga., U.S.A.,
Chemist.
1908. Terleski, Fred. H., Oakwood, Hilton Lane, Prestwich,
Manchester, Technical Chemist.
1911. Terrey, Augustus G., 6, Alexandra Road, South
Woodford, Essex, Chemist.
1884. Terry, Hubert L., (Journals) Fairfield House,
Brook Road, Fallowfield, Manchester; and
(Laboratory) 23, Hopwood Avenue, Manchester
Consulting Chemist.
- O.M. Tervet, R., 68, Windsor Road, Leyton, Essex,
Oil Works Manager.
1893. Tetley, C. F., Messrs. Jos. Tetley and Sons, The
Brewery, Leeds, Brewer.
1915. Thäberg, N. T., A.B. Lina Myr, Stureplan 13,
Stockholm, Sweden, Technical Chemist.
1903. Thatcher, Ed. J., The Manor House, Chew Magna,
near Bristol, Merchant and Manufacturer.
1909. Thaxter, Gerald N., c/o Brewer and Co., Worcester,
Mass., U.S.A., Chemist.
1908. Thom, Wm. H., 131, Oakwood Avenue, Toronto,
Canada, Chemist.
1911. Thomas, D. Hibbert, 56, Waun Road, Morriston,
Glamorganshire, Chemical Works Manager.
1916. Thomas, E. R., The Farm, H.M. Factory, Sandy-
croft, near Chester, Chemist.
1912. Thomas, Frederick, c/o Williams Bros. and Co.,
Colour Manufacturers, Hounslow, Middlesex,
Chemist and Works Manager.
1894. Thomas, H. Russell, Broad Plain Soap Works,
Bristol, Soap Manufacturer.
1909. Thomas, John, Highfield, Brettell Lane, near
Stourbridge, Analytical Chemist.
1916. Thomas, John S. G., Physical Laboratory, South
Metropolitan Gas Co., 709, Old Kent Road,
London, S.E., Physicist.
1902. Thomas, Nehemiah M., Wellesley Road, Pymble,
N.S.W., Australia, Inspector.
1901. Thomas, Octavins, Gas and Water Office, Pentre,
Glamorganhire, Gas and Water Engineer.
1908. Thomas, Oswald J. D., c/o The E. B. Eddy Co.,
Hull, Quebec, Canada, Research Chemist.
1888. Thomas, S. Percy, c/o Baird and Tatlock, (London)
Ltd., 14, Cross Street, Hatton Garden, London,
E.C., Technical Chemist.
1898. Thomas, Wm. Harrison, jun., South Norwalk,
Conn., U.S.A., Printworks Chemist.
1905. Thomlinson, Wm., Seaton Carew Ironworks, West
Hartlepool, Ironmaster.
1905. Thompson, Alf. J., c/o R. W. Greeff and Co.,
Thames House, Queen Street Place, London,
E.C., Chemical Merchant.
1916. Thompson, Bertie, Nile Villa, Meldrum Road,
Kirkcaldy, Journals to Kelvin Lodge, 59,
Northumberland Park, Tottenham, N., Tech-
nical Chemist.
1885. Thompson, Prof. Claude M., 38, Park Place, Cardiff,
Professor of Chemistry.
1898. Thompson, Edw. C., 9, Elderslie Road, Eltham,
London, S.E., Manufacturing Chemist.
1909. Thompson, Edwin, 25, Sefton Drive, Liverpool,
Manufacturing Chemist.
1914. Thompson, F. C., 183, Hyde Park Road, Leeds,
Demonstrator in Leather Industries Department.
1893. Thompson, G. Rudd, 69, Dock Street, Newport,
Mon., Analytical and Consulting Chemist.
1895. Thompson, Gustave W., 129, York Street, Brooklyn,
N.Y., U.S.A., Chemist.
1913. Thompson, Howard, c/o Wm. Pearson, Ltd., Stone-
ferry, Hull, Analytical Chemist.
1907. Thompson, Jas. G., Donegall Quay Mills, Belfast,
Ireland, Corn Miller.
1903. Thompson, Jno. T., Corporation Sewage Works,
Knostrop, Leeds, Analyst.
1912. Thompson, Kenworthy J., c/o The Columbia Tire
& Rubber Co., Columbiana, Ohio, U.S.A., Rubber
Works Chemist.
1907. Thompson, Milton S., 72, Broad Street, Boston,
Mass., U.S.A., Manufacturer.
1916. Thompson, Wm. F., 140, London Road, Nottingham,
Works Chemist.
- O.M. Thompson, W. P., Patent Office, 6, Lord Street,
Liverpool, Patent Agent.
1896. Thomsen, Alonzo L., Maryland Club, 1, East Eager
Street, Baltimore, Md., U.S.A., Manufacturing
Chemist.
1884. Thomson, G. Carruthers, 53, Bedford Road, Rock
Ferry, Birkenhead, Engineer.
1907. Thomsen, H. N., 918, South Kingsley Drive, Los
Angeles, Cal., U.S.A., Metallurgist.

1891. Thomson, Jas. M., Royal Gunpowder Factory, and (Jnls.) Powder Mill Lane, Waltham Abbey, Essex, Manager (Cordite Branch).
1884. Thomson, Robt. T., 156, Bath Street, Glasgow, Analytical Chemist.
1899. Thomson, Thos., c/o Waterproofing Co., Barrhead, near Glasgow, Manufacturer.
- O.M. Thomson, W., Royal Institution Laboratory, 79A, Princess Street, Manchester, Analytical and Consulting Chemist.
1915. Thomson, W. Loekerbie, 34, Craighouse Avenue, Morningside, Edinburgh, Chemist.
1890. Thomaon, Wm. Thos., "Stanton," Parkestone Road, Poole, Dorset, Explosives Chemist.
1902. Thorburn, Jas., 30, Cromartie Avenue, Newlands, Glasgow, Analytical Chemist.
1910. Thorne, Carl B., c/o Riordan Paper Co., Hawkebury, Ontario, Canada, Manager.
- O.M. Thorne, Dr. L. T., Highlands, The Crescent, Belmont, Surrey, and (Journals) Southampton Wharf, Battersea, S.W., Technical Chemist.
1916. Thorne, P. C. L., 40, Kidbrook Park Road, Blackheath, S.E., Works Chemist.
1907. Thornwell, A. R., 163, Rood End Road, Oldbury, Birmingham, Works Chemist.
- O.M. Thorneycroft, Wallace, (Jnls.) Plean House, Plean, Stirling, and 113, St. Vincent Street, Glasgow, Technical Chemist.
1904. Thornley, Thomas, 19, Hope Street, Glasgow, Chemical Manufacturer.
1895. Thorp, Dr. Frank H., 220, Mount Vernon Street, West Roxbury, Mass., U.S.A., Assistant Professor of Industrial Chemistry.
1906. Thorp, Walter, Sorrentoville, Dalkey, Co. Dublin, Ireland, Analytical Chemist.
- O.M. Thorpe, Sir Edward, C.B., F.R.S., Whinfield, Salcombe, South Devon, Professor of Chemistry.
1905. Thorpe, Prof. J. F., C.B.E., F.R.S., The Imperial College, South Kensington, London, S.W., Professor of Organic Chemistry.
1915. Threlfall, Sir R., K.B.E., F.R.S., Oakhurst, Church Road, Edgbaston, Birmingham, Chemical Manufacturer.
1905. Thresh, Dr. John C., Chelmsford, Essex, Medical Officer of Health and Sanitary Expert.
1898. Thurnauer, Dr. Gustav, c/o Aurora Metal Co., Aurora, Ill., U.S.A., Chemist.
1904. Thurston, Azor, Grand Rapids, Ohio, U.S.A., Chemist.
1916. Thwaite, Alwyn H., Northwood, Bowden Close, Crook, Co. Durham, By-Product Coke Oven Manager.
1904. Tickle, Thos., Laboratory, 83, Queen Street, Exeter, Analyst.
1913. Tilburn, Charles, The Australian Explosives and Chemical Co., Ltd., Brabrook, Vic., Australia, Works Manager and Explosives Chemist.
1917. Tilden, Philip S., 317, South 43rd Street, Philadelphia, Pa., U.S.A., Sales Manager.
1900. Tilley, Jas. W., 95A, Southwark Street, London, S.E., Research Chemist.
1906. Tillson, Henry E., 5858, Pine Street, Philadelphia, Pa., U.S.A., Dyer.
1901. Timmans, W. G., The Basford Chemical Co., Ltd., Basford, Nottingham, Chemical Manufacturer.
1917. Ting, Su H., c/o Mr. H. C. Chen, 11, Tar-Wang-Mu Lane, Wush, Kiangsu, China (via Siberia), Chemist.
1916. Tinniswood, Joseph, c/o Hough, Hoscason and Co., 2, Bridge Street, Manchester, Wholesale Druggists Manager.
1894. Tipler, Fred. C., 2, Wellington Villas, Crewe, Analytical Chemist.
1907. Tischbein, Dr. Robert, The Heyden Chemical Works, Garfield, N.J., U.S.A., Chemist.
1894. Toch, Maximilian, 320, Fifth Avenue, New York City, U.S.A., Chemist.
1915. Tocher, Dr. J. F., Crown Mansions, Union Street, Aberdeen, Public Analyst.
1886. Todd, A. M., c/o The A. M. Todd Co., Kalamazoo, Mich., U.S.A., Manufacturing Chemist and Distiller of Essential Oils.
1911. Todd, Fred W., 16, Lansdowne Road, Tonbridge, Kent, Chemist.
1913. Tomlinson, George G., Anglo-Chilian Nitrate and Railway Co., Tocopilla, Chile, South America, Chemist.
1914. Tompkin, Albert, 101, Lenton Boulevard, Nottingham, Pharmacist.
- O.M. Toms, F. Woodland, States Analyst's Office, St. Heliers, Jersey, Analytical Chemist.
1902. Tone, Frank Jerome, c/o The Carborundum Co., Niagara Falls, N.Y., U.S.A., Manager.
1909. Tonry, Wm. S., Passaic Street, near Elm Street, Maywood, N.J., U.S.A., Chemical Engineer.
1913. Toppin, Richmond D., No. 9212, 1st Australian Dermatological Hospital, A.I.F., Bulford, Wiltshire, Chemist.
1916. Torpy, Hubert L., Carlton Brewery, Melbourne, Australia, Brewer.
1907. Torrey, Dr. Joseph, Park Drive, Blundellsands, Liverpool, Engineer.
- O.M. Towers, J. W., Widnes, Lancashire, Analytical Chemist.
1907. Towler, A. E., c/o Sulphide Corporation, Cockle Creek, N.S.W., Australia, Chemist.
1915. Townsend, Clinton P., 918, F. St. N.W., Washington, D.C., U.S.A., Patent Lawyer.
1897. Towse, Walter, c/o Clark, Son & Morland, Ltd., Glastonbury, Technical Chemist.
1904. Toyne, Francis D., c/o Kelaal and Kemp, Ltd., Woodhouse Mills, Norden, near Rochdale, Chemist.
1899. Trantom, Dr. Wm., Borås, Grappenhall, near Warrington, Chemist.
1894. Traphagen, Dr. Frank W., Colorado School of Mines, Golden, Colo., U.S.A., Professor of Metallurgy and Assaying.
1900. Traquair, Jno., Ayer, Mass., U.S.A., Analytical Chemist.
1906. Travell, Norman E., Grosvenor Avenue, Mapperley Park, Nottingham, Lace Dresser. On Active Service, retain Journals.
1893. Travers, Dr. Morris W., F.R.S., Beacon Hall, Priory Gardens, Highgate, London, N.; Journals c/o Duroglass Ltd., Blackhorse Lane, Walthamstow, Essex, Professor of Chemistry.
1889. Trechmann, A. O., Dene Garth, Springfield Avenue, Harrogate. Journals to Trechmann Bros., West Hartlepool. Cement Manufacturer.
1911. Trechmann, C. T., Warren Cement Works, Hartlepool, Cement Manufacturer.
1895. Treharne, F. Gwilym, Wrangbrook, Llanishen, near Cardiff, Analytical Chemist.
1901. Trigger, Oliver, Chem. Dept., Royal Arsenal, Woolwich, S.E., Analytical Chemist.
1898. Tripp, Dr. E. Howard, 9, Westbury Road, Woodside Park, London, N., Editor.
- O.M. Trobridge, A., c/o Trobridge and Co., Ltd., Heworth Shore, Felling-on-Tyne, Technical Chemist.
1916. Tromp, Felix J., Transvaal University College, Pretoria, S. Africa, Research Chemist.
1897. Trotman, Saml. R., The City Laboratory, 1, Regent Street, Nottingham, City Analyst.
1887. Tsukiyama, S., c/o Nippon Senrio Seizo, Kaisha Works, Kawakishi-Cho, Nishiku, Osaka, Japan, Paper Mills Chemist.
1916. Tuck, Dr. Wm. B., 45, Bartholomew Road, London, N.W., Chemist.
1894. Tucker, Alex. E., 55, Station Street, Birmingham, Metallurgist and Chemist.
1897. Tucker, Samuel A., Columbia University, New York City, U.S.A., Tutor in Industrial Chemistry.
1886. Tuer, Arthur H., Douglas House, Worthington, near Wigan, Analytical Chemist.
1903. Tufts, C. G., c/o Semet-Solvay Co., Syracuse, N.Y., U.S.A., Chemical Engineer.

1909. Tulloch, Capt. T. G., Bank Buildings, St. James's Street, London, S.W., Director of Public Companies.
1901. Tulloch, Wm. F., c/o The Olympia Oil & Cake Co., Ltd., Olympia Mills, Selby, Merchant.
1914. Tungay, Sydney J., Haughton's Ltd., 30, St. Mary at Hill, London, E.C., Chemical Engineer.
1909. Tunks, Dr. F. R., Powder Mills, Tonbridge, Kent, Manager.
1904. Tunnell, Raymond W., 251, West Walnut Lane, Germantown, Philadelphia, Pa., U.S.A., Manufacturer.
1899. Turnbull, Dr. Andrew, 18, Hackins Hey, Liverpool, Consulting Chemist.
1888. Turnbull, G. W., Ash Cottage, North Road, Carnforth, Lancashire, Metallurgical Chemist.
1916. Turnbull, John, c/o 44A, Moore End, Spondon, by Derby, Analytical Chemist.
1904. Turnbull, R. H., Messrs. Turnbull's (Glasgow) Ltd., 10, Strand Road, Calcutta, India, Chemist.
1884. Turnbull, W. S., 38, Bath Street, Glasgow, Chemical Manufacturer.
1911. Turner, Prof. A. J., Technical Institute, Byculla, Bombay, India, Professor of Chemistry.
1917. Turner, Francis M., jun., Room 272, 1, Madison Avenue, New York, Chemical Engineer.
1915. Turner, James, c/o Read, Holliday and Sons, Ltd., 8-10, West Market Street, Toronto, Canada, Manufacturing Chemist.
1902. Turner, Jos., c/o British Dyes, Ltd., and (Jnls.) Azo House, Birkby, Huddersfield, Director.
1905. Turner, Prof. Thomas, 75, Middleton Hall Road, King's Norton, Birmingham, Professor of Metallurgy.
1917. Turner, Dr. W. E. S., The University, Sheffield, Hon. Secretary, Society of Glass Technology.
1887. Turney, Sir J., Trent Bridge Leather Works, Nottingham, Tanner.
1908. Turnill, Thos. W., c/o Atlas Preservative Co., Ltd., Windmill Lane, Deptford, S.E., Works Chemist.
1916. Tuttle, Dr. F. E., 125, East Maxwell Street, Lexington, Ky., U.S.A., Professor of Chemistry.
1905. Tutwiler, Carrington C., Real Estate Trust Building, Philadelphia, Pa., U.S.A., Consulting Gas Chemist.
1916. Tweedie, Geo. R., 2, Hambledon Road, Southfields, S.W., Technical Chemist.
1890. Tweedy, Jas., 245, Burdett Road, Limehouse, E., Metallurgical Chemist.
1905. Twigg, Geo. F., Gas Works, Castleford, Yorks, Gas Works Chemist.
1915. Twiss, Dr. D. F., "Glendevon," Royal Road, Sutton Coldfield, Chief Chemist, Dunlop Rubber Co.
1891. Twitchell, E., Wyoming, Ohio, U.S.A., Candle Works Manager.
1913. Twomey, Jerome, 21, Onslow Road, Elm Park, Liverpool, Research Chemist.
- O.M. Twynam, T., Wynyard House, Coatham Road, Redcar, Yorks, Metallurgist.
1904. Tyler, Chas. R., c/o Dr. Francis Wyatt, 402, West 23rd Street, New York City, U.S.A., Analytical Chemist.
- O.M. Tykke, P. G. W., Lawn House, New Malden, Surrey, Chemical Manufacturer.
- O.M. Tyrer, Thos., Stirling Chemical Works, Stratford, E.; and (Journals) 14, Sandwell Mansions, West End Lane, N.W., Chemical Manufacturer.
1905. Umney, John C., 48, Southwark Street, London, S.E., Wholesale Druggist.
1889. Underhill, Thos. J., 53, Lanecost Road, Tulso Hill, S.W., Inspector of Stoves.
1885. Underwood, G. R., 10, Emerson Street, Peabody, Mass., U.S.A., Glue Works Chemist.
1917. Upton, Adolph W. H., Brooklyn, Tavistock Road, South Woodford, London, E., Research Chemist.
1915. Upton, W. C., Tara Cook Street, Randwick, Sydney, N.S.W., Soap and Candle Manufacturer.
1916. Urwin, Alfred, Urwin and Co., The Manors, Newcastle-on-Tyne, Manufacturing Chemist.

V

1911. Vakil, Kapibram H., "Ivyhurst," Burlington Road, Altrincham, Chemist.
1915. Valentine, Geo., Engineer's Dept., St. James' Gate Brewery, Dublin, Chemical Engineer.
1916. Vance, John F. C. B., 947, Richard Street, Vancouver B.C., Canada, City Analyst.
1896. Van der Linde, Dr. Harold, 142 Western Road, Toronto, Ontario, Canada, Rubber Chemist.
1895. Vanderpool, Dr. Frank, 175, Park Avenue, Orange, N.J., U.S.A., Chemist.
1903. Van Dyck, Edwin M., 57, Greene Street, New York City, U.S.A., Chemist and Ink Maker.
1897. Van Gelder, Arthur P., c/o Hereules Powder Co., Wilmington, Del., U.S.A., Superintendent.
1891. Van Gundy, Chas. P., Laboratory, B. and O. R. R., Baltimore, Md., U.S.A., Metallurgical Chemist.
1896. Van Laer, Norbert, 6, Emerson Road, Ilford, Essex, Brewer and Chemist.
1897. Van Marken, J. C., 32, Zeekant, Scheveningen, Holland, Chemical Engineer.
1888. Vargas-Vergara, J. M., Apartado No. 120, Bogota, Colombia, S. America, Metallurgical Chemist.
1910. Vass, David, Gas Works, Perth, Manager.
1915. Vaughan, F. W., H. R. Vaughan and Co., Ltd., South Shore Road, Gateshead-on-Tyne, Roofing Felt Manufacturer.
1912. Ventress, Ernest W. S., 48, Queen's Road, Richmond, Surrey, Oil Mill Manager.
1898. Verity, Ben., 550, Hood Street, Fall River, Mass., U.S.A., Print Works Chemist.
1908. Vickers, Benj. Threlfall, Gascoigne Street, Boar Lane, Leeds, Oil Merchant.
- O.M. Vickers, Wm., c/o Thos. Vickers and Son, Miles Platting, Manchester, Chemical Manufacturer.
1916. Vincent, F. D'Abernon, Branksome Court, Fleet, Hants., Explosives Manufacturer.
1909. Virolleaud, Leopold, 3, Rue de Paris, St. Denis, Seine, France, Chemical Engineer. On active service.
1897. Vlies, Leonard E., Belmont, Gowan Road, Alexandra Park, Manchester, Aniline Dye Manufacturer.
- O.M. Voelker, E. W., 1, Tudor Street, London, E.C., Analytical and Consulting Chemist.
1887. Voelker, Dr. J. A., 20, Upper Phillimore Gardens, Kensington, W., Agricultural Chemist.
1897. Vogel, Julius L. F., High Speed Steel Alloys, Ltd., Ditton Road, Widnes, Engineer.
1897. Voorhees, Louis A., 111, Carroll Place, New Brunswick, N.J., U.S.A., Agricultural Chemist.
1899. Voorhees, Samuel S., Bureau of Standards, Washington, D.C., U.S.A., Chemist.
1899. Voss, Walter A., Carlton Chemical Works, Glengall Road, Millwall, E., Manufacturing Chemist.
1916. Vowler, John N., 54, Gondar Gardens, West Hampstead, London, N.W., Research Chemist.
1916. Vries, Dr. Otto de, Buitenzorg, Java, Director of the Central Rubber Station.

W

1905. Waddell, Montgomery, 30, Church Street, New York City, U.S.A., Consulting Engineer.
1916. Waddell, R. Henderson, The Standard Chemical Co., 9, White Cross Place, Wilson Street, E.C., Chemical Manufacturer.

U

1911. Waddock, Wm. P., 666, Harris Street, Ultimo, Sydney, N.S.W., Milk Analyst.
1913. Wade, Albert J., c/o Fowler Ltd., Sugar Refiners, Blackwall, E., Sugar Analyst.
1916. Wade, Arthur E. L., 28, West Kensington Gardens, W., Manufacturing Chemist.
1917. Wade, Ernest G., Dinting Vale Print Works, Dinting, near Manchester, Analytical Chemist.
1902. Wade, Frank, 26, St. Ronan's Avenue, Southsea, Hants. Analytical Chemist.
1890. Wade, Jas. L., 28, West Kensington Gardens, London, W., Chemical Manufacturer. Retain Journals.
1915. Wade-Wilton, E., Planet Works, Bramley, near Leeds, Chemical Manufacturer.
1889. Wadman, W. E., 102, Lord Avenue, Bayonne, N.J., U.S.A., Manufacturing Chemist.
1911. Waele, Armand de, Aeronautical Inspection Department, University College, Gower Street, W.C.; (Journals to "Dundee," Rosefield Road, Staines), Technical Chemist.
1897. Wagner, Dr. Theodore B., Room 2229, 17, Battery Place, New York City, U.S.A., Chemist.
1893. Wagner, W. G., 12, North Common Road, Ealing, W., Manufacturing Chemist.
1906. Wagstaffe, Dr. E. A., 22, Blackfriars Street, Manchester, Analytical Chemist.
1906. Wahl, Dr. Robert, 1135-1147, Fullerton Avenue, Chicago, Ill., U.S.A., President, Brewers' School.
1917. Wainwright, Joseph, "Ellerslie," The Wiend, Lower Bebington, Ches., Manager.
1895. Wainwright, Wm., Dublin Vitriol Works, Ballybough, Dublin, Chemist.
1908. Wait, Douglas, c/o R. Gay and Co., Ltd., Langthorne Works, Stratford Market, London, E., Analytical Chemist.
1916. Waites, Harold, 44, Cranbrook Avenue, Cottingham Road, Hull, Analytical and Research Chemist.
1899. Wakefield, Wm. C., Mill Street East, Savile Town, Dewsbury, Chemical Manufacturer.
1915. Waldo, Dr. Leonard, 49, Wall Street, New York City, U.S.A., Consulting Engineer.
1895. Waldstein, Dr. Martin E., 23, Broadwater Down, Tunbridge Wells, Kent, Manufacturing Chemist.
1917. Walker, Alexr. B., "Donwal," Kings Road, Welsend-on-Tyne, Gas Engineer.
1887. Walker, Archibald, Nowark Castle, Ayr, Scotland, Distiller.
1915. Walker, Arthur, "Woodbourne," Aneaster Road, Far Headingley, Leeds, Chemical Manufacturer.
1917. Walker, Ernest, c/o Mardon, Son & Hall, The Caxton Works, Bristol, Engineer.
1913. Walker, Frederick Handel, 3, Stannington Grove, Heaton, Newcastle-on-Tyne, Technical Chemist.
1917. Walker, Frederick W., 89, High Street, Welling, Kent, Analytical Chemist.
1908. Walker, George, c/o Burmah Oil Co., Ltd., P.O. Box 67, Rangoon, Burmah, Analytical Chemist.
1913. Walker, Henry, "Thornfield," 65, Madeley Road, Ealing, London, W., Chemical Engineer.
1897. Walker, H. V., 323, Ridgo Street, Newark, N.J., U.S.A., Chemist.
1894. Walker, Prof. Jas., F.R.S., 5, Wester Coates Road, Edinburgh, Professor of Chemistry (University of Edinburgh).
1916. Walker, Jas., c/o Jas. Robertson & Co., Ltd., 142, William Street, Montreal, Canada, Chemist.
1897. Walker, Jas. W., Gales Road, Irvine, Scotland, Chemical Manufacturer.
1906. Walker, Jas. W., Farley, Oakamoor, Stoke-on-Trent, Assayer.
1902. Walker, Jno. H., Gourepore Works, Naihati, E.B.S.R., Bengal, India, Chemist.
1910. Walker, John S., Hiratsuka, Sagami, Japan, Explosives Chemist.
1884. Walker, S. R., Fern Bank, Starling Road, Radcliffe, Manchester, Foreman Dyer.
1912. Walker, Prof. W. O., Dept. of Chemistry, School of Mining, Kingston, Ont., Canada, Professor of Chemistry.
1895. Walker, W. Sloane, c/o Walker, Ltd., Litherland, near Liverpool, Tanner.
1916. Wall, Prof. E. J., Syracuse University, Syracuse, N.Y., U.S.A., Professor of Photography.
1916. Wall, Ernest D., Châlet, Grove Hill, Woodford, N.E., Technical Chemist.
1897. Wallace, Edwin C., 92, Corey Street, West Roxbury, Mass., U.S.A., Chemist.
1897. Wallace, Robt. A., 66, Holland Road, London, W., Chemical Manufacturer.
1917. Wallace, Thos., c/o Castner Kellner Alkali Co., Wallsend, Northumberland, Works Chemist.
- O.M. Waller, Dr. Elwyn, 7, Franklin Place, Morristown, N.J., U.S.A., Professor of Chemistry.
1906. Wallerstein, Leo, 171, Madison Avenue, New York City, U.S.A., Chemist.
1899. Wallerstein, Dr. Max, 171, Madison Avenue, New York City, U.S.A., Chemist.
1916. Walley, Robert J., Canadian Explosives, Ltd., Shand Works, James Island, B.C., Canada, Chemical Engineer and Superintendent.
1917. Walls, Ernest, The Garthe, Pereival Road, Clifton, Bristol, Soap Manufacturer.
1916. Walmsley, Wm. A., c/o Hardman & Holden, Ltd., Colliery Street, Clayton, Manchester, Works Manager.
1886. Walsh, F. T., 12, Valentine Street, West Newton, Mass., U.S.A., Colour Printer.
1901. Walsh, Lionel O. P., c/o Dominion Tar and Chemical Co., Ltd., Sydney, Cape Breton, Canada, Chemist.
1903. Walsh, Peter H., P.O. Box 569, Magog, Quebec, Canada, Analytical Chemist.
1915. Walter, Albert, c/o Stauffer Chemical Co., Chauncey, New York, U.S.A., Works Manager.
1904. Walther, Wm., Holzapfel's Compositions Co., Ltd., Heworth Shore, Felling-on-Tyne, Chemist and Works Manager.
1908. Walton, Robert H., Railway Stores, Newtown, Sydney, N.S.W., Analyst.
1911. Walton, Wm. Keighley, Beechwood, Upper Rushton Road, Thornbury, Bradford, Analyst.
1895. Want, W. Philip, 194-200, Bishopsgate, London, E.C., Pharmacist and Editor.
1901. Warburton, Frank, 50, Rosebery Road, Muswell Hill, N., Manager.
1916. Warburton, F. W., "The Hämsted," Norman Road, Runcorn, Cheshire, Technical Chemist.
1904. Warburton, George H., 75, Mill Lane, West Hampstead, N.W., Analytical Chemist.
1915. Warburton, Stanley, Titaghur Paper Mills, Ltd., Titaghur, Calcutta, India, Analytical Chemist.
1896. Warburton, Thos., Rathlin, Birch Hall Lane, Rusholme, Manchester, Chemist.
- O.M. Ward, Geo., Messrs. Hirst, Brooke, and Hirst, Ltd., Millgarth Mills, Leeds, Chemical Manufacturer.
1891. Ward, G. J., Hallam Fields, Ilkeston, Notts, Civil Engineer.
1898. Ward, John, Barnstone Blue Lias Lime Co., Ltd., Barnstone, Notts, Manager.
1899. Ward, Wm. J., 28, Sefton Road, Sale, Manchester, Chemist.
1917. Wardlaw, Thomas D., 23, Scott Street, Toronto, Canada, Agent for Dyes & Chemicals.
1917. Wardlaw, William, The University, Edmund Street, Birmingham, Lecturer in Chemistry.
1908. Wardleworth, Theo. H., 32, St. Gabriel Street, Montreal, Canada (Journals to c/o Explosives Dept., Imperial Munitions Board, Ottawa, Canada), Wholesale Druggist.
1902. Waring, W. Geo., Webb City, Mo., U.S.A., Metallurgical Chemist.
1913. Warner, Arthur L. D., P.O. Box 203, Edgewater, N.J., U.S.A., Sugar Refiner.
1899. Warnes, Arthur R., 47, Cranbrook Avenue, Cottingham Road, Hull, Consulting Technical Chemist.
1912. Warren, E. Bruce, c/o India Rubber Gutta Percha Telegraph Works, Ltd., Silvertown, E., Consulting Analytical Chemist.
1890. Warren, Fiske, c/o S. D. Warren and Co., Laboratory, Cumberland Mills, Maine, U.S.A., Paper Manufacturer.

1901. Warren, Jno. E., Eagle Chemical Works, Barchester Street, Poplar, E., Tar Distiller.
1913. Wassmer, Dr. E., 2, Boulevard de la Tour, Geneva, Switzerland, Chemist.
1917. Waterfall, Chas. J., 4, Queen Square, Bristol, Analytical Chemist.
1917. Waterfall, Robinson, 4, Redland Court Road, Bristol, Acid and Fertilizer Manufacturer.
1917. Waterhouse, Carl N., c/o Thermit Ltd., 675, Commercial Road, Poplar, E., Metallurgical Chemist.
1917. Watkins, Edwin F., 561, Bourke Street, Melbourne, Victoria, Australia, Technical Chemist.
1902. Watkins, E. J., 72, King's Road, Peckham, S.E., Works Chemist.
1898. Watkins, Willard H., c/o Schoellkopf, Hartford and Hanna Co., P.O. Drawer 57, Buffalo, N.Y., U.S.A., Chemist.
1894. Watmough, Benj., c/o Brotherton and Co., Ltd., Ammonia Works, Calder Vale, Wakefield, Analytical Chemist.
1884. Watson, Chas., Rose Bank, School Road, Moseley, Birmingham, Manufacturing Chemist.
1894. Watson, Chas. Ernest, 33, Oxford Road, St. Anne's-on-Sea, Lancashire, Chemical Assistant.
1908. Watson, C. I. Wilkinson, c/o Wailuku Sugar Co., Wailuku, Mani, Hawaiian Islands, Chemist.
1901. Watson, Herbert J., 64, Peel House Lane, Widnes, Chemist.
1917. Watson, Herbert W., "Stoneleigh," The Drive, Roundhay, Leeds, Chemical Manufacturer.
1894. Watson, Jas., Tyne View, Hebburn-on-Tyne, Alkali Works Manager.
1891. Watson, Jno., Langdon, Beaconsfield Road, Blackheath, S.E., Analytical Chemist.
- O.M. Watson, Jno. C., Arnold Printworks, North Adams, Mass., U.S.A., Printworks Chemist.
- O.M. Watt, A., c/o Macfie and Sons, 34, Moorfields, Liverpool, Sugar Works Chemist.
1901. Watt, Francis L., City Mart Building, 5, Hamilton Street, Sydney, N.S.W., Australia, Analytical Chemist.
1906. Watt, Dr. H. E., 2, Abinger Gardens, Edinburgh, W., Chemist.
1917. Watterson, James H., Braeside, Mag-dale, Honley, Huddersfield, Chemist.
1916. Watts, Hugh E., Gordon House, Hutton, Essex, Technical Chemist.
1916. Wattleworth, D. R., 6, Dean Street, Workington, Cumberland, Technical Chemist.
1893. Watts, Jno. Isaac, Fairleigh, Hartford, Cheshire, Alkali Works Manager.
1908. Watts, Jno. Wm., Newcastle Tar Works, Blaydon-on-Tyne, Manager.
1907. Waunsley, Harry, 14, Jesmond Avenue, Wembley Hill, London, N.W., Chemical Engineer.
1903. Wayland, Wm. A., 12, Albert Road, Brockley, S.E., Manufacturing Chemist.
1906. Webb, Frank H., 46, Swan Street, Lawrence, Mass., U.S.A., Chemist.
1915. Webber, Arthur H., 16, Thorndike Street, Beverly, Mass., U.S.A., Chemist.
1901. Webster, Geo. J., P.O. Box 1003, Marquette, Mich., U.S.A., Secretary.
1897. Wedge, Utley, Ardmore, Pa., U.S.A., Chemist.
1902. Weed, Hy. T., 471, Stratford Road, Brooklyn, N.Y., U.S.A., Teacher of Chemistry.
1893. Weeks, H. B., 2, Infield Park Road, Barrow-in-Furness, Analytical Chemist.
1904. Weil Jacob A., "Helvetia," Leicester Road, Higher Broughton, Manchester, Chemical Engineer.
1906. Weir, James, c/o Imperial Varnish and Color Co., 6-24, Morse Street, Toronto, Canada, Chemist.
1902. Weiskopf, Dr. Eric H., See Whytehead, Dr. Eric H.
1910. Weiss, John M., c/o Barrett Co., 17, Battery Place, New York City, U.S.A., Chemist.
1908. Weissmüller, Edward F., Spring Lodge, Helsby, Cheshire, Chemist.
1905. Weissmüller, Ernest C., Rockcliffe, Helsby, Cheshire, Research Chemist.
1910. Welch, Bertie M., 80, Hunter Street, Sydney, N.S.W., Australia, Assayer.
1912. Weld, Fred. C., 263, Fairmount Street, Lowell, Mass., U.S.A., Analytical Chemist.
1899. Weldon, Leonard E., Hadleigh, Alma Street, Sherwood Rise, Nottingham, Dyer.
1903. Wellecome, Henry S., Snow Hill Buildings, London, E.C., Manufacturing Chemist.
1914. Wells, E. E., 9, Dalhousie Street, Montreal, Quebec, Canada, Chemical Engineer.
1912. Wells, Jas. H., "Tralce," Sketty Road, Swansea, S. Wales, Metallurgist.
1885. Welsh, Jas., Standard Mills, Ferguson Road, Bombay, India, Printworks Manager.
1890. Welsh, Thos. L., 3, Prince's Gardens, Downhill, Glasgow, Analytical Chemist.
- O.M. Welsh, W., Holt Town Oil Works, Manchester.
1905. Welt, Dr. Ida, 25, Quai de Mont Blanc, Geneva, Switzerland, Chemist.
1906. Wenger, Major Francis E., The Brampton, Newcastle, Staffs., Ceramic Colour Manufacturer.
1909. Wescott, J. P., jr., 224, Calvary Street, Waltham, Mass., U.S.A., Manager.
1903. Wesener, Dr. John A., 31, North State Street, Chicago, Ill., U.S.A., Consulting Chemist.
1889. Wesson, D., 111, South Mountain Avenue, Montclair, N.J., U.S.A., Cotton-oil Expert.
1908. West, Chas. A., c/o American Camphor Refining Co., 14, Fulton Street, Boston, Mass., U.S.A., President.
1909. West, Percy C. H., 61-62, Chancery Lane, London, W.C., Analytical Chemist.
1917. Westmoreland, Wm. R., c/o Thomas Adams, Ltd., Sherwood Hill Works, Nottingham, Works Manager.
1898. Weston, David B., Sharon, Mass., U.S.A., Chemist.
1894. Weston, Robt. S., 14, Beacon Street, Boston, Mass., U.S.A., Chemist and Bacteriologist.
1890. Wetter, Jasper, Room 23, Holborn Hall, Gray's Inn Road, London, W.C., Patent Agent.
1912. Weyman, Geoffrey, The Cwm, Saltwell Road, Low Fell, Co. Durham, Technical Chemist.
- O.M. Whalley, L. J. de, 18, Blandram Road, Lee, S.E., Sugar Chemist.
1916. Wharton, Edward, Rosemont, Station Road, Brimington, Chesterfield, Chemist.
1909. Wharton, Fredk. M., c/o The New Explosives Co., Ltd., Stowmarket, Suffolk, Chemist.
1917. Wheatley, William, 16, Rathbone Road, Warley Woods, Smethwick, Birmingham, Works Chemist.
1908. Wheaton, H. J., 5, Walton New Road, Lower Walton, Cheshire, Chemical Engineer.
1909. Wheeler, Edward, Ailsa View, 10, Melbourne Terrace, Salteeots, Ayrshire, Demonstrator of Chemistry.
1898. Wheeler, Dr. Edwd. J., 79, Chapel Street, Albany, N.Y., U.S.A., Analytical Chemist.
1903. Wheeler, Ernest, c/o Chemical Lab., Crossley Bros. Ltd., "Otto" Gas Engine Works, Openshaw, Manchester, Metallurgical Chemist.
1906. Wheeler, Frank G., 683, Harris Street, Appleton, Wis., U.S.A., Chemist (Bleach Process Co.)
1907. Wheeler, Dr. R. Vernon, Home Office Experimental Station, Eskmeals, Cumberland, Chemist.
1912. Wheeler, Thorne L., c/o Edible Products Co., 156-186, East 22nd Street, Bayonne, N.J., U.S.A., Chemist.
1916. Wheldon, A. H. F., 200, Amesbury Avenue, Streatham, S.W., Chief Chemist (Natal Estate Co.).
1915. Whetmore, S. A. H., c/o British Dyes, Ltd. Empire House, Kingsway, London, W.C., Secretary.
1909. Whiffen, G. Goodman, Lombard Road, Battersea, London, S.W., Chemical Engineer.
- O.M. Whiffen, Thos. J., Cerris House, West Hill, Putney, S.W., Manufacturing Chemist.
- O.M. Whiffer, W. G., Lombard Road, Battersea, London, S.W., Manufacturing Chemist.

1916. Whinyates, Leonard, "Glen Mona," Rochdale Road, Blackley, Manchester, Aniline Colour Chemist.
1899. Whitaker, Milton C., 27, William Street, New York City, U.S.A., Chemist.
1895. Whitaker, Thos., Aire Vale Dye Works, Newlay, near Leeds, Dyer.
- O.M. Whitaker, Thorpe, (Journals) Bradford Dyers' Association, Ltd., and 35, Pemberton Drive, Bradford, Yorks, Dyer's Chemist.
1915. White, Albert S., "Fairlawn," Bromborough, Cheshire, Chemist.
1893. White, Arthur F., 2, Melbourne Grove, Thornbury, Bradford, Yorks, Manufacturing Druggist.
1915. White, Gerald N., 15, West End Avenue, Pinner, Middlesex, Research Chemist.
1898. White, Jno., County Offices, St. Mary's Gate, Derby, Public Analyst to County of Derby.
1911. White, John W., c/o E.C. Powder Co., Green Street Green, Dartford, Kent, Works Chemist.
- O.M. White, Paul T., Hortonfield House, West Drayton, Chemical Manufacturer.
1910. White, P. Winzar, Viewswley Chemical Works, West Drayton, Middlesex, Manufacturing Chemist, On Active Service.
1911. White, Walter W., c/o Citro Chemical Co., Maywood, N.J., U.S.A., Secretary and Manager.
1912. Whitehead, Charles E., Devonshire Villas, Barrow Hill, near Chesterfield, Derbyshire, Chemist.
1903. Whitehouse, P. L., 16, Lombard Street, West Bromwich, Staffordshire, Oil Chemist.
1906. Whiteley, C. E., 21, Brudenell View, Leeds, Demonstrator of Chemistry.
1885. Whiteley, R. Lloyd, The Institute, West Bromwich, Staffordshire, Principal.
1892. Whiteside, Jno. L., 376, St. Helen's Road, Bolton-le-Moors, Chemical Lecturer.
1912. Whitney, Wm. L., c/o U.S. Graphite Co., Saginaw, Mich., U.S.A., Chemist.
1885. Whittaker, C. J., Roetfield, Clitheroe, Chemical Engineer.
1916. Whittaker C. M., 55, Cleveland Road, Huddersfield, Technical Chemist.
1913. Whittelsey, Dr. Theodore, c/o U.S. Rubber Co., 11th Avenue and 58th Street, New York City, U.S.A., Chemical Director.
1904. Whittier, Charles T., 78, Brinkerhoff Street, Jersey City, N.J., U.S.A., Manager.
1901. Whitton, Jas. T., Nobel Villas, Ardeer, Stevenston, Ayrshire, Explosives Chemist.
1884. Whowell, F., Croich Hey, Tottington, Bury, Lanes, Bleacher.
1910. Whympere, R., 37, Lovelose Gardens, Surbiton, Surrey, Chemist.
1902. Whythead, Dr. Erie H., c/o Brotherton and Co., Ltd., Leeds, Works Manager.
1899. Wiarda, Jno. C., 259-273, Green Street, Brooklyn, N.Y., U.S.A., Manufacturing Chemist.
1915. Wibberley, Geo., c/o Mrs. Howlett, 501, Old Kent Road, London, S.E., Technical Chemist.
1913. Wickenden, Leonard, c/o West Virginia Paper and Pulp Co., 521, West 23rd Street, New York City, U.S.A., Research Chemist.
1908. Wickes, Clarence S., 28, Franklin Avenue, Merchantville, N.J., U.S.A., Factory Superintendent.
1915. Wickstead, J. B., c/o Messrs. Lankshear, Wickstead & Co., 17, St. Anne's Square, Manchester, Chemical Manufacturer.
1916. Wiegand, Wm. B., c/o Canadian Consolidated Rubber Co., Papineau Square, Montreal, Canada, Chief Chemist.
1904. Wieler, Eric E., Northern Assurance Buildings, Albert Square, Manchester, Chemical Merchant.
1906. Wiffen, Henry J., 17, Albany Road, Manor Park, Essex, Manufacturing Chemist.
1883. Wiggin, W. W., 55, George Street Parade, Birmingham, Nickel Refiner.
1897. Wigglesworth, H., 25, Broad Street, New York City, U.S.A., Manufacturing Chemist.
1913. Wigner, J. H., The White Cottage, Helsby, Cheshire, Works Chemist.
1906. Wikner, Sigurd A., "Lynton," Kingsbury Road, Gravelly Hill, Birmingham, Tar Works Chemist.
1915. Wilbraham, Dr. Evelyn C. B., 6, Bury Court, St. Mary Axe, E.C., Chemical Manufacturer.
1899. Wild, Roland C., The Grange, New Eltham, Kent, Analytical Chemist.
1893. Wilder, F. L., Morro Velho, Minas Geraes, Brazil, Assayer.
1902. Wilder, Salmon W., jun., 148, State Street, Boston, Mass., U.S.A., Treasurer.
1911. Wildt, Dr. Edwin, 85, Clarendon Park Road, Leicester, Technical Chemist.
1912. Wiley, Samuel W., 7, South Gay Street, Baltimore, Md., U.S.A., Analytical Chemist.
1916. Willford, A. F., "Eversloigh," Ashville Avenue, Norton-on-Tees, Works Chemist.
1906. Wilke, Wm., 86, Norwood Avenue, Buffalo, N.Y., U.S.A., Chemical Engineer.
1903. Wilkie, Jno. M., 5, Balmoral Avenue, West Bridgford, Notts, Analytical Chemist.
1885. Wilkin, Sir Walter, K.C.M.G., Appold Street, Finsbury, E.C., Yeast Manufacturer.
1915. Wilkins, C. R., 8, Crookston Road, Eltham, S.E., Works Chemist.
1916. Wilkinson, C. D., c/o The Penketh Tanning Co., Ltd., Penketh, near Warrington, Leather Chemist.
1911. Wilkinson, Frank, West Lodge, Handsworth near Sheffield, Chemical Manufacturer.
1916. Wilkinson, Herbert Tatlock, c/o The Wardle Engineering Co., Ltd., 196, Deansgate, Manchester, Engineer.
1904. Wilkinson, Prof. J. A., South African School of Mines and Technology, P.O. Box 1176, Johannesburg, Transvaal, Professor of Chemistry.
1886. Wilkinson, J. B., Tong Street, Dudley Hill, Bradford, Yorks, Chemical Manufacturer.
1916. Wilks, Leslie P., Hillside, Stone Road, Stafford, Works Chemist (Siemens Bros.).
1893. Willeox, Benjamin, 47, Lincoln's Inn Fields, London, W.C., Patent Agent.
1911. Willeox, Stuart J., c/o United Alkali Co., Ltd., 30, James Street, Liverpool, Chemist.
1916. Williams, Aneurin, 57, Frederiek Street, Widnes, Research Chemist.
1903. Williams, Chas. E., Thornhayea, Sleaford, Seed Crusher.
1895. Williams, David T., 42, Finsbury Square, London, E.C., Chemist and Assayer.
1916. Williams, Dean, 221, Orchard Avenue, Ridgway, Pa., U.S.A., Industrial Chemist.
1912. Williams, Egbert R., York Town, Va., U.S.A., Chemist, Retain Journals.
1891. Williams, Henry J., 30, Norfolk Road, Chestnut Hill, Mass., U.S.A., Chemical Engineer.
1908. Williams, Herbert E., 19, Chatham Grove, Withington, Manchester, Chemist.
1914. Williams, J. A., Mackenzie, c/o A. E. Ames and Co., Union Bank Building, Toronto, Canada.
1904. Williams, Jno. T., 100, Broadway, New York City, U.S.A.
1913. Williams, Jos. H., 54, Dangan Road, Wanstead, Essex, Works Chemist.
1904. Williams, Naboth, 28, Rolleston Street, Warrington, Technical Chemist.
1902. Williams, Percy, 94, Telford Avenue, Streatham Hill, S.W., Chemist.
1916. Williams, Peter, c/o John Lysaght, Ltd., Scunthorpe, Lincoln, General Manager.
1885. Williams, Rowland, 79, Queen Square, Lancaster, Analytical Chemist.
1912. Williams, Samuel B., Homestead, Roskear, Camborne, Cornwall, Metallurgist.
1900. Williams, Saml. H., Glastonbury, Conn., U.S.A., Soap Manufacturer.
1903. Williams, S. M., 269, Springdale Avenue, East Orange, N.J., U.S.A., Chemist.
1885. Williams, T. Howell. See Idris, T. H. W.

1884. Williams, Prof. W. Carleton, Broomgrove, Goring-on-Thames, Professor of Chemistry.
1902. Williams, Walter Scott, Baker's Corner, Attleboro', Mass., U.S.A., Textile Engineer.
1916. Williams, Wm. H., 19, Royal Mint Street, E., Chemist and Assayer.
1887. Williams, W. Collingwood, 36, Dansie Street, Liverpool, Analytical Chemist.
- O.M. Williams, W. J., 1503, Foulkrod Street, Frankford, Philadelphia, Pa., U.S.A., Analytical Chemist.
1894. Williamson, J. Alex., The Croft, Chase Court Gardens, Enfield, N., Analytical Chemist.
1911. Williamson, John, jun., Alne Hill, Camp Road, Maryport, Cumberland. Tanner.
1903. Wills, J. Lainson, 3457, Crittenden Street, St. Louis, Mo., U.S.A., Technical and Brewing Chemist.
1888. Wilson, Cecil H., c/o Sheffield Smelting Co., Ltd., Royd's Mills Street, Sheffield, Chemist.
1888. Wilson, Dr. David, Carbeth, Killearn, by Glasgow.
1885. Wilson, Frank, 7, Bedford Square, London, W.C., Brewer.
- O.M. Wilson, G. E., The Chemical Works, Oldbury, near Birmingham, Chemical Manufacturer.
1899. Wilson, Gordon, c/o Consuelo Ingles, Zacatecas, Mexico, Chemist and Assayer.
1916. Wilson, Jas. H., 40, Western Road, Cowlesley, Huddersfield, Works Chemist.
1836. Wilson, Jno., Tyneside, 381, Hagley Road, Birmingham, Technical Chemist.
1909. Wilson, Jno., Battersea Polytechnic, London, S.W., Head of Chemical Dept.
1905. Wilson, J. E., c/o General Chemical Co., 25, Broad Street, New York City, U.S.A., Chemical Salesman.
1915. Wilson, J. H., Caledonia Engine Works, MacDowall Street, Paisley, Scotland, Engineer.
1902. Wilson, Leonard P., Rosemount, Holyhead Road, Coventry, Technical Chemist.
1910. Wilson, Leslie, West Bank, Doxey, near Stafford.
- O.M. Wilson, R. H., Egglecliffe P.O., Co. Durham, Chemical Manufacturer.
1912. Wilson, S. Siddons. See Siddons-Wilson, S.
1917. Wilson, Thos. A., Corporation Chemical Dept., 20, Trongate, Glasgow, Analytical Chemist.
1908. Wilson, William James, Whangarei Club, Whangarei, New Zealand, Consulting Cement Engineer.
1909. Wilson, Wm. J., Haslemere, Lyndhurst Gardens, Church End, Finchley, N., Chemist.
1890. Wilson, W. W., Dalmonach House, Alexandria, Dumbartonshire, Analytical Chemist.
1912. Windsor, P. L., Library, University of Illinois, Urbana, Ill., U.S.A., Librarian.
1913. Windsor-Richards, W., Siluminite Insulator Co., Ltd., The Green, Southall, Chemist.
- O.M. Wingham, A., 57, Victoria Road South, Southsea, Hants, Metallurgical Chemist.
1907. Winsloe, Louis S., 1, Booth Street, Manchester, Manufacturing Chemist.
1892. Winstanley, Capt. W. Hy., Park Lodge, Willington Road, South Stockport, Technical Chemist.
1886. Winstone, E. H., Members' Mansions, 36, Victoria Street, London, S.W., Ink Manufacturer.
1917. Winton, Albert J., Benwell Cottage, Dene Avenue, Rowlands Gill, co. Durham, Metallurgical Chemist.
1892. Wirtz, Dr. Quirin, 32, Great Ormond Street, London, W.C., Consulting Chemist.
1889. Wishart, Jno., Oakbank Oil Co., Ltd., 29, St. Vincent Place, Glasgow, General Manager.
1917. Witherell, A. L., Fred. Rucping Lea Co., Fond du Lac, Wis., U.S.A., Chief Chemist.
1902. Withers, Prof. W. A., State A. and M. College, West Raleigh, N.C., U.S.A., Professor of Chemistry.
1915. Witmer, H. E., 310, Board of Trade Building, Toronto, Canada, Manufacturers' Agent.
1916. Witte, Wm., c/o U.S. Finishing Co., Norwich, Conn., U.S.A., Chemist.
1903. Wolf, Jacques, c/o Jacques Wolf and Co., Passaic, N.J., U.S.A., Manufacturing Chemist.
1916. Wolfe, Harold M., The University, Leeds. Journals to "Cliff Lawn," Cliff Road, Leeds. Explosives Inspector.
1912. Wolff, Dr. Salamon, 2, Curzon Avenue, Victoria Park, Manchester, Chemical Engineer.
1911. Wollaston, T. Roland, Dirleton House, Priory Road Sale, Cheshire, Consulting Engineer.
1903. Wolton, Wm. R., c/o Joseph Fison and Co., Ltd., Ipswich, Manager.
1914. Wood, Arthur S., 6, Walton Road, Sidecup, Kent, Works Chemist.
1916. Wood, A. Selhy, Dalehead, Stocksfield-on-Tyne, Paint, Colour, and Varnish Manufacturer.
1906. Wood, E. Esecott, Hurricane House, Brymbo, near Wrexham, North Wales, Chemist and Metallurgist.
1900. Wood, Frank, Ardsley House, near Barnsley, Yorks, Assistant Manager (Glass Works).
1901. Wood, Frank S., 12, Carlton Avenue, Hornsea, East Yorks, Cement Works Chemist.
1917. Wood, Henry, The Limes, 62, Culverden Road, Balham, London, S.W., Scientific Chemist.
1909. Wood, Hubert R., c/o Fenner, Alder and Co., Fenner's Wharf, Millwall, E., Works Chemist.
1887. Wood, Jos. T., 62, Park Road, Nottingham, Tanner.
1916. Wood, T. T., 26, Graver Lane, Newton Heath, Manchester, Technical Chemist.
1915. Wood, William, Royal Gunpowder Factory, Weltham Cross, Essex, Chemical Manufacturer.
- O.M. Woodcock, R. C., 30, Dover Road, South Wansted, Essex, Chemist.
1910. Woodhead, Arthur E., Bemerside, Cornwall Road, Harrogate, Yorks, Research Chemist.
1884. Woodhead, Jas., Inglewood, Slaithwaite, near Huddersfield, Tar Distiller.
1917. Woodhouse, William, 6, Longfield Lane, Ikeston, Derbyshire, Iron Works Chemist.
1915. Woodmansey, A., 12, Ridgeway Terrace, Dolphin Lane, Leeds, Analyst and Chemical Engineer.
1915. Wood-Mason, Harold, H.M. Factory, Queen's Ferry, Chester, Chemist.
1914. Woodroffe, David, c/o P. E. Fisher, Leather Manufacturer, Basingstoke, Research Assistant.
1900. Woodrow, John, 84, Harpenden Road, Manor Park, E., Chemist.
1906. Woodward, Horace A., Cowell Avenue, West Orange, N.J., U.S.A., Chemist.
1904. Woolecott, Geo. H., Lady's Well Brewery, Cork Ireland, Brewer's Chemist.
- O.M. Woolley, G. S., Victoria Bridge, Manchester, Pharmaceutical Chemist.
1905. Woore, N. Lycester, c/o South Australian Gas Co., Brompton, Adelaide, South Australia, Works Chemist.
1909. Work, Charles O., 22, Cambridge Road, Great Crosby, Liverpool, Chemist.
1914. Worley, Prof. Fred. P., University College, Auckland, New Zealand, Prof. of Chemistry.
- O.M. Worrall, H., Culmington House, Stanton Lacey, Ludlow, Dyer.
1903. Worstall, Roht. A., 2500, West Railroad Avenue, Evanston, Ill., U.S.A., Paint and Varnish Specialist.
1900. Worthington, Arthur, Lynwood, Great Lever, Bolton, Chemist and Manager.
1896. Wrampelmeier, T. J., 565, Monadnock Building, San Francisco, Cal., U.S.A., Chemist.
1914. Wray, Edward, 65, Manchester Road, Fairfield, near Manchester, Chemist.
- O.M. Wray, O. J. P., Hazlemere, 95, Coleraine Road, Blackheath, S.E., Technical Chemist.
1904. Wright, Allister M., Box 617, G.P.O., Christchurch, N.Z., Chemist (Christchurch Meat Co.).
1912. Wright, Arthur, 45, Markwood Road, Forest Hills, Long Island, N.Y., U.S.A., Lawyer.
1895. Wright, Arthur C., c/o Turner, Morrison, and Co., 6, Lyons Range, Calcutta, India, Chemist.
1908. Wright, C. Harold, Dept. of Agriculture, Suva, Fiji, Agricultural Chemist.

1915. Wright, E. W., 51, Bertram Road, Hendon, N.W., Analytical Chemist.
1901. Wright, Harold E., c/o Sir B. Samuelson and Co., Ltd., Middlesbrough, Chemist.
1907. Wright, John Henry, 16, Norwood Avenue, Shipley, Yorks. Technical Chemist.
1885. Wright, Jos., 19, Arboretum Street, Nottingham, Lace Dresser.
- O.M. Wright, L. T., Junior Constitutional Club, Piccadilly, London, W., Chemical Engineer.
1911. Wright, W. Robt., c/o Thos. Adams, Ltd., Sherwood Hill Works, Nottingham, Bleacher and Dyer.
1900. Wright, Walter J., 48, The Mall, Faversham, Kent, Chief Chemist (Cotton Powder Co.).
1907. Würster, Oscar H., c/o Louisville Soap Co., Louisville, Ky., U.S.A., Soap Works Chemist.
1905. Wyer, Malcolm G., The Library, State University Iowa City, Iowa, U.S.A., Librarian.
- O.M. Wyld, Jno., Rose Ville, Menston, via Leeds, Chemical Works Manager.
1908. Wyler, Dr. Max, c/o Levinstein, Ltd., Blackley, Manchester, Manufacturing Chemist.
1906. Wynne, Prof. W. Palmer, F.R.S., The University, Sheffield, and (Journals) 17, Tiptonville Road, Sheffield, Professor of Chemistry.
- Y
1901. Yardley, Frank, c/o Henry Jutson and Sons, Liverpool Street, Birmingham, Chemical Manufacturer.
1897. Yates, W. H., Durdley Park, Keynsham, Bristol, Technical Chemist.
1915. Yeoman, Ernest W., 1, Regent Square, London, W.C., Analyst and Metallurgist.
1913. Yeomans, Wm. W., c/o Standard Chemical Iron and Lumber Co., St. Henri, Montreal, Canada, Chemist.
1906. Yerkes, Leonard A., c/o Jos. Bancroft and Sons Co., Wilmington, Del., U.S.A., Bleacher and Finisher.
1898. Yetton, Thos., 86, Bow Road, London, E., Consulting Distiller's Chemist.
1894. Yocum, Dr. Jno. H., 325, Academy Street, Newark, N.J., U.S.A., Chemist.
1886. Yoshida, Prof. H., Imperial University of Kyoto, Kyoto, Japan, Professor of Chemistry.
1900. Yoshitake, E., Nishihara Machi, Koishikawa, Tokyo, Japan, Chemist.
1885. Young, Alfred C., 17, Vicar's Hill, Lewisham, S.E.
1885. Young, Brougham, Patent Hygienic Bin Co., 4 and 8, Arthur Street, King William Street, London, E.C., Analytical Chemist.
1902. Young, Chas. C., c/o The Bayer Co., 117, Hudson Street, New York City, U.S.A., Colourist.
1890. Young, Qr. Geo., Bradda Church Crescent, Church End, Finchley, N., Chemist.
1913. Young, Hamish, 21, West Park, Clifton, Bristol, Chemist.
1917. Young, Harry A., 5, Cottage Place, White Plains, N.Y., U.S.A., Chemist.
1904. Young, James, 2, Montague Terrace, Kelvinside, Glasgow, Chemist.
- O.M. Young, Jno., 2, Montague Terrace, Kelvinside, Glasgow, Technical Chemist.
1886. Young, Jno., Claremont House, Beverley Road, Hull, Gas Engineer.
1909. Young, John, 610, Weber Avenue, Akron, Ohio, U.S.A., Analytical Chemist.
1904. Young, Jno H., c/o The Cassel Cyanide Co., Ltd., Shuna Street, Maryhill, Glasgow, Technical Chemist.
1898. Young, J. W., 22, Maxwell Drive, Glasgow, S., Inspector under Alkali Acts.
1883. Young, Prof. Sydney, F.R.S., University Chemical Laboratory, Trinity College, Dublin, Professor of Chemistry.
1917. Young, Thomas O., 14, Normanton Terrace, Newcastle-on-Tyne.
- O.M. Young, W. C., Laboratory, 24, Aldgate, London, E., Gas Examiner and Consulting Chemist.
1898. Young, W. Gathorne, Analyst's Dept., G.N.R., Doncaster, Yorks, Chief Chemist.
- Z
1899. Zabriskie, C. B., c/o Pacific Coast Borax Co., 100, William Street, New York City, U.S.A. Manager.
1897. Zacharias, Dr. P. D., Philhellinon Street 22, Athena, Greece, Industrial Chemist.
1912. Zanetti, Joaquin E., Columbia University, New York City, U.S.A., Chemist.
1906. Zaremba, Edw., 707, D. S. Morgan Building, Buffalo, N.Y., U.S.A., President (Zaremba Co.).
1906. Zlanowicz, Joseph, 24, St. James's Street, London, S.W., Chemical Engineer (Artificial Silk).
- O.M. Zimmermann, A., 3, Lloyd's Avenue, London, E.C., Chemical Agent.
1905. Zimmermann, Chas., 9 and 10, St. Mary-at-Hill, London, E.C., Chemical Merchant.
1897. Zinsser, Dr. Fred. G., Hastings-upon-Hudson, N.Y., U.S.A., Manufacturing Chemist.
1916. Zumbach, Dr. Jacques, 19, Radcliffe Road, West Bridgford, Notts, Research Chemist.
1912. Zwingenberger, Dr. Otto K., 142, State Street, Perth Amboy, N.J., U.S.A., Chemical Engineer.

List of Members on Active Service in whose cases the Application of By-law 12 has been waived.

1913. Acland, L. H. Dyke.
1903. Acton, J. Rowland.
1907. Adam, Capt. Wm. Anol.
1912. Akers, Noel Charles (Sub-Lieut.).
1913. Allmand, Dr. A. J.
1915. Ashworth, Fred.
1909. Baker, Robert Percival.
1901. Barber, Capt. René R.
1910. Bowater, John W.
1913. Bridge, Stanley W.
1910. Campbell, James Robertson.
1911. Cochrane, Capt. John Bray.
1914. Cousins, Francis, George.
1913. Deakin, Lieut. John Bertram.
1915. Dickinson, Frank Edwin.
1914. Dunn, Ralph John.
1913. Farrow, Lieut. Frederick Denny.
1914. Fell, Harry.
1896. Fox, A. Stanley.
1912. Frankenburg, Sydney.
1904. Gair, C. J. Dickenson.
1912. Gloag, Vivian Ford.

1898. Golding, Capt. Jno.
1905. Hall, A. A.
1904. Heaton, Capt. Noel.
1905. Higgins, Dr. Eric B.
1908. Hughes, William Earl.
1905. King, Frank Eustace.
1907. Kynaston, P.e. Wm. Chas. Robert.
1904. Lane, Chas. Cyril P.
1907. McConnan, Dr. James.
1908. Mason, Capt. Douglas H. Campbell.
1889. Mawdsley, W. H.
1912. Millar, Charles James.
1913. Mumford, Capt. Ernest Moore.
1912. Murdoch, Barclay B.
1914. Rodger, Lawton H.
1915. Shingler, Sydney Vernon.
1913. Slade, Dr. Roland Edgar.
1909. Spence, John.
1913. Stephenson, Guy.
1902. Stevens, Lieut. M. White.
1913. Tennant, Robert.



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